IMPROVING GAS PRODUCTION EFFICIENCY IN CARBONATE RESERVOIR BY USING ACID FRACTURING

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การพัฒนาประสิทธิภาพการผลิตก๊าซในแหล่งกักเก็บหินคาร์บอเนต โดยการใช้กรดและสร้างรอยแตก

นางสาววิมณฑา จันทร์บำรุง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
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Suranaree University of Technology has approved this thesis submitted in partial fulfillment of the requirements for a Master's Degree.

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วิมณฑา จันทร์บำรุง : การพัฒนาประสิทธิภาพการผลิตก๊าซในแหล่งกักเก็บหินคาร์บอเนต โดยการใช้กรดและสร้างรอยแตก (IMPROVING GAS PRODUCTION EFFICIENCY IN CARBONATE RESERVOIR BY USING ACID FRACTURING) อาจารย์ที่ปรึกษา : รองศาสตราจารย์ เกรียงไกร ไตรสาร, 190 หน้า.

จุดประสงค์ในการศึกษาครั้งนี้เพื่อศึกษาประสิทธิภาพการผลิตปิโตรเลียมจากการกระตุ้นหลุมเจาะด้วยกรด และสร้างรอยแตก ของแหล่งภาคตะวันออกเฉียงเหนือโดยใช้โปรแกรมคอมพิวเตอร์ที่พัฒนาขึ้นมาเอง เปรียบเทียบกับแบบจำลองคอมพิวเตอร์สำเร็จรูปเชิงพาณิชย์ โดยการหาศักยภาพ และเปรียบเทียบผลมีขั้นตอนการดำเนินการดังนี้ 1) ศึกษาการกระตุ้นหลุมผลิตด้วยการกัดด้วยกรด และการสร้างรอยแตก เพื่อที่จะเพิ่มคุณสมบัติความสามารถในการซึมผ่าน และเพิ่มประสิทธิภาพการไหลโดยใช้โปรแกรมที่ถูกสร้างขึ้น 2) ค่าคุณสมบัติความสามารถในการซึมผ่าน จากโปรแกรมที่ถูกพัฒนาจะถูกนำมาใช้ในแบบจำลองแหล่งกักเก็บโดยใช้โปรแกรม Eclipse เพื่อที่จะประเมินประสิทธิภาพการไหล

ค่าความสามารถในการซึมผ่านของแหล่งปิโตรเลียมเดิมมีค่า 0.5 มิลลิดาร์ซี มีอัตราการผลิตก๊าซสูงสุด 19.11 ล้านลูกบาศก์ฟุตต่อวัน หลังจากกัดด้วยกรด พบว่าค่าความสามารถในการซึมผ่านเพิ่มขึ้นเป็น 1.75มิลลิดาร์ซี และอัตราการผลิตสูงสุดเพิ่มขึ้นเป็น 20.77 ล้านลูกบาศก์ฟุตต่อวัน หลังจากการทำรอยแตกโดยใช้กรด ทำให้ค่าความสามารถในการซึมผ่านเพิ่มเป็น $38x10^6$ มิลลิดาร์ซี ทำให้อัตราการผลิตเพิ่มขึ้นเป็น 228 ล้านลูกบาศก์ฟุตต่อวัน ผลการวิเคราะห์เชิงเศรษฐศาสตร์ปิโตรเลียมพบว่า หลังจากการสร้างรอยแตกด้วยกรด จะสามารถคืนทุนได้ในปีการผลิตที่ 6 โดยมีอัตราการคืนทุนร้อยละ 34.49ผลการศึกษาเปรียบเทียบศักยภาพการผลิตก๊าซ จากโปรแกรมที่สร้างขึ้นเอง และ Eclipse พบว่า ผลที่ได้จากโปรแกรมที่พัฒนาขึ้น และEclipseใกล้เคียงกัน

สาขาวิชา เทคโนโลยีธรณี　　　　　　ลายมือชื่อนักศึกษา ____________________

ปีการศึกษา 2557　　　　　　　　　ลายมือชื่ออาจารย์ที่ปรึกษา______________

VIMONTHA JANBUMRUNG : IMPROVING GAS PRODUCITON EFFICIENCY IN CARBONATE RESERVOIR BY USING ACID FRACTURING. THESIS ADVISOR : ASSOC. PROF. KRIANGKRAI TRISARN., 190 PP.

ACID STIMULATION/ CARBONATE RESERVOIR/ RESERVOIR SIMULATION

The purpose of this study is to analyze production performance of well stimulation by acidizing and acid fracturing of northeastern field reservoir using developed computer program to compare with commercial reservoir simulator. The performance estimation and results preparation are as follows: 1) Studying acidizing and acid fracturing to increase the permeability and improve in flow performance using developed program. 2) The permeability results from the developed program will be used in reservoir simulation by Eclipse to evaluate flow performance.

The original permeability of reservoir is 0.5 md. with the maximum gas production rate of 19.11 MMSCF/D. After acidizing, the permeability increases to be 1.75 md. and maximum gas production increase to be 20.77 MMSCF/D. After acid fracturing, the permeability increases to be $38x10^6$ md. and maximum gas production rate increases to be 228 MMSCF/D. The economic analysis result shows that after acid fracturing has completely paid back in the 6^{th} year of production with internal rate of return at 34.49%. The results of gas production performance from developed program and Eclipse show the closed results.

School of Geotechnology . Student's Signature_________________

Academic Year 2014 Advisor's Signature_________________

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Vimontha Janbumrung

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SYMBOLS AND ABBREVIATIONS

ROMAN ABBREVIATIONS:

A	=	Fracture area
C	=	Acid concentration fraction
C/C_o	=	Fraction of injected acid concentration remaining
D	=	Reservoir depth
d	=	Pipe diameter
D_e	=	Effective equivalent coefficient
D_α	=	Effective mixing coefficient
E	=	Young's Modulus
f	=	Friction factor
J	=	Stimulation ratio
k, k_i	=	Original permeability
K, K_w	=	Fluid loss coefficient
K_f, k_f	=	Permeability in fracture zone
K_L, K_S, K_U, and $K_{\eta L}$	=	Dimensionless factor
L_f	=	Fracture length
N_{Ac}	=	Acid capacity number
N_{Pe}	=	Peclet number for fluid loss
N_{Re}	=	Reynold number

SYMBOLS AND ABBREVIATIONS (Continued)

P_r	=	Reservoir pressure
P_s	=	Surface treatment pressure
P_t	=	Tubing pressure
q_{ac}	=	Acid injection rate
q_{ipf}	=	Pad fluid injection rate
r_e	=	External or reservoir radius
r_s	=	Skin radius
r_w	=	Wellbore radius
r_{wh}	=	Wormhole radius
S	=	Skin factor
S_{re}	=	Rock strength
t	=	Time
T_{pf}	=	Pad fluid temperature
T_r	=	Reservoir temperature
$\bar{V}_{fl}$	=	Average fluid loss velocity
V_{fract}	=	Fracture volume
$(V_f)_t$	=	Minimum acid volume required
V_{sp}	=	Fluid loss spurt volume
V_t	=	Total volume required
W_a	=	Open channel width
W_{fw}	=	Fracture width

SYMBOLS AND ABBREVIATIONS (Continued)

Wf_{avg}	=	Average fracture width
W_{kf}	=	Expected fracture conductivity
xL	=	Acid penetration distance
Z_{avg}	=	Average gas deviation

GREEK ABBREVIATIONS:

ϕ	=	Porosity
η	=	Wormholing efficiency
μ_{ac}	=	Acid viscosity
μ_{avg}	=	Average gas viscosity
μ_{pf}	=	Pad fluid viscosity
μ_{ra}	=	Reacted acid viscosity
ρ_{ac}	=	Acid density
ε, e	=	Relative roughness
ΔP_f	=	Friction pressure loss
ΔP_s	=	Static pressure

CHAPTER II

LITERATURE REVIEW

A primary review of relevant subjects is summarized below.

2.1 Acid treatments in carbonate reservoirs

2.1.1 Al-Dahlan, Nasr-El-Din, and Saudi Aramco (2000) discuss a new technique that was used to evaluate matrix acid treatment conducted on a cased water disposal well in a carbonate reservoir. The technique relies on calculation amount of corrosion products and minerals dissolved by the acid. It was used to calculate the amount of iron dissolved by the acid and the live acid present in the flow back following the pickle treatment. Chloride ion concentration was used to determine the degree of mixing between the spent acid and formation brine. The degree of mixing was then used to calculate the volume of the produced spent acid and the amount of minerals (calcite and dolomite) that were dissolved by the acid. The chemical efficiency of the acid, defined as the actual amount of calcite dissolved by the acid the theoretical amount of calcite that should dissolve, was finally determined. Therefore, the objective of their study is to introduce a new method to evaluate acid reactions with various minerals present in carbonate reservoirs, reservoir fluids and corrosion products, if present. A similar procedure can be used to evaluate acid treatments performed in sandstone reservoirs.

Mixing and Reactions of Injected Acids.

When an acid is pumped into a formation, it will contact several metal surfaces including mixing tanks, coiled tubing or well tubing and casing. The acid will dissolve corrosion products during this process. A pickling treatment is commonly performed and strongly recommended to minimize the amount of iron present in the injected acid. The acid then enters the formation where it will mix with reservoir fluids and react with the reservoir rocks. The two processes, mixing and reaction, will consume most of the acid. At the end of the treatment, the spent acid is removed from the wellbore area either by flowing the well back, if the reservoir pressure is high, or by lifting the well using nitrogen gas and coiled tubing, if the reservoir pressure is low.

2.2 Arcasolve stimulation of natural fracture networks in Austin Chalk

Arcasolve stimulation of natural fracture networks in Austin Chalk in Austin written by Harris and McKay (2002). They report that a 100 ft vertical interval is treated as follows: 1300 bbls slick water pre-flush, 300 bbls Arcasolve formation 2, 175 bbls slick water post –flush, and all stages are pumped at approximately 10 bbls/min. The well is shut in for 72 hours and back production of injected fluids initiated via swabbing until produced water is restively free from particulates. The down-hole pump is re-installed on day 5 (post treatment) and oil production, water production, gas production and calcium levels in the produced water are monitored over the following 50 days.

Arcasolve is a catalyst based technology for the in-situ production of acid within oil/gas well-bores and reservoirs. The technology has been proven in the field for deep matrix acidizing of oil producer and water injector wells and Cleansorb is developing the use of Arcasolve for a rage of other acidizing application with US and European based operators.

Preparation and injection of Arcasolve fluid is carried out according to plan with no operational problems. Field tests result of pre- Arcasolve production are 17 mcfd gas, 10 bpd oil, and 16 bpd water. Results of the production are 38 mcfd gas, 27 bpd oil, and 57 bpd water. Results of production at day 50 are 17 mcfd gas, 10 bpd oil, and 16 bpd water. By day 50 all the 1880 bbls of injected treatment fluid had been recovered from the well. Following the trial the well is taken off production prior to capping as originally.

2.3 Carbonate acidizing: A physical simulation of well treatments.

Bazin and Longeron (2009) discuss that, the acid injection is the recommended treatment for productivity enhancement in carbonate reservoirs. Acid stimulation is a difficult challenge due to the instability of the dissolution figure, named wormhole, which depends strongly from the nature of the carbonate (heterogeneity). The objective of the study described here after is to compare various stimulation strategies to improve current treatment procedures.

In matrix acidizing of horizontal wells, the propagation of wormholes as deeply as possible into the formation with the maximum coverage along the wellbore is a major concern. Diverting agents based on polymer crosslinking at high pH are currently used for matrix acidizing (Figure 2.1). The crosslinking occurs as the acid is consumed. Wormholes formed in the high permeability zone are temporarily sealed and the subsequent acid slug enters the low permeability zone. The treatment is efficient, provided that the diversion procedure is adequately designed.

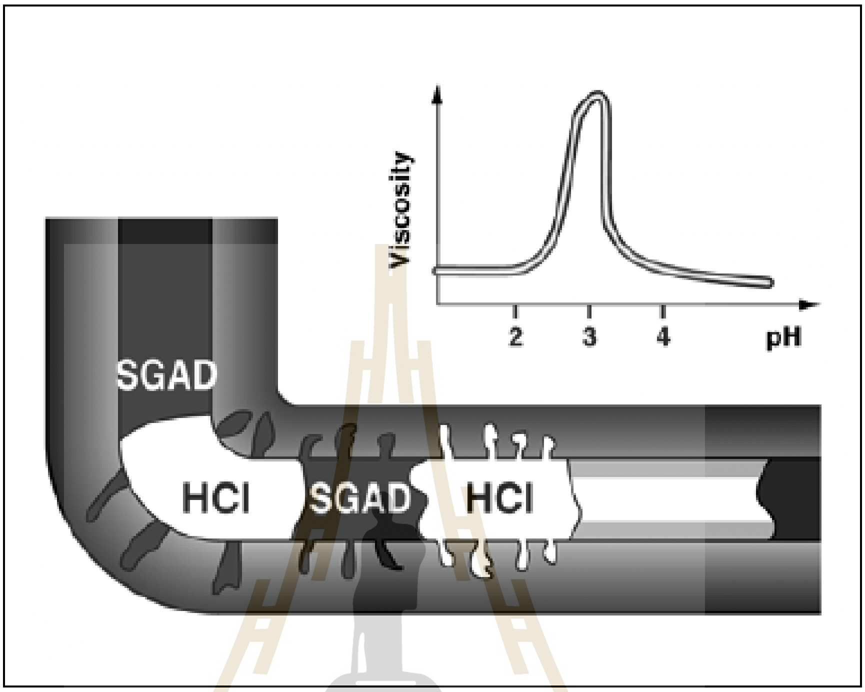

Figure 2.1 Schematic representation of the diversion with the Self Gelling Acid Diverter

For acid fracturing treatments, the productivity benefit is directly related to the fracture length and conductivity (Figure 2.2). Maximizing the fracture length cannot be achieved without controlling the acid filtration rate from the fracture walls (fluid loss). Since most of the filtration occurs from the wormholes rather than uniformly, it is important to limit the wormhole formation. Finally, the last criterion for the selection of a fracturing fluid is related to the etching of the fracture walls: an irregular etching pattern favors good fracture conductivity.

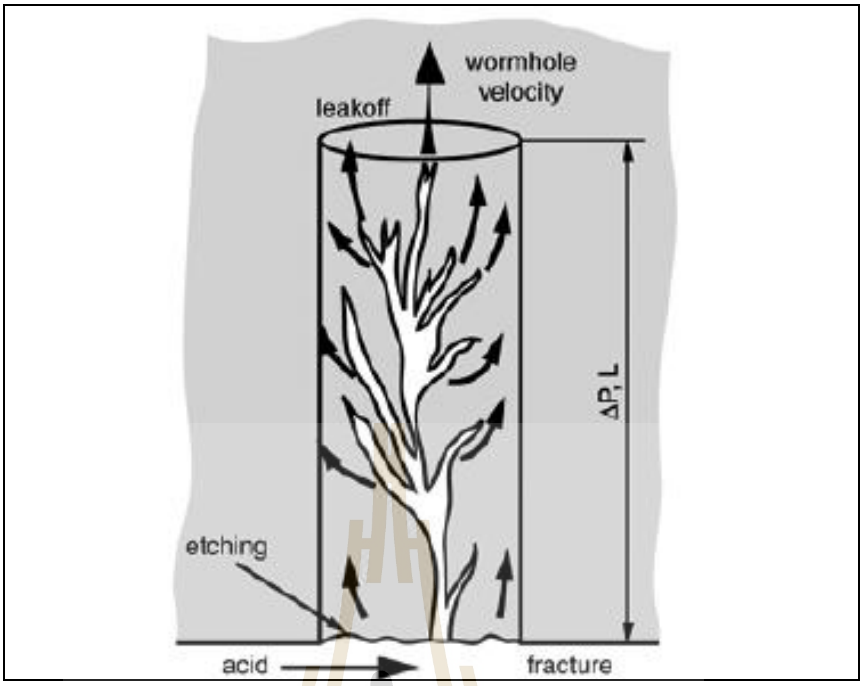

Figure 2.2 Acid Fracturing Application.

The experimental methodology described in this paper helps to choose the best strategy in terms of fluid composition, either for matrix acidizing of horizontal wells or for acid fracturing. In the first part, we present the laboratory equipment used to mimic the dynamic process occurring during acid placement and acid fracturing. The discussion of the results gives elements for the implementation of the best strategy for acid treatments in carbonate reservoirs.

Experimental design for the simulation of well stimulation.

The main originality of the equipment is that it simulates flow from an open-hole or a fracture wall. One or two tangential cells are used for acid fracturing or acid diversion respectively (Figure 2.3). The fluid is injected continuously in the tangential loop at a high flow rate and enters the core through a ΔP. The volume of fluid recovered at the outlet of the core is measured and the filtration rate is calculated. The acid breakthrough time is recorded and the wormhole propagation rate is calculated. The main parameters are the pressure gradient, the nature of the fluid and the mineralogy of the core, and the temperature.

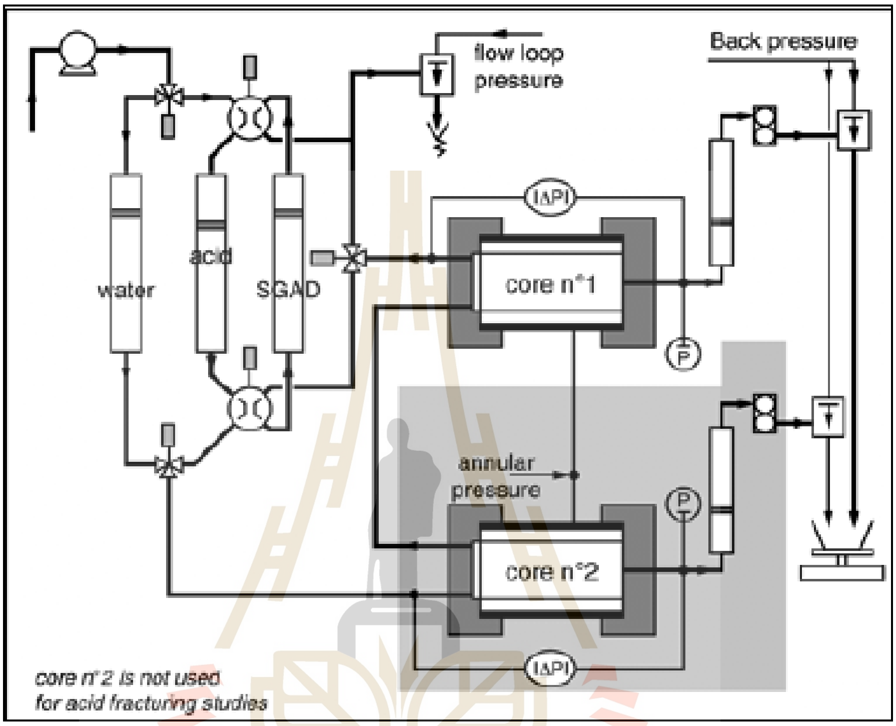

Figure 2.3 Experimental Set up.

Acid fracturing: behavior of gelled acids, acids in emulsion and straight acids.

Three fluids at an acid concentration of 15% are compared at 50°C in a 5 md limestone. The filtration rate ranges in the order plain acid > acid in emulsion > gelled acid (Figure 2.4). The last one has a very low filtration rate and is very powerful to limit fluid loss from the fracture. Acids range in the same order for the wormhole propagation rate. These data are readily explained when considering that the development of wormholes increases the surface area for fluid filtration.

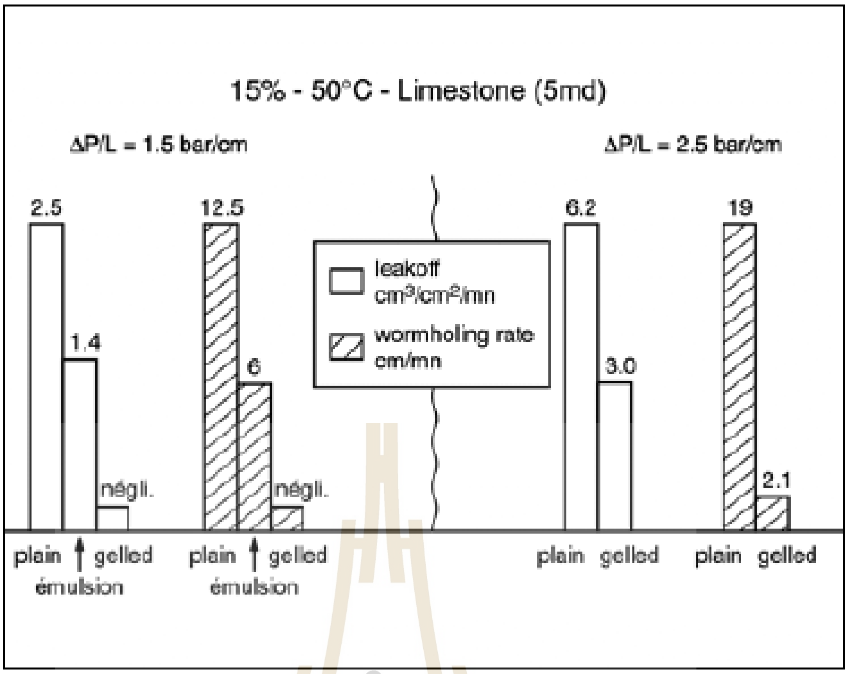

Figure 2.4 Properties of common acid fracturing fluids

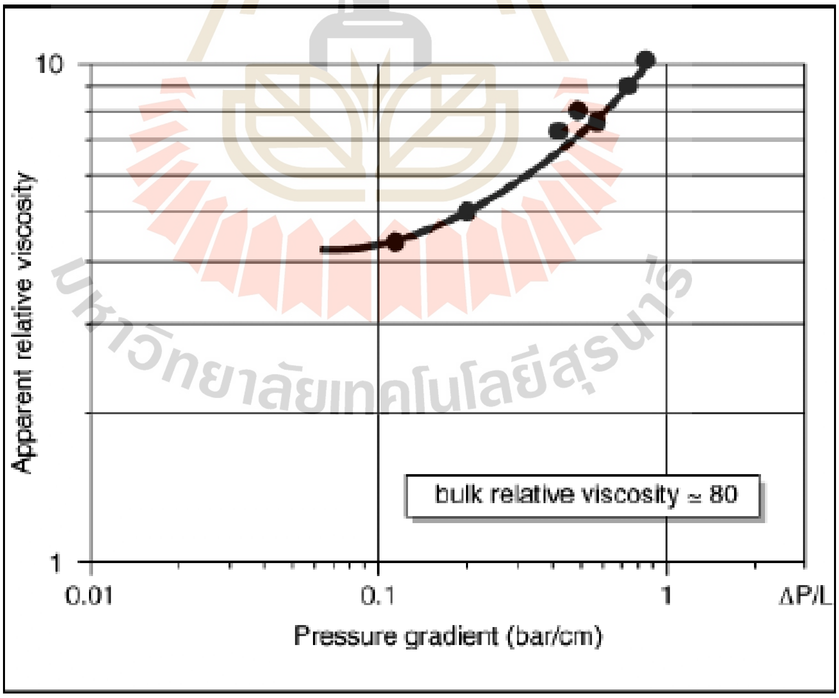

Figure 2.5 Apparent relative viscosity of the gelled acid in a carbonate porous media.

In order to appreciate the effect of viscosity, the filtration rate measured with the gelled acid is compared to the filtration rate of water in the same conditions. Indeed, this represents the apparent relative viscosity (ηr^a) of the gelled acid in porous media (Figure 2.5). When compared to the relative viscosity of the gelled acid, the value of ηr^a is very low and ranges from 4 to 10. This shows that there is a considerable loss of viscosity in the porous medium and that the filtration rate for viscous acids cannot be estimated from a simple Darcy evaluation, i.e. with the bulk value of the viscosity, but must be affected by a coefficient which can be deduced from experiments. Although such practice is well known in the modeling of acid fracturing, values of the fluid loss coefficient are rather seldom.

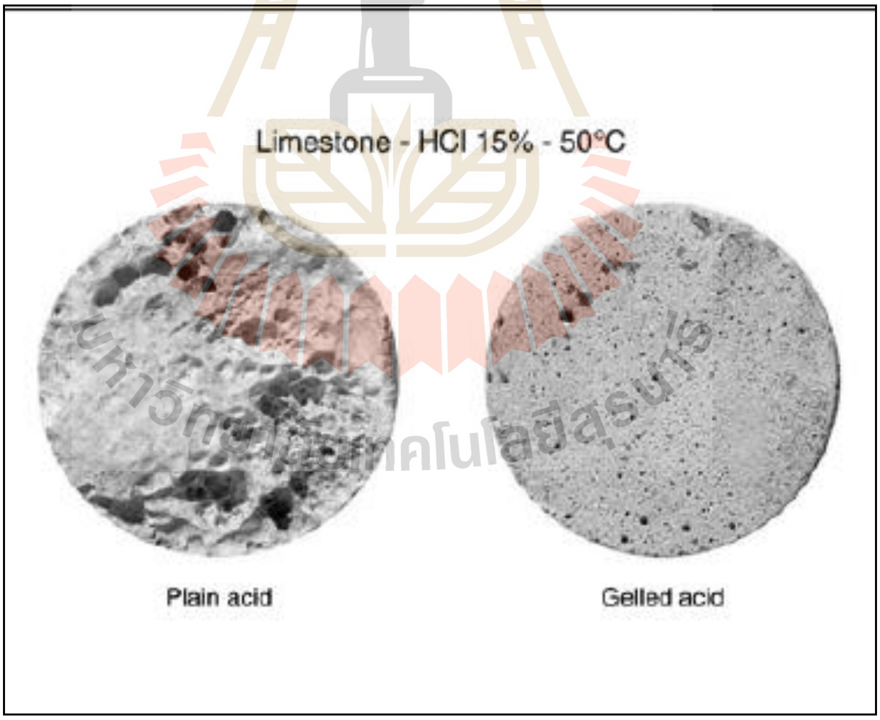

Figure 2.6 Comparison of the etching behavior.

Finally, etching on the core face must be appreciated for a complete evaluation of the efficiency of the acid fluid. The fracture faces must be etched in a non-uniform manner to create conductive flow channels that remain after closure of the fracture. Unfortunately, viscous acids are not suitable for an appropriate etching of the fracture wall (Figure 2.6). Core faces are very flat. In contrast, etching is maximum with plain acids with compact dissolution. Actually, various factors will affect the etching. Among them, the rock heterogeneity provides various dissolution rates and favors non-uniform dissolution. The temperature is another factor. Consequently, the use of the reservoir core material is highly recommended to make these evaluations.

In conclusion:

- The equipment and the methodology described here are useful for the comparison of various acid fracturing fluid,
- Wormhole formation, fluid loss and etching are evaluated,
- Moreover, an estimation of the fluid loss coefficient is readily available by comparing the filtration rate of the viscous acid fluid to the filtration rate of non viscous water in the same conditions,
- The use of the reservoir core material is highly recommended to make these evaluations.

Matrix acidizing: optimizing acid placement in horizontal wells.

The SGAD (Self gelling acid diverter) is currently used in open-hole horizontal wells. The questions encountered for the design of a treatment with this product are twice:

- First, what is the diversion efficiency in terms of flow distribution between the various zones?

- Second, what is the extent of the acid stimulation in the low permeability zone? The methodology presented below provides guidelines for the choice of the composition of the treatment.

Figure 2.7 gives results of dual core experiments where the diverter composition is varied. The best formulation is with a diverter fluid with 1% HCl. For example in the case where the permeability ratio is 11, the flow rate ratio during the diverter injection is strongly reduced to a value of 2. Although the flow rate ratio increases during the stimulation (acid 15%), the treatment is very efficient with the same acid penetration in each core. Note that if no diverter was injected, the stimulation length should be at least 11 times deeper for the high permeability core compared to the low permeability one. In such case, no stimulation of the low permeability would occur, most of the treatment by-passing the damage.

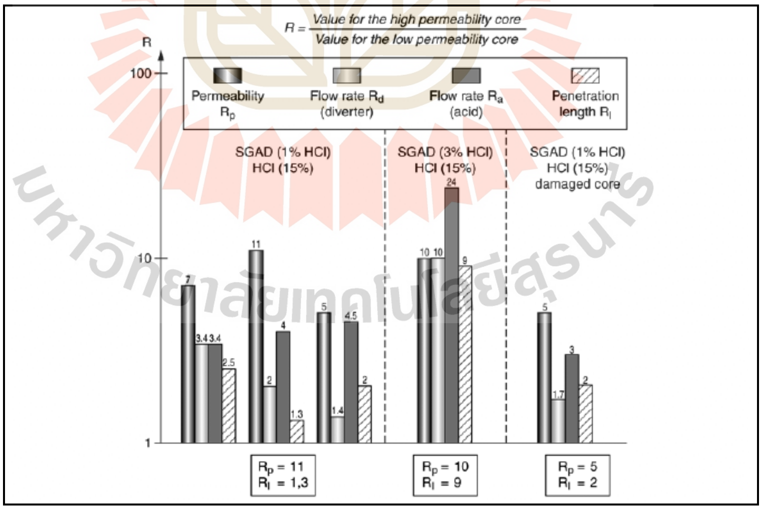

Figure 2.7 Diversion efficiency of the SGAD for matrix treatment in open-holes.

The effect of drilling mud damage is also investigated. The drilling fluid is a carbonate based fluid. It is injected following a current IFP procedure. There is no drastic difference in the diversion efficiency. Analysis by photo-observations of the cores after the treatments gives complementary information (Figure 2.8). First, the face of the damaged core after acidizing shows pitting, which means that some damaged material remains, even after the acid treatment. The treatment penetrates only by some preferential points, even if on the whole wormholing has occurred as shown on the X-ray photograph.

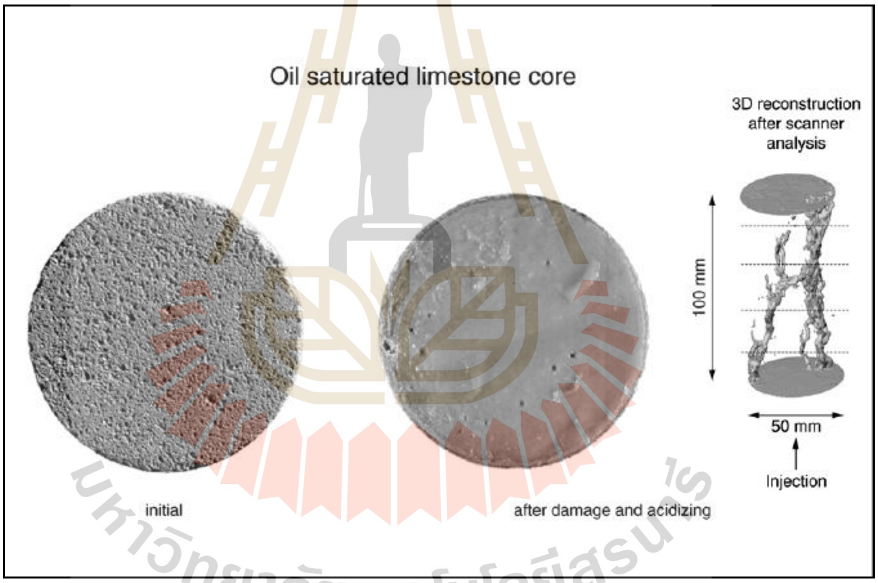

Figure 2.8 Treatment of an oil saturated carbonated core previously damaged with a drilling fluid.

In conclusion, the methodology described in this paper provides a laboratory evaluation of an acid placement technique with a Self Gelling Acid Diverter.

- The experiments consist in the injection at constant ΔP of alternate slugs of diverter and acid in two cores mounted in parallel.

- The fractional flow is recorded and the acid penetration is measured from X-ray photographs. It is shown that the injection of a low acid concentration in the diverter slug followed by an acid treatment with 15% HCl provides the stimulation of a low permeability core previously damaged with a drilling fluid.

2.4 Reservoir efficiency determination by using the tank model.

Reservoir efficiency determination by using the tank model is written by Trisarn (1987). The method uses the simulation model to determine the energy production and predict the production rate of wells at the interested area in the northeastern of Thailand. The well model has 2 km2 and 1 mile2 in drainage area. His model assumption is beginning with production rate equal to 22 MMSCF/D and 25 MMSCF/D. The results of simulation run are 63 BCF and 70 BCF of gas production with the constant rate along 8.4 years and 8.2 years. The rate will decline until 20th year of production. The flow rates are 2.8 and 5.1 MMSCF/D. Gas in places are 123 and 158 BCF and total gas productions are 105 and 128 BCF. Mathematics of each well is constructed based on actual data and relationship of equations by using the computer to calculate the production capacity of each well. The drainage areas are 640 acre and 2979 feet in radius. The characteristic of formation and gas quantity can be determined by using exploration and well test data. He uses the tank model to calculate the efficiency by using the model simulation in state of radial flow. Radial model of Trisarn K. was based on the geologic interpretations and the buildup analysis. Simulation method differs from his study in term of flow regime which is linear flow from cells to cells. The model is based on FASPU program that has different variation in verifying the efficiency and potential of the model and resulted the most likely gas in place of 255 BCF. This study starts with total gas production rate at 92 MMSCF/D of five wells. The reserve of simulation run is 225 BCF and gas in place is 250 BCF.

2.5 Improved oil recovery in carbonate reservoirs

The project of improved oil recovery in Mississippian carbonate reservoirs of Kansas is written by Bhattacharya *et al* of the University of Kansas center for research Inc. The project target improves the reservoir performance of mature oil fields located in shallow shelf carbonate reservoirs (Bhattacharya *et al*., 1999). The focus of this project is development and demonstration of 5 cost-effective reservoir description and management technologies to extend the economic life of mature reservoirs in Kansas and the mid-continent. The project introduced a number of potentially useful technologies, and demonstrated these technologies in actual oil field operations. Included in this report is a summary of significant project results at the demonstration site. The value of cost-effective techniques for reservoir characterization and simulation at Schaben Field were demonstrated to independent operators. At the Schaben demonstration site, the additional locations resulted in incremental production increases of 200 BOPD from a smaller number of wells. In Kansas, the majority of Mississippian production occurs at or near the top just below a regional unconformity. Production from Mississippian reservoirs accounts for approximately 43% of total annual production, and cumulative production exceeds 1 billion barrels. The objective of project was to characterize and simulate a typical oil field producing from a Mississippian reservoir by using tools that are modern and cost-effective for small independent producers operating mature fields. General application of PC-based simulators such as BOAST3 to large-scale or full-field simulation has been restricted by hardware and software limitations. Integrated reservoir characterization forms the foundation for the development of a descriptive reservoir model and provides the framework for simulation. The descriptive reservoir model integrated existing and newly acquired well. Simulation input parameters were generated from the reservoir model and used to simulate the reservoir performance of the Schaben field from discovery to 1996. The reservoir model is composed of dolomite, packstone and wackstone. Analysis of the reservoir performance and the distribution of the remaining mobile oil in place led to the identification of regions with potential for incremental oil recovery. The simulator was used to predict the performance of potential infill wells drilled in these areas. It is hoped that this study will provide a model for improving field management of similar reservoirs in Kansas and in the mid-continent. The major premise of this simulation study was to enter eleven years of historical data and have the simulator predict and match the next 23 years of known field production data. At the field level, a good match between simulated and observed was obtained for both oil and water production rates during the 34 years encompassed by the historical and predictive periods. The project of improved oil recovery in carbonate reservoir in Mississippian carbonate reservoirs of Kansas differs from this study. The project is simulated on oil reservoir but this 6 study is simulated on gas reservoir. The model of the project is composed of dolomite, packstone and wackstone but this study is composed of limestone and dolomite. The simulator was used in the project is BOAST3. The Work Bench is the software program being used as simulator in this study.

2.6 Reviews on the northeastern Thailand reservoir

2.6.1 General geology of northeastern Thailand

The northeastern region of Thailand is located between latitudes 14^{o} to 19^{o} North and longitudes 101^{o} to 106^{o} East, covering an area about one third of the country or about 200,000 square kilometers. The northern and eastern border is bounded by the Lao People’s Democratic Republic (Laos) and the Mekong river. The southern part is connected to the Democratic Kampuchea and the western part is bounded by central and northern of Thailand. The Khorat Plateau forms a part of the Indochina plate bounded by major Tertiary strike-slip faults. Although several tectonic models indicate that the Khorat Plateau is largely underformed. It contains two fold belts; the N-S trending Loei - hetchabunfoldbeltiintthe westerna area and NW-ESE trendingPPhu Phan range in the 8 central part which divided the central plain in the northern SakhonNakhon basin, and the southern Khorat basin (Department of Mineral Fuels, 2006).

The general geology of the area is consisted of Khorat Group which is mainly sedimentary sequence of Mesozoic Era. The Khorat Group comprises of siltstone, sandstone, claystone, and conglomerate. The total thickness of these sediments is up to 4,000 m. and ranging in age from Late Triassic to Cretateous Tertiary. It overlies the erosional surface of Upper Paleozoic rocks. The structure of the bedding is gently tilted to the central part of the Khorat and Sakon Nakhon Basins. The southern part of the Khorat Plateau is sporadically coverd by the Quaternary Basalt.

Based on the drilled well data, the Khorat Group has been restricted to the Late Triassic to Early Cretaceous sediments. The underlying Late Triassic

HuaiHinLat and Kuchinarai Group and the overlying Early Cretaceous-Middle Eocene Mahasarakham and PhuTokformatioms are excluded from the Khorat Group. In addition, an uppermost unit of the Late Tertiary called Tha Chang formation (Department of Mineral Fuels, 2006).

2.6.2 Carbonate reservoir characterization

Glumglomjit (2010) reviews about Carbonate reservoir characterization that, for the time being, Permian carbonates are the main gas producing reservoir rocks in the northeastern region. The best reservoir rocks of this group are limestones and dolomites, expecially dolomitized limestone, well-bedded dolomite, or the reefal origin. The rock units are coarsely crystalline and may have very high intercrystalline porosities. Various type of the limestone such as fusulinid, crinoid calcarenites, oolite limestones, and the limestone reef bodies. Besides the matrix and vugular porosity, fractures are very important parameter to enhance its reservoir quality (Sattayarak , 2005).

Prididtan (1995) described the characteristics and properties of the Permian

Carbonate reservoir are summarized as follows;

1) The carbonate was deposited on the platforms or related with the platforms. Lithofacies of the carbonates as observed in core are mainly of fossiliferous packstone and grainstone with minor wackestone and mudstone.

2) The porosity and permeability of these carbonates are generally low. The porosity values ranges from 0 to 18 percent with an average matrix porosity of about 4.0 percent.

3) The Permian carbonates were deposited and buried at the great depth. They were subjected to many phases of karstifications and severe erosion.

4) The carbonates which contain a high mud such as mudstone, and wackestone, have a higher porosity values than those bearing a high grain such as packstone, grainstone, and boundstone. The dolomites have higher porosity than the limestones.

5) The permeability of the carbonate in generally depends on the micro-fractures. The high flow rate of the Nam Phong gas field evidently related to existence of open micro-factures in limestone.

CHAPTER III

ACID STIMULATION PROGRAM

3.1 Theory

Well stimulation process is the method creating to increase productivity. It can increase production rate by enlarging old channels or creating new ones of sand or limestone formation. Acid stimulation may be divided into two main classes as matrix acidizing and fracturing acidizing. Matrix acidizing involves the acid injection into the formation. Acid fracturing involves the high hydraulic pressure injection and the acid is forced into the formation to cause a fracture.

3.2 Fundamental of acid stimulation

3.2.1 Matrix acidizing

Matrix acidizing is designed to remove formation damage, there are improving the permeability of the near-wellbore formation. Sandstone reservoir is normally treated with hydrofluoric acid and limestone reservoir is practiced with hydrochloric acid. The acid is pumped slowly through the matrix of the reservoir, taking care not to exert enough pressure to fracture the reservoir. The acid commonly used is 28 percent of hydrochloric by weight reacts with limestone or other carbonate according to the following equation (3.1) and flowchart of acidizing is shown in Figure 3.1

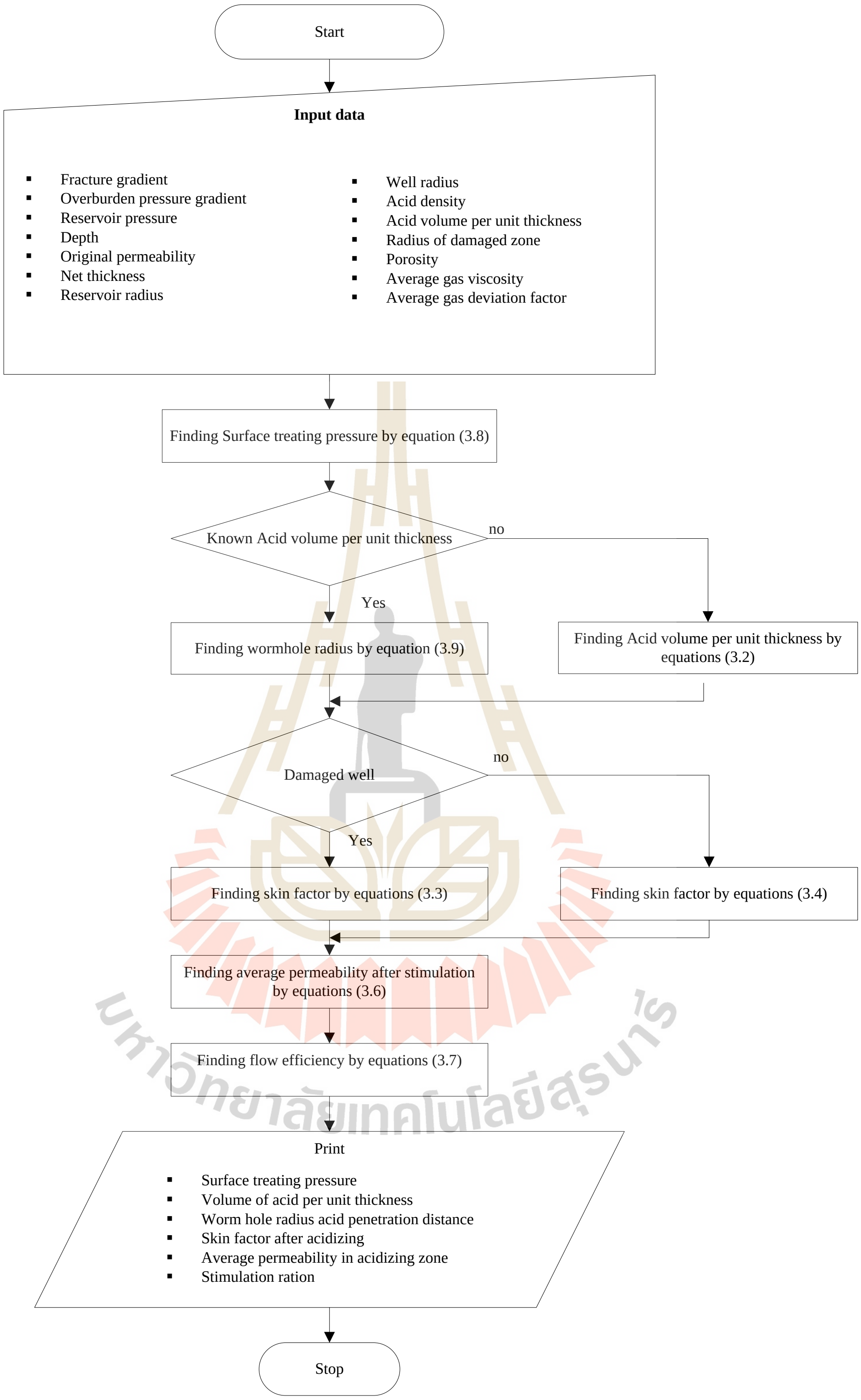

Figure 3.1 Flowchart of acidizing design

Equation of acidizing design

$$2HCL + CaCo_3 \rightarrow CaCl_2 + H_2O + CO_2 \qquad (3.1)$$

Acid volume per unit thickness

$$\frac{v}{h} = 7.48\pi\emptyset(r_{wh}^2 - r_w^2)PV_{bt} \qquad (3.2)$$

The skin effect predicted by Daccord's model is

- With a damaged zone

$$S_1 = -\frac{k}{2ks}\ln\left[\left(\frac{r_w}{r_s}\right)^2 + \left(\frac{N_{Ac}V}{\eta\pi r_s^2\emptyset h}\right)\right] - \ln\frac{r_s}{r_w} \qquad (3.3)$$

- With no damaged or the wormholes penetrating beyond the damaged region

$$S_2 = -\frac{1}{2}\ln\left[1 + \frac{v}{h}\frac{1}{\pi r_w^2\emptyset PV_{bt}}\right] \qquad (3.4)$$

Wormholing efficiency

$$\eta = N_{Ac}PV_{bt} \qquad (3.5)$$

Average permeability after stimulation

$$k_J = k\left[\left(\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4}\right) / \left(\ln\left(\frac{r_e}{r_w}\right) - \frac{3}{4}\right) + s\right] \qquad (3.6)$$

Flow efficiency

$$J = \frac{k_J h}{1422\bar{\mu}\bar{Z}T\left[\ln\left(\frac{r_e}{r_w}\right) - 0.75\right]} \qquad (3.7)$$

Surface treating pressure

$$Ps = 0.9[g_f - 0.052\rho_{ac}]D \qquad (3.8)$$

Wormhole radius

$$r_{wh} = \left[r_{wh}^2 - \frac{V}{h}\frac{1}{PV_{bt}\pi\emptyset}\right]^2 \qquad (3.9)$$

Acid capacity number

$$N_{ac} = \frac{0.016\emptyset\beta_{100}C\rho_{ac}}{(1-\emptyset)\rho_{rock}} \qquad (3.10)$$

3.2.2 Acid fracturing

Acid fracturing is used to stimulation production in limestone and dolomite reservoir. These rocks are composed largely of calcium carbonate ($CaCo_3$), which dissolves in hydrochloric acid (HCl).

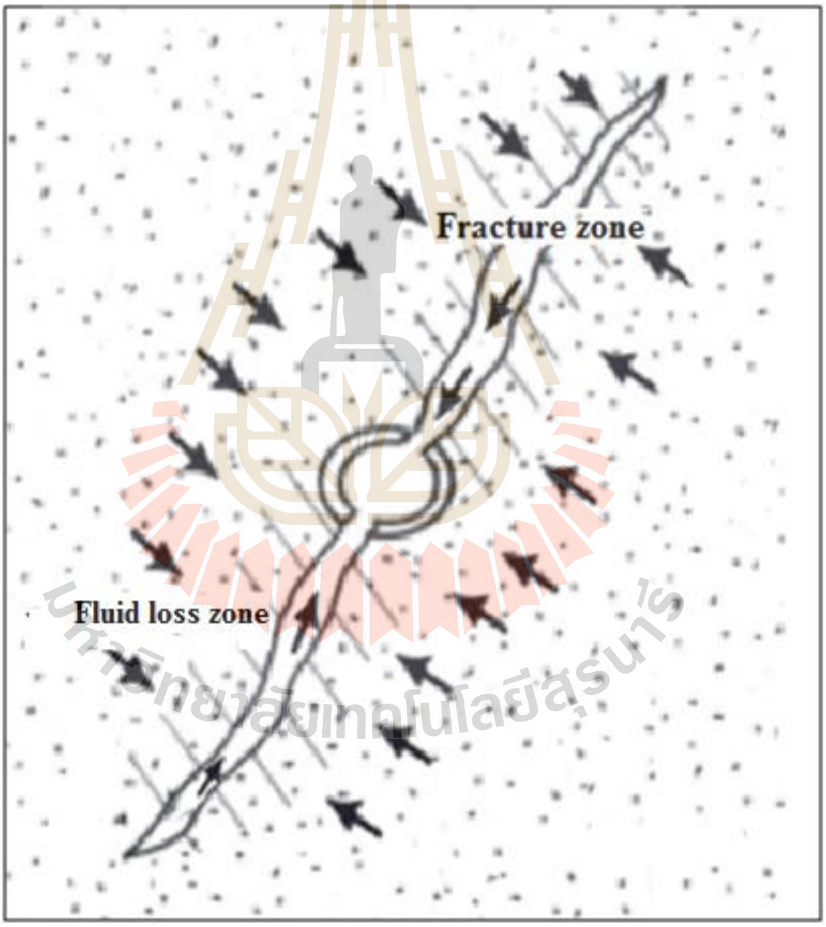

Figure 3.2 Flow pattern after acid fracturing (Modified after Conaway,1999)

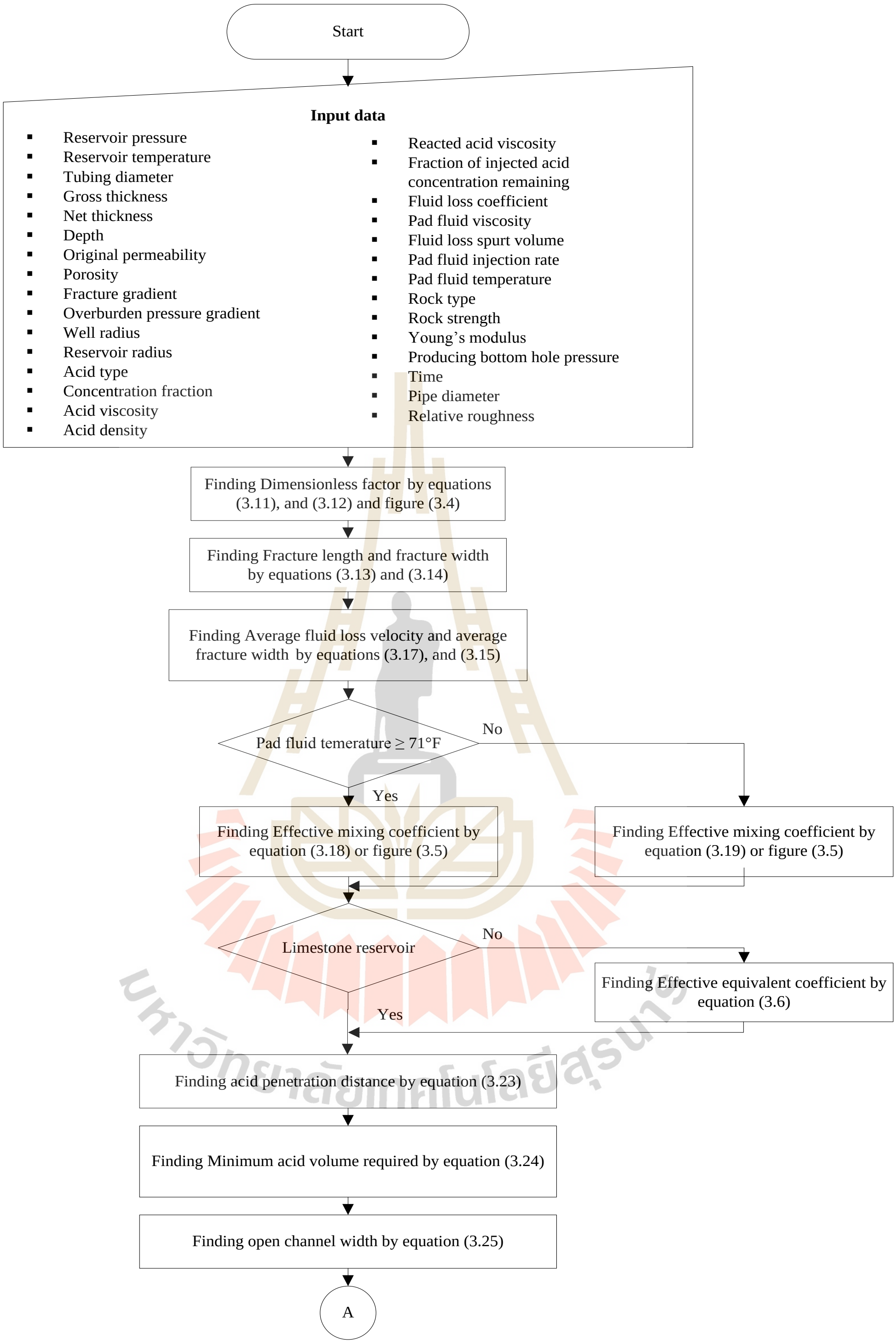

Figure 3.3 Flowchart of acid fracturing design

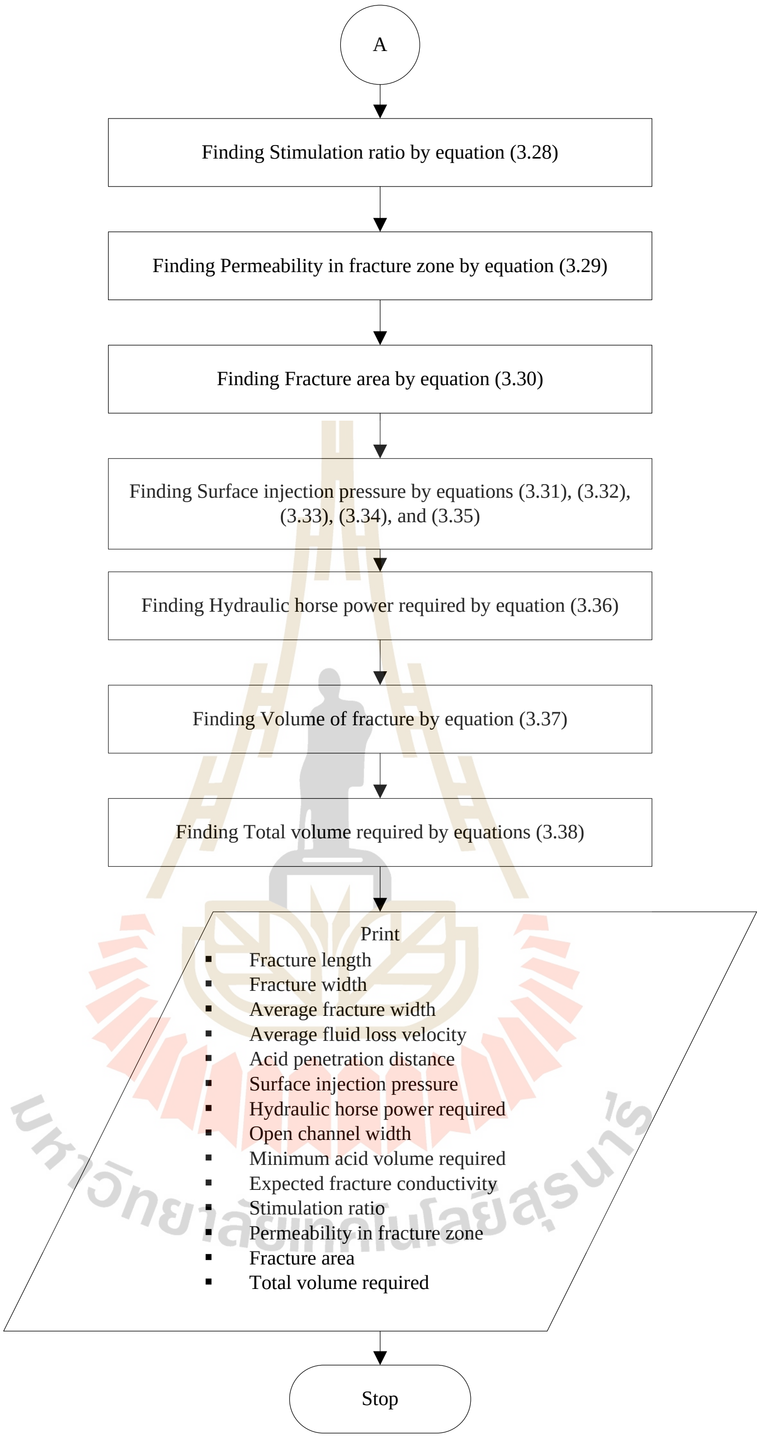

Figure 3.3 Flowchart of acid fracturing design (continued)

The treatment consists of injecting HCL at high hydraulic pressure into the formation to cause a fracture. The orientation of the fracture is roughly vertical (when the formation is > 3,000 feet depth), but may deviate from the vertical to follow pre-existing fractures. As the pressure of the pumped acid extends the fractures, it chemically etches an irregular surface on the sides of the fracture. When the pump is shutdown, the fracture close black up but does not completely heal. The material removed by etching leaves a high-volume flow channel to the wellbore. The fracture changes the flow pattern around the wellbore from the radial flow to many higher volume lateral-flow patterns (Figure 3.2)

The design of an acid fracturing treatment to stimulate production from carbonate formations involves the following flow chart in Figure 3.3 and six steps below:

1. Select an appropriate candidate and determine the current status of the well.

2. Determine formation rock and contained fluid properties such as formation thickness, permeability, porosity, fracture gradient, Poisson's ratio, formation temperature, fluid injection temperature, reservoir pressure, reservoir fluid viscosity, reservoir fluid compressibility, and reservoir fluid density.

3. Select variable parameters such as the type and viscosity of pad fluids, acid concentration and additives to be used, injection rate for the pad fluid and acid, and the required design volumes of the two fluids.

4. Predict the fracture geometry and the acid penetration distance for the fracturing fluid and acid selected.

5. Predict the fracture conductivity and the expected stimulation ratio for pad and acid volumes to be injected.

6. Repeat step 3 to 5, varying parameters until a most economic and optimum acid treatment design is achieved.

Equation of acid fracturing design

Dimensionless

$$K_s = \frac{7.48K\sqrt{t}}{V_{sp}} \tag{3.11}$$

$$K_{nL} = 9.26 \times 10^{-6} \frac{q_{ipf}^3 \mu_{pf}}{h_n^3 K^t E t} \tag{3.12}$$

K_u and K_L are shown in Figure 3.4 by crossing of K_s and K_{nL}

Fracture length

$$L_f = \frac{5.615K_L q_{ipf}^3 \sqrt{t}}{K h_n} \tag{3.13}$$

Fracture width (in)

$$W_{fw} = \frac{12K\sqrt{t}}{K_u} \tag{3.14}$$

Average fracture width

$$\bar{W}_{fw} = 0.7854W_{fw} \tag{3.15}$$

Reynold number

$$N_{Re} = \frac{140.375\rho_{ac} q_{iac}}{\mu_{ac} h_g} \tag{3.16}$$

Average fluid loss velocity

$$\bar{V}_{fl} = \frac{1.571K_w}{\sqrt{t}} \tag{3.17}$$

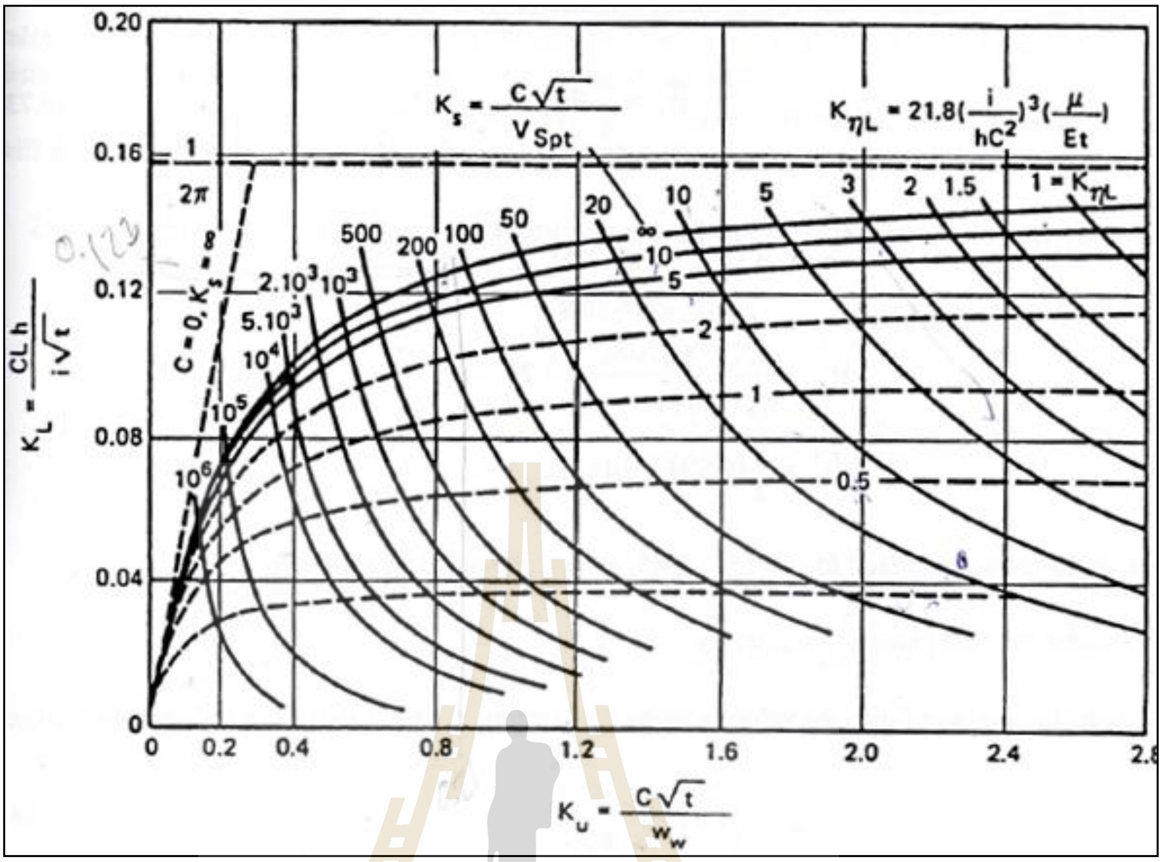

Figure 3.4 Fracture design for linear vertical fracture (Geertsma *et al.*, 1969).

Effective mixing coefficient

$$D_{\infty 1} = 6 \times 10^{-7} N_{Re}^2 + 0.01 N_{Re} + 15.439 \; : \; T_{pf} \geq 71°F \quad (3.18)$$

$$D_{\infty 2} = 5 \times 10^{-6} N_{Re}^2 - 0.014 N_{Re} + 11.447 \; : \; T_{pf} < 71°F \quad (3.19)$$

or following in Figure 3.5

Effective equivalent coefficient

$$D_e = D_{\infty 1,2} \times \frac{D_e}{D_\infty} \quad (3.20)$$

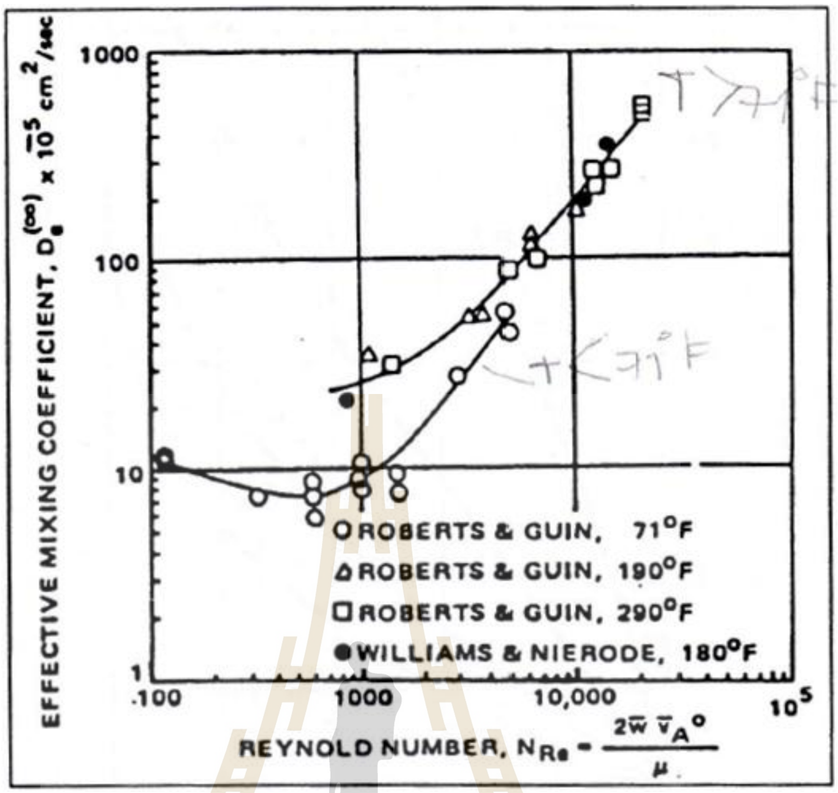

Figure 3.5 Effective mixing coefficient (Williams *et al.*, 1979).

$$\frac{D_e}{D_\infty} = 1 - exp\left(\frac{2445}{T_R} - 4.813\right) \qquad (3.21)$$

Peclet number of fluid loss

$$N_{pe} = \frac{\bar{W}_f \bar{V}_{fl}}{24\, D_\infty} \qquad (3.22)$$

Dimensionless acid penetration distance

The dimensionless acid penetration distance or L_{aD} is shown in Figure 3.6

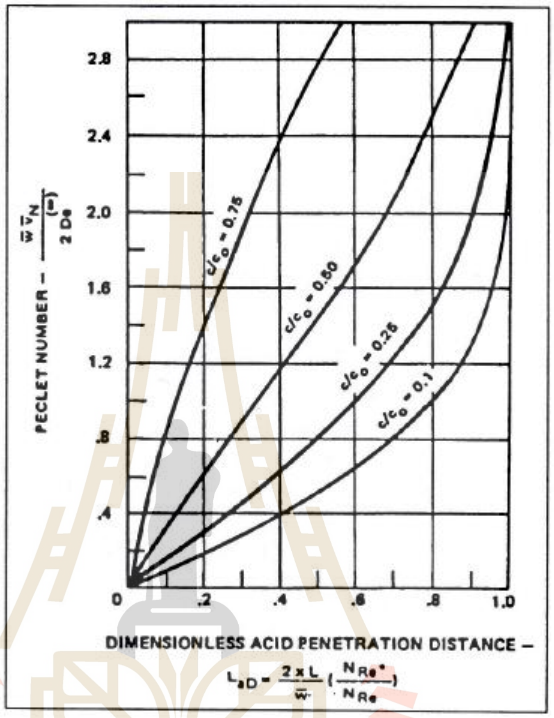

Figure 3.6 Acid penetration along a fracture (Williams *et al.*, 1979).

Acid penetration distance

$$xL = \frac{1.4 q_{iac} \mu_{rac} L_{aD}}{\mu_{ac} h_g \bar{V}_{fl}} \tag{3.23}$$

Table 3.1 Dissolving power of various acids (Williams *et al.*, 1979).

Formulation	**Acid**	β_{100}	**X**			
			5%	**10%**	**15%**	**30%**
Limestone	Hydrochloric (HCl)	1.37	0.026	0.053	0.082	0.175
$CaCO_3$	Formic (HCOOH)	1.09	0.020	0.041	0.062	0.129
$\rho = 2.71\ g/cm^3$	Acetic (CH_3COOH)	0.83	0.016	0.031	0.047	0.096
Dolomite	Hydrochloric (HCl)	1.27	0.023	0.046	0.071	0.152
$CaMg(CO_3)_2$	Formic (HCOOH)	1.00	0.018	0.036	0.054	0.112
$\rho = 2.87\ g/cm^3$	Acetic (CH_3COOH)	0.77	0.014	0.027	0.041	0.083

β is mass of rock dissolved/mass of acid reacted.

X is volume of rock dissolved/volume of acid reacted

The minimum acid volume required

$$\left(V_f\right)_t = n\left(XxLh_g\overline{W}_{fw}\right) \qquad (3.24)$$

Where;

n	=	1	when	$0.20 < C \leq 0.30$
n	=	2	when	$0.15 < C \leq 0.20$
n	=	3	when	$0.10 < C \leq 0.15$
n	=	4	when	$0.05 < C \leq 0.10$
n	=	5	when	$C \leq 0.05$

Open channel width

$$W_a = \frac{6X\left(V_f\right)_t}{xLh_g(1-\phi)} \qquad (3.25)$$

Expected fracture conductivity

Where;

$0 < S_{RE} < 20{,}000$ psi

$$W_{kfl} = 8.084 \times 10^{10} W_a^{0.822}$$

$$x\ exp\left[0.001\left(-19.9 + 1.31 \ln S_{RE}\right)\left(g_f D - P_{bth}\right)\right] \qquad (3.26)$$

$20{,}000 < S_{RE} \leq 50{,}000$ psi

$$W_{kf2} = 8.084 \times 10^{10} W_a^{0.822}$$

$$x\ exp\left[0.001\left(-3.8 + 0.28 \ln S_{RE}\right)\left(g_f D - P_{bth}\right)\right] \qquad (3.27)$$

Stimulation ratio

$$J_s/J_0 = \frac{\ln\left(\frac{r_e}{r_w}\right)}{\ln\left[\frac{37.7xL + \left(W_{kf} h_g / kh_n\right)}{W_{kf} h_g / kh_n}\right] + \ln\left(\frac{r_e}{r_w}\right)} \qquad (3.28)$$

Permeability in fracture zone

$$K_f = 5.347 \times 10^{10} \overline{W}_{fw}^2 \tag{3.29}$$

Fracture area

$$A_f = 2L_f h_g \tag{3.30}$$

Tubing pressure

$$P_t = G_f Depth \tag{3.31}$$

$$N_{Re} = \frac{119115 \rho_{ac} q_{iac}}{\mu_{ac} d^2}$$

Friction factor

$$f = \frac{1}{\left(-4\log\left[\left(\frac{\varepsilon}{3.7065}\right) - \left(\frac{5.0452}{N_{Re}}\right)\log\left[\frac{\varepsilon^{1.1098}}{2.8257} + \frac{5.85}{N_{Re}^{0.8181}}\right]\right]\right)^2} \tag{3.32}$$

Friction pressure loss

$$\Delta P_f = \frac{1.5247 f D \rho q^2}{d^5} \tag{3.33}$$

Static pressure

$$\Delta P_s = \frac{\rho_{ac} D}{144} \tag{3.34}$$

Surface injection pressure

$$P_s = P_t + \Delta P_f - \Delta P_s \tag{3.35}$$

Hydraulic horse power required

$$H_h = 0.0245 P_s q_{ac} \tag{3.36}$$

Volume of fracture

$$V_{frac} = 2\overline{w}_f h_g L_f \tag{3.37}$$

Total volume required

$$V_t = V_{frac} + (V_f)_t \tag{3.38}$$

3.3 Data preparation of acid stimulation design

The general required data are as following:

1) Reservoir data

-	Formation thickness	650	ft
-	Reservoir pressure	6,500	Psia
-	Reservoir temperature	200	°F
-	Depth	8,500	ft
-	Original permeability	0.5	md
-	Fracture gradient	0.7	md
-	Well radius	0.5	ft
-	Reservoir radius	660	ft

2) Acidizing design data

-	Acid type	Hydrochloric acid	
-	Spurt loss	2	cm^3
-	Acid concentration	28%	
-	Acid density	71.1	lbm/ft^3
-	Acid viscosity	1.2	cp
-	Spending time	200	min
-	Permeability in damaged zone	0.15	md
-	Acidizing or skin radius	50	ft

3) Acid fracturing design data

- Acid type	Hydrochloric acid	
- Acid concentration	15%	
- Reacted acid viscosity @ Tr	1.7	cp
- Acid injection rate	12.34	bbl/min
- Acid density	71.1	lb/ft^3
- Acid viscosity	1.2	cp
- Fraction of the injected acid concentration remaining	0.1	
- Fluid loss coefficient	0.002	$feet/\sqrt{min}$
- Pad fluid viscosity	60	cp
- Fluid loss spurt volume	0.007	gal/ft^2
- Pad fluid injection rate	12.34	bbl/min
- Pad fluid temperature	>71	°F
- Spending time	60	min
- Rock strength	50,000	psia
- Young's modulus	6,450,000	psia

4) Tubing data

- Tubing diameter	4	in
- Relative pipe roughness	0.005	

3.4 Results of acid stimulation design

1) Acidizing results

-	Average permeability	1.76	md
-	Flow efficiency	35%	
-	Acid volume per unit thickness yield	5876	gal/ft^3
-	Skin factor	-4.605	

2) Acid fracturing results

-	Fracture length	151	ft
-	Fracture width	0.09	in
-	Average fracture width	0.07	in
-	Average fluid loss velocity	0.00039	ft/min
-	Acid penetration distance	12	ft
-	Surface injection pressure	1,950	psia
-	Hydraulic horse power required	589.4	hp
-	Open channel width	0.0191	ft
-	Minimum acid volume required	273	ft^3
-	Expected fracture conductivity	330	md-in
-	Stimulation ratio	1.69	
-	Permeability in fracture zone	37.73x10^9	md
-	Fracture area	196,283	ft^2
-	Total volume required	14,012.82	ft^3

3.5 Tank model

3.5.1 Theory

The concept and techniques of flow equation in porous media and circular pipe are applied for creating Tank Model. The Tank Model is used for analyzing the behavior of petroleum reservoir system. It is developed in Visual Basic program, which runs on Window. Tank model reservoir in three dimensions is shown in Figure 3.7. Flowchart of Tank model is shown in Figure 3.8 and 3.9.

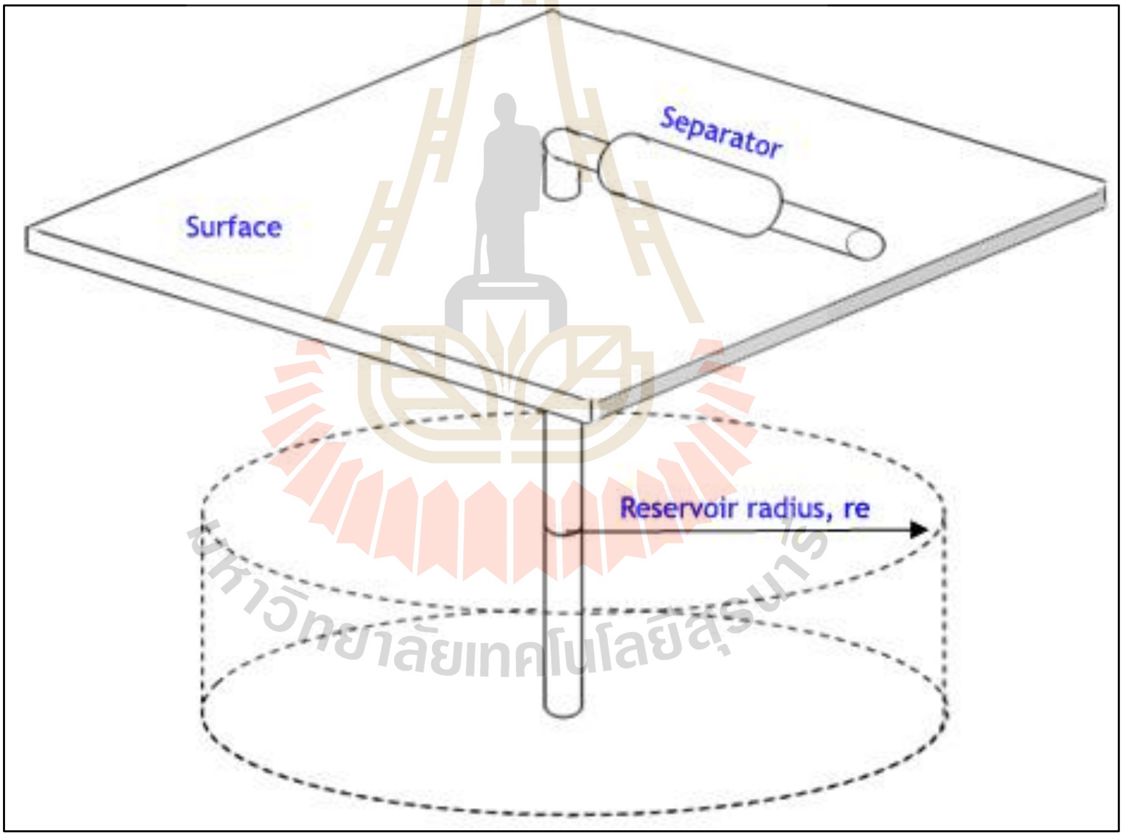

Figure 3.7 Tank model in three dimension of gas field reservoir model

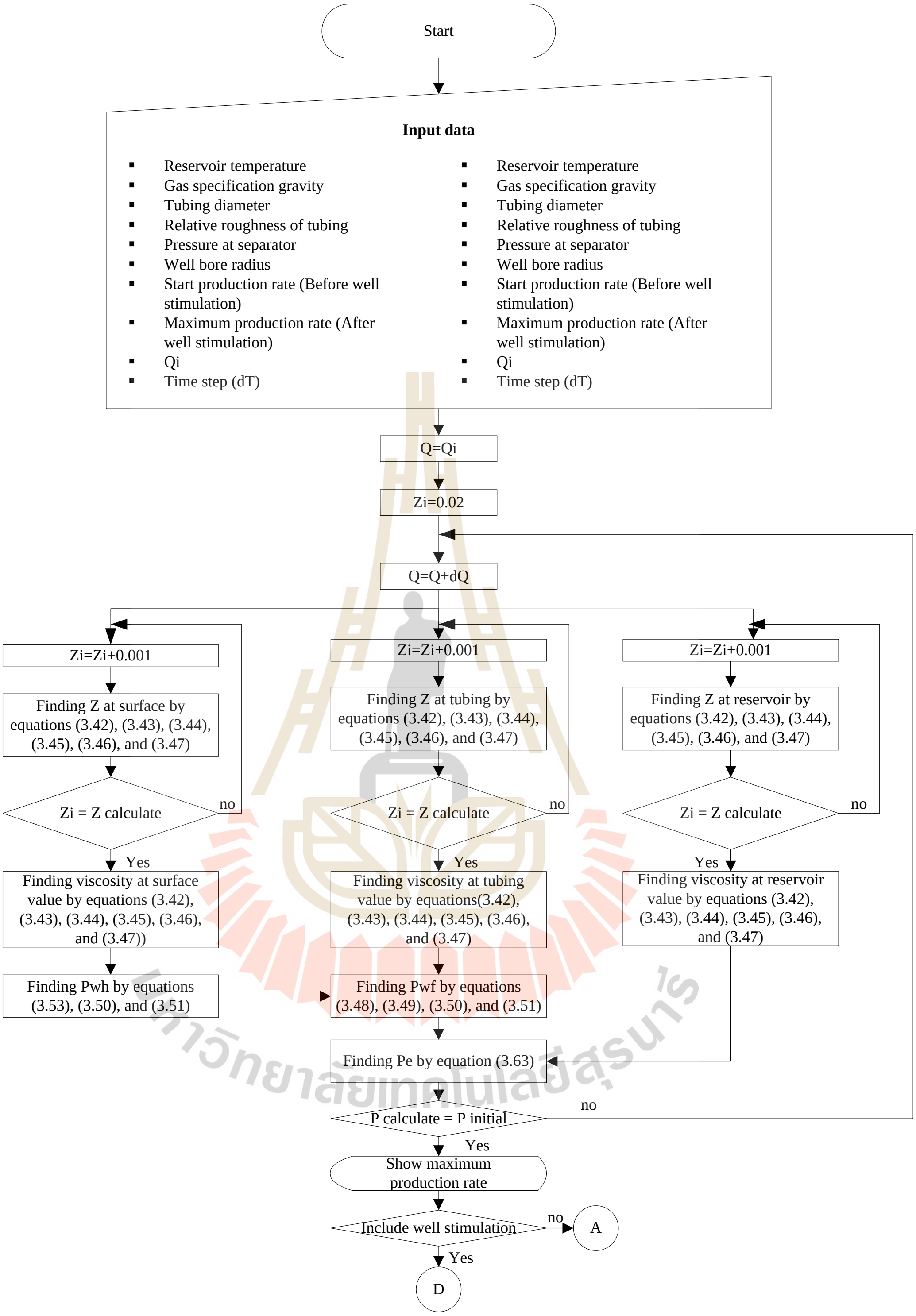

Figure 3.8 Flowchart of Tank model.

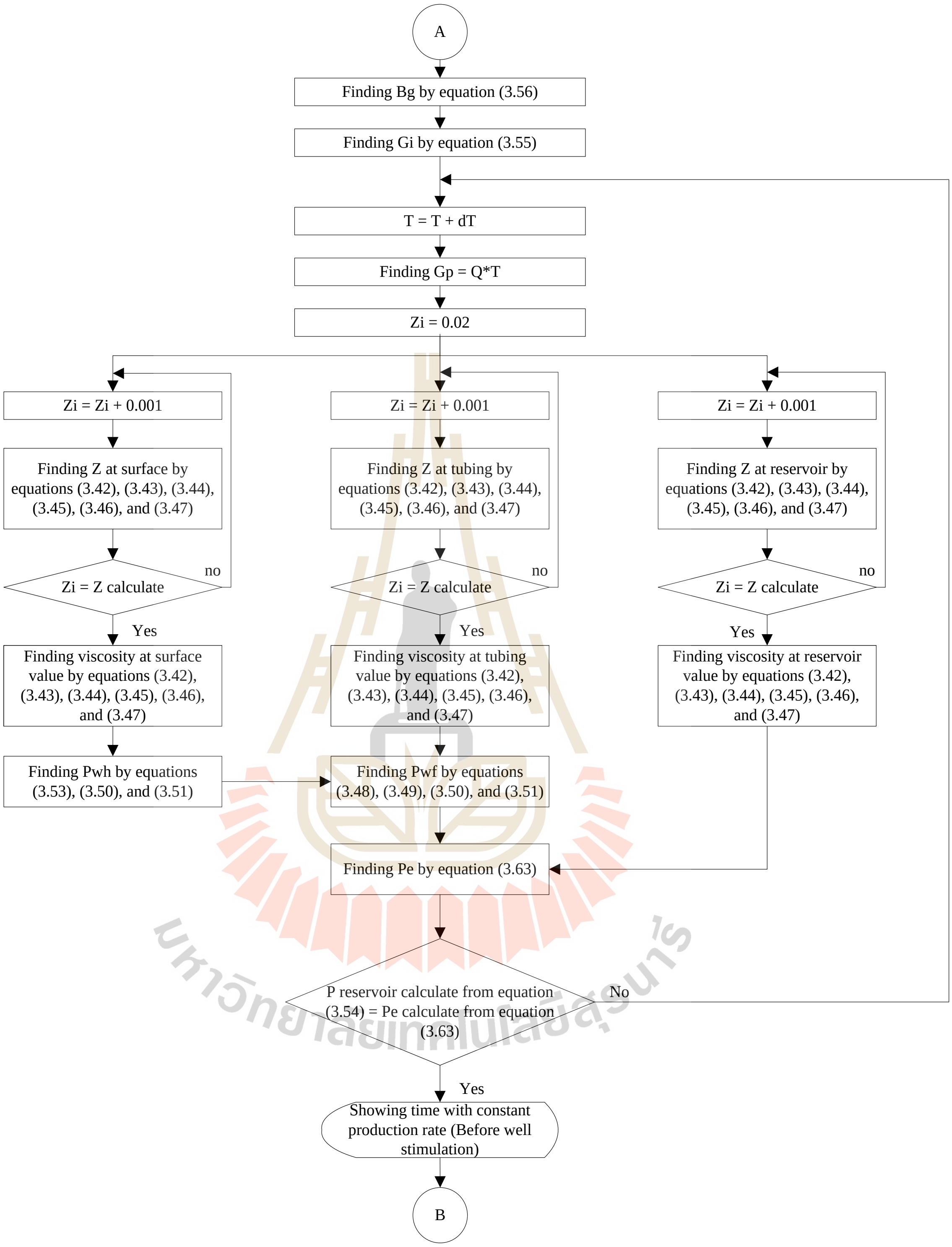

Figure 3.8 Flow chart of Tank model (continued)

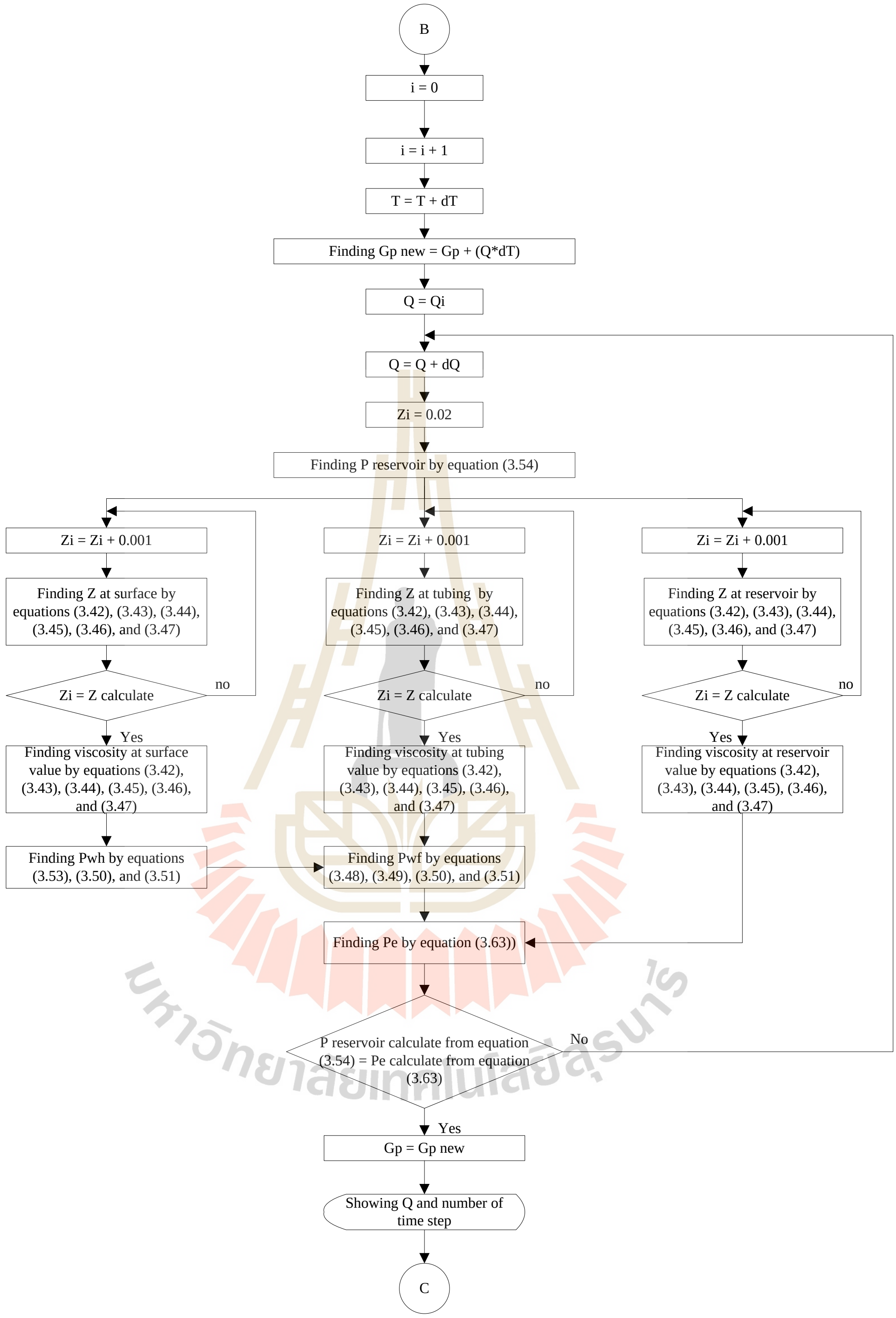

Figure 3.8 Flowchart of Tank model (continued)

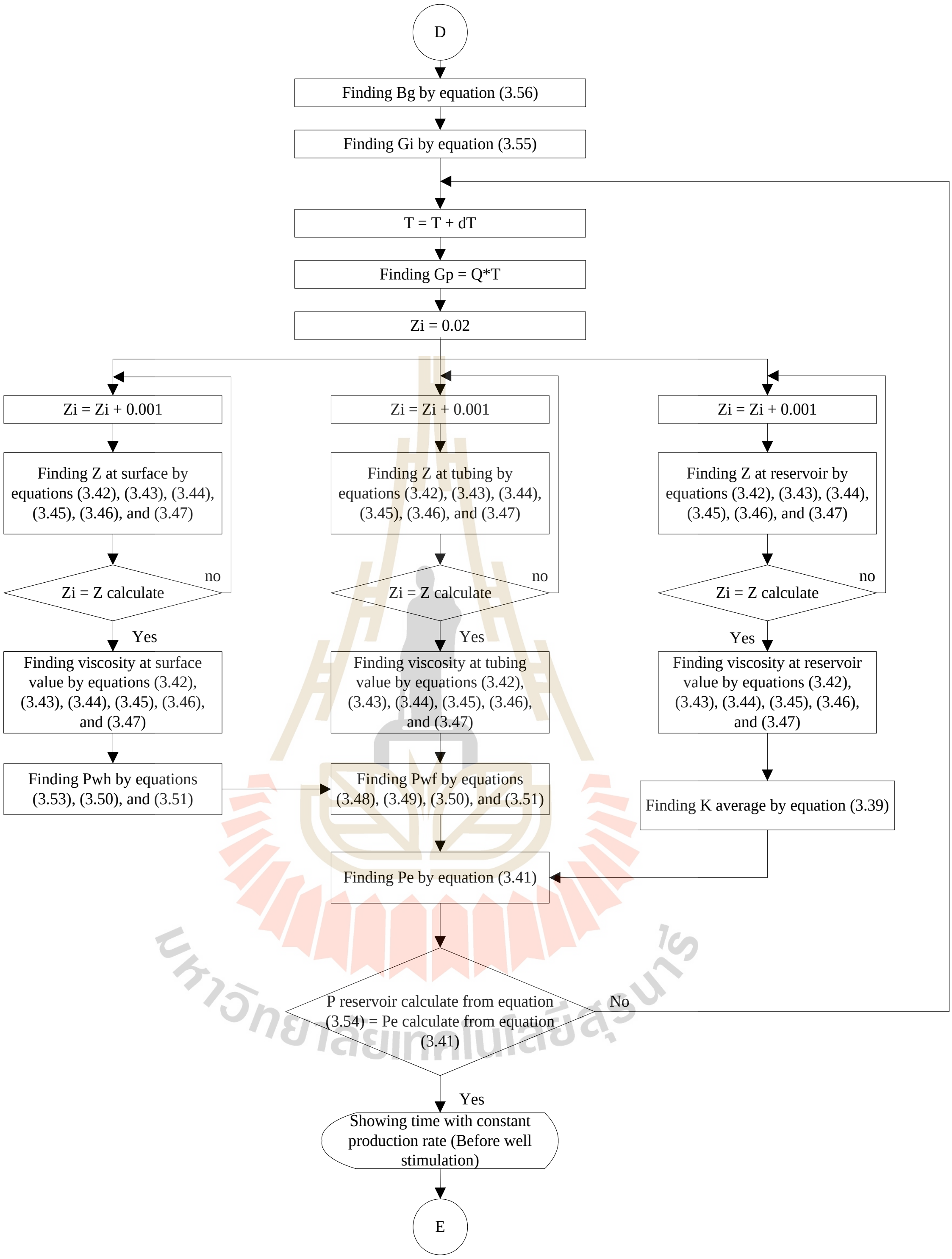

Figure 3.8 Flowchart of Tank model (continued)

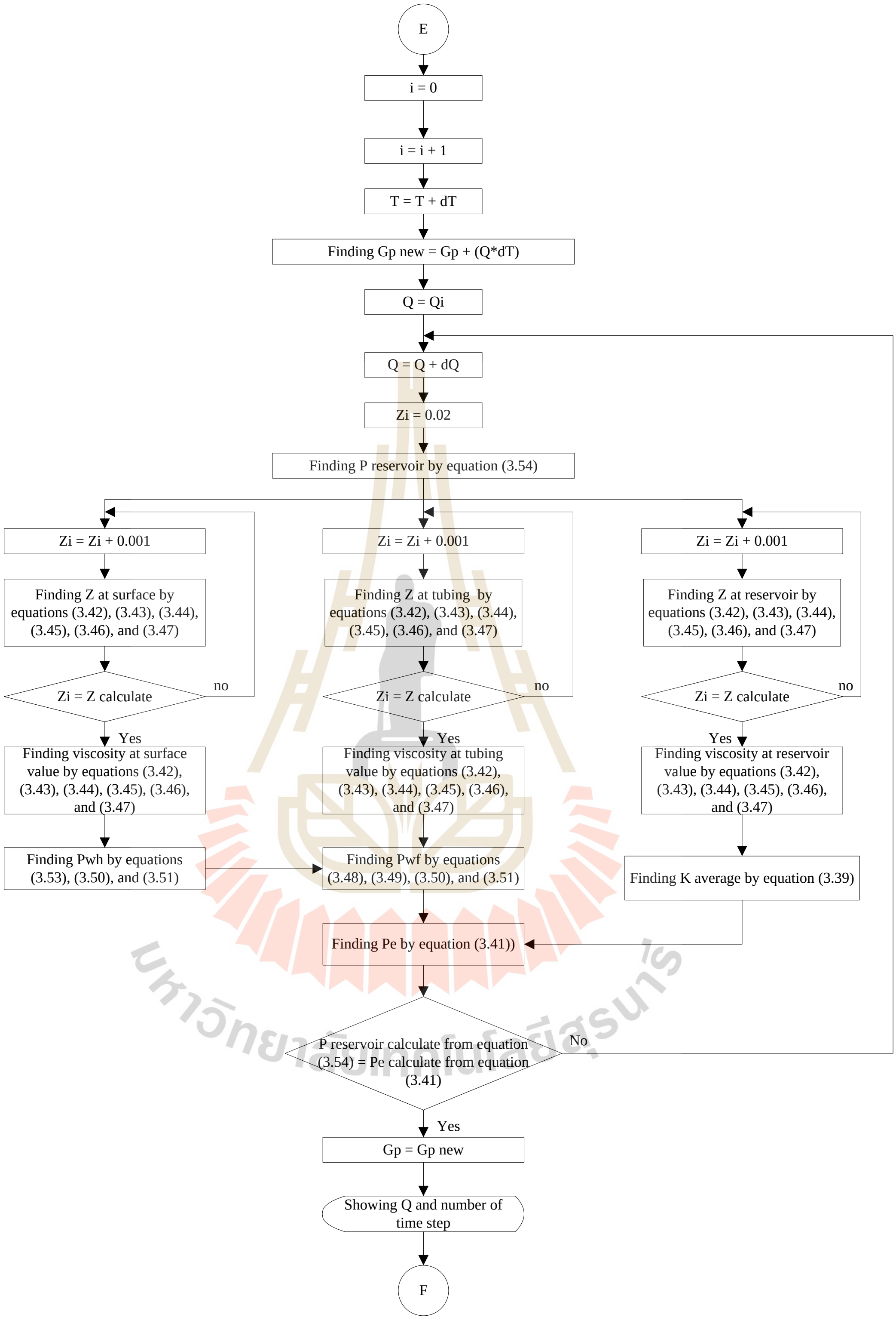

Figure 3.8 Flowchart of Tank model (continued)

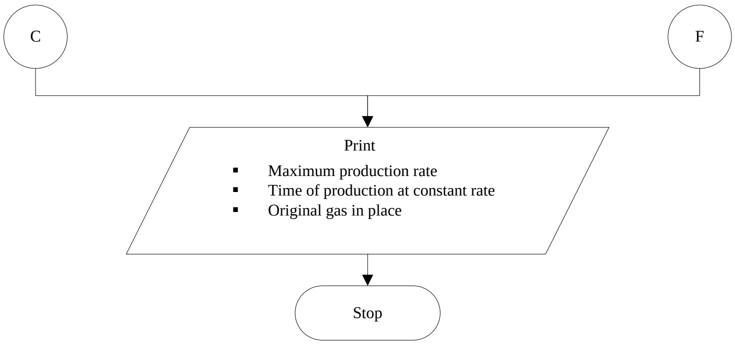

Figure 3.8 Flowchart of Tank model (continued)

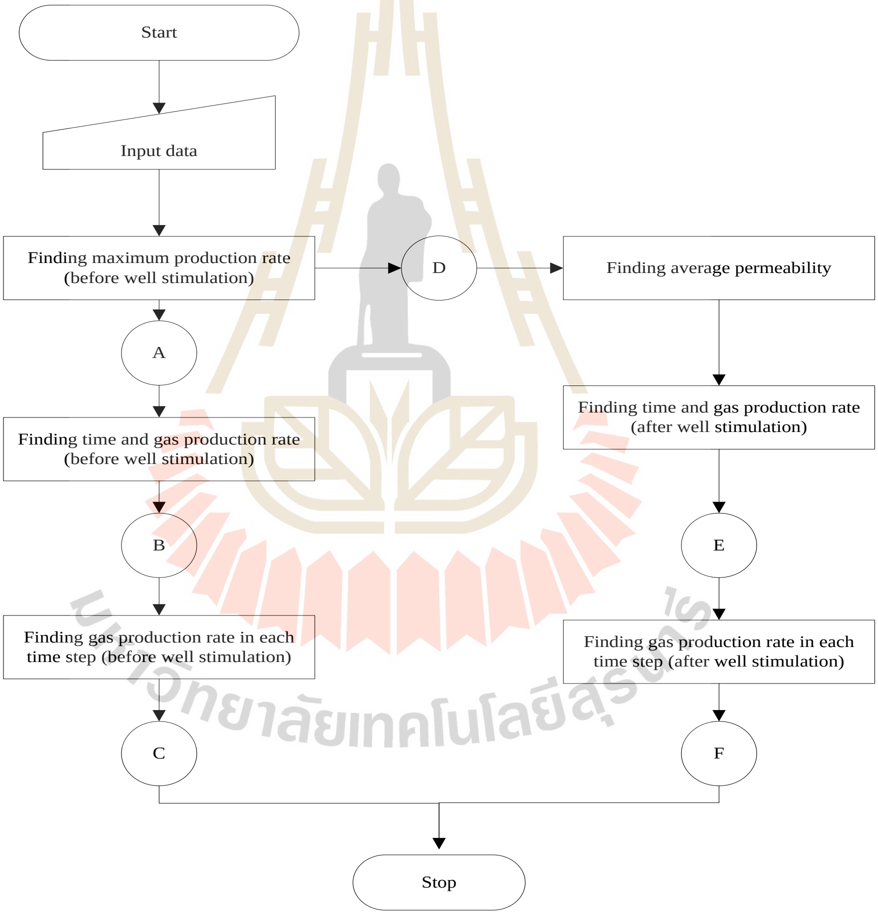

Figure 3.9 Step summary of Tank model

3.5.2 Fundamental of Tank model

The gas reservoir is represented by Tank mode. It uses flow equation, material balance and others by following conditions.

1) Gas flow equation
   - Flow in porous media
   - Flow in circular pipe
2) Material balance
   - Material balance of gas reservoir
3) Gas properties
   - Compressibility factor of gas
   - Gas formation volume factor
   - Gas viscosity

Equation of acid fracturing design

In petroleum reservoir model is divided into 2 zones as showing in Figure 3.10 The permeability of each zones are;

Kx is a permeability of stimulated or damaged zone

K is original permeability in reservoir

The average permeability K_{avg} in equation (3.39) is used to calculate gas flow rate of reservoir.

$$K_{avg} = \frac{K\,K_a \ln(\frac{r_e}{r_w})}{K_a \ln(\frac{r_e}{r_a}) + K \ln(\frac{r_w}{r_w})} \qquad (3.39)$$

q = Gas production rate, MSCF/D

μ = Viscosity, cp

K_{avg} = Average permeability, md

T = Reservoir temperature, °F

h = Reservoir thickness, ft

Z = Compressibility factor

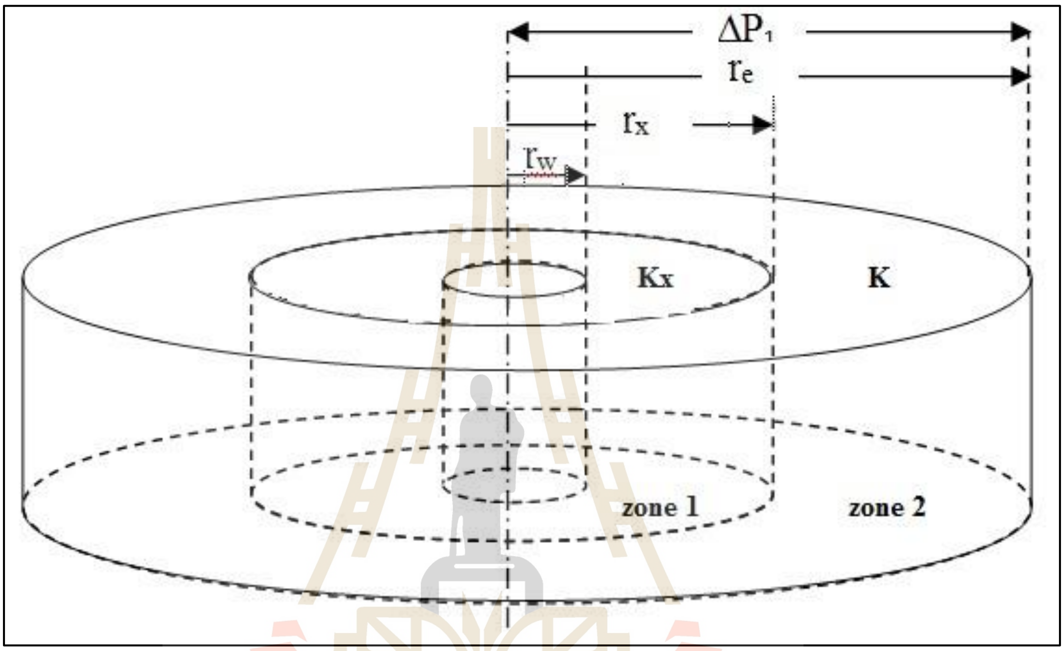

Figure 3.10 Zone of altered permeability K_x near a well

The pressure drop calculation in reservoir is following in Figure 3.11

Flow from external radius to bottom hole

$$\overline{P}_r^2 - \overline{P}_{wf}^2 = \frac{1424 q \mu Z T}{Kh} \left(\ln 0.472 \frac{r_e}{r_w} \right) \quad (3.40)$$

Substitute K_{avg} from (3.39) in K of equation (3.40)

$$\overline{P}_r^2 - \overline{P}_{wf}^2 = \frac{1424q\mu ZT}{K_{avg}h}\left(\ln 0.472\frac{r_e}{r_w}\right) \quad (3.41)$$

Gas properties

Gas compressibility factor

$$P_{Pc} = 702.5 - 50\gamma_g \quad (3.42)$$

$$T_{pc} = 167 + 316.67\gamma_g \quad (3.43)$$

$$\rho_{pr} = 0.27\frac{P_{pr}}{ZT_{pr}} \quad (3.44)$$

$$P_{pr} = \frac{P}{P_{pc}} \quad (3.45)$$

$$T_{pr} = \frac{T}{T_{pc}} \quad \text{(3.46}$$

$$Z = 1 + \left(A_1 + \frac{A_2}{T_{pr}} + \frac{A_3}{{T_{pr}}^3}\right)\rho_{pr} + \left(A_4 + \frac{A_5}{T_{pr}}\right){\rho_{pr}}^2 + \left(\frac{A_5A_6{\rho_{pr}}^5}{T_{pr}}\right)$$
$$+\left(\frac{A_7{\rho_{pr}}^2}{{T_{pr}}^3}\right)\left(1 + A_8{\rho_{pr}}^2\right)\exp\left(-A_8{\rho_{pr}}^2\right) \quad (3.47)$$

$A_1 = 0.31506237, A_2 = -1.0467099,\ A_3 = -0.57832829,$

$A_4 = 0.53530771, A_5 = -0.61232032,\ A_6 = -0.10488813,$

$A_7 = 0.68157001, A_8 = 0.68446549$

Pressure loss across completion, ΔP_2, ΔP_3, and ΔP_4 are neglected.

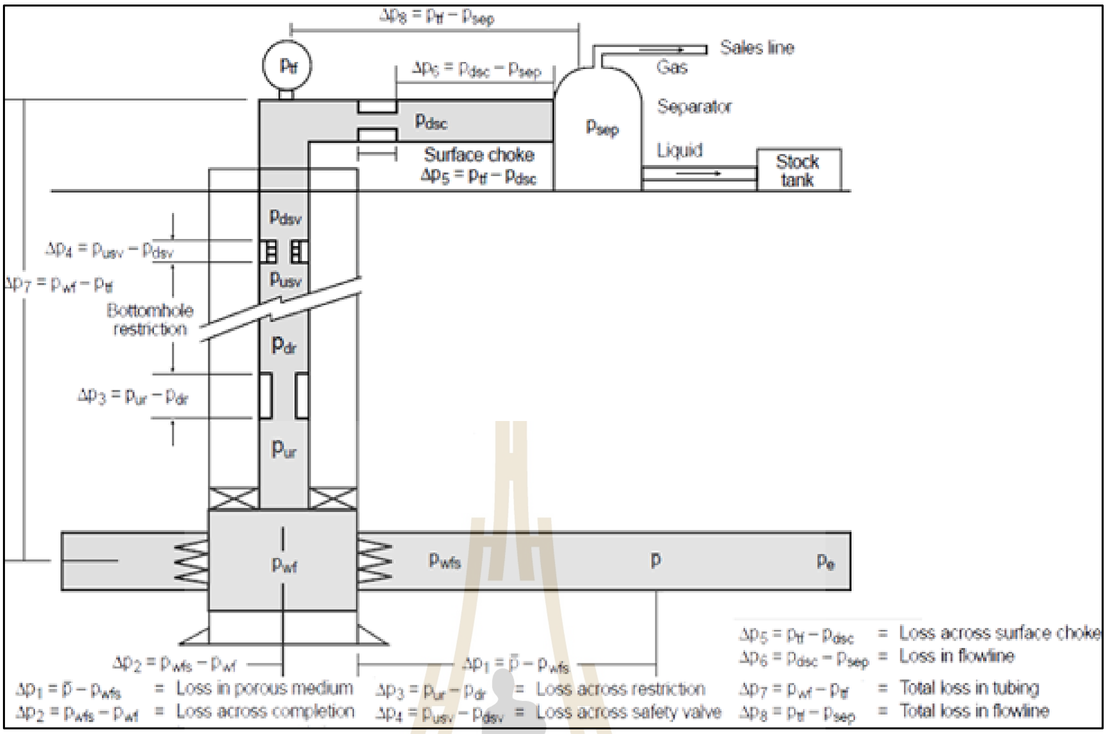

Figure 3.11 Well production systems (Economides, 2000)

Pressure loss in vertical flow along tubing, P_{wf} to P_{wh}

$$\bar{P}_{wf}^2 = e^{-s}\bar{P}_{wh}^2 - \frac{2.685x10^{-3} f_f(\overline{ZT}q)^2}{sin\theta\, d^5}(1 - e^{-s}) \qquad (3.48)$$

$$s = \frac{-0.0375\gamma_g L}{\overline{ZT}} \qquad (3.49)$$

Friction loss coefficient

$$\frac{1}{\sqrt{f}} = -4\,log\left\{\frac{\epsilon}{3.7065} - \frac{5.0452}{N_{Re}} log\left[\frac{\epsilon^{1.1098}}{2.8257} + \left(\frac{7.149}{N_{Re}{}^{0.8981}}^{0.8981}\right)\right]\right\}^2 \qquad (3.50)$$

γ_g = Specific gravity of gas

μ = Viscosity, cp

q = Gas production rate, MSCF/D

d = Tubing diameter, in

L = Tubing length, ft

Z = Compressibility factor

Reynold number

$$N_{Re} = \frac{20.09\gamma_g q}{d\mu} \tag{3.51}$$

Average flowing temperature

$$T = \frac{T_r + T_{wfs}}{2} \tag{3.52}$$

Flow through surface pipe P_{wh} to P_{sep}

$$\bar{P}_{sep}^2 = \bar{P}_{wh}^2 - 1.007x10^{-4} \frac{\gamma_g f_f (\overline{ZT} q)^2}{{d_s}^5} L_s \tag{3.53}$$

d_s = Surface pipe diameter, in

L_s = Surface pipe length, ft

Gas material balance equation

$$\frac{P}{Z} = -\frac{P_i}{Z_i G} G_p + \frac{P_i}{Z_i} \tag{3.54}$$

Initial gas in place

$$G_i = \frac{43{,}560\ A\emptyset(1-S_w)h}{B_g} \tag{3.55}$$

Gas formation volume factor

$$B_g = 0.02829\ \frac{ZT}{P} \tag{3.56}$$

Gas viscosity

$$\mu = 10^{-4} K \exp\left(X{\rho_1}^y\right) \tag{3.57}$$

$$K = \frac{(9.4+0.62M)T^{1.5}}{209+19M+T} \tag{3.58}$$

$$X = 3.5 + \frac{986}{T} + 0.01M \tag{3.59}$$

$$Y = 2.4 - 0.2X \tag{3.60}$$

$$M = 28.964\gamma_g \tag{3.61}$$

$$\rho_1 = (1.4926x10^{-3})\frac{PM}{ZT} \tag{3.62}$$

Radial flow of compressible fluid, steady state

$$q = \frac{0.003164\, T_{sc}Kh({P_1}^2 - {P_2}^2)}{P_{SC}T(Z\mu)\ln\left(\frac{r_2}{r_1}\right)} \tag{3.63}$$

3.5.3 Benefits of Tank model

1) All data are compiled pertinent to a reservoir into one compact database.

2) Tank model predicts reservoir production rate and reservoir pressure in the future

3) It can be utilized as the management tool for selecting development plan and operational changes.

3.5.4 Input data of the Tank model

1) Basic data

- Pressure at separator	200	psia
- Initial reservoir pressure	6,500	psia

2) Fluid data

- Specific gravity	0.709	
- Initial water saturated	0.2	

3) Rock data

- Porosity	0.1	
- Permeability	0.5	md

4) Pipe data

- Pipe diameter	4	in
- Pipe length	1,000	ft
- Pipe relative roughness	0.001	

5) Tubing data

- Tubing diameter	4	in
- Tubing length	8,500	ft
- Tubing relative roughness	0.001	
- Angle	90°	

6) Other data

- Net perforated thickness	650	ft
- Well bore radius	0.5	ft
- Reservoir radius	3,000	ft

3.5.5 Tank model result

Tank model was designed for 291.37 MMSCF gas in place and 650 feet thickness. It covers area about 300 Acres. The top structure of model is at 8,500 feet depth. The output data from prospect Tank model running results of three cases are following:

1) Conventional production results

Average permeability	0.5	md
Maximum production rate	3,821.6	MSCF/D
Initial gas in place	291,371.24	MMSCF
Time production at constant rate	1.198	month

2) Production results after acidizing

Average permeability in acidizing zone	1.76	md
Maximum production rate	4,153.9	MSCF/D
Initial gas in place	291,371.2	MMSCF
Time production at constant rate	13.000	month

3) Production results after acid fracturing

Average permeability in fracturing zone	37.73×10^9	md
Maximum production rate	45,691.1	MSCF/D
Initial gas in place	291,371.2	MMSCF
Time production at constant rate	36.000	month

Gas productions in three cases are shown in Table 3.2 and Figure 3.12-3.14.

Table 3.2 Gas production rate, pressure, and cumulative gas production (Gp) in each cases

	Natural flow				Flow after acidized				Flow after fractured			
Time	Production rate		Pressure	Gp	Production rate		Pressure	Gp	Production rate		Pressure	Gp
year	MMSCF/D		psi	MMSCF	MMSCF/D		psi	MMSCF	MMSCF/D		psi	MMSCF
	1 well	5 well			1 well	5 well			1 well	5 well		
0	0	0	6500	0	0	0	6500	0	0	0	6500	0
1	3.8216	19.1080	5900.38	6974.4	4.1539	20.7695	5197.53	7580.9	45.6911	228.4555	4990.8	83386.3
2	3.4001	17.0005	4964.58	13179.6	4.0002	20.0010	4243.78	14881.2	45.6911	228.4555	3354.3	166772.5
3	3.1001	15.5005	4254.17	18837.3	3.8000	19.0000	3595.65	21816.2	11.0120	55.0600	2613.7	250158.8
4	2.8601	14.3005	3736.12	24057.0	3.6002	18.0010	3130.99	28386.6	1.3860	6.9300	2150.5	270255.7
5	2.5999	12.9995	3332.53	28801.8	3.2998	16.4990	2774.96	34408.7	0.1040	0.5200	1827.1	272785.1
6	2.4000	12.0000	3007.42	33181.8	3.2002	16.0010	2453.23	40249.1	0.0265	0.1325	1585.1	272974.9
7	2.2999	11.4995	2740.73	37379.1	3.1000	15.5000	2259.37	45906.6	0.0106	0.0530	1398.4	273023.3
8	2.2001	11.0005	2516.51	41394.3	2.7000	13.5000	2066.54	50834.1	0.0060	0.0300	1249.2	273042.6
9	2.1000	10.5000	2324.75	45226.8	2.6601	13.3005	1902.82	55688.8	0.0032	0.0160	1126.9	273053.6
10	1.9999	9.9995	2158.95	48876.6	2.5401	12.7005	1761.44	60324.5	0.0021	0.0105	1025.1	273059.4
11	1.9001	9.5005	2014.39	52344.3	2.3399	11.6995	1639.3	64594.8	0.0018	0.0090	939.8	273063.3
12	1.8000	9.0000	1886.94	55629.3	2.1999	10.9995	1531.71	68609.6	0.0160	0.0800	934.3	273066.5
13	1.7599	8.7995	1773.65	58841.1	2.0001	10.0005	1437.12	72259.8	0.0013	0.0065	929.8	273095.7
14	1.5199	7.5995	1672.76	61614.9	1.8402	9.2010	1351.88	75618.1	0.0010	0.0050	925.3	273098.1
15	1.4400	7.2000	1581.89	64242.9	1.6898	8.4490	1275.99	78702	0.0008	0.0040	923.4	273099.9
16	1.3999	6.9995	1499.29	66797.7	1.6001	8.0005	1207.91	81622.2	0.0008	0.0040	923.0	273101.4
17	1.3601	6.8005	1424.94	69279.9	1.5199	7.5995	1146.06	84396	0.0006	0.0030	914.7	273102.9
18	1.3399	6.6995	1356.5	71725.2	1.3600	6.8000	1089.92	86878	0.0005	0.0025	884.4	273104.0
19	1.2600	6.3000	1294.54	74024.7	1.2399	6.1995	1038.47	89140.8	0.0005	0.0025	824.6	273104.9
20	1.2199	6.0995	1237.31	76251.1	1.1739	5.8695	991.69	91283.2	0.0004	0.0020	775.3	273105.8

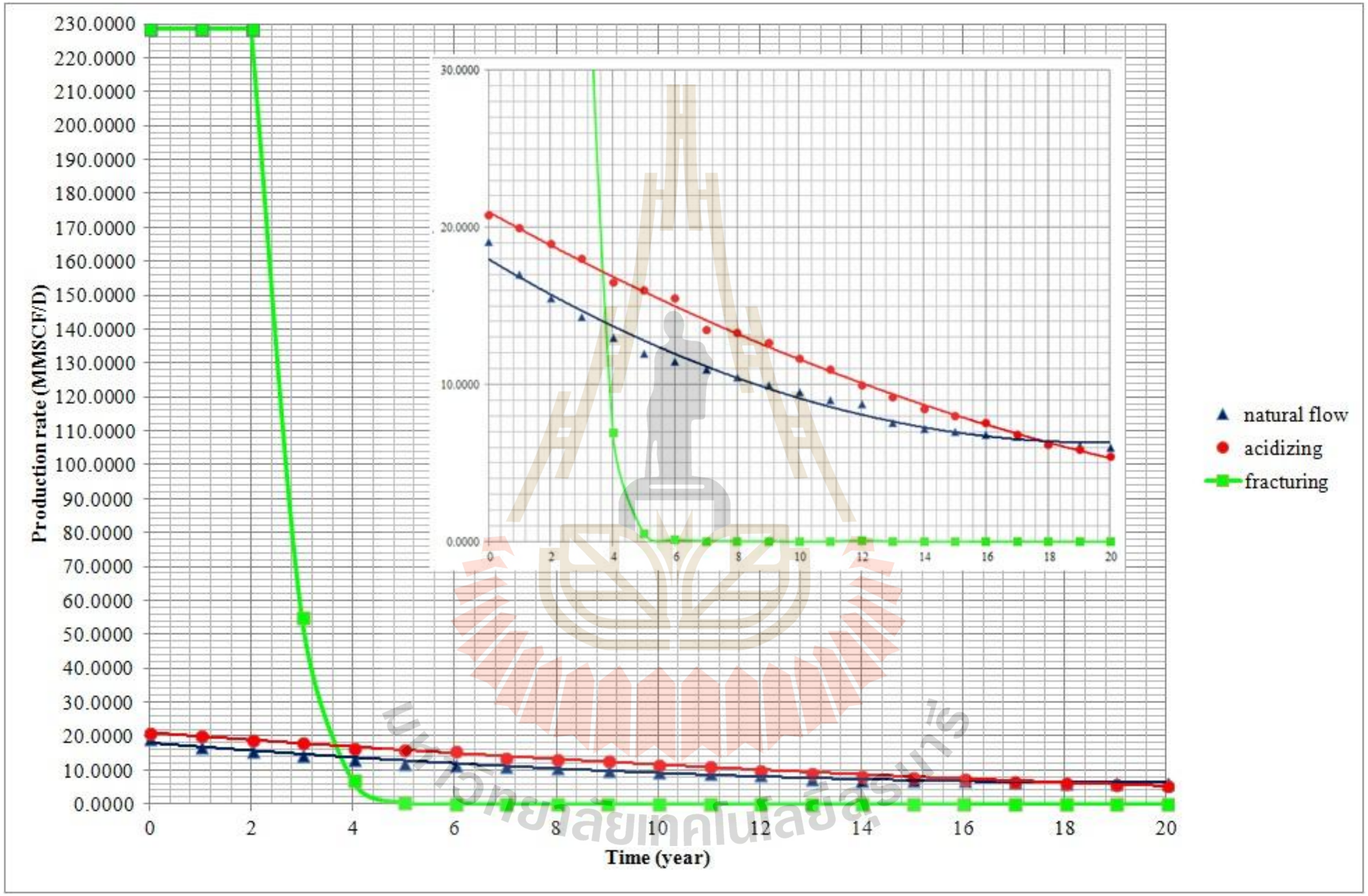

Figure 3.12 The relationship between gas production rate and time

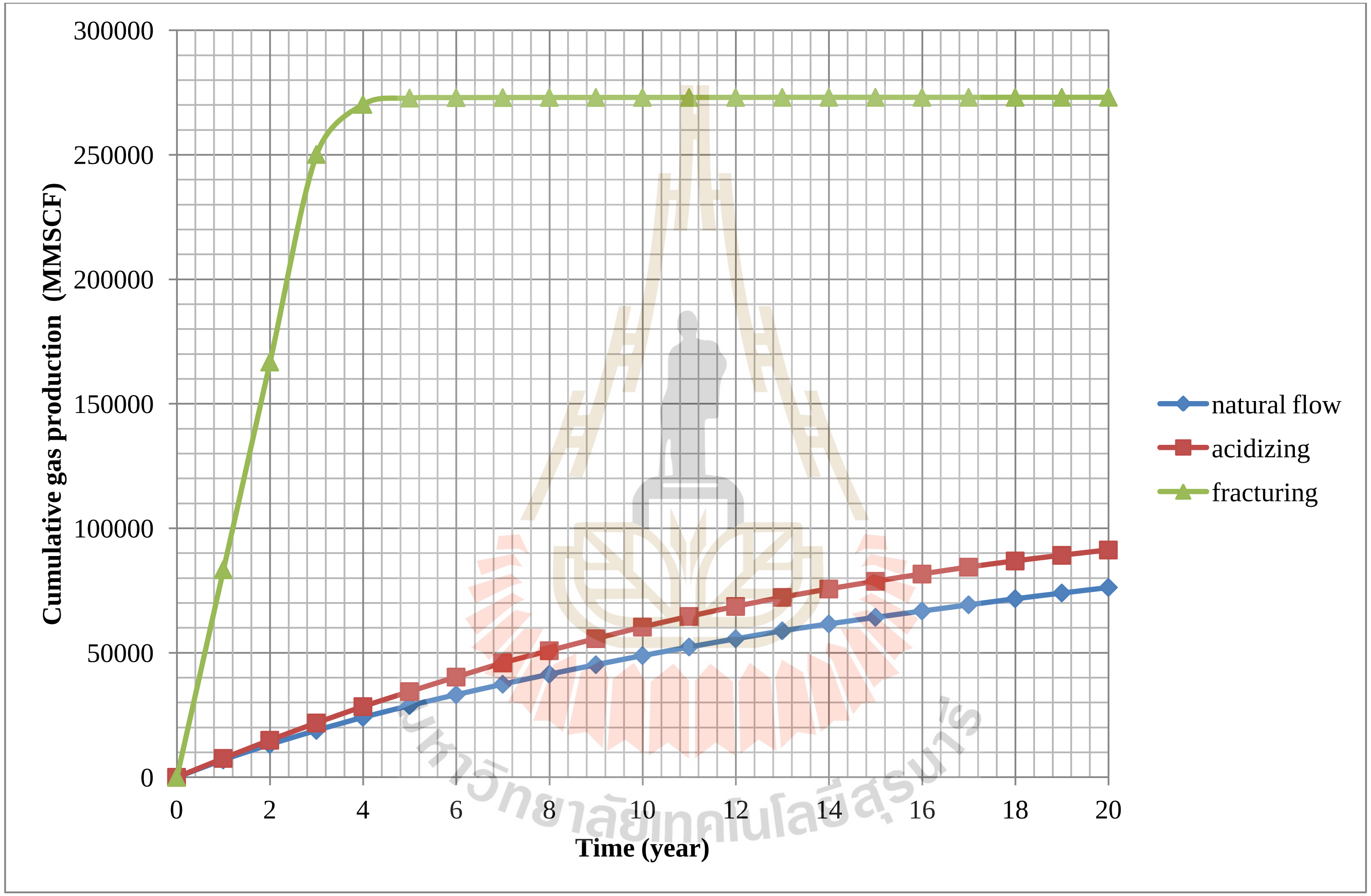

Figure 3.13 The relationship between cumulative gas production and time

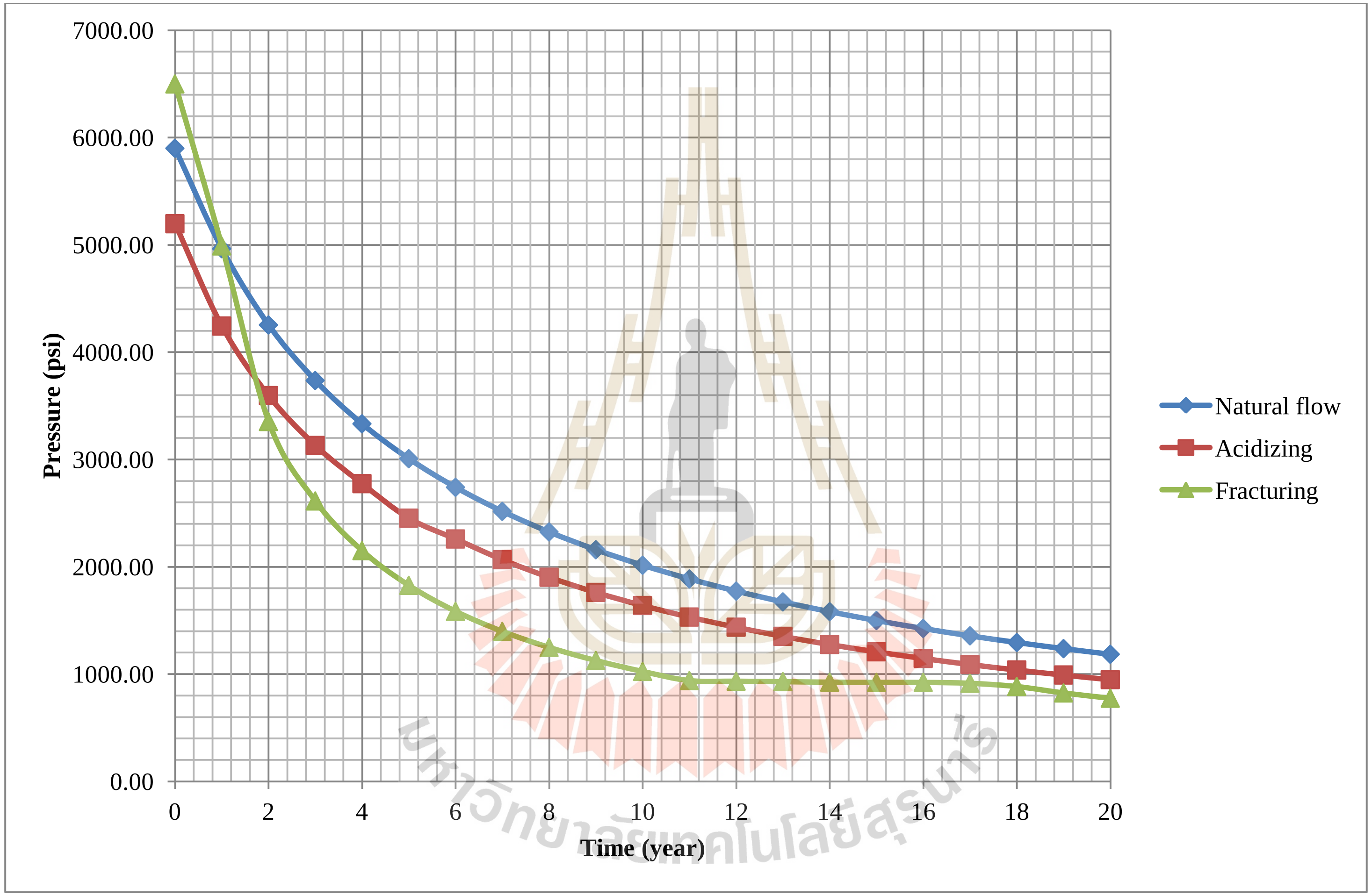

Figure 3.14 The relationship between pressure and time

3.5.6 Conclusions

The acidizing and acid fracturing are used to stimulate carbonate reservoir by increasing of permeability and production rate.

1) Stimulation by acidizing

The importance factor of acidizing are acid type, concentration and time. Treating time 200 minute of hydrochloric acid 28% in limestone reservoir was used to be a case study. Permeability of reservoir at 50 ft of acidizing radius increased from 0.15 to 1.75 md. This stimulation required acid injection rate 7,345 gal/min, 5,876 of acid volume per unit thickness to get skin factor equal to -4.

Tank model was used to determine flow rate of reservoir after acidizing compare with natural flow. Gas flow rate slightly increased 8.70% from 19.11 to 20.77 MMSCF/D but gas can be produced at constant rate for a year after acidizing. .

The production rate slightly declined after first year until the end (20^{th}) at 5.78MMSCF/D and 948 psia.

Cumulative gas production at the 20^{th} year was 91,283 MMSCF increased about 19.71% from 76,251 MMSCF. After acidizing recovery factor increased about 19.71% from 26.17% (natural flow) to 31.33%.

2) Stimulation by acid fracturing

The importance factor of acidizing are acid type, concentration and pumping horse power. The acid fracturing process is designed in 650 ft of formation thickness with hydrochloric 15% in limestone reservoir. This process required pumping horse power 590 hp, minimum acid volume 273 ft^3 and totals fluid volume (acid and pad fluid) 14,013 ft^3. Vertical fracture size 151 ft x 0.07 in. of length and width was produced under surface 8,500 ft. This process increased permeability higher from 0.5 to 37.73x10^9md.

Gas flow rate after acid fracturing was determined by Tank model to compare with natural flow. Gas flow rate highly increased 1,096% from 19.11 to 228.46 MMSCF/D. Gas production rate was produced at constant rate for 3 years before decline immediately next 2 years before slightly decline until the 20th year at rate 2 MSCF/D and 775.3 psia.

Cumulative gas production at the 20th year was 273,106 MMSCF increased about 258.17% from 76,251 MMSCF. After acid fracturing recovery factor increased about 258.17% from 26.17% (natural flow) to 93.73% as a result of gas in place remaining about 18,265 MMSCF.

CHAPTER IV

RESERVOIR SIMULATION

4.1 Objective

The main objective of this chapter is to detail a reservoir simulation modeling data requirement in term of static (reservoir structure and rock properties) and dynamic (fluid saturation, pressure, and fluid flow rate) properties of reservoir, and describe about reservoir simulation scenarios test selection.

4.2 Basic model definition and structure of model

In this study used black oil reservoir simulator (Eclipse Office E100) of total 5,250 grid blocks to stimulated production scenarios, the detail summarize as follow:

-	Simulator	Black Oil
-	Model dimension (x, y, z)	25, 21, 10 (5,250 grid blocks)
-	Unit	Field
-	Grid Type	Cartesian
-	Geometry Type	Conner Point
-	Solution Type	Fully – Implicit

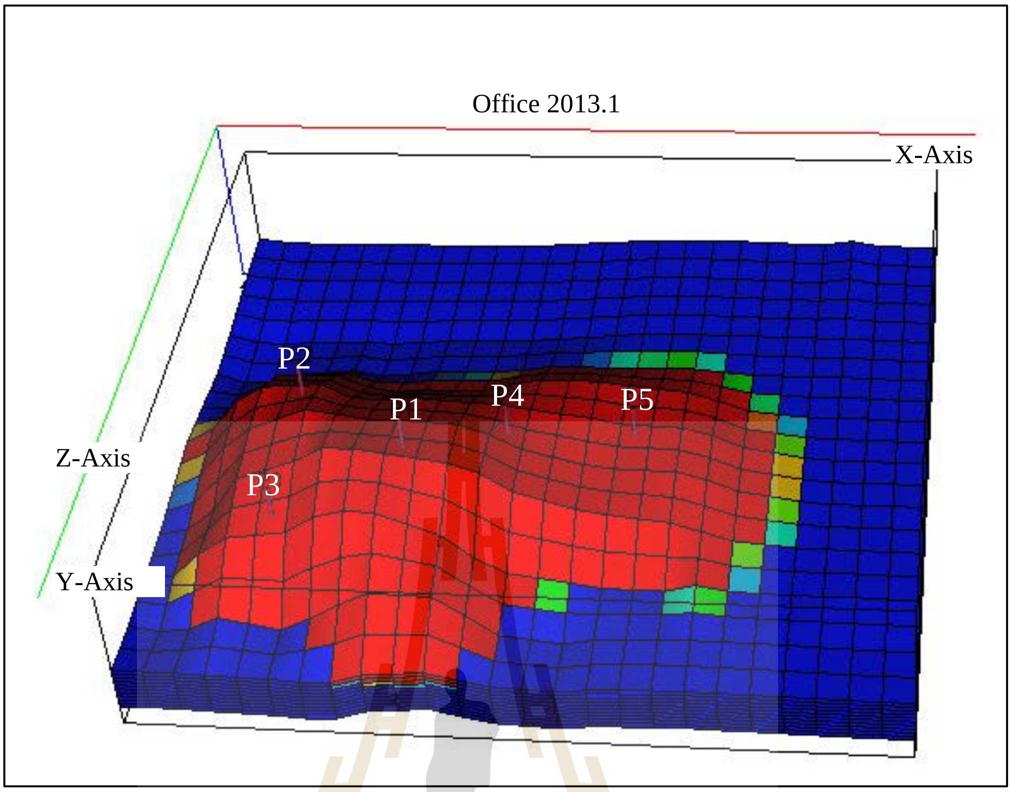

Figure 4.1 Oblique view of structure

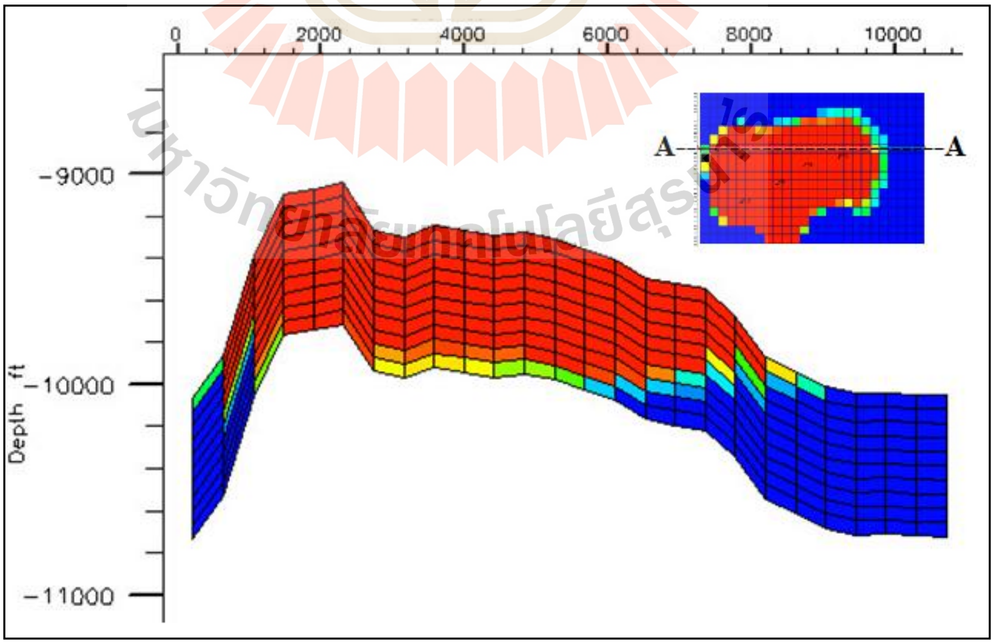

Figure 4.2 Cross-section view (A-A)of structure

4.3 Reservoir model input parameters

The model input parameter description follow the main input section data of the simulator, Grid section, PVT section, SCAL section, Initialization section and Schedule section, respectively.

4.3.1 Porosity and permeability data of grid section

Porosity (Figure 4.3) and permeability of the model obtained from the concessionaire results, and researched paper of some cores sample in the northeastern gas field, as shown in appendix A. The distribution of permeability development after stimulation which filled in reservoir model is shown in Table 4.1 to 4.2 and Figure 4.4 to 4.6. The vertical permeability developments in each case are shown in Figure 4.7 to 4.9. In case of acid fracturing the equivalent flow radius can be calculated as equation (4.1) and Figure 4.10.

Flow radius, r_w'

$$r_w' = \frac{2}{\pi} X_f \tag{4.1}$$

r_w' = equivalent flow radius, ft

X_f = fracture length, ft

Table 4.1 The development of average permeability after stimulation by acid fracturing

	Well	Layer	Stimulated K ($x10^9$md)	Avg. grid block radius (ft)	No. stimulated grid	Eq. flow radius (ft)	Original K (md)	Avg K (md)
Acid fracturing simulation	P1	1	37.73	246	1	96.08	0.40	2.64
		2	37.73	246	1	96.08	0.39	2.57
		3	37.73	246	1	96.08	0.38	2.51
		4	37.73	246	1	96.08	0.80	5.27
		5	37.73	246	1	96.08	0.71	4.68
		6	37.73	246	1	96.08	0.70	4.62
		7	37.73	246	1	96.08	0.62	4.09
		8	37.73	246	1	96.08	0.60	3.96
		9	37.73	246	1	96.08	0.58	3.82
		10	37.73	246	1	96.08	0.56	3.69
	P2	1	37.73	246	1	96.08	0.50	3.30
		2	37.73	246	1	96.08	0.48	3.16
		3	37.73	246	1	96.08	0.47	3.10
		4	37.73	246	1	96.08	0.45	2.97
		5	37.73	246	1	96.08	0.44	2.90
		6	37.73	246	1	96.08	0.78	5.14
		7	37.73	246	1	96.08	0.48	3.16
		8	37.73	246	1	96.08	0.76	5.01
		9	37.73	246	1	96.08	0.72	4.75
		10	37.73	246	1	96.08	0.50	3.30
	P3	1	37.73	246	1	96.08	0.50	3.30
		2	37.73	246	1	96.08	0.48	3.16
		3	37.73	246	1	96.08	0.47	3.10
		4	37.73	246	1	96.08	0.45	2.97
		5	37.73	246	1	96.08	0.44	2.90
		6	37.73	246	1	96.08	0.78	5.14
		7	37.73	246	1	96.08	0.48	3.16
		8	37.73	246	1	96.08	0.76	5.01
		9	37.73	246	1	96.08	0.72	4.75
		10	37.73	246	1	96.08	0.75	4.94
	P4	1	37.73	246	1	96.08	0.30	1.98
		2	37.73	246	1	96.08	0.39	2.57
		3	37.73	246	1	96.08	0.28	1.85
		4	37.73	246	1	96.08	0.36	2.37
		5	37.73	246	1	96.08	0.63	4.15
		6	37.73	246	1	96.08	0.62	4.09
		7	37.73	246	1	96.08	0.61	4.02
		8	37.73	246	1	96.08	0.60	3.96
		9	37.73	246	1	96.08	0.54	3.56
		10	37.73	246	1	96.08	0.58	3.82
	P5	1	37.73	246	1	96.08	0.70	4.62
		2	37.73	246	1	96.08	0.69	4.55
		3	37.73	246	1	96.08	0.68	4.48
		4	37.73	246	1	96.08	0.65	4.29
		5	37.73	246	1	96.08	0.63	4.15
		6	37.73	246	1	96.08	0.62	4.09
		7	37.73	246	1	96.08	0.60	3.96
		8	37.73	246	1	96.08	0.59	3.89
		9	37.73	246	1	96.08	0.58	3.82
		10	37.73	246	1	96.08	0.60	3.96

Table 4.2 The development of average permeability after stimulation by acidizing

	Well	Layer	Stimulated K (md)	Avg. grid block radius (ft)	No. stimulated grid	Acidizing radius (ft)	Original K (md)	Avg. K (md)
Acidizing stimulation	P1	1	1.76	246	1	50	0.40	0.94
		2	1.76	246	1	50	0.39	0.92
		3	1.76	246	1	50	0.38	0.91
		4	1.76	246	1	50	0.80	1.35
		5	1.76	246	1	50	0.71	1.28
		6	1.76	246	1	50	0.70	1.27
		7	1.76	246	1	50	0.62	1.20
		8	1.76	246	1	50	0.60	1.18
		9	1.76	246	1	50	0.58	1.16
		10	1.76	246	1	50	0.56	1.13
	P2	1	1.76	246	1	50	0.50	1.07
		2	1.76	246	1	50	0.48	1.04
		3	1.76	246	1	50	0.47	1.03
		4	1.76	246	1	50	0.45	1.01
		5	1.76	246	1	50	0.44	0.99
		6	1.76	246	1	50	0.78	1.33
		7	1.76	246	1	50	0.48	1.04
		8	1.76	246	1	50	0.76	1.32
		9	1.76	246	1	50	0.72	1.28
		10	1.76	246	1	50	0.50	1.07
	P3	1	1.76	246	1	50	0.50	1.07
		2	1.76	246	1	50	0.48	1.04
		3	1.76	246	1	50	0.47	1.03
		4	1.76	246	1	50	0.45	1.01
		5	1.76	246	1	50	0.44	0.99
		6	1.76	246	1	50	0.78	1.33
		7	1.76	246	1	50	0.48	1.04
		8	1.76	246	1	50	0.76	1.32
		9	1.76	246	1	50	0.72	1.28
		10	1.76	246	1	50	0.75	1.31
	P4	1	1.76	246	1	50	0.30	0.78
		2	1.76	246	1	50	0.39	0.92
		3	1.76	246	1	50	0.28	0.75
		4	1.76	246	1	50	0.36	0.88
		5	1.76	246	1	50	0.63	1.20
		6	1.76	246	1	50	0.62	1.20
		7	1.76	246	1	50	0.61	1.19
		8	1.76	246	1	50	0.60	1.18
		9	1.76	246	1	50	0.54	1.11
		10	1.76	246	1	50	0.58	1.16
	P5	1	1.76	246	1	50	0.70	1.27
		2	1.76	246	1	50	0.69	1.26
		3	1.76	246	1	50	0.68	1.25
		4	1.76	246	1	50	0.65	1.22
		5	1.76	246	1	50	0.63	1.20
		6	1.76	246	1	50	0.62	1.20
		7	1.76	246	1	50	0.60	1.18
		8	1.76	246	1	50	0.59	1.17
		9	1.76	246	1	50	0.58	1.16
		10	1.76	246	1	50	0.60	1.18

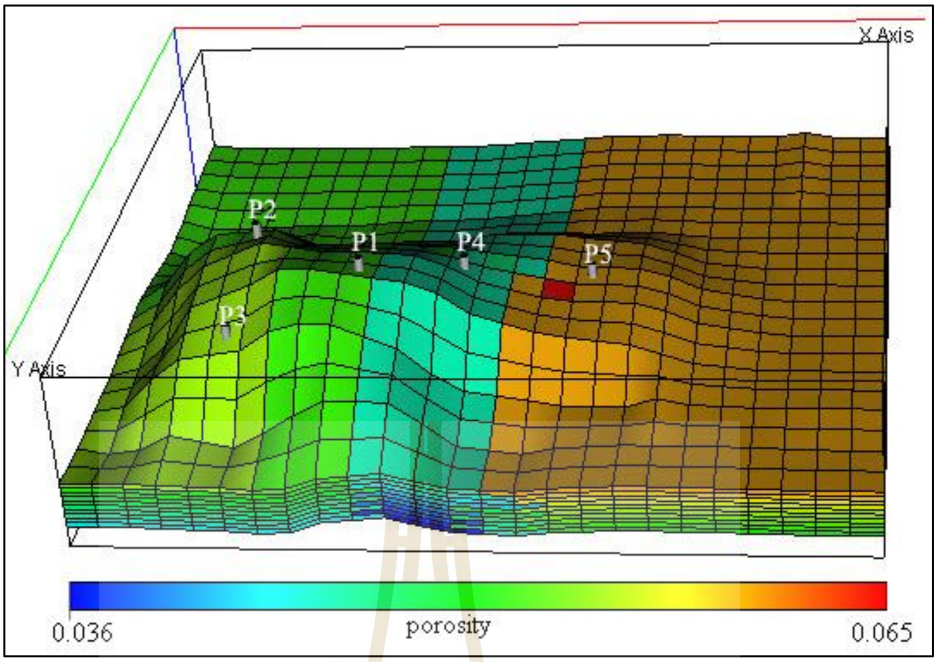

Figure 4.3 Porosity distribution of reservoir model

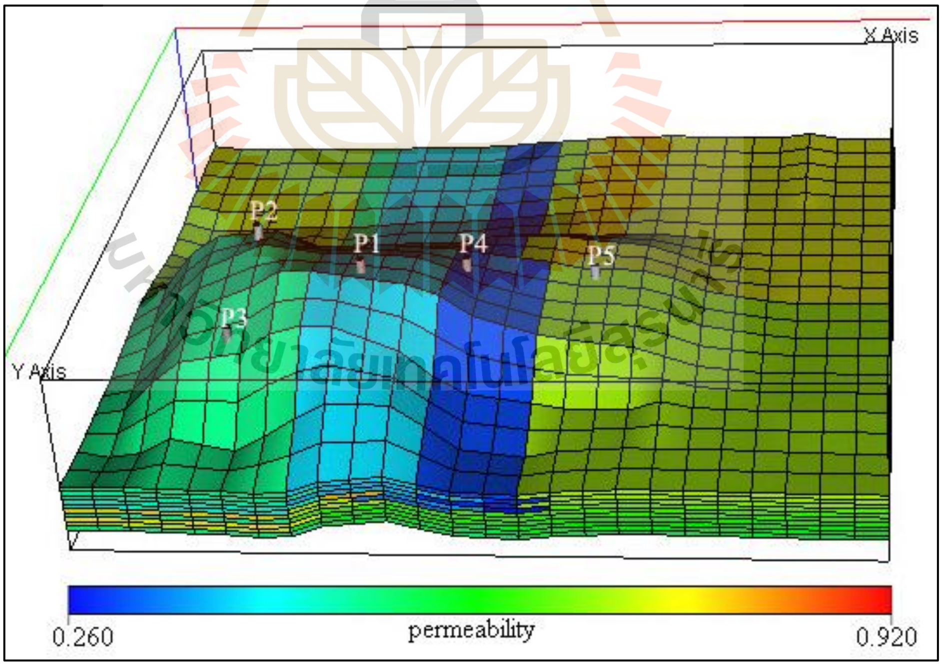

Figure 4.4 Original permeability distribution

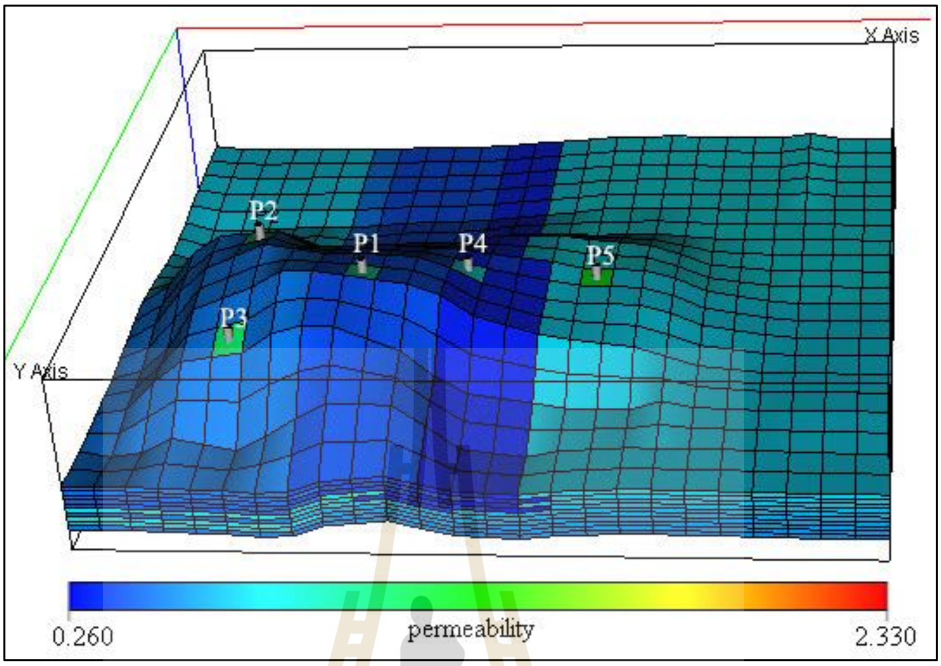

Figure 4.5 Permeability distribution after acidizing

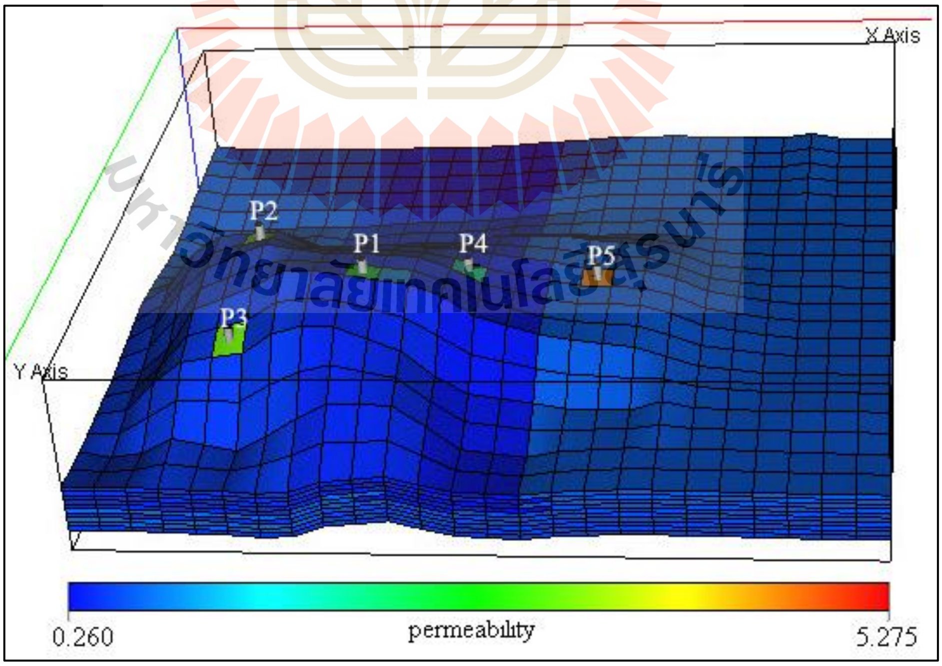

Figure 4.6 Permeability distribution after acid fracturing

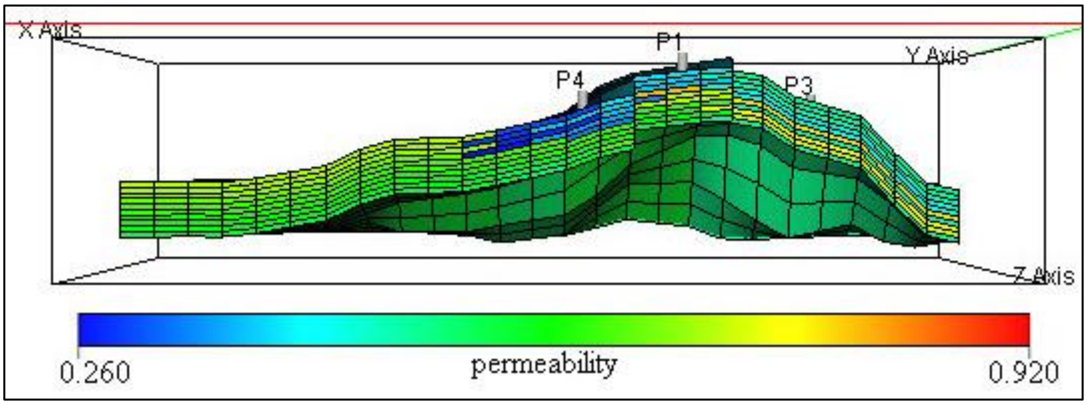

Figure 4.7 Original permeability distribution of cross-section structure

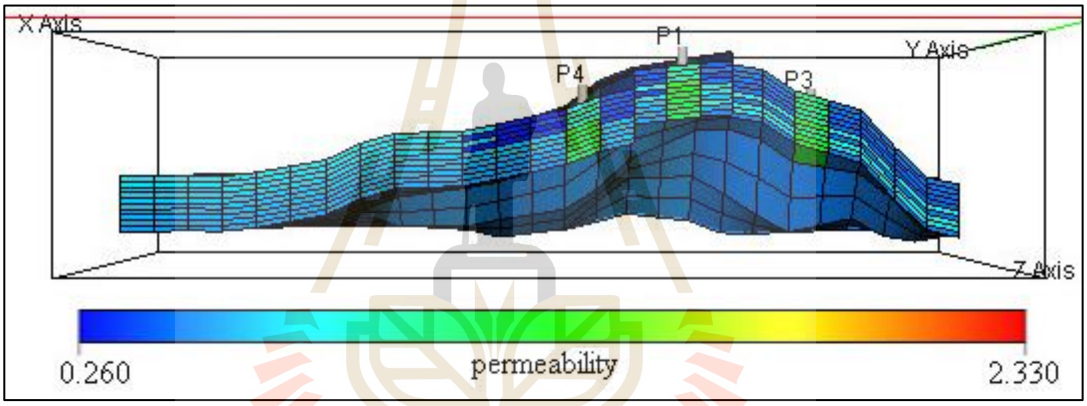

Figure 4.8 Permeability distribution after acidizing of cross-section structure

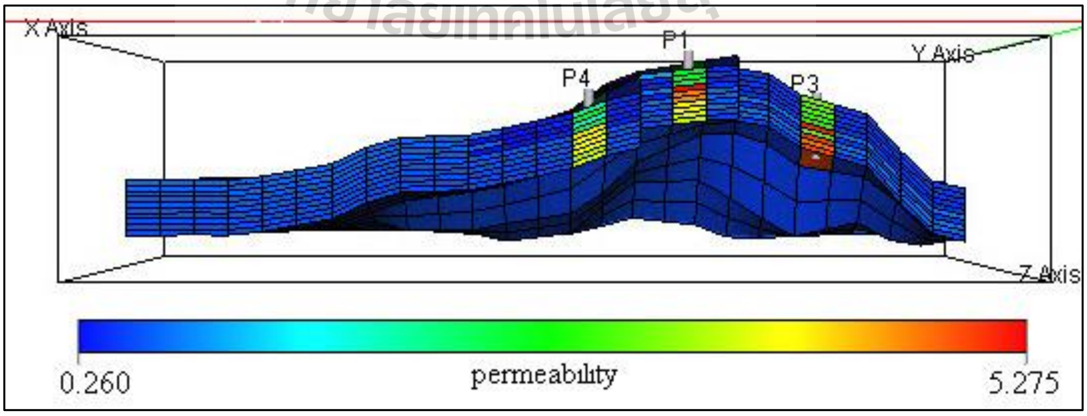

Figure 4.9 Permeability distribution after acid fracturing of cross-section structure

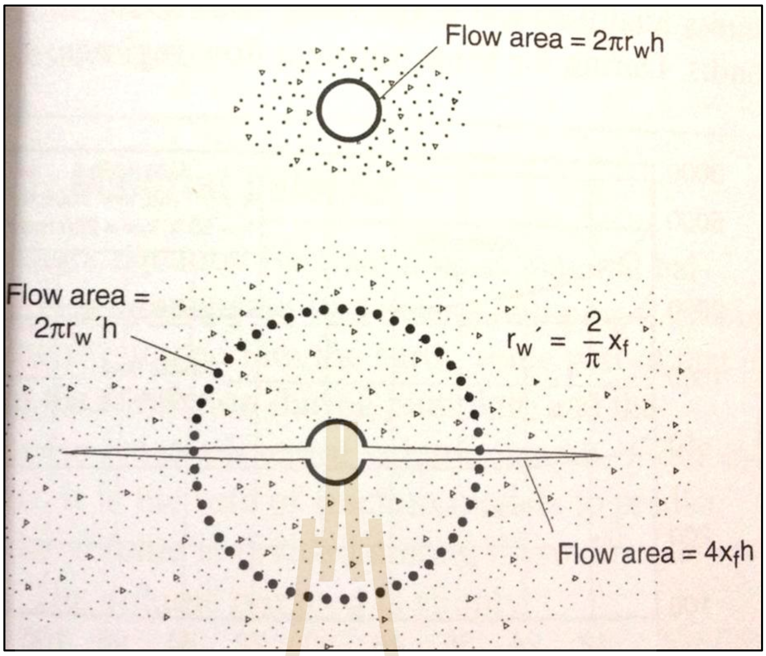

Figure 4.10 Equivalent flow radius after acid fracturing (Economides, 2000)

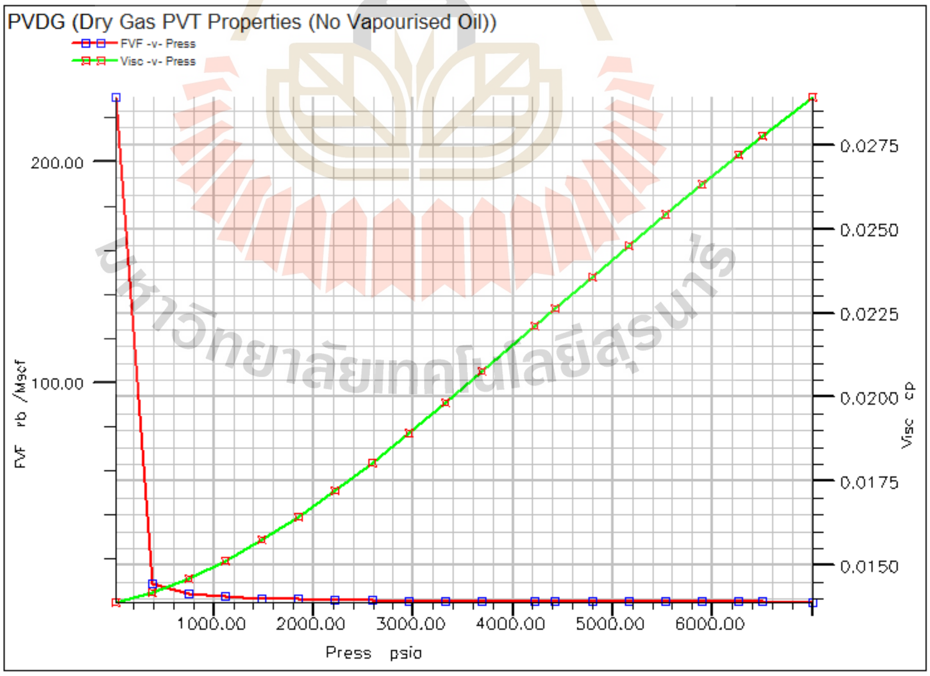

Figure 4.11 Dry Gas PVT Properties (No Vaporized Oil) graph display result form

4.3.2 Reservoir fluid properties of PVT section

This section data is related to PVT section data used in the simulator to indicated fluid properties (fluid formation volume factors, viscosities, densities, gas-oil ratio, and rock and water compressibility) at each phase due to pressure changes after production or injection phase. The reservoir fluid properties are detail as follow:

-	Reference pressure (P_{ref})	6,500	psia
-	Water FVF at P_{ref}	1.02135	rb/stb
-	Water compressibility	2.925239×10^{-6}	psi^{-1}
-	Water viscosity at P_{ref}	0.2917606	cp
-	Water viscosibility	5.955879×10^{-6}	psi^{-1}
-	Gas density at surface	0.0368325	lb/ft^3

The result from input these data is shown in Figure 4.11.

4.3.3 Fluid saturation of SCAL section

The SCAL section refers to the term of rock properties which is sets of input tables of relative permeability versus saturation. Effectively this defines the connate (or irreducible), critical and maximum saturation of each phase supplies information for defining the transition zone and defines the conditions of flow of phases relative to one another. Fluid saturation is list as follow:

-	Water saturation	0.35
-	Gas saturation	0.75

The result from input these data is shown in Figure 4.12.

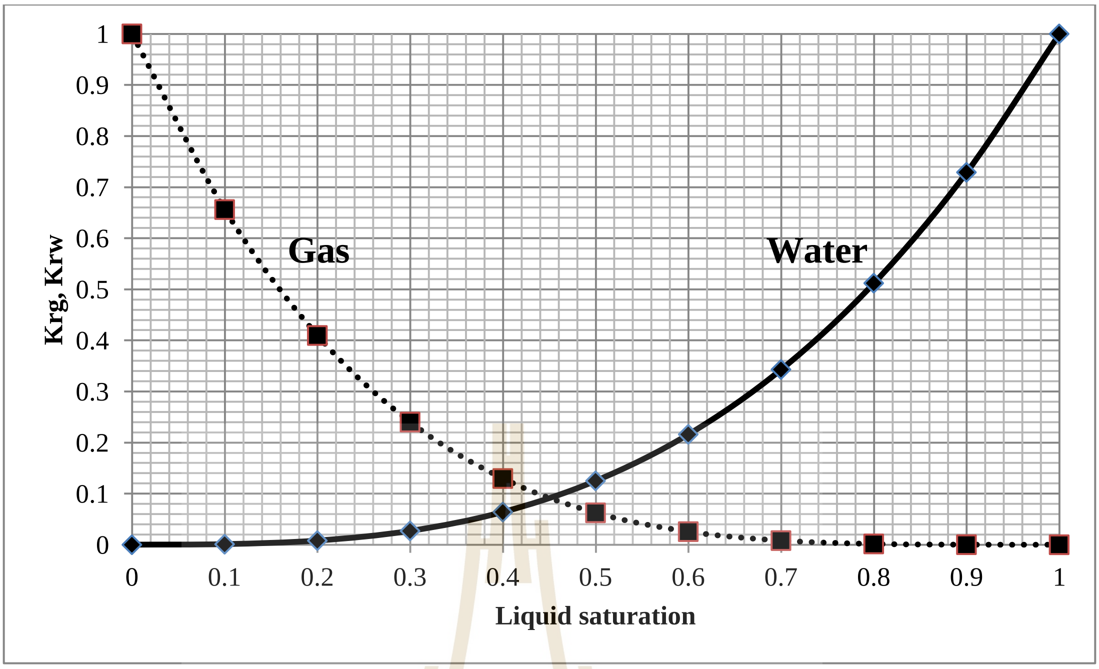

Figure 4.12 Relationship between liquid saturation and oil-gas relative permeability

4.3.4 Fluid contact of initialization section

Initialization refers to defining the initial conditions of the simulation. The initial conditions are defines by specifying the GWC (Gas-Water contact) depths and the pressure at a known depth. ECLIPSE uses this information in conjunction with much of the information from previous stages to calculate the initial hydrostatic pressure gradients in each zone of the reservoir model and allocate the initial saturation of each phase in every grid cell prior to production. The data of equilibration is following:

-	Datum depth, (feet)	9,000
-	Pressure at datum depth, (psi)	6,500
-	Water/Oil contact depth, (feet)	10,000

4.3.5 Well data of schedule section

Well data provide well and completion locations, production rates of wells and other data such as skin factors, well radius, and well controls, etc. The well data which use in producing wells as following;

- Diameter of well bore 0.5 feet
- Perforation of Production zone $1^{st} – 10^{th}$ layer

4.4 Simulation scenarios selection

From structure style and reservoir input parameters that described above, result to select the original of gas in place (or standard cubic foot of gas initial in placed, SCFGIIP) to performed the simulation tests. Three model were selected to study base on acidizing, acid fracturing and natural properties from acid simulation program. The variation of properties in each cases depended on permeability are shown in Appendix A

This study used 5 production wells to estimate production rate between reservoir after acid stimulated and natural flow are shown in Table 4.3 and Figure 4.13.

Table 4.3 Wells location on reservoir model in grid dimension

Well Number	**X(i)**	**Y(j)**
P1	9	15
P2	5	12
P3	5	17
P4	12	13
P5	16	12

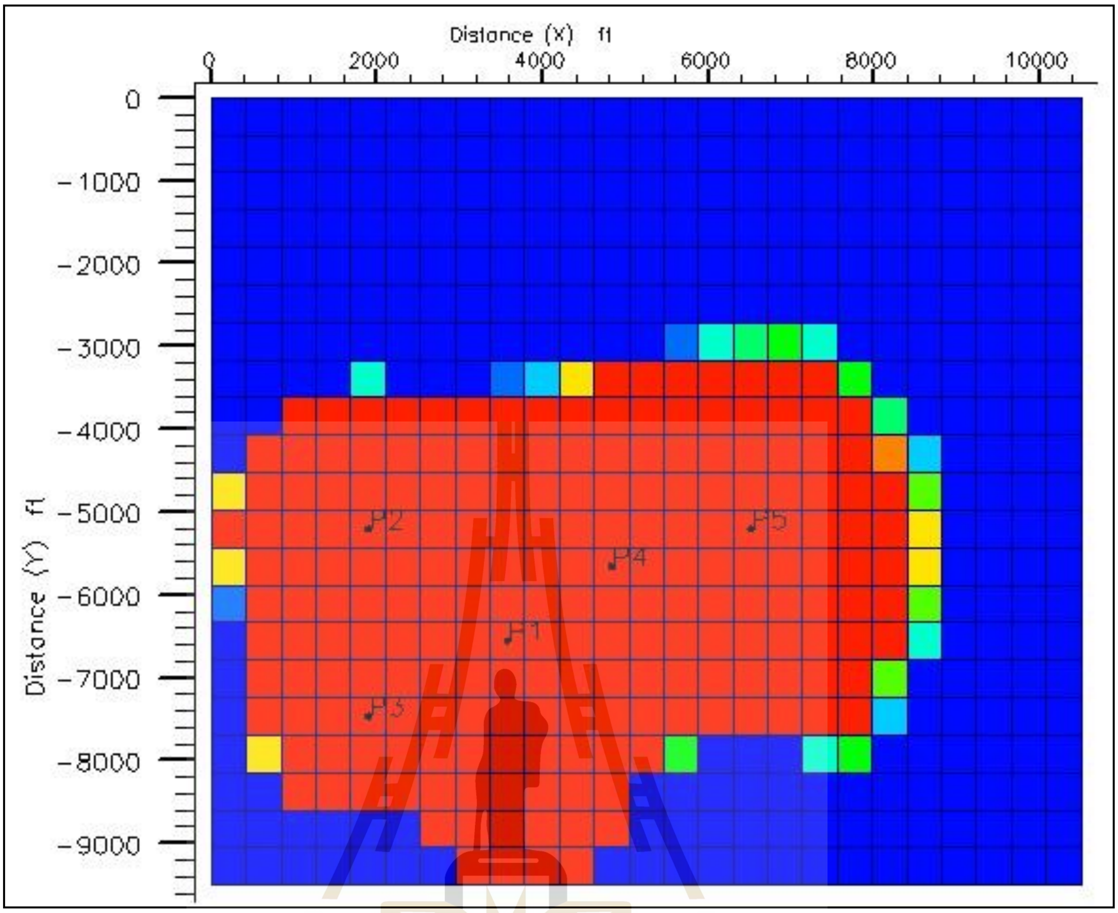

Figure 4.13 Top view of reservoir model and wells location

4.5 Reservoir simulation result

4.5.1 Reservoir simulation result

This section illustrated and describes results from the reservoir simulation model in carbonate rock. Production scenarios perform to understand and forecast the recovery efficiency gained from each run. The simulation run results displayed through the cross plot of 3 main graphs to observed fluids production behavior from reservoir. Detail of showing graphs are described in Table 4.4.

Table 4.4 Parameters description

Graph	Parameter	Description	Common Refer
1	FGIP	Field Gas in Place	Original of Gas in Place
	FWIP	Field Water in Place	Original of Water in Place
2	FGPT	Field Gas Production Total	Cumulative Gas Production
	FWPT	Field Water Production Total	Cumulative Water Production
3	FGPR	Field Gas Production Rate	Daily Gas Production Rate
	FWPR	Field Water Production Rate	Daily Water production Rate
4	FWCT	Field Water Cut	Water Cut (WCT)
	FPR	Field Pressure	Reservoir Pressure

4.5.2 Model NE scenario result

Model NE has 2.250 x 10^8 MSCF of gas in place. Reservoir produced with no injection through the production period (20 years) by 5 wells production. The results in each case are shown in Table 4.5.

1) Stimulation by acidizing

Flow rate of reservoir after acidizing compare with natural flow (Figure 4.14 and 4.15). Gas flow rate slightly increased 11.85% from 18.57 to 20.77 MMSCF/D but gas can be produced at constant rate for 3 years after acidizing. The production rate slightly declined after year 3th until the end (20th) at 4.99 MMSCF/D and 1,986 psia.

Cumulative gas production (Figure 4.17) at the 20th year was 87,481 MMSCF increased about 11.66% from 78,345 MMSCF. After acidizing recovery factor increased about 11.66% from 34.82% (natural flow) to 38.88%.

2) Stimulation by acid fracturing

Gas flow rate highly increased 1,128% from 18.571 to 228 MMSCF/D (Figure 4.14 and 4.16). Gas production rate was produced at constant rate for a year before decline immediately until year 4th before slightly decline until to 1 MSCF/D and about 200 psia.

Cumulative gas production (Figure 4.17) at the 20th year was 220,000 MMSCF increased about 178% from 79,070 MMSCF. After acid fracturing recovery factor increased about 181% from 34.82% (natural flow) to 97.78% as a result of gas in place remaining about 5,000 MMSCF.

Table 4.5 Results of simulation in each cases

	Natural flow			Flow after acidized			Flow after fractured		
Time	**Production rate**	**Pressure**	**Gp**	**Production rate**	**Pressure**	**Gp**	**Production rate**	**Pressure**	**Gp**
	MMSCF/D			**MMSCF/D**			**MMSCF/D**		
year	**5 well**	**psi**	**MSCF**	**5 well**	**psi**	**MSCF**	**5 well**	**psi**	**MSCF**
0	0	6541.0913	0	0	6541.091	0	0	6541.8682	0
1	18571.385	6053.8418	6848867.5	20769.5	6003.774	7601637	228.005	3647.6257	83450016
2	17260.146	5637.6846	13324710	20450.168	5526.038	15117440	137.837	1695.7971	1.59E+08
3	16141.418	5271.5059	19364066	19550.551	5090.89	22432106	49.376	1025.0632	1.86E+08
4	15167.75	4943.8042	25029980	18028.818	4709.143	29214694	24.548	726.61139	1.98E+08
5	14277.855	4647.1895	30375238	16712.736	4372.485	35505304	14.313	557.85822	2.04E+08
6	13427.393	4379.3594	35397684	15552.005	4072.991	41337988	9.259	451.1409	2.08E+08
7	12428.354	4138.8574	40068308	14504.395	3804.535	46772236	6.431	377.9769	2.11E+08
8	11522.641	3922.6135	44394640	13179.795	3563.346	51759432	4.707	324.96756	2.13E+08
9	10698.535	3725.5154	48422012	12020.387	3350.738	56313552	3.582	284.78821	2.15E+08
10	9941.1758	3545.6772	52151572	10973.486	3160.386	60457812	2.814	253.48112	2.16E+08
11	9265.6572	3383.5381	55624144	10058.736	2990.45	64250876	2.268	228.39227	2.17E+08
12	8636.04	3234.1816	58860548	9225.6611	2835.79	67729616	1.865	207.86469	2.17E+08
13	8066.1304	3096.8394	61888844	8484.7695	2695.729	70933816	1.559	190.73297	2.18E+08
14	7548.7241	2970.4021	64713788	7824.7119	2567.877	73878104	1.323	176.30225	2.18E+08
15	7065.8691	2852.8403	67357600	7224.4805	2450.567	76595376	1.137	163.95412	2.19E+08
16	6625.9106	2744.1624	69834928	6684.3984	2343.102	79107256	0.987	153.26991	2.19E+08
17	6223.5317	2642.5522	72166944	6197.4072	2243.456	81440856	0.865	143.91188	2.20E+08
18	5852.3511	2547.7075	74352856	5757.1152	2151.391	83600904	0.764	135.69003	2.20E+08
19	5506.6865	2459.0056	76409216	5358.0244	2066.196	85610088	0.68	128.39139	2.20E+08
20	5188.5396	2376.0515	78345776	4992.8638	1986.894	87481256	0.609	121.86868	2.20E+08

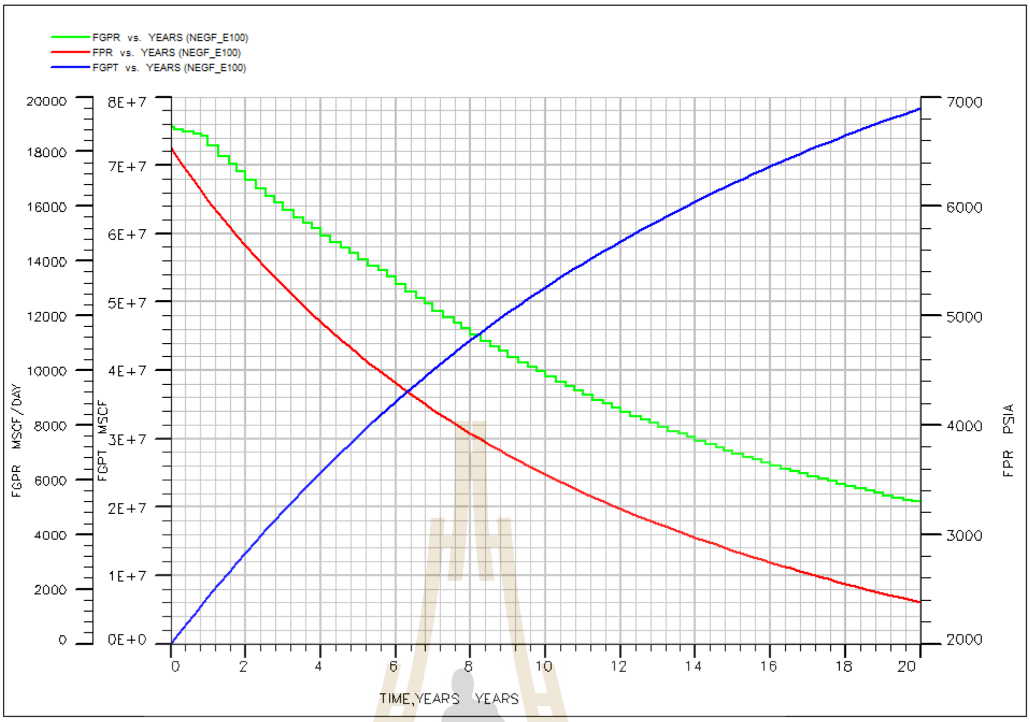

Figure 4.14 Result of simulation by natural flow

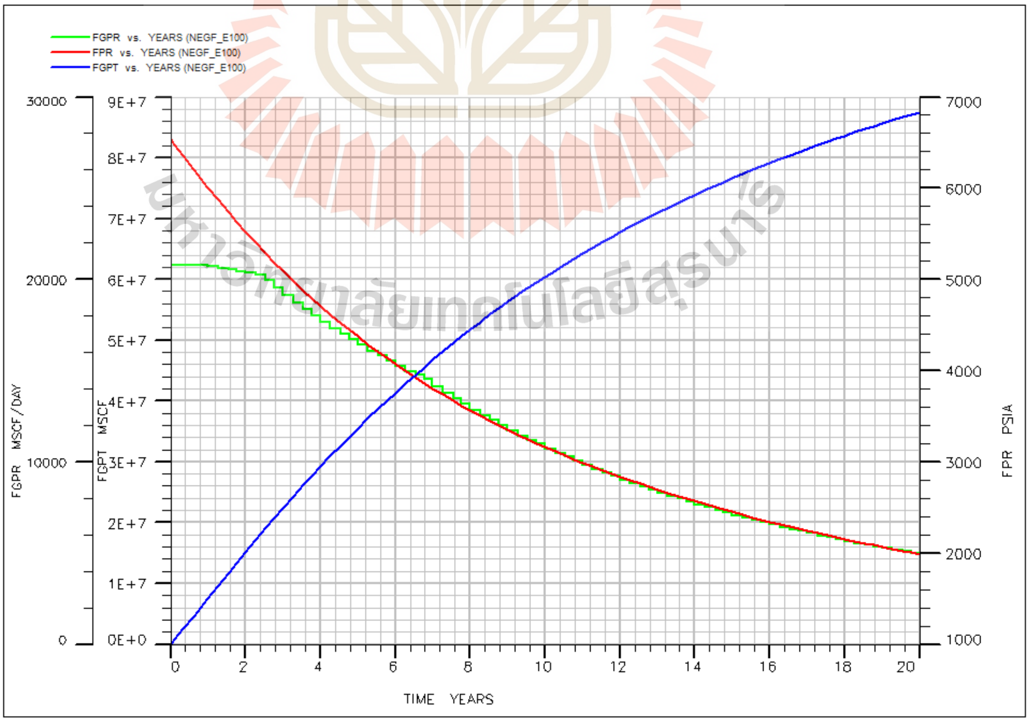

Figure 4.15 Result of simulation after stimulation by acidizing

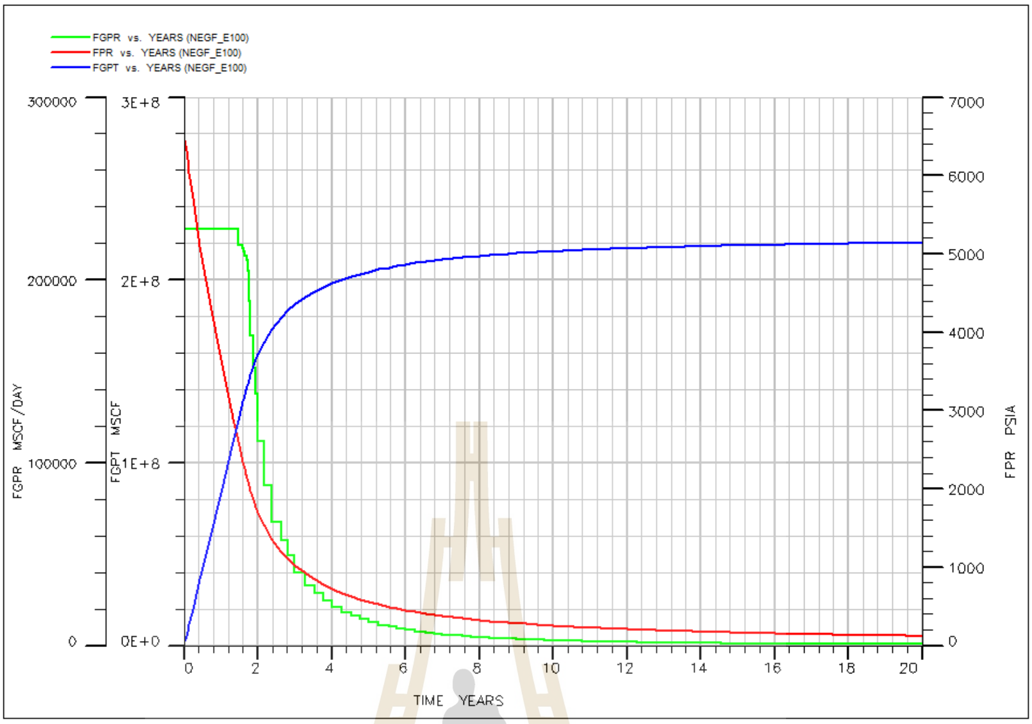

Figure 4.16 Result of simulation after stimulation by acid fracturing

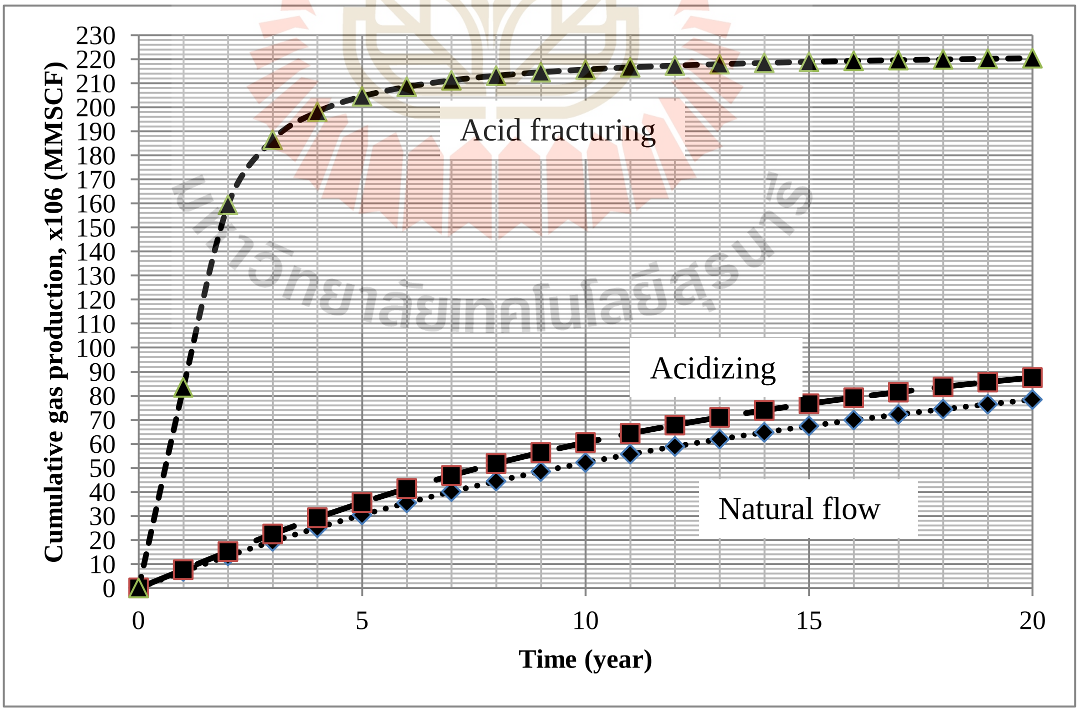

Figure 4.17 Cumulative gas production along production of each cases

CHAPTER V

ECONOMIC EVALUATION

5.1 Objective

The objective of this chapter is to determine economic parameters that used to analyze project investment possibility including of the profit investment ratio (PIR) and internal rate of return (IRR). The 291,371,240,000 SCF with 5 production wells is simulated three cases of reservoir property (natural flow and after well stimulation).

5.2 Exploration and production schedule

The exploration period and production region following under the Petroleum Acts “Thailand III” statute are divided into 4 years of exploration period and 20 years of production period. The work plan of project can summarize as follow.

1st year: Petroleum concession

2nd year: Geological and geophysical survey

3rd year: Drill exploration well

4th year: Drill development well and prepare to start production plan

5th year: Starting the production plan

The reservoir production is divided into 3 cases:

- Reservoir property in case of natural flow
- Reservoir property after stimulation by acidizing
- Reservoir property after stimulation by acid fracturing

The total production wells are five, in the first year of production five wells will be produced. The total gas production rate from Tank model (Chapter III) is listed in Table 3.2.

5.3 Economic Assumption

The petroleum economic studies under the concession system and petroleum economics evaluation of Thailand III (Department of Mineral Resource, 1999) has assumption and detail that into basic assumptions add other assumptions cost.

5.3.1 Basic assumptions

Gas price ($/1,000 SCF)	7.00
Exchange rate (Baht/$)	30.00
Income tax (%)	50
Escalation factor (%)	2
Discount rate (%)	10
Tangible cost (%)	20
Intangible cost (%)	80
Depreciation of tangible cost (%)	20
Reserve size (MMMSCF)	291.371

Sliding scale royalty (%) for gas production following in Table 5.2

Table 5.1 Monthly sale volume (BCF)

Monthly sale volume (BCF)	Rate (%)
0-600	5
600-1,500	6.25
1,500-3,000	10
3,000-6,000	12.5
>6,000	15

Monthly sale volume levels are calculated from production rate level of oil that relate with block by block basic;

Table 5.2 Sliding scale royalty

Production level (MMSCF/month) Rate (%)	Production level (MMSCF/month) Rate (%)
0 - 600	5
600 - 1,500	6.25
1,500 - 3,000	10
3,000 - 6,000	12.5
> 6,000	15

The gas production levels are calculated by using gas and oil heating value condition. In this study it is assumed that one standard cubic foot of gas has heating value equal to 1,000 BTU and a generous conversion factor of 10 million BTU gas to one barrel oil is provide, for example

$$= \left(60{,}000\frac{\text{bbl}}{\text{month}}\right) \text{x} \left(10\text{x}10^6 \frac{\text{BTU}}{\text{bbl}}\right) \text{x} \left(\frac{1}{1{,}000}\frac{\text{cubic feet}}{\text{BTU}}\right)$$

$$= 600\text{x}10^6 \frac{\text{cubic feet}}{\text{month}}$$

5.3.2 Cost assumptions

Expenses and cost used in cash flow analysis are estimated based on 2009 price as follows;

a. Capital cost

Petroleum concession (MMUS$)	0.50
Seismic surveys-2D (MMUS$)	3.00
Seismic surveys-3D (MMUS$)	1.00
Exploration and Appraisal well (MMUS$/well)	20.00
Production well (MMUS$/well)	20.00
Gas pipeline (MMUS$)	7.00
Processing production facilities (MUS$)	140.00
b. Operating cost (US$/MMCF)	1,000

5.3.3 Other assumptions

a. The gas price is constant over the production period.

b. Increasing rate of capital expenditure comes from the price increasing of machinery and equipment used in oil industries, and given to two percent per year.

c. Discount rate of money is 10.00 percent (Bank of Thailand, January 2013).

d. Operating cost is escalated 2 percent each year forward.

e. The expense used in cash flow analysis is listed in Table 5.3.

Table 5.3 Cash flow expenditure cost detail.

Expenditure Cost Detail NE Model	Expenditure Cost Detail NE Model
Concession (Baht)	150,000,000
Geological and geophysical (Baht)	400,000,000
Exploration and apprisal wells (Baht)	1,200,000,000
Production wells without well stimulation(Baht/Well)	240,000,000
Production wells with acidizing (Baht/Well)	360,000,000
Production wells with acid fracturing (Baht/Well)	600,000,000
Pipelines and processing production facilities (Baht)	6,000,000,000
Operation cost (Baht/MMSCF)	2,000
Fixed operation cost (Baht/year)	150,000,000

5.4 Cash flow table explanations

The cash flow table explanations are shown in Table 5.4-5.6. Detail of each column in the cash flow table is explained as follows;

Table 5.4 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of without stimulation

No.	Year	Gas Production					Income (Baht)	Taxable income (Baht)
		Gas in place SCF	Cumulative Gas production (SCF)	(SCF/month)	BOE (Barrel/month)	(SCF/day)		
0								
1	2009							-150,000,000
2	2010							-400,000,000
3	2011							-1,200,000,000
4	2012							-960,000,000
5	2013	291,371,240,000	6,974,400,000	581,200,000	58,120	19,118,421	1,464,624,000	-7,865,419
6	2014	291,371,240,000	13,179,600,000	517,100,000	51,710	17,009,868	1,303,092,000	-161,204,440
7	2015	291,371,240,000	18,837,300,000	471,475,000	47,148	15,509,046	1,188,117,000	-270,350,765
8	2016	291,371,240,000	24,057,000,000	434,975,000	43,498	14,308,388	1,096,137,000	-357,669,149
9	2017	291,371,240,000	28,801,800,000	395,400,000	39,540	13,006,579	996,408,000	-452,338,948
10	2018	291,371,240,000	33,181,800,000	365,000,000	36,500	12,006,579	919,800,000	722,937,582
11	2019	291,371,240,000	37,379,100,000	349,775,000	34,978	11,505,757	881,433,000	686,508,602
12	2020	291,371,240,000	41,394,300,000	334,600,000	33,460	11,006,579	843,192,000	650,200,334
13	2021	291,371,240,000	45,226,800,000	319,375,000	31,938	10,505,757	804,825,000	613,773,661
14	2022	291,371,240,000	48,876,600,000	304,150,000	30,415	10,004,934	766,458,000	577,348,199
15	2023	291,371,240,000	52,344,300,000	288,975,000	28,898	9,505,757	728,217,000	541,043,557
16	2024	291,371,240,000	55,629,300,000	273,750,000	27,375	9,004,934	689,850,000	504,620,637
17	2025	291,371,240,000	58,841,100,000	267,650,000	26,765	8,804,276	674,478,000	490,019,248
18	2026	291,371,240,000	61,614,900,000	231,150,000	23,115	7,603,618	582,498,000	402,725,768
19	2027	291,371,240,000	64,242,900,000	219,000,000	21,900	7,203,947	551,880,000	373,660,428
20	2028	291,371,240,000	66,797,700,000	212,900,000	21,290	7,003,289	536,508,000	359,062,290
21	2029	291,371,240,000	69,279,900,000	206,850,000	20,685	6,804,276	521,262,000	344,584,164
22	2030	291,371,240,000	71,725,200,000	203,775,000	20,378	6,703,125	513,513,000	337,219,640
23	2031	291,371,240,000	74,024,700,000	191,625,000	19,163	6,303,454	482,895,000	308,157,753
24	2032	291,371,240,000	76,251,100,000	185,533,333	18,553	6,103,070	467,544,000	293,581,665
					6,354,258,333		16,012,731,000	3,246,014,807

Table 5.4 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of without stimulation (continued)

No.	Taxable income (Baht) AFTER SRB	Cumulative taxable income (Baht)	Annual cash flow (Baht)	Cumulative annual cash flow (Baht)	COPANY CASH FLOW(Baht)	Cumulative Company Cash(baht)	Discounted Factor, % 10.00	Discounted cash flow (Baht)	Cumulative discounted cash flow (Baht)
0									
1	-150,000,000	-150,000,000	150,000,000	150,000,000	-150,000,000	-150,000,000	0.9090909	-136,363,636	-136,363,636
2	-400,000,000	-550,000,000	550,000,000	700,000,000	-400,000,000	-550,000,000	0.8264463	-330,578,512	-466,942,149
3	-1,200,000,000	-1,750,000,000	1,750,000,000	2,450,000,000	-1,200,000,000	-1,750,000,000	0.7513148	-901,577,761	-1,368,519,910
4	-960,000,000	-2,710,000,000	2,710,000,000	5,160,000,000	-7,200,000,000	-8,950,000,000	0.6830135	-4,917,696,879	-6,286,216,788
5	-7,865,419	-2,717,865,419	2,736,983,840	7,896,983,840	1,244,067,290	-7,705,932,710	0.6209213	772,467,908	-5,513,748,881
6	-161,204,440	-2,879,069,860	2,896,079,728	10,793,063,568	1,167,397,780	-6,538,534,930	0.5644739	658,965,613	-4,854,783,268
7	-270,350,765	-3,149,420,624	3,164,929,670	13,957,993,239	1,112,824,618	-5,425,710,312	0.5131581	571,054,987	-4,283,728,281
8	-357,669,149	-3,507,089,773	3,521,398,162	17,479,391,400	1,069,165,425	-4,356,544,887	0.4665074	498,773,562	-3,784,954,720
9	-452,338,948	-3,959,428,722	3,972,435,301	21,451,826,701	1,021,830,526	-3,334,714,361	0.4240976	433,355,892	-3,351,598,827
10	722,937,582	-3,236,491,139	3,248,497,718	24,700,324,419	361,468,791	-2,973,245,570	0.3855433	139,361,867	-3,212,236,960
11	686,508,602	-2,549,982,537	2,561,488,293	27,261,812,712	343,254,301	-2,629,991,268	0.3504939	120,308,539	-3,091,928,422
12	650,200,334	-1,899,782,203	1,910,788,782	29,172,601,494	325,100,167	-2,304,891,101	0.3186308	103,586,932	-2,988,341,490
13	613,773,661	-1,286,008,542	1,296,514,299	30,469,115,793	306,886,830	-1,998,004,271	0.2896644	88,894,183	-2,899,447,306
14	577,348,199	-708,660,343	718,665,277	31,187,781,071	288,674,100	-1,709,330,172	0.2633313	76,016,913	-2,823,430,394
15	541,043,557	-167,616,786	177,122,543	31,364,903,613	270,521,779	-1,438,808,393	0.239392	64,760,763	-2,758,669,631
16	504,620,637	337,003,851	-327,998,917	31,036,904,696	252,310,319	-1,186,498,074	0.2176291	54,910,077	-2,703,759,554
17	490,019,248	827,023,099	-818,218,823	30,218,685,874	245,009,624	-941,488,451	0.1978447	48,473,848	-2,655,285,706
18	402,725,768	1,229,748,867	-1,222,145,249	28,996,540,625	201,362,884	-740,125,566	0.1798588	36,216,885	-2,619,068,821
19	373,660,428	1,603,409,295	-1,596,205,348	27,400,335,277	186,830,214	-553,295,352	0.163508	30,548,233	-2,588,520,589
20	359,062,290	1,962,471,585	-1,955,468,296	25,444,866,981	179,531,145	-373,764,207	0.1486436	26,686,161	-2,561,834,428
21	344,584,164	2,307,055,749	-2,300,251,472	23,144,615,509	172,292,082	-201,472,126	0.1351306	23,281,927	-2,538,552,500
22	337,219,640	2,644,275,389	-2,637,572,264	20,507,043,245	168,609,820	-32,862,306	0.122846	20,713,038	-2,517,839,463
23	308,157,753	2,952,433,142	-2,946,129,688	17,560,913,556	154,078,877	121,216,571	0.1116782	17,207,245	-2,500,632,218
24	293,581,665	3,246,014,807	-3,239,911,737	14,321,001,819	146,790,833	268,007,404	0.1015256	14,903,027	-2,485,729,191
	3,246,014,807		14,321,001,819		0.00450			-2,485,729,191	

Table 5.5 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of stimulation by acidizing

No.	Year	Gas Production					Income (Baht)	Taxable income (Baht)
		Gas in place SCF	Cumulative Gas production (SCF)	(SCF/month)	BOE (Barrel/month)	(SCF/day)		
0								
1	2009							
2	2010							-150,000,000
3	2011							-400,000,000
4	2012							-1,200,000,000
5	2013	291,371,240,000	7,580,900,000	631,741,667	63,174	20,780,976	1,591,989,000	-1,440,000,000
6	2014	291,371,240,000	14,881,200,000	608,358,333	60,836	20,011,787	1,533,063,000	69,122,053
7	2015	291,371,240,000	21,816,200,000	577,916,667	57,792	19,010,417	1,456,350,000	13,903,209
8	2016	291,371,240,000	28,386,600,000	547,533,333	54,753	18,010,965	1,379,784,000	-39,769,156
9	2017	291,371,240,000	34,408,700,000	501,841,667	50,184	16,507,950	1,264,641,000	-112,463,087
10	2018	291,371,240,000	40,249,100,000	486,700,000	48,670	16,009,868	1,226,484,000	-221,767,025
11	2019	291,371,240,000	45,906,600,000	471,458,333	47,146	15,508,498	1,188,075,000	1,013,996,497
12	2020	291,371,240,000	50,834,100,000	410,625,000	41,063	13,507,401	1,034,775,000	977,521,840
13	2021	291,371,240,000	55,688,800,000	404,558,333	40,456	13,307,840	1,019,487,000	832,015,129
14	2022	291,371,240,000	60,324,500,000	386,308,333	38,631	12,707,511	973,497,000	817,486,494
15	2023	291,371,240,000	64,594,800,000	355,858,333	35,586	11,705,866	896,763,000	773,822,688
16	2024	291,371,240,000	68,609,600,000	334,566,667	33,457	11,005,482	843,108,000	700,985,755
17	2025	291,371,240,000	72,259,800,000	304,183,333	30,418	10,006,031	766,542,000	650,052,035
18	2026	291,371,240,000	75,618,100,000	279,858,333	27,986	9,205,866	705,243,000	577,379,743
19	2027	291,371,240,000	78,702,000,000	256,991,667	25,699	8,453,673	647,619,000	519,197,112
20	2028	291,371,240,000	81,622,200,000	243,350,000	24,335	8,004,934	613,242,000	464,503,955
21	2029	291,371,240,000	84,396,000,000	231,150,000	23,115	7,603,618	582,498,000	431,870,870
22	2030	291,371,240,000	86,878,000,000	206,833,333	20,683	6,803,728	521,220,000	402,686,147
23	2031	291,371,240,000	89,140,800,000	188,566,667	18,857	6,202,851	475,188,000	344,532,019
24	2032	291,371,240,000	91,283,200,000	178,533,333	17,853	5,872,807	449,904,000	300,845,560
				7,606,933,333			19,169,472,000	276,845,742

Table 5.5 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of stimulation by acidizing (continued)

No.	Taxable income (Baht) AFTER SRB	Cumulative taxable income (Baht)	Annual cash flow (Baht)	Cumulative annual cash flow (Baht)	COPANY CASH FLOW(Baht)	Cumulative Company Cash(baht)	Discounted Factor, % 10.00	Discounted cash flow (Baht)	Cumulative discounted cash flow (Baht)
0									
1			-150,000,000				1		
2	-150,000,000	-150,000,000	-400,000,000	-150,000,000	-150,000,000	-150,000,000	0.9090909	-136,363,636	-136,363,636
3	-400,000,000	-550,000,000	-1,200,000,000	-550,000,000	-400,000,000	-550,000,000	0.8264463	-330,578,512	-466,942,149
4	-1,200,000,000	-1,750,000,000	-1,440,000,000	-1,750,000,000	-1,200,000,000	-1,750,000,000	0.7513148	-901,577,761	-1,368,519,910
5	-1,440,000,000	-3,190,000,000	34,561,026	-3,190,000,000	-7,800,000,000	-9,550,000,000	0.6830135	-5,327,504,952	-6,696,024,862
6	69,122,053	-3,120,877,947	6,951,604	-3,155,438,974	1,306,561,026	-8,243,438,974	0.6209213	811,271,601	-5,884,753,261
7	13,903,209	-3,106,974,739	-19,884,578	-3,148,487,369	1,278,951,604	-6,964,487,369	0.5644739	721,934,839	-5,162,818,422
8	-39,769,156	-3,146,743,895	-56,231,544	-3,168,371,947	1,252,115,422	-5,712,371,947	0.5131581	642,533,194	-4,520,285,228
9	-112,463,087	-3,259,206,982	-110,883,512	-3,224,603,491	1,215,768,456	-4,496,603,491	0.4665074	567,164,957	-3,953,120,271
10	-221,767,025	-3,480,974,007	506,998,248	-3,335,487,003	1,161,116,488	-3,335,487,003	0.4240976	492,426,737	-3,460,693,534
11	1,013,996,497	-2,466,977,510	488,760,920	-2,828,488,755	506,998,248	-2,828,488,755	0.3855433	195,469,772	-3,265,223,761
12	977,521,840	-1,489,455,670	416,007,564	-2,339,727,835	488,760,920	-2,339,727,835	0.3504939	171,307,721	-3,093,916,041
13	832,015,129	-657,440,541	408,743,247	-1,923,720,271	416,007,564	-1,923,720,271	0.3186308	132,552,830	-2,961,363,210
14	817,486,494	160,045,953	386,911,344	-1,514,977,023	408,743,247	-1,514,977,023	0.2896644	118,398,359	-2,842,964,851
15	773,822,688	933,868,641	350,492,877	-1,128,065,679	386,911,344	-1,128,065,679	0.2633313	101,885,850	-2,741,079,002
16	700,985,755	1,634,854,396	325,026,017	-777,572,802	350,492,877	-777,572,802	0.239392	83,905,208	-2,657,173,793
17	650,052,035	2,284,906,431	288,689,871	-452,546,785	325,026,017	-452,546,785	0.2176291	70,735,131	-2,586,438,662
18	577,379,743	2,862,286,174	259,598,556	-163,856,913	288,689,871	-163,856,913	0.1978447	57,115,752	-2,529,322,910
19	519,197,112	3,381,483,285	232,251,978	95,741,643	259,598,556	95,741,643	0.1798588	46,691,082	-2,482,631,828
20	464,503,955	3,845,987,240	215,935,435	327,993,620	232,251,978	327,993,620	0.163508	37,975,054	-2,444,656,774
21	431,870,870	4,277,858,110	201,343,073	543,929,055	215,935,435	543,929,055	0.1486436	32,097,426	-2,412,559,347
22	402,686,147	4,680,544,257	172,266,010	745,272,128	201,343,073	745,272,128	0.1351306	27,207,604	-2,385,351,743
23	344,532,019	5,025,076,276	150,422,780	917,538,138	172,266,010	917,538,138	0.122846	21,162,186	-2,364,189,557
24	300,845,560	5,325,921,836	138,422,871	1,067,960,918	150,422,780	1,067,960,918	0.1116782	16,798,939	-2,347,390,618
	276,845,742	5,602,767,578	1,206,383,789	1,206,383,789	138,422,871	1,206,383,789	0.1015256	14,053,465	-2,333,337,153

Table 5.6 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of stimulation by acid fracturing

No.	Year	Gas Production					Income (Baht)	Taxable income (Baht)
		Gas in place SCF	Cumulative Gas production (SCF)	(SCF/month)	BOE (Barrel/month)	(SCF/day)		
0	-	-	-	-	-	-	-	-
1	2009	-	-	-	-	-	-	-150,000,000
2	2010	-	-	-	-	-	-	-400,000,000
3	2011	-	-	-	-	-	-	-1,200,000,000
4	2012	-	-	-	-	-	-	-2,400,000,000
5	2013	291,371,240,000	83386260000	6,948,855,000	694,886	228,580,757	17,511,114,600	13,399,404,082
6	2014	291,371,240,000	1.66773E+11	6,948,853,333	694,885	228,580,702	17,511,110,400	13,399,099,649
7	2015	291,371,240,000	2.50159E+11	6,948,858,333	694,886	228,580,866	17,511,123,000	13,398,803,464
8	2016	291,371,240,000	2.70256E+11	1,674,741,667	167,474	55,090,186	4,220,349,000	2,324,466,597
9	2017	291,371,240,000	2.72785E+11	210,783,333	21,078	6,933,662	531,174,000	-965,878,633
10	2018	291,371,240,000	2.72975E+11	15,816,667	1,582	520,285	39,858,000	-112,172,705
11	2019	291,371,240,000	2.73023E+11	4,033,333	403	132,675	10,164,000	-140,354,033
12	2020	291,371,240,000	2.73043E+11	1,608,333	161	52,906	4,053,000	-146,153,650
13	2021	291,371,240,000	2.73054E+11	916,667	92	30,154	2,310,000	-147,807,825
14	2022	291,371,240,000	2.73059E+11	483,333	48	15,899	1,218,000	-148,844,150
15	2023	291,371,240,000	2.73063E+11	325,000	32	10,691	819,000	-149,222,808
16	2024	291,371,240,000	2.73067E+11	266,667	27	8,772	672,000	-149,362,318
17	2025	291,371,240,000	2.73096E+11	2,433,333	243	80,044	6,132,000	-144,181,281
18	2026	291,371,240,000	2.73098E+11	200,000	20	6,579	504,000	-149,521,760
19	2027	291,371,240,000	2.731E+11	150,000	15	4,934	378,000	-149,641,328
20	2028	291,371,240,000	2.73101E+11	125,000	13	4,112	315,000	-149,701,114
21	2029	291,371,240,000	2.73103E+11	125,000	13	4,112	315,000	-149,701,121
22	2030	291,371,240,000	2.73104E+11	91,667	9	3,015	231,000	-149,780,828
23	2031	291,371,240,000	2.73105E+11	75,000	8	2,467	189,000	-149,820,682
24	2032	291,371,240,000	2.73106E+11	75,000	7	2,467	189,000	-149,820,687
				22,758,816,667			57,352,218,000	35,219,808,868

Table 5.6 The cash flow table calculates income, annual cash flow, and cumulative discounted cash flow of stimulation by acid fracturing (continued)

No.	Taxable income (Baht) AFTER SRB	Cumulative taxable income (Baht)	Annual cash flow (Baht)	Cumulative annual cash flow (Baht)	COPANY CASH FLOW(Baht)	Cumulative Company Cash(baht)	Discounted Factor, % 10.00	Discounted cash flow (Baht)	Cumulative discounted cash flow (Baht)
1	-150,000,000	-150,000,000	-150,000,000	-150,000,000	-150,000,000	-150,000,000	0.9090909	-136,363,636	-136,363,636
2	-400,000,000	-550,000,000	-400,000,000	-550,000,000	-400,000,000	-550,000,000	0.8264463	-330,578,512	-466,942,149
3	-1,200,000,000	-1,750,000,000	-1,200,000,000	-1,750,000,000	-1,200,000,000	-1,750,000,000	0.7513148	-901,577,761	-1,368,519,910
4	-2,400,000,000	-4,150,000,000	-2,400,000,000	-4,150,000,000	-9,000,000,000	-10,750,000,000	0.6830135	-6,147,121,098	-7,515,641,008
5	13,399,404,082	9,249,404,082	6,699,702,041	2,549,702,041	8,019,702,041	-2,730,297,959	0.6209213	4,979,604,002	-2,536,037,006
6	13,399,099,649	22,648,503,731	6,699,549,824	9,249,251,865	8,019,549,824	5,289,251,865	0.5644739	4,526,826,807	1,990,789,800
7	13,398,803,464	36,047,307,194	6,699,401,732	15,948,653,597	8,019,401,732	13,308,653,597	0.5131581	4,115,221,102	6,106,010,902
8	1,927,012,845	37,974,320,040	963,506,423	16,912,160,020	2,283,506,423	15,592,160,020	0.4665074	1,065,272,599	7,171,283,501
9	-965,878,633	37,008,441,407	-482,939,316	16,429,220,703	837,060,684	16,429,220,703	0.4240976	354,995,442	7,526,278,944
10	-112,172,705	36,896,268,702	-56,086,352	16,373,134,351	-56,086,352	16,373,134,351	0.3855433	-21,623,717	7,504,655,227
11	-140,354,033	36,755,914,669	-70,177,017	16,302,957,334	-70,177,017	16,302,957,334	0.3504939	-24,596,616	7,480,058,611
12	-146,153,650	36,609,761,019	-73,076,825	16,229,880,510	-73,076,825	16,229,880,510	0.3186308	-23,284,528	7,456,774,082
13	-147,807,825	36,461,953,194	-73,903,913	16,155,976,597	-73,903,913	16,155,976,597	0.2896644	-21,407,331	7,435,366,751
14	-148,844,150	36,313,109,044	-74,422,075	16,081,554,522	-74,422,075	16,081,554,522	0.2633313	-19,597,658	7,415,769,093
15	-149,222,808	36,163,886,236	-74,611,404	16,006,943,118	-74,611,404	16,006,943,118	0.239392	-17,861,377	7,397,907,716
16	-149,362,318	36,014,523,918	-74,681,159	15,932,261,959	-74,681,159	15,932,261,959	0.2176291	-16,252,796	7,381,654,920
17	-144,181,281	35,870,342,638	-72,090,640	15,860,171,319	-72,090,640	15,860,171,319	0.1978447	-14,262,749	7,367,392,171
18	-149,521,760	35,720,820,877	-74,760,880	15,785,410,439	-74,760,880	15,785,410,439	0.1798588	-13,446,401	7,353,945,770
19	-149,641,328	35,571,179,549	-74,820,664	15,710,589,774	-74,820,664	15,710,589,774	0.163508	-12,233,776	7,341,711,993
20	-149,701,114	35,421,478,435	-74,850,557	15,635,739,217	-74,850,557	15,635,739,217	0.1486436	-11,126,058	7,330,585,935
21	-149,701,121	35,271,777,313	-74,850,561	15,560,888,657	-74,850,561	15,560,888,657	0.1351306	-10,114,599	7,320,471,336
22	-149,780,828	35,121,996,485	-74,890,414	15,485,998,243	-74,890,414	15,485,998,243	0.122846	-9,199,986	7,311,271,350
23	-149,820,682	34,972,175,803	-74,910,341	15,411,087,902	-74,910,341	15,411,087,902	0.1116782	-8,365,849	7,302,905,501
24	-149,820,687	34,822,355,117	-74,910,343	15,336,177,558	-74,910,343	15,336,177,558	0.1015256	-7,605,317	7,295,300,184
	34,822,355,117		15,336,177,558		0.47943			7,295,300,184	

Amortization is 20 percent of tangible cost and it will be accounted for 5 years forward. Net present value, profit investment ratio, and interest rate of return are calculated by the equations below;

a. Net present value (NPV)

$$NPV = A \times (1 + i)^{-n} \quad (5.1)$$

where A = the net cash flow

n = the amount of year

i = the discount rate.

b. Profit to investment ratio (PIR)

Profit to investment ratio is the ratio of sum of net cash flow divided by sum of CAPEX

$$PIR = \frac{\sum(\text{Net cash flow})}{\sum(\text{CAPEX})} \quad (5.2)$$

c. Internal rate of return (IRR)

Using trial & error to find I value. I value make the lower equation to be zero when replace I in the equation.

$$0 = (-C) + A(1 + I)^{-1} + A(1 + I)^{-2} + \ldots + A(1 + I)^{-n} \quad (5.3)$$

where C = negative net cash flow value

A = net cash flow value

I = the assume value

5.5 Result of cash flow analysis

The cash flow is calculated at 30 baht/US$ of exchange rate, 7 $/1,000SCF of gas price. The results of economics evaluation (Table5.7) is divided into 3 cases

1) Cash flow of natural flow

From total of cash flow analysis shows the total study worth of 20th years of Tank model which is natural flow process. The total worth is divided in to gross sale income 16,013 M baht and total cost 8,950 M baht. The internal rate of return no discount as equal to 0.45%. The cash flow still be minus until at the end of year production

2) Cash flow of reservoir after stimulation by acidizing

From total of cash flow analysis shows the total study worth of 20th years of Tank model which is flow after acidizing process. The total worth is divided in to gross sale income 19,169 M baht and total cost 9,950 M baht. The internal rate of return no discount as equal to 1.84%. Although, stimulated by acidizing to get higher production rate, this method is not enough to get better production rate. The production rate increased a little as the results of income that the cash flow still is minus value until at the end of year production

3) Cash flow of reservoir after stimulation by acid fracturing

After stimulated reservoir by acid fracturing and used the results to calculate cash flow show the better results. From total of cash flow analysis shows the total study worth of 20th years of Tank model which is flow after fracturing. The total worth is divided in to gross sale income 57,352 M baht and total cost 10,750 M baht. The high production rate in year 1st to 3rd has an effect to increasing of income and slightly decline after the end of year 3rd. The natural gas production has completely paid back in the 6th year of production with internal rate of return around 35%.

Table 5.7 Summary of calculations of economic evaluation

	Natural flow	Acidizing	Acid fracturing
Gas in place, SCF	291,371,240,000	291,371,240,000	291,371,240,000
Cumulative gas production, SCF	76,251,100,000	91,283,200,000	273,105,800,000
Exchange rate, Baht/$	30.00	30.00	30.00
Gas price, $/1,000 SCF	7.00	7.00	7.00
Income, bath	16,012,731,000	19,169,472,000	57,352,218,000
Royalty, baht	800,636,550	997,536,750	8,331,963,150
Operation cost, baht	3,016,079,643	3,019,167,672	3,050,445,982
Total allow expense+SRB, baht	12,766,716,193	13,566,704,422	22,529,862,883
Taxable income after SRB, baht	3,246,014,807	5,602,767,578	34,822,355,117
Income tax, baht	2,978,007,404	4,396,383,789	19,486,177,558
Annual cash flow, baht	268,007,404	1,206,383,789	15,336,177,558
Discounted cash flow, baht	-2,485,729,191	-2,333,337,153	7,295,300,184
Total investment, baht	8,950,000,000	9,550,000,000	10,750,000,000
Profit to investment Ratio (PIR)	0.03	0.13	1.43
Net cash flow10%Discount(Baht), baht	-2,485,729,191	-2,333,337,153	7,295,300,184
Internal rate of return (IRR)10%disc.	-8.68%	-7.42%	34.49%
Profit to Investment Ratio (PIR)	-0.40	-0.35	0.97
Payout period, year	-	-	6.00
IRR no discount	0.45%	1.84%	47.94%

CHAPTER VI

CONCLUSIONS AND RECOMENDATIONS

6.1 Conclusions

The main objective of the research is to improve and increase production efficiency in carbonate reservoir of northeastern Thailand.

Well stimulation by acid is calculated from acid stimulation program. In the part of well stimulation, in this study reservoir model is carbonate reservoir with acidizing and acid fracturing to increase permeability and production rate. The important factors of acidizing are acid type, acid concentration, and time. Hydraulic horse power and acid types are important factor of acid fracturing.

At the same condition, acid fracturing gave higher value of permeability than acidizing and natural flow. Production rate is increased highly after stimulated acid fracturing followed by acidizing about 1,096 and 8.7%, respectively from 19.11 MMSCF of natural flow.

The comparison of production efficiency results from acid stimulation program and reservoir simulation (Eclipse 2013.1) in Figure 6.1 to 6.3 shows that at the first period 1^{st} to 3^{rd} from program gave the results closely with Eclipse but almost higher decline in next year. The results of acid fracturing from program gave the results closely with Eclipse, the program produce gas with constant for 4 years. After that production rate highly decline next 2 year and slightly decline until the end of year 20th.

The cash flow table in chapter 3 can be conclude that stimulation by acid fracturing gave the highest IRR is 34.49%, and paid back period at year 6th. Acidizing and natural flow will not be economically produce because the internal rate of return is minus.

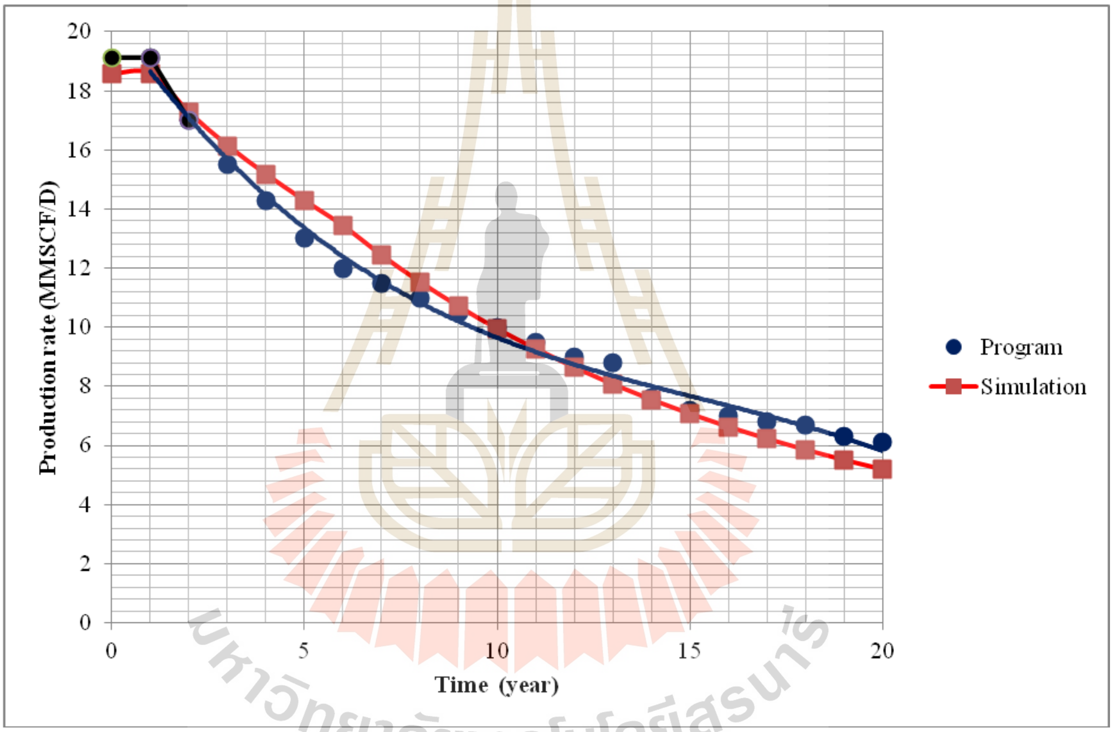

Figure 6.1 The relationship between production rate and time of natural flow

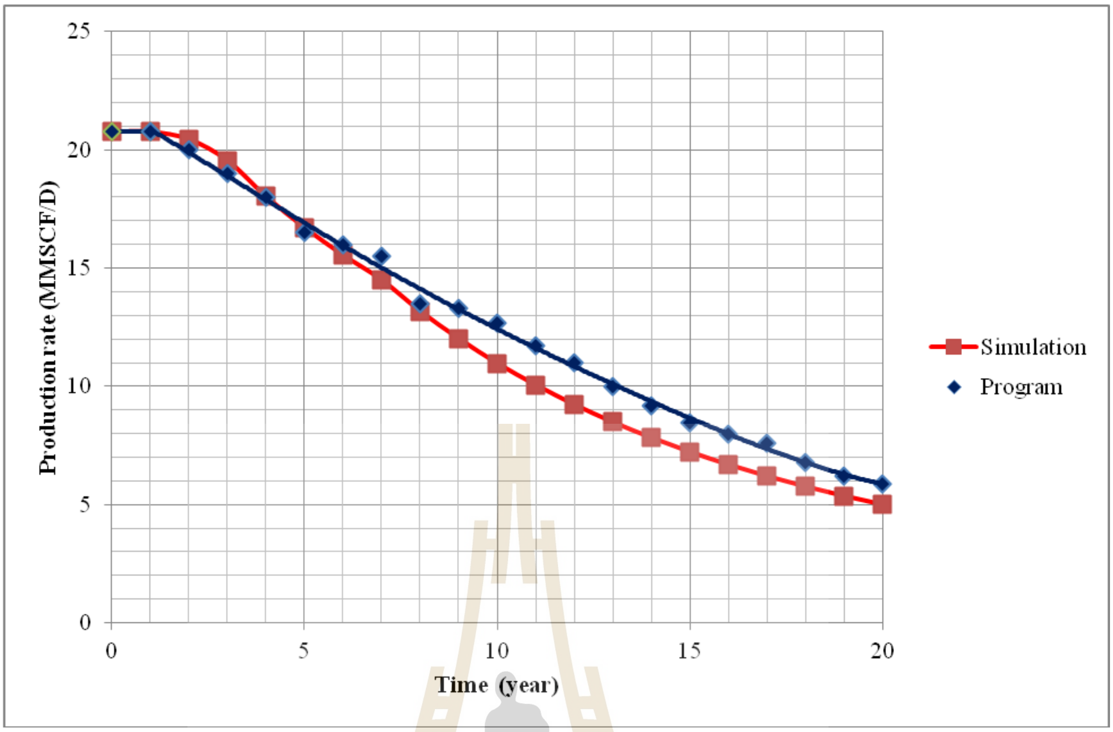

Figure 6.2 The relationship between production rate and time after acidizing

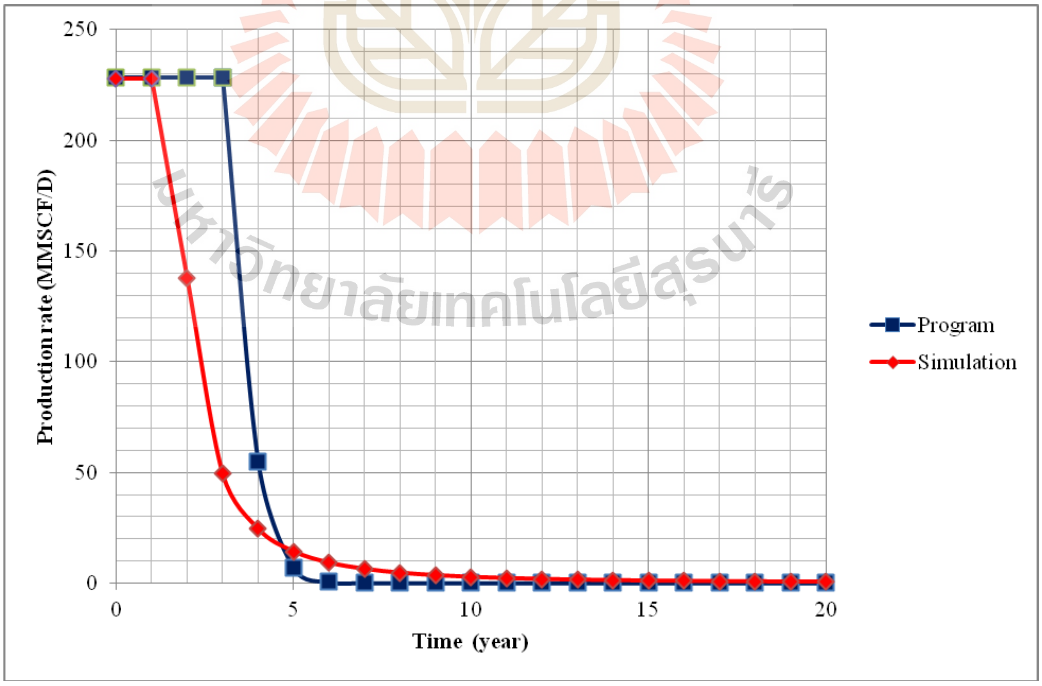

Figure 6.3 The relationship between production rate and time after acid fracturing

6.2 Recommendations

1) The research should study and learn to understand the gas flow, acidizing and acid fracturing.

2) The research should know about basic of visual basic program because the visual basic program is used for creating well stimulation design

3) The limitation of well stimulation program is it can predict the petroleum production rate on one well

4) The well stimulation is used in carbonate reservoir.

5) Carbonate reservoir is heterogeneous reservoir, the using of program correct the permeability is more important.

6) This program can be applied at reservoir depth more than 3,000 ft as carbonate reservoir in northeastern Thailand.

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APPENDIX A

POROSITY AND PERMEABILITY DISTRIBUTION

A.1 Porosity distribution of reservoir model

Table A.1.1 Porosity distribution of 1st layer of NE field

0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.06	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.05	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.047	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.05	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.065	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06

Table A.1.2 Porosity distribution of 2nd layer of NE field

0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.059	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.049	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.046	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.046	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059
0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059	0.059

Table A.1.3 Porosity distribution of 3rd layer of NE field

0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.053	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.058	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.048	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.045	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.063	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058
0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058	0.058

Table A.1.4 Porosity distribution of 4th layer of NE field

0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.052	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.057	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.047	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.044	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.062	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057
0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057	0.057

Table A.1.5 Porosity distribution of 5th layer of NE field

0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.051	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.056	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.046	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.053	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.061	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056
0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056	0.056

Table A.1.6 Porosity distribution of 6th layer of NE field

0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.05	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.055	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.045	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.052	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048	0.048
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.06	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055

Table A.1.7 Porosity distribution of 7th layer of NE field

0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.049	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.054	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.044	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039	0.039
0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.051	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047	0.047
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.059	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054

Table A.1.8 Porosity distribution of 8th layer of NE field

0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.048	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.053	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.043	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038	0.038
0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.05	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.058	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053
0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0.053

Table A.1.9 Porosity distribution of 9th layer of NE field

0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.047	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.052	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.042	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.049	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.057	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052

Table A.1.10 Porosity distribution of 10^{th} layer of NE field

0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.046	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.051	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.041	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036	0.036
0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.048	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044	0.044
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.056	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051
0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.051

A.2 Permeability distribution of reservoir model

Table A.2.1 Permeability distribution of 1st layer of NE field by natural flow

0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.43	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.35	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Table A.2.2 Permeability distribution of 2nd layer of NE field by natural flow

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.59	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.42	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.34	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

Table A.2.3 Permeability distribution of 3rd layer of NE field by natural flow

0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.66	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.58	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.32	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.72	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68

Table A.2.4 Permeability distribution of 4th layer of NE field by natural flow

0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.64	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.4	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.3	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.71	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65

Table A.2.5 Permeability distribution of 5th layer of NE field by natural flow

0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.62	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.85	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.38	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.67	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.68	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63

Table A.2.6 Permeability distribution of 6th layer of NE field by natural flow

0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.9	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.82	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.7	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.65	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.67	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62

Table A.2.7 Permeability distribution of 7th layer of NE field by natural flow

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.58	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.8	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.68	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.63	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.65	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Table A.2.8 Permeability distribution of 8th layer of NE field by natural flow

0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.92	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.78	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.66	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.6	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.64	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59

Table A.2.9 Permeability distribution of 9th layer of NE field by natural flow

0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.88	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.76	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.64	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.62	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58

Table A.2.10 Permeability distribution of 10th layer of NE field by natural flow

0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.52	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.74	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.58	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.56	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.6	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

Table A.2.11 Permeability distribution of 1st layer of NE field by acidizing stimulation

0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.07	0.5	0.5	0.5	0.5	1.07	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.94	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.43	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.78	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.35	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.27	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Table A.2.12 Permeability distribution of 2nd layer of NE field by acidizing stimulation

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	1.04	0.48	0.48	0.48	0.48	1.04	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.59	0.39	0.39	0.39	0.92	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.42	0.39	0.92	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.34	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	1.26	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

Table A.2.13 Permeability distribution of 3^{rd} layer of NE field by acidizing stimulation

0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	1.03	0.47	0.47	0.47	0.47	1.03	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.66	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.58	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.91	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.75	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.32	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.72	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	1.25	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68

Table A.2.14 Permeability distribution of 4th layer of NE field by acidizing stimulation

0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	1.01	0.45	0.45	0.45	0.45	1.01	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.64	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	1.35	0.8	0.8	0.8	0.8	0.8	0.8
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.4	0.36	0.88	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.3	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.71	0.65	1.2	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65

Table A.2.15 Permeability distribution of 5th layer of NE field by acidizing stimulation

0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.99	0.44	0.44	0.44	0.44	0.99	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.62	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.85	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.71	0.71	0.71	1.28	0.71	0.71	0.71	0.71	0.71	0.71
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.38	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.2	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.67	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.68	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	1.2	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63

Table A.2.16 Permeability distribution of 6th layer of NE field by acidizing stimulation

0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	1.33	0.78	0.78	0.78	0.78	1.33	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.9	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.82	0.7	0.7	0.7	1.33	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.7	0.62	1.2	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.65	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.67	0.62	1.2	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62

Table A.2.17 Permeability distribution of 7th layer of NE field by acidizing stimulation

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	1.04	0.48	0.48	0.48	0.48	1.04	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.58	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.8	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.62	0.62	0.62	0.62	1.2	0.62	0.62	0.62	0.62	0.62	0.62
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.68	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	1.19	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.63	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.65	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	1.18	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Table A.2.18 Permeability distribution of 8th layer of NE field by acidizing stimulation

0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	1.32	0.76	0.76	0.76	0.76	1.32	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.92	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.78	0.6	0.6	1.18	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.66	1.18	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.6	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.64	1.17	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59

Table A.2.19 Permeability distribution of 9th layer of NE field by acidizing stimulation

0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	1.28	0.72	0.72	0.72	0.72	1.28	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.88	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.76	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	1.16	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.64	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	1.11	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.62	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	1.06	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58

Table A.2.20 Permeability distribution of 10^{th} layer of NE field by acidizing stimulation

0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.52	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.74	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	1.31	0.56	0.56	0.56	0.56	1.31	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.58	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.56	0.52	0.52	1.13	0.52	0.52	0.52	0.52	0.52
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.6	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	1.16	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	1.18	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

Table A.2.21 Permeability distribution of 1st layer of NE field by acid fracturing stimulation

0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	3.3	0.5	0.5	0.5	0.5	3.3	0.5	0.5	0.5	0.5
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.6	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	2.64	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.43	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	1.98	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.35	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	4.62	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Table A.2.22 Permeability distribution of 2nd layer of NE field by acid fracturing stimulation

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	3.16	0.48	0.48	0.48	0.48	3.16	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.59	0.39	0.39	0.39	2.57	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.42	0.39	2.57	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.34	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	4.55	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.73	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69

Table A.2.23 Permeability distribution of 3rd layer of NE field by acid fracturing stimulation

0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	3.1	0.47	0.47	0.47	0.47	3.1	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.66	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.58	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	2.51	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.41	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	1.85	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.32	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.72	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	4.48	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68
0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68

Table A.2.24 Permeability distribution of 4th layer of NE field by acid fracturing stimulation

0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	2.97	0.45	0.45	0.45	0.45	2.97	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.64	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.8	5.27	0.8	0.8	0.8	0.8	0.8	0.8
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.4	0.36	2.37	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.3	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.71	0.65	4.29	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65

Table A.2.25 Permeability distribution of 5th layer of NE field by acid fracturing stimulation

0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	2.9	0.44	0.44	0.44	0.44	2.9	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.62	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.85	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71
0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.71	0.71	0.71	4.68	0.71	0.71	0.71	0.71	0.71	0.71
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.38	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	4.15	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.67	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.68	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	4.15	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63

Table A.2.26 Permeability distribution of 6th layer of NE field by acid fracturing stimulation

0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	5.14	0.78	0.78	0.78	0.78	5.14	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.9	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.82	0.7	0.7	0.7	4.62	0.7	0.7	0.7	0.7	0.7	0.7
0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.7	0.62	4.09	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.65	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.67	0.62	4.09	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62

Table A.2.27 Permeability distribution of 7th layer of NE field by acid fracturing stimulation

0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	3.16	0.48	0.48	0.48	0.48	3.16	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.58	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.8	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62	0.62
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.62	0.62	0.62	0.62	4.09	0.62	0.62	0.62	0.62	0.62	0.62
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.68	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	4.02	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.63	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.65	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	3.96	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6

Table A.2.28 Permeability distribution of 8th layer of NE field by acid fracturing stimulation

0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	5.01	0.76	0.76	0.76	0.76	5.01	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.92	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.78	0.6	0.6	3.96	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.66	3.96	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.6	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.64	3.89	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59
0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.59

Table A.2.29 Permeability distribution of 9th layer of NE field by acid fracturing stimulation

0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	4.75	0.72	0.72	0.72	0.72	4.75	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.88	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.76	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	3.82	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.64	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	3.56	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.62	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	3.82	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58
0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58

Table A.2.30 Permeability distribution of 10th layer of NE field by acid fracturing stimulation

0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	3..30	0.5	0.5	0.5	0.5	3.3	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.52	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.74	0.56	3.69	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	3.82	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.56	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	3.96	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56
0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56

APPENDIX B

VERTICAL NET THICKNESS OF EACH LAYER

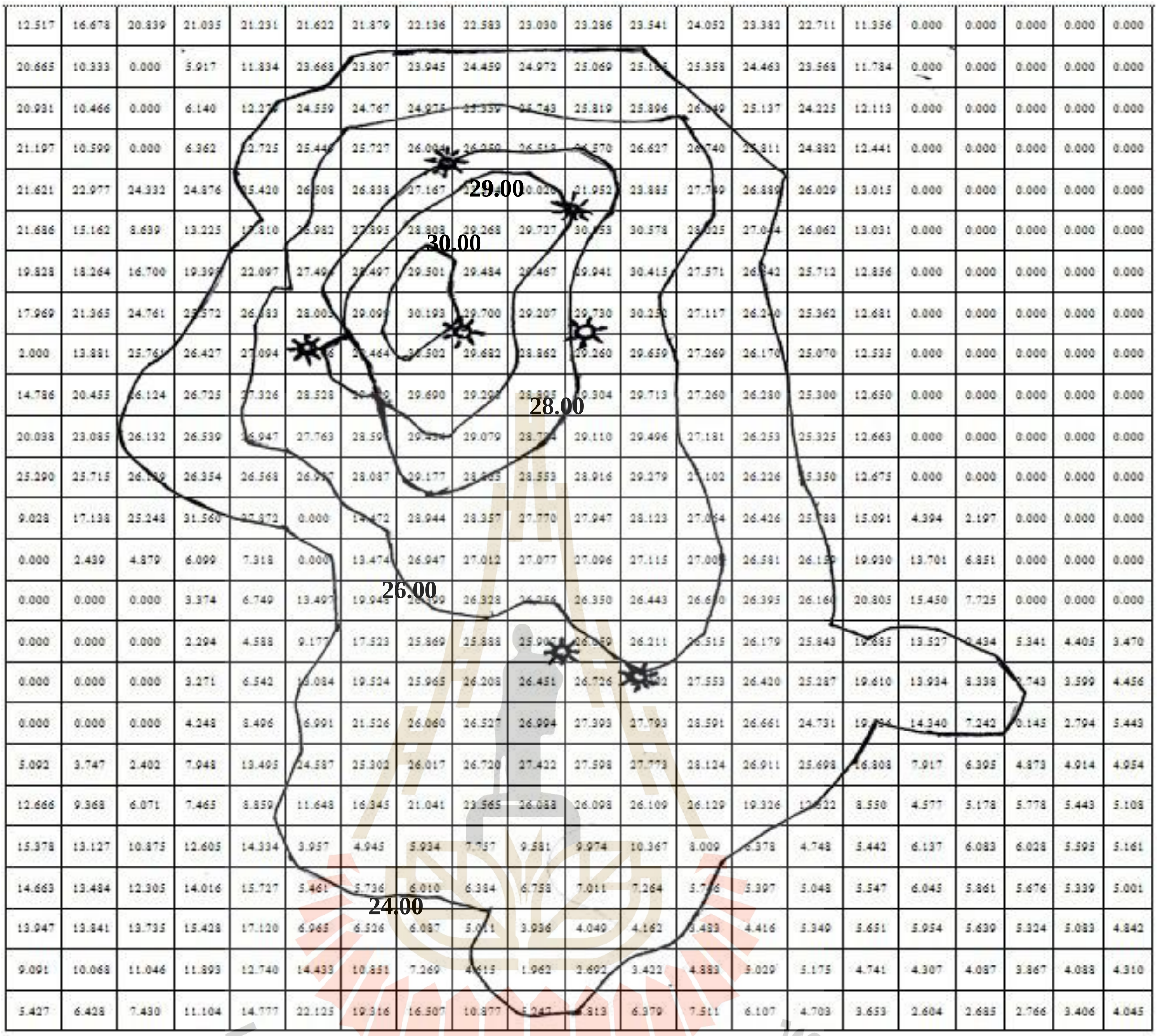

Figure B.1 Vertical net thickness of layer 1st

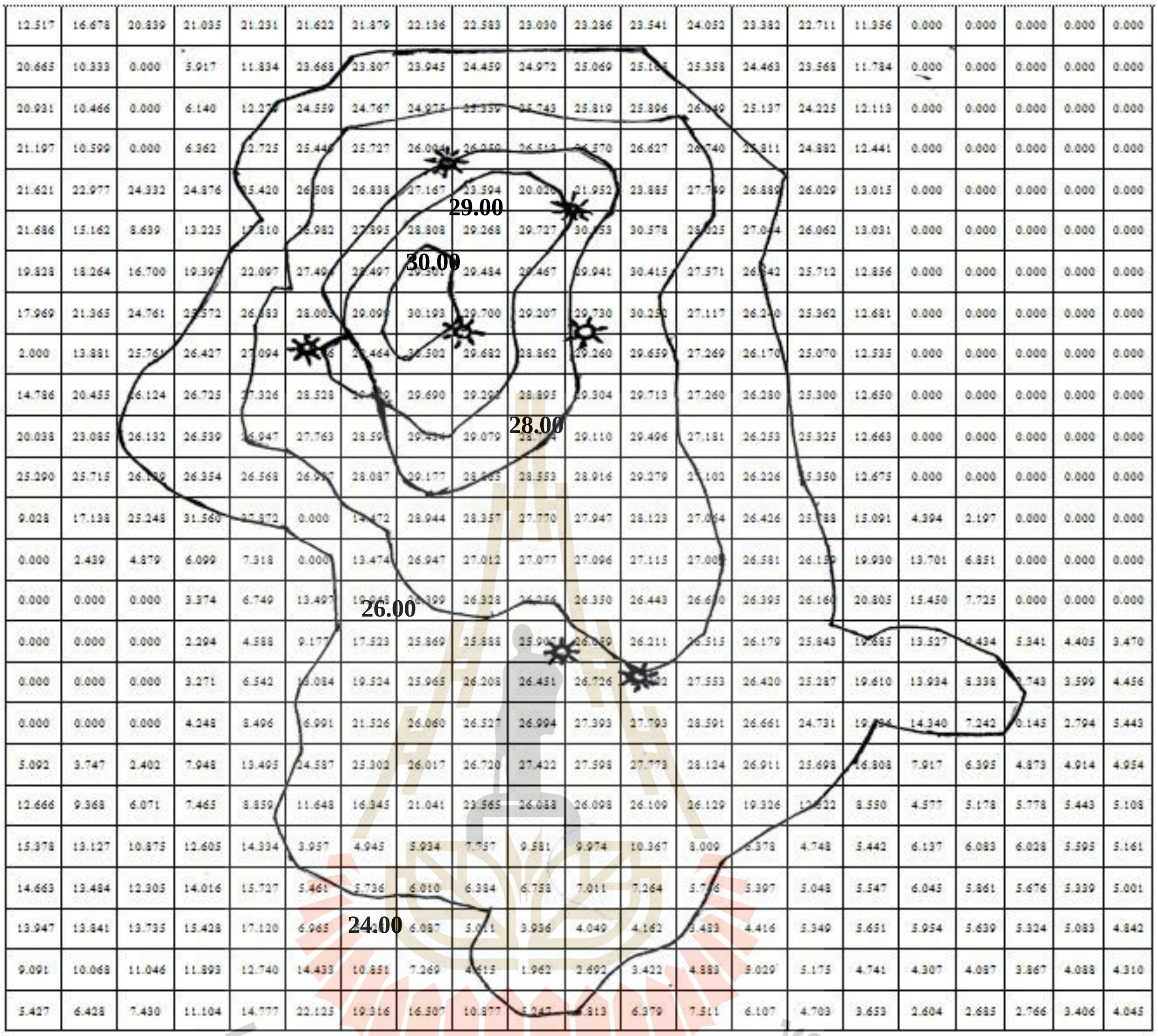

Figure B.2 Vertical net thickness of layer 2nd

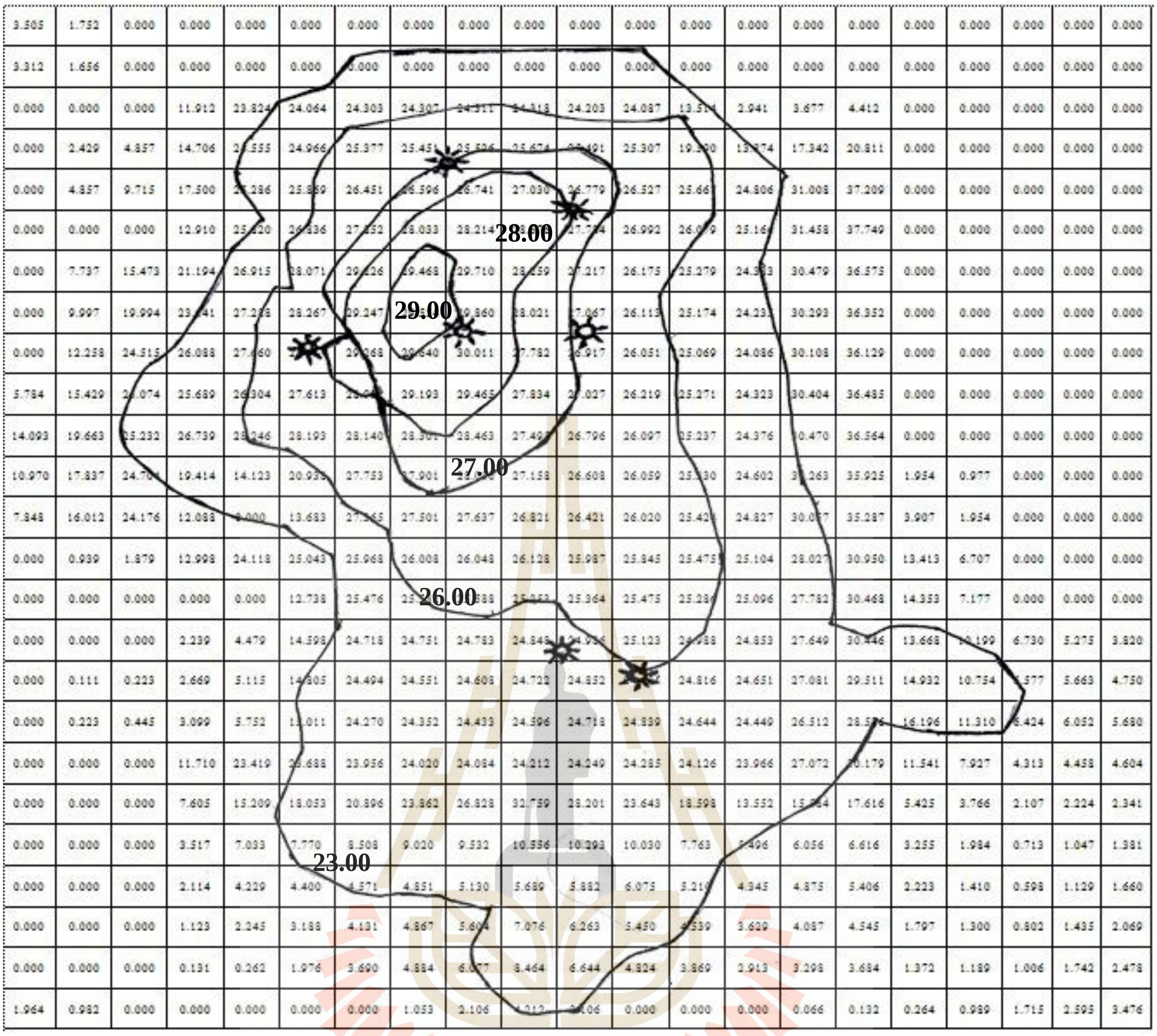

Figure B.3 Vertical net thickness of layer 3rd

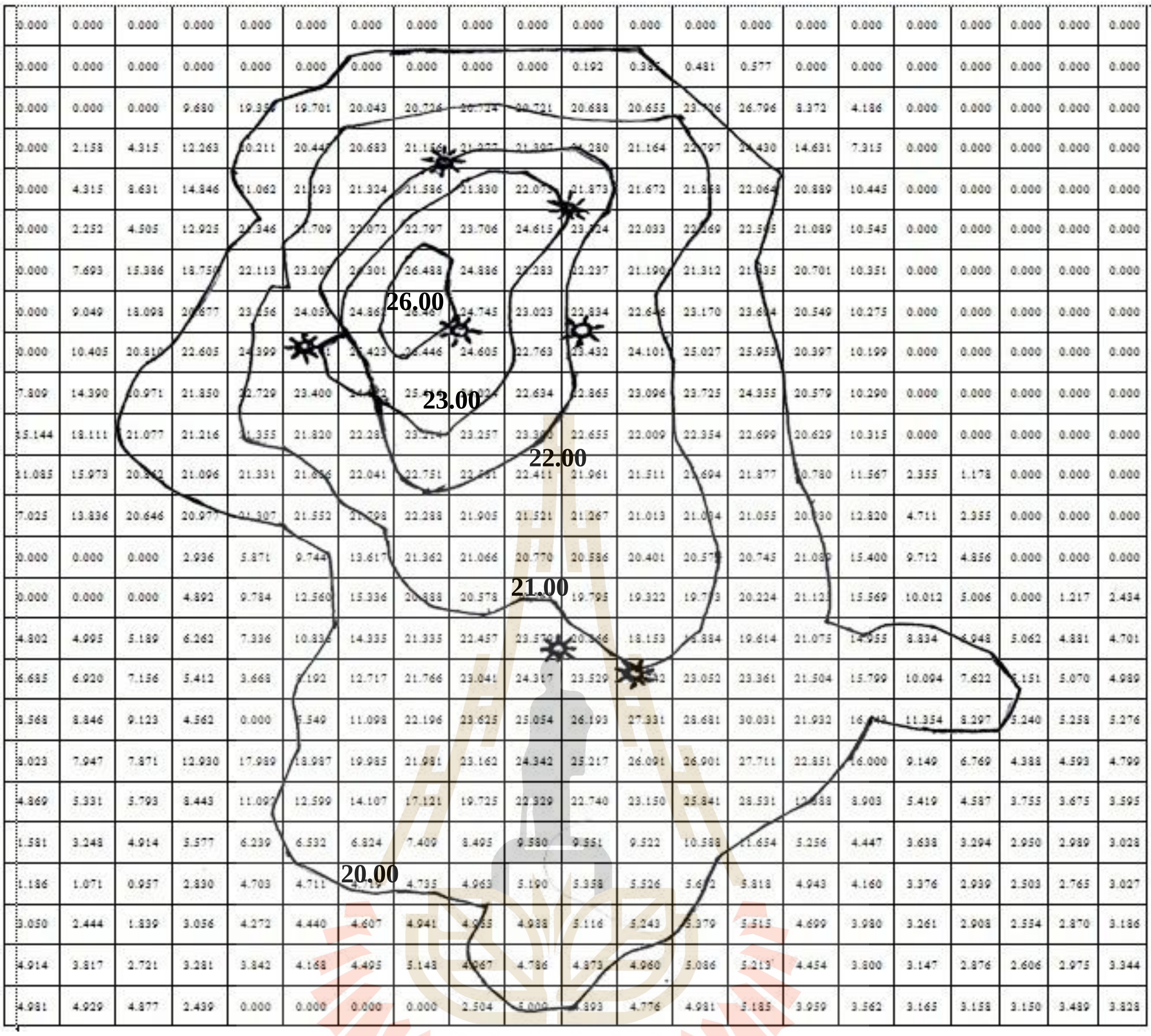

Figure B.4 Vertical net thickness of layer 4th

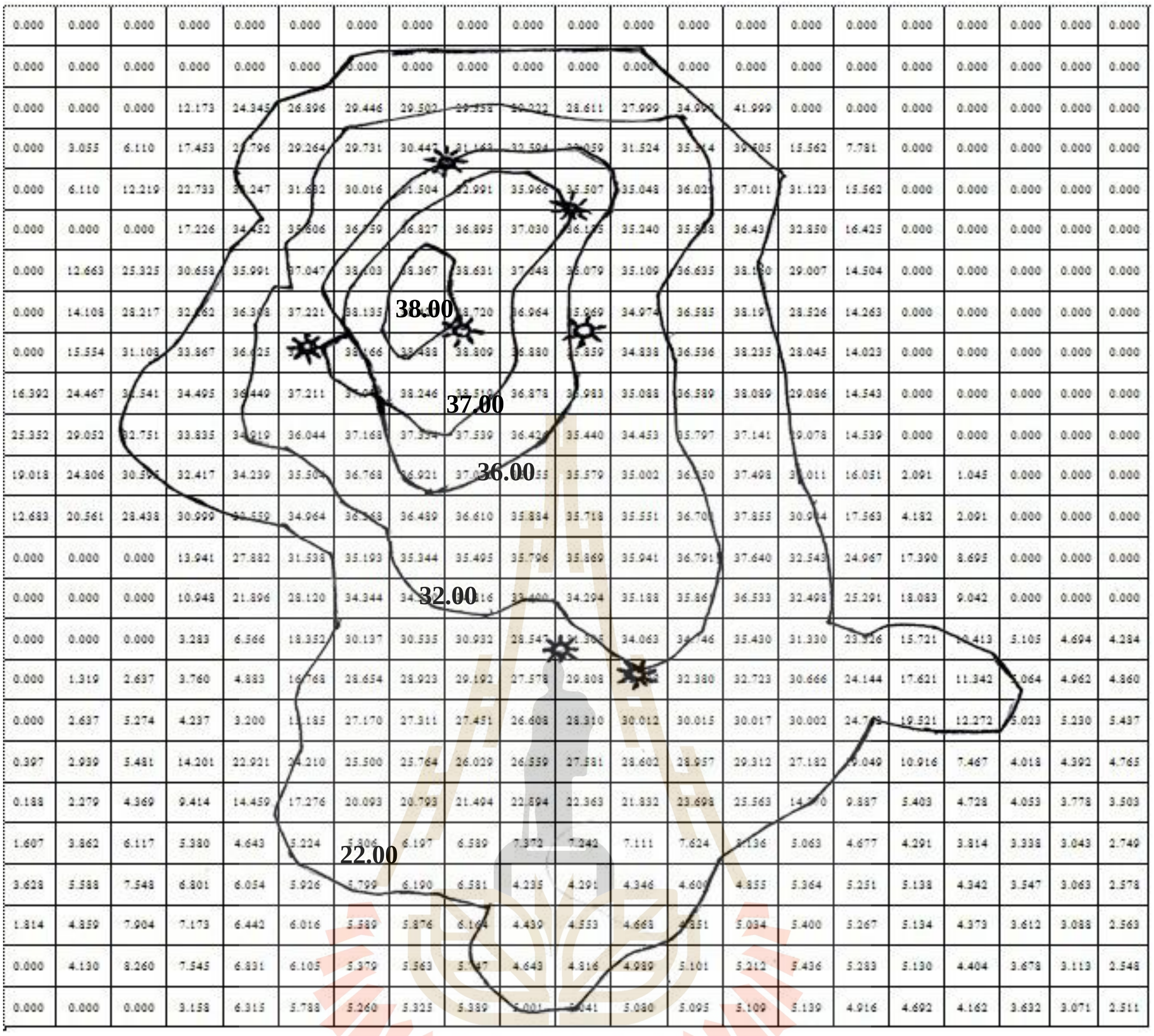

Figure B.5 Vertical net thickness of layer 5th

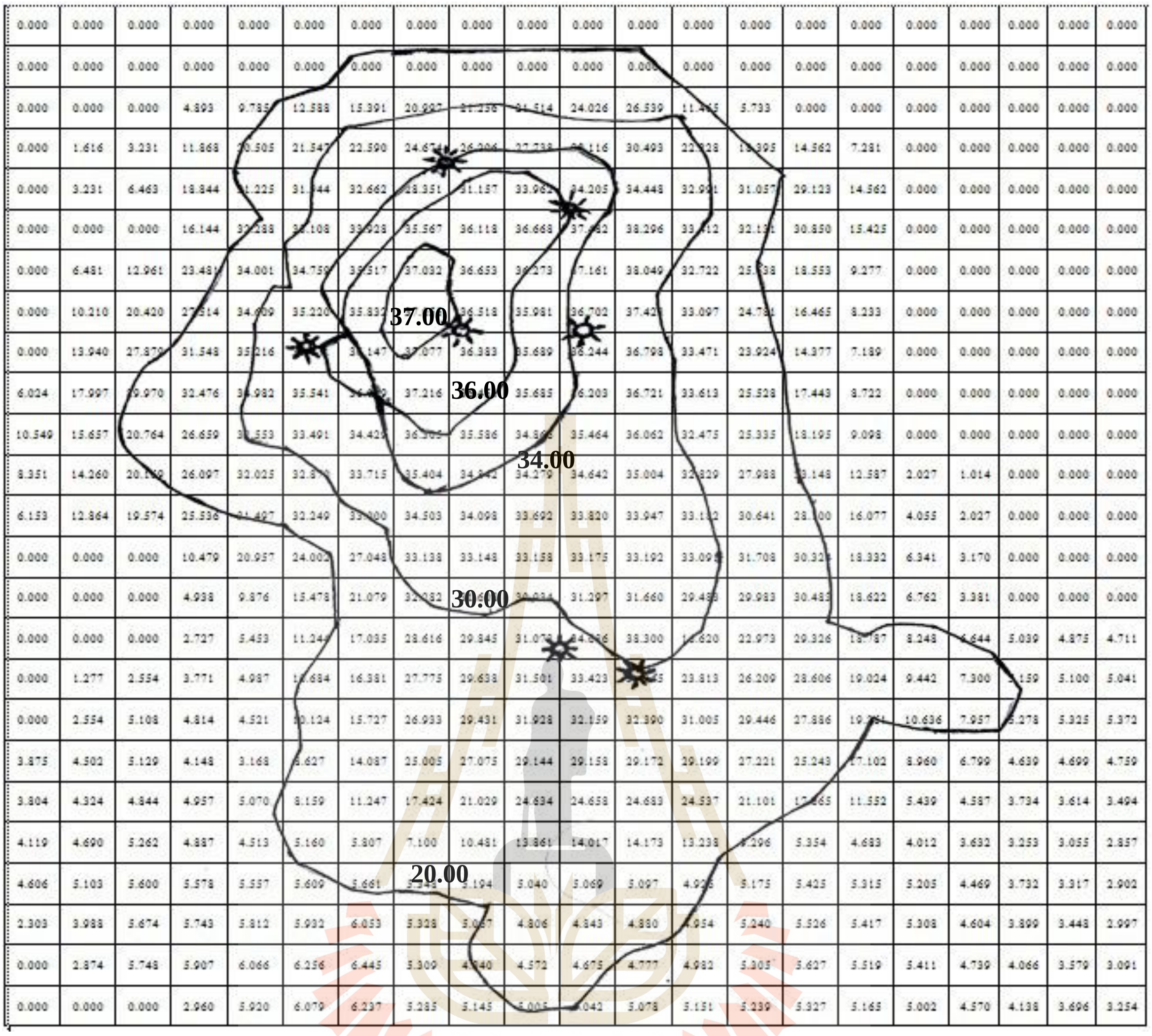

Figure B.6 Vertical net thickness of layer 6th

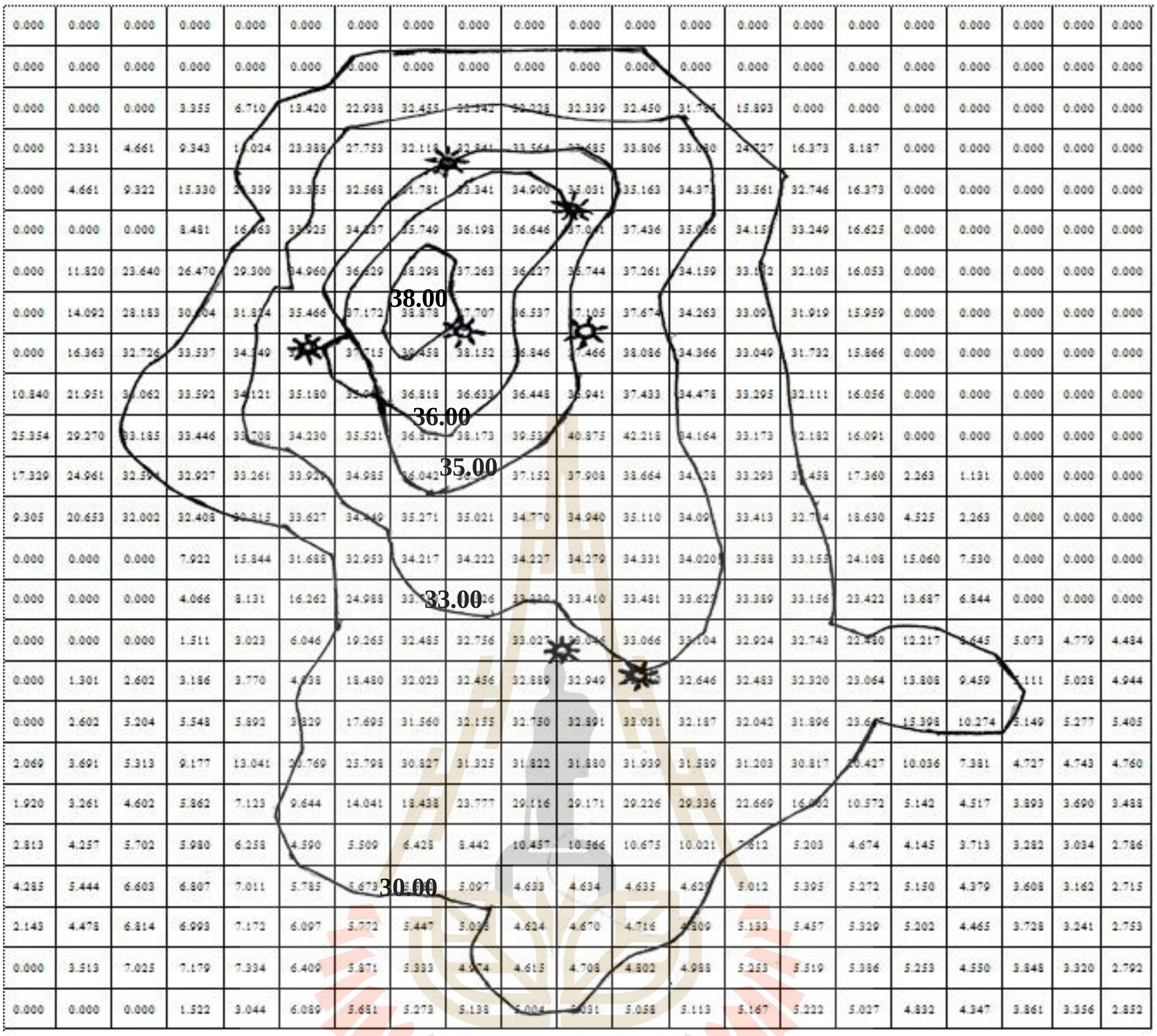

Figure B.7 Vertical net thickness of layer 7th

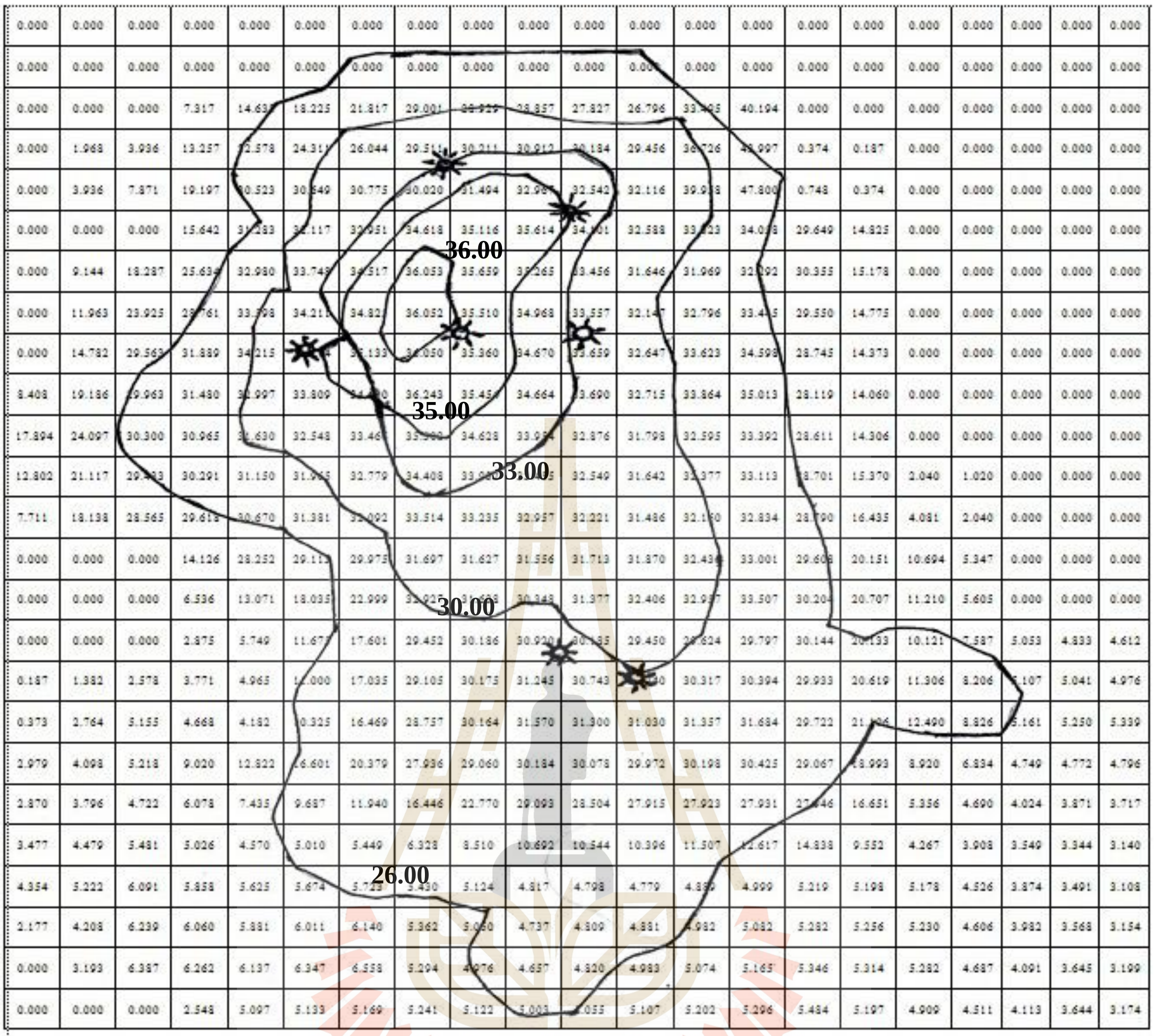

Figure B.8 Vertical net thickness of layer 8th

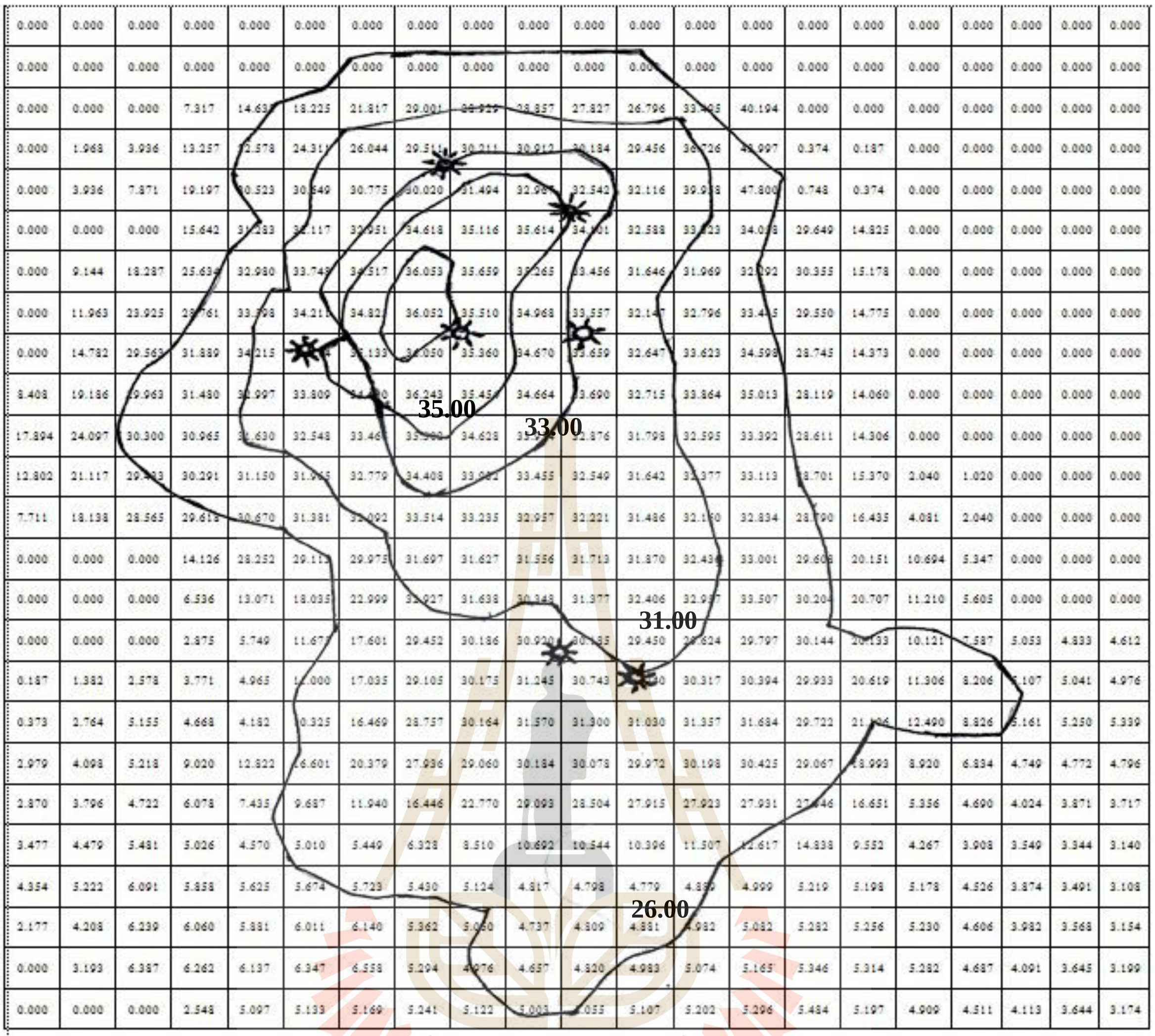

Figure B.9 Vertical net thickness of layer 9^{th}

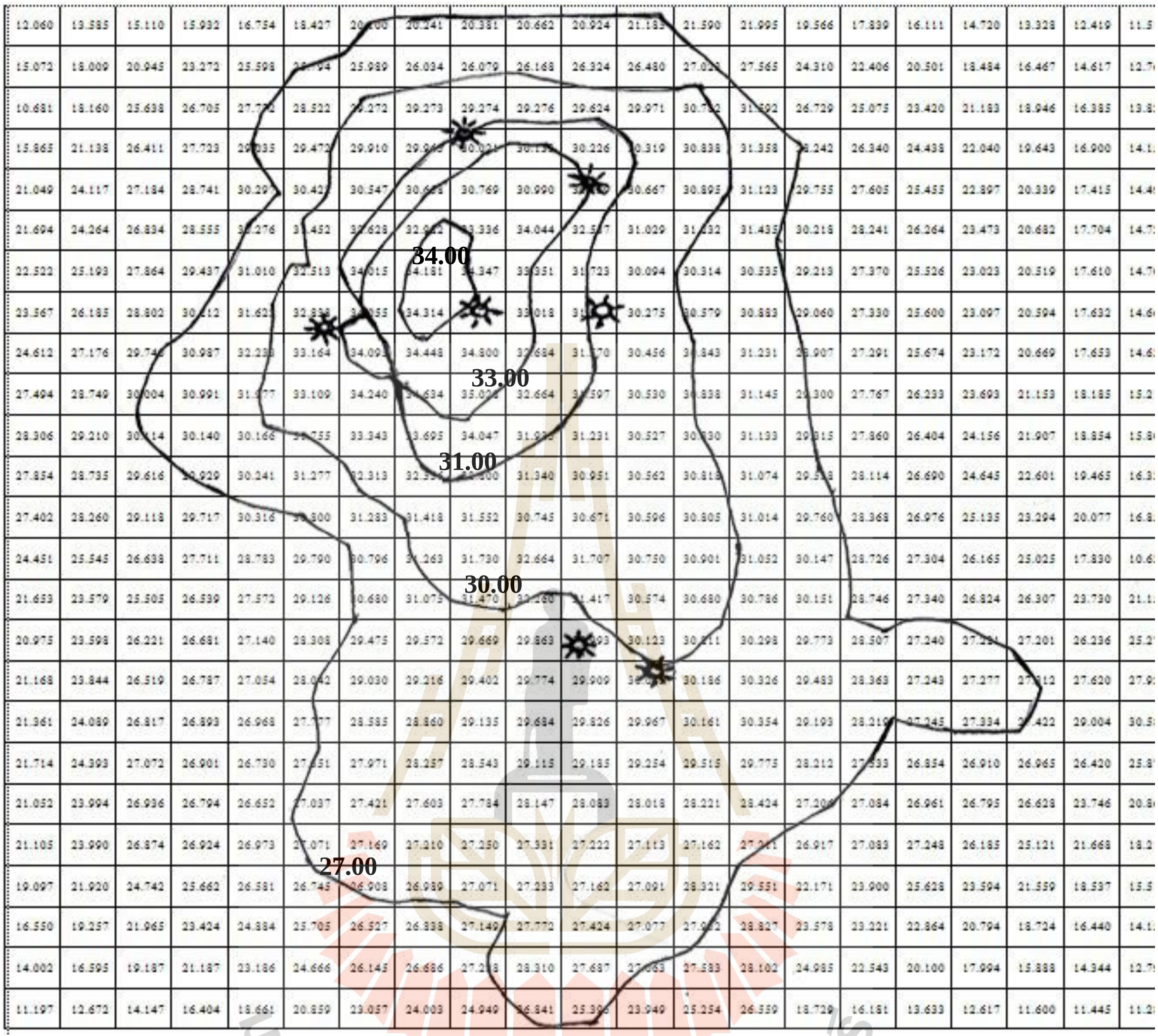

Figure B.10 Vertical net thickness of layer 10th

APPENDIX C

USER INTERFACE OF PROGRAM

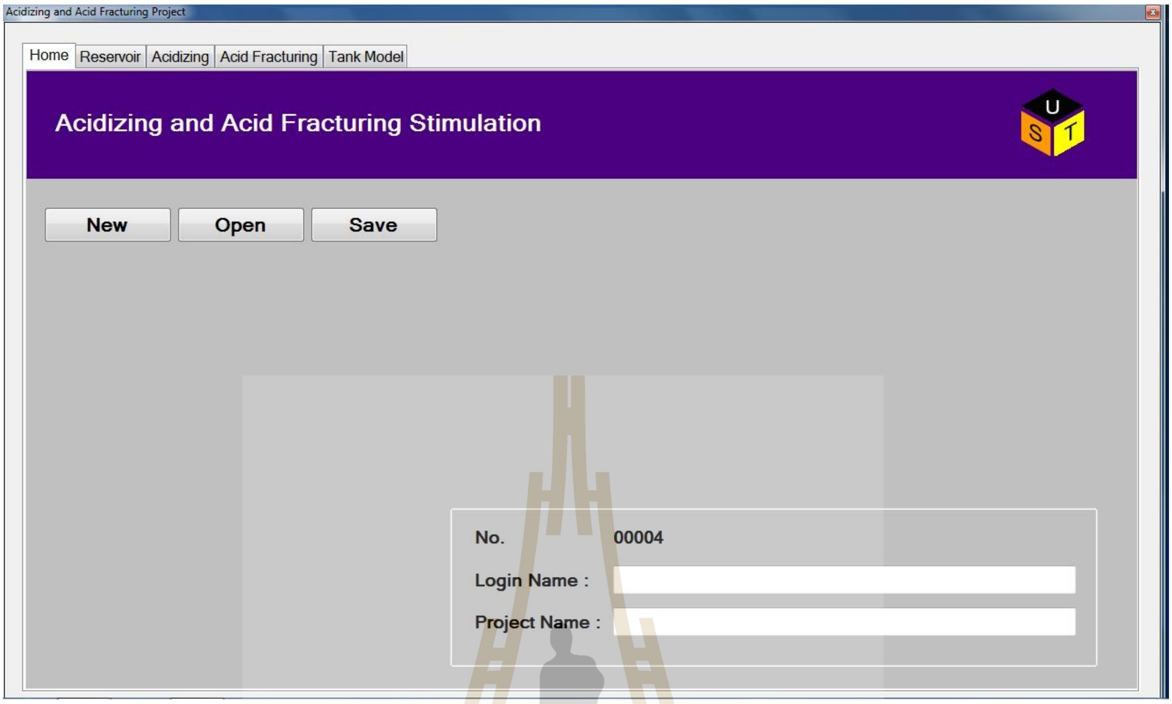

Figure C.1 Home page form

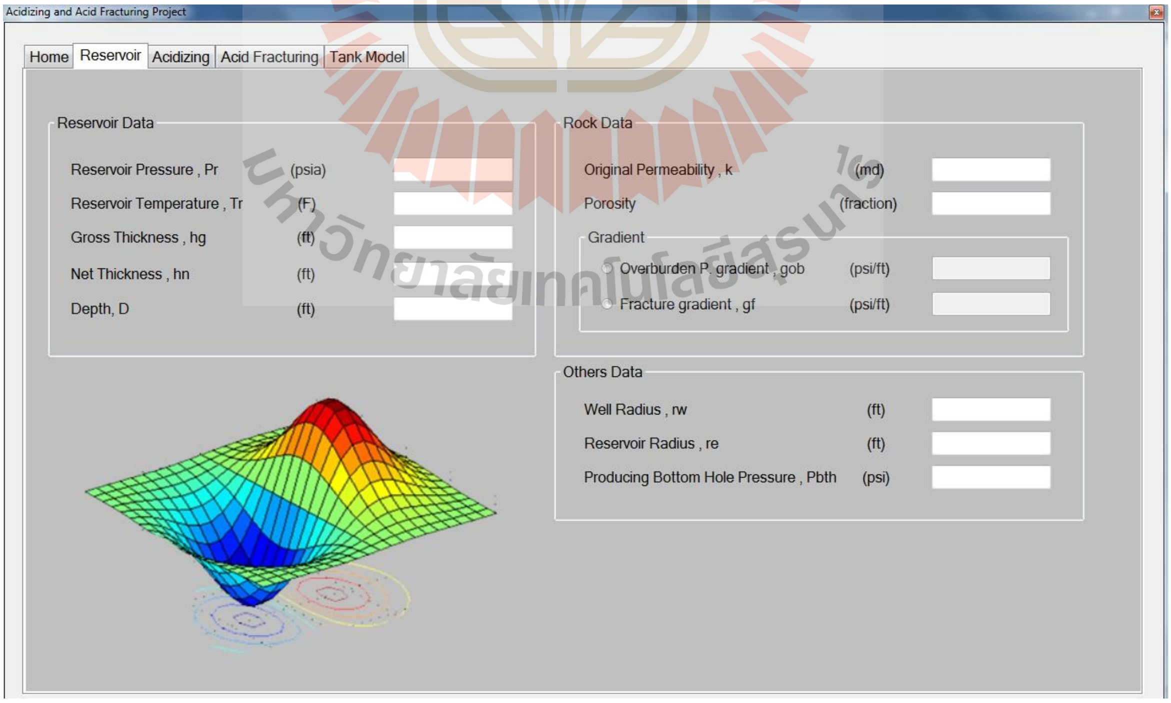

Figure C.2 Basic data input form

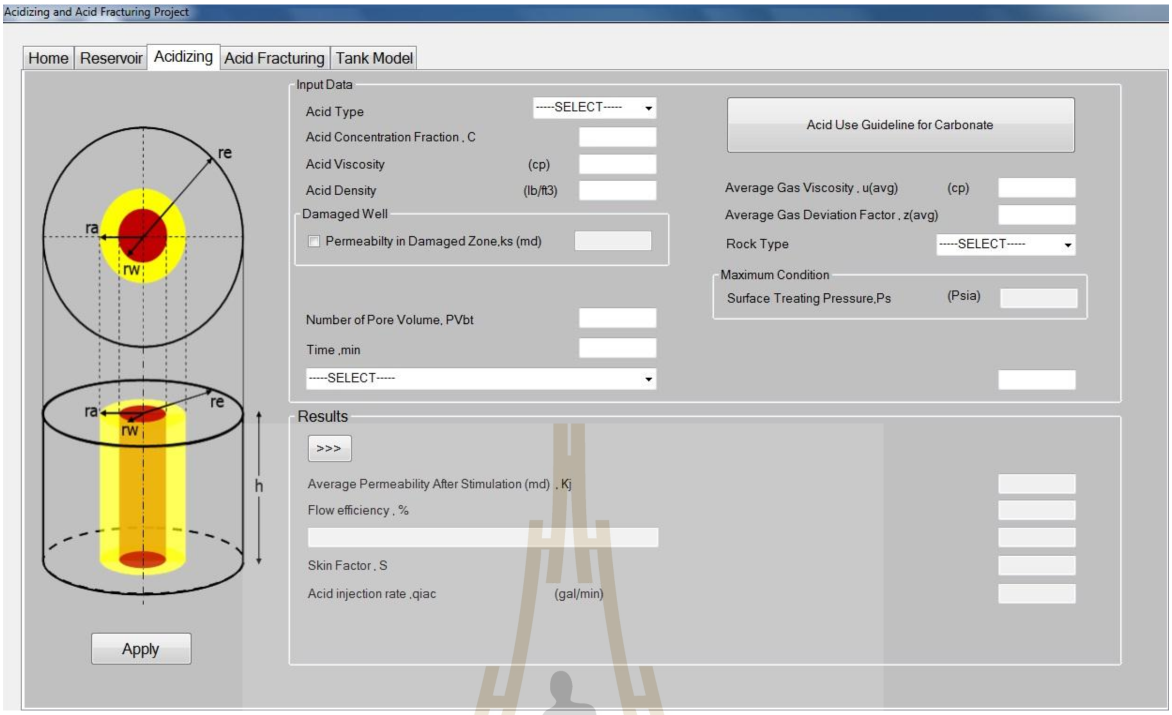

Figure C.3 Acidizing input and output form

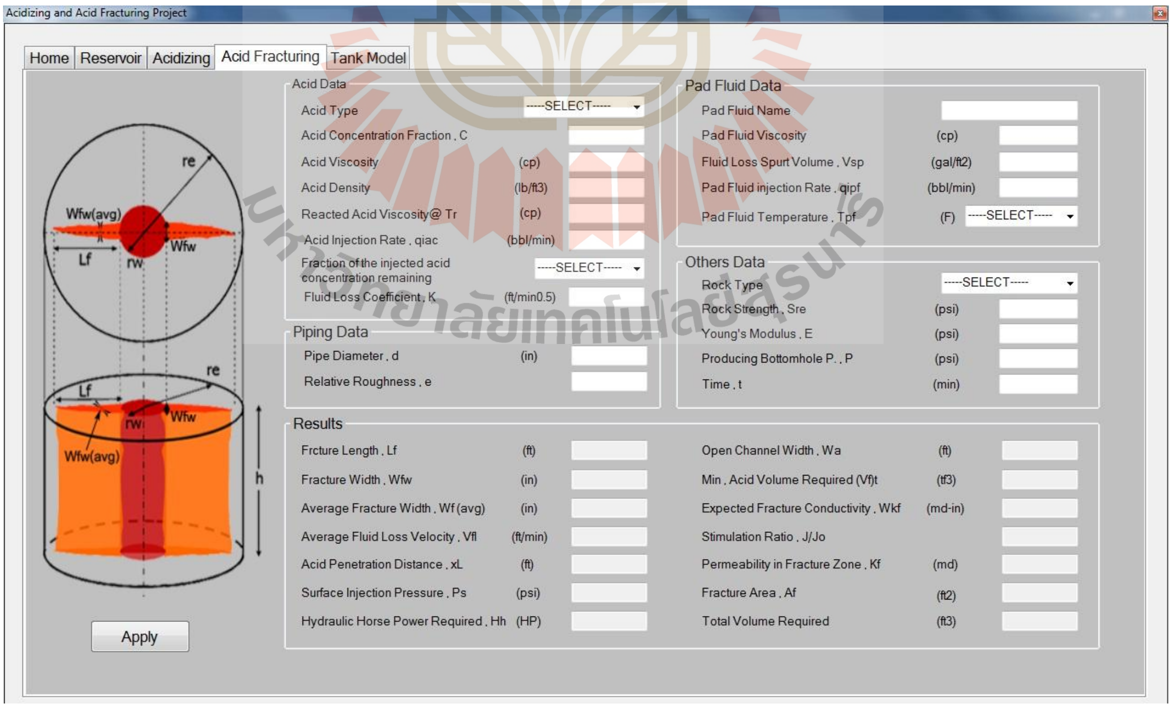

Figure C.4 Acid fracturing input and output form

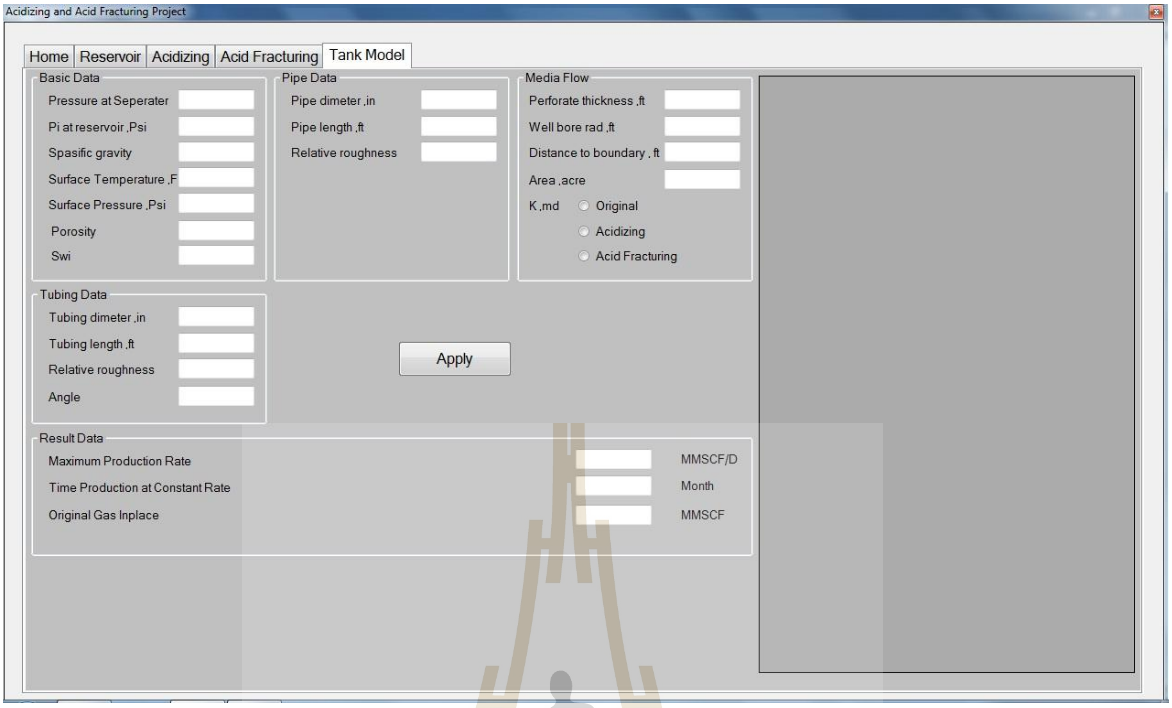

Figure C.5 Tank model input and out form

APPENDIX D

SOURCE CODE OF PROGRAM

Source code of program

```
Imports System
Imports System.Data
Imports System.Data.OleDb
Imports System.Data.OleDb.OleDbConnection
Imports MySql.Data.MySqlClient
Imports System.Threading
Imports System.Globalization
Public Class Form1
    Public strConnServer As String = "Server=localhost; database=acidstimulation; UID=root; PWD=1234;"
    Public ConnServer As New MySqlConnection
    Public da_server As MySqlDataAdapter
    Public sqlComm As String
    Dim dt_time As New DataTable
    Dim dr_time As DataRow
    Dim dt_blank As New DataTable
    Dim dt_search As New DataTable
    Dim dr_search As DataRow

    Private Sub Form1_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load
        Me.FormBorderStyle = Windows.Forms.FormBorderStyle.FixedToolWindow
        TabControl1.SelectedIndex = 2
        f_setbegin()
        dt_time.Columns.Add("tm_month", GetType(System.Double))
        dt_time.Columns.Add("tm_q", GetType(System.Double))
        dt_time.Columns.Add("tm_Gp", GetType(System.Double))
        dt_time.Columns.Add("tm_Pwf", GetType(System.Double))
        dt_time.Columns.Add("tm_Pe", GetType(System.Double))

        If connecttoserver() = 0 Then
            MessageBox.Show("missing connection with database. Please, check the connection", "warning")
            ConnServer.Close()
            Exit Sub
        End If
    End Sub

    Private Sub f_showdata()

        DGV_data.DataSource = dt_time
        DGV_data.AlternatingRowsDefaultCellStyle.BackColor = Color.FromArgb(128, 255, 255)
        DGV_data.AlternatingRowsDefaultCellStyle.SelectionForeColor = Color.Black
        DGV_data.RowsDefaultCellStyle.BackColor = Color.White
        DGV_data.RowsDefaultCellStyle.ForeColor = Color.Black
        DGV_data.ColumnHeadersDefaultCellStyle.Alignment = DataGridViewContentAlignment.MiddleCenter

        For a = 0 To 4
            DGV_data.Columns(a).SortMode = DataGridViewColumnSortMode.NotSortable
        Next
        DGV_data.Columns("tm_month").HeaderText = "Time" & vbCrLf & "(YEAR)"
        DGV_data.Columns("tm_q").HeaderText = "Q" & vbCrLf & "(MMSCF/D)"
        DGV_data.Columns("tm_Pe").HeaderText = "Pe" & vbCrLf & "(psi)"
        DGV_data.Columns("tm_month").Width = 115
        DGV_data.Columns("tm_q").Width = 115
        DGV_data.Columns("tm_Pe").Width = 67
        DGV_data.MultiSelect = False
        DGV_data.ColumnHeadersHeightSizeMode = DataGridViewColumnHeadersHeightSizeMode.DisableResizing
        dgv_view.ColumnHeadersHeight = 60
        DGV_data.RowHeadersWidthSizeMode = DataGridViewRowHeadersWidthSizeMode.DisableResizing
        DGV_data.AllowUserToResizeColumns = False
        DGV_data.AllowUserToResizeRows = False
        DGV_data.Columns("tm_year").DefaultCellStyle.Alignment = DataGridViewContentAlignment.MiddleRight
        DGV_data.Columns("tm_q").DefaultCellStyle.Alignment = DataGridViewContentAlignment.MiddleRight
```

```
    DGV_data.Columns("tm_Pe").DefaultCellStyle.Alignment = DataGridViewContentAlignment.MiddleRight

End Sub

Public Function connecttoserver()
    ConnServer.ConnectionString = strConnServer
    Try
        ConnServer.Open()
    Catch ex As Exception
        Return 0
        Exit Function
    End Try
    Return 1
End Function
Private Sub f_setbegin()
    tb_rd_8_1.Enabled = False
    tb_rd_8_2.Enabled = False
    cb_af_1.Items.Clear()
    cb_af_1.Items.Add("Hydrochloric Acid")
    cb_af_1.Items.Add("Fomic Acid")
    cb_af_1.Items.Add("Acetic Acid")
    cb_af_1.Items.Add("-----SELECT-----")
    cb_af_1.Text = "-----SELECT-----"
    cb_af_7.Items.Clear()
    cb_af_7.Items.Add("C/Co = 0.75")
    cb_af_7.Items.Add("C/Co = 0.50")
    cb_af_7.Items.Add("C/Co = 0.25")
    cb_af_7.Items.Add("C/Co = 0.10")
    cb_af_7.Items.Add("-----SELECT-----")
    cb_af_7.Text = "-----SELECT-----"
    cb_af_15.Items.Clear()
    cb_af_15.Items.Add(">= 71")
    cb_af_15.Items.Add("<  71")
    cb_af_15.Items.Add("-----SELECT-----")
    cb_af_15.Text = "-----SELECT-----"
    cb_af_16.Items.Clear()
    cb_af_16.Items.Add("Limestone")
    cb_af_16.Items.Add("Dolomite")
    cb_af_16.Items.Add("-----SELECT-----")
    cb_af_16.Text = "-----SELECT-----"
    cb_ac_1.Items.Clear()
    cb_ac_1.Items.Add("Hydrochloric Acid")
    cb_ac_1.Items.Add("Fomic Acid")
    cb_ac_1.Items.Add("Acetic Acid")
    cb_ac_1.Items.Add("-----SELECT-----")
    cb_ac_1.Text = "-----SELECT-----"
    cb_ac_12.Items.Clear()
    cb_ac_12.Items.Add("Limestone")
    cb_ac_12.Items.Add("Dolomite")
    cb_ac_12.Items.Add("-----SELECT-----")
    cb_ac_12.Text = "-----SELECT-----"
    cb_ac_9.Items.Clear()
    cb_ac_9.Items.Add("Acidizing or Skin Radius: ra,rs,rwh                 ( ft )")
    cb_ac_9.Items.Add("Acid Volume Per Unit Thickness Yeild, V/h (gal/ft3)")
    cb_ac_9.Items.Add("-----SELECT-----")
    cb_ac_9.Text = "-----SELECT-----"
    tb_ac_6.Enabled = False
    tb_ac_13.ReadOnly = True
    tb_ac_14.ReadOnly = True
    tb_ac_17.ReadOnly = True
    tb_ac_18.ReadOnly = True
    tb_ac_19.ReadOnly = True
    tb_ac_20.ReadOnly = True
```

```
    End Sub

    Private Sub tb_rd_1_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_1.KeyPress

        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub tb_rd_2_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_2.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub tb_rd_3_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_3.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub tb_rd_4_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_4.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub tb_rd_5_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_5.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub tb_rd_6_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_6.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
    End Sub

    Private Sub rb_gd_1_CheckedChanged(ByVal sender As Object, ByVal e As System.EventArgs) Handles
rb_gd_1.CheckedChanged
        If rb_gd_1.Checked = True Then
            tb_rd_8_1.Enabled = True
            tb_rd_8_2.Enabled = False
```

```
    End If
  End Sub

  Private Sub rb_gd_2_CheckedChanged(ByVal sender As Object, ByVal e As System.EventArgs) Handles
rb_gd_2.CheckedChanged
    If rb_gd_2.Checked = True Then
      tb_rd_8_1.Enabled = False
      tb_rd_8_2.Enabled = True
    End If
  End Sub

  Private Sub tb_rd_7_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_7.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
      If tb_rd_7.TextLength > 0 Then
        For a = 1 To tb_rd_7.TextLength
          If Mid(tb_rd_7.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If
  End Sub

  Private Sub tb_rd_8_1_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_rd_8_1.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""

    End If
    If e.KeyChar = "." Then
      If tb_rd_8_1.TextLength > 0 Then
        For a = 1 To tb_rd_8_1.TextLength
          If Mid(tb_rd_8_1.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If
  End Sub

  Private Sub tb_rd_8_2_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_rd_8_2.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""

    End If
    If e.KeyChar = "." Then
      If tb_rd_8_2.TextLength > 0 Then
        For a = 1 To tb_rd_8_2.TextLength
          If Mid(tb_rd_8_2.Text, a, 1) = "." Then
```

```
                e.KeyChar = ""
                Exit For
            End If
        Next
    End If
End If
End Sub

Private Sub tb_rd_9_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_rd_9.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""

    End If
    If e.KeyChar = "." Then
        If tb_rd_9.TextLength > 0 Then
            For a = 1 To tb_rd_9.TextLength
                If Mid(tb_rd_9.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub
Private Sub tb_rd_10_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_rd_10.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""

    End If
    If e.KeyChar = "." Then
        If tb_rd_10.TextLength > 0 Then
            For a = 1 To tb_rd_10.TextLength
                If Mid(tb_rd_10.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub

Private Sub tb_rd_11_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_rd_11.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If
End Sub
Private Sub tb_af_2_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_2.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""

    End If
```

```
        If e.KeyChar = "." Then
            If tb_af_2.TextLength > 0 Then
                For a = 1 To tb_af_2.TextLength
                    If Mid(tb_af_2.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub tb_af_3_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_3.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then
            If tb_af_3.TextLength > 0 Then
                For a = 1 To tb_af_3.TextLength
                    If Mid(tb_af_3.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub tb_af_4_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_4.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then
            If tb_af_4.TextLength > 0 Then
                For a = 1 To tb_af_4.TextLength
                    If Mid(tb_af_4.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub tb_af_5_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_5.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then
            If tb_af_5.TextLength > 0 Then
                For a = 1 To tb_af_5.TextLength
```

```
            If Mid(tb_af_5.Text, a, 1) = "." Then
               e.KeyChar = ""
               Exit For
            End If
         Next
      End If
   End If
End Sub

Private Sub tb_af_6_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_6.KeyPress
   If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
   End If

   If e.KeyChar = "." Then
      If tb_af_6.TextLength > 0 Then
         For a = 1 To tb_af_6.TextLength
            If Mid(tb_af_6.Text, a, 1) = "." Then
               e.KeyChar = ""
               Exit For
            End If
         Next
      End If
   End If
End Sub




Private Sub tb_af_8_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_8.KeyPress
   If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
   End If

   If e.KeyChar = "." Then
      If tb_af_8.TextLength > 0 Then
         For a = 1 To tb_af_8.TextLength
            If Mid(tb_af_8.Text, a, 1) = "." Then
               e.KeyChar = ""
               Exit For
            End If
         Next
      End If
   End If
End Sub

Private Sub tb_af_9_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_af_9.KeyPress
   If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
   End If

   If e.KeyChar = "." Then
      If tb_af_9.TextLength > 0 Then
```

```
            For a = 1 To tb_af_9.TextLength
                If Mid(tb_af_9.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub


Private Sub tb_af_10_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_10.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_af_10.TextLength > 0 Then
            For a = 1 To tb_af_10.TextLength
                If Mid(tb_af_10.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub

Private Sub tb_af_11_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_11.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_af_11.TextLength > 0 Then
            For a = 1 To tb_af_11.TextLength
                If Mid(tb_af_11.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub

Private Sub tb_af_12_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_12.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_af_12.TextLength > 0 Then
            For a = 1 To tb_af_12.TextLength
                If Mid(tb_af_12.Text, a, 1) = "." Then
```

```
                e.KeyChar = ""
                Exit For
            End If
        Next
    End If
End If
End Sub

Private Sub tb_af_13_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_13.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_af_13.TextLength > 0 Then
            For a = 1 To tb_af_13.TextLength
                If Mid(tb_af_13.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub

Private Sub tb_af_14_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_14.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_af_14.TextLength > 0 Then
            For a = 1 To tb_af_14.TextLength
                If Mid(tb_af_14.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub

Private Sub tb_af_17_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_17.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If
End Sub

Private Sub tb_af_18_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_18.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
```

```
      End If
   End Sub

   Private Sub tb_af_19_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_19.KeyPress
      If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
         e.KeyChar = ""
      End If
   End Sub

   Private Sub tb_af_20_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_af_20.KeyPress
      If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
         e.KeyChar = ""
      End If
   End Sub

   Private Sub bt_ok_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles bt_ok.Click

      Try
         Dim Ks As Double = 0
         Dim KnL As Double = 0
         '*********************************************************************
         Dim K As Double = tb_af_8.Text
         Dim Vsp As Double = tb_af_13.Text
         Dim t As Double = tb_af_20.Text
         Ks = (7.48 * K * Math.Sqrt(t)) / Vsp
         Ks = System.Math.Round(Ks, 2)
'*********************************************************************
         Dim qipf As Double = tb_af_14.Text
         Dim Upf As Double = tb_af_12.Text
         Dim hn As Double = tb_rd_4.Text
         Dim E1 As Double = tb_af_18.Text
         KnL = 9.262 * (10 ^ (-6)) * (((qipf ^ 3) * Upf)) / ((hn ^ 3) * (K ^ 6) * E1 * t)
         KnL = System.Math.Round(KnL, 0)
         '*********************************************************************

         Dim A As Double = 0
         Dim B As Double = 0
         Dim C As Double = 0
         Dim D As Double = 0
         Dim E2 As Double = 0
         Dim F As Double = 0
         Dim a1 As Double = 0
         Dim a2 As Double = 0
         Dim a3 As Double = 0
         Dim a4 As Double = 0
         Dim b1 As Double = 0
         Dim b2 As Double = 0
         Dim b3 As Double = 0
         Dim b4 As Double = 0
         Dim x1 As Double = 0
         Dim x2 As Double = 0
         Dim x3 As Double = 0
         Dim x4 As Double = 0
         Dim y1 As Double = 0
         Dim y2 As Double = 0
         Dim y3 As Double = 0
         Dim y4 As Double = 0
```

```
A = Ks
B = KnL
If Ks >= 22 Then
   C = 22
   D = 10
ElseIf Ks >= 10 Then
   C = 22
   D = 10
ElseIf Ks >= 5 Then
   C = 10
   D = 5
ElseIf Ks >= 2 Then
   C = 5
   D = 2
ElseIf Ks >= 1 Then
   C = 2
   D = 1

ElseIf Ks >= 0.5 Then
   C = 1
   D = 0.5
ElseIf Ks >= 0 Then
   C = 0.5
   D = 0
Else
   MessageBox.Show("Ks<0", "Warnning")
   Exit Sub
End If

If KnL >= 1000000 Then
   E2 = 1000000
   F = 100000
ElseIf KnL >= 100000 Then
   E2 = 1000000
   F = 100000
ElseIf KnL >= 10000 Then
   E2 = 100000
   F = 10000
ElseIf KnL >= 5000 Then
   E2 = 10000
   F = 5000
ElseIf KnL >= 2000 Then
   E2 = 5000
   F = 2000
ElseIf KnL >= 1000 Then
   E2 = 2000
   F = 1000
ElseIf KnL >= 500 Then
   E2 = 1000
   F = 500
ElseIf KnL >= 200 Then
   E2 = 500
   F = 200
ElseIf KnL >= 100 Then
   E2 = 200
   F = 100
ElseIf KnL >= 50 Then
   E2 = 100
   F = 50
ElseIf KnL >= 20 Then
   E2 = 50
   F = 20
```

```
        ElseIf KnL >= 10 Then
            E2 = 20
            F = 10
        ElseIf KnL >= 5 Then
            E2 = 10
            F = 5
        ElseIf KnL >= 3 Then
            E2 = 5
            F = 3
        ElseIf KnL >= 2 Then
            E2 = 3
            F = 2
        ElseIf KnL >= 1.5 Then
            E2 = 2
            F = 1.5
        ElseIf KnL >= 1 Then
            E2 = 1.5
            F = 1
        Else
            MessageBox.Show("KnL<0", "Warnning")
            Exit Sub

        End If


'*********************************************************************************************
*
        Dim dt_ab1 As New DataTable

        dt_ab1.Clear()
        sqlComm = "SELECT ku,kl FROM coefficient WHERE Ks='" & C & "' AND Knl='" & E2 & "'"
        da_server = New MySqlDataAdapter(sqlComm, ConnServer)
        da_server.Fill(dt_ab1)

        If dt_ab1.Rows.Count = 1 Then
            a1 = dt_ab1.Rows(0).Item("ku")
            b1 = dt_ab1.Rows(0).Item("kl")
        Else
            MessageBox.Show("Not found DATA a1,b1")
            Exit Sub
        End If

        Dim dt_ab2 As New DataTable

        dt_ab2.Clear()
        sqlComm = "SELECT ku,kl FROM coefficient WHERE Ks='" & D & "' AND Knl='" & E2 & "'"
        da_server = New MySqlDataAdapter(sqlComm, ConnServer)
        da_server.Fill(dt_ab2)

        If dt_ab2.Rows.Count = 1 Then
            a2 = dt_ab2.Rows(0).Item("ku")
            b2 = dt_ab2.Rows(0).Item("kl")
        Else
            MessageBox.Show("Not found DATA a2,b2")
            Exit Sub
        End If

        Dim dt_ab3 As New DataTable

        dt_ab3.Clear()
        sqlComm = "SELECT ku,kl FROM coefficient WHERE Ks='" & C & "' AND Knl='" & F & "'"
        da_server = New MySqlDataAdapter(sqlComm, ConnServer)
        da_server.Fill(dt_ab3)
```

```
        If dt_ab3.Rows.Count = 1 Then
            a3 = dt_ab3.Rows(0).Item("ku")
            b3 = dt_ab3.Rows(0).Item("kl")
        Else
            MessageBox.Show("Not found DATA a3,b3")
            Exit Sub
        End If

        Dim dt_ab4 As New DataTable
        dt_ab4.Clear()
        sqlComm = "SELECT ku,kl FROM coefficient WHERE Ks='" & D & "' AND Knl='" & F & "'"
        da_server = New MySqlDataAdapter(sqlComm, ConnServer)
        da_server.Fill(dt_ab4)

        If dt_ab4.Rows.Count = 1 Then
            a4 = dt_ab4.Rows(0).Item("ku")
            b4 = dt_ab4.Rows(0).Item("kl")
        Else
            MessageBox.Show("Not found DATA a4,b4")
            Exit Sub
        End If

'*****************************************************************************************************
*

        x1 = (((A - C) * (a2 - a1)) / (D - C)) + a1
        x2 = (((A - C) * (a4 - a1)) / (D - C)) + a3
        x3 = (((B - E2) * (a4 - a2)) / (F - E2)) + a2
        x4 = (((B - E2) * (a3 - a1)) / (F - E2)) + a1

        y1 = (((A - C) * (b2 - b1)) / (D - C)) + b1
        y2 = (((A - C) * (b4 - b3)) / (D - C)) + b3
        y3 = (((B - E2) * (b4 - b2)) / (F - E2)) + b2
        y4 = (((B - E2) * (b3 - b1)) / (F - E2)) + b1


        Dim Ku As Double = 0

        Ku = ((y3 - y1) + (x1 * ((y2 - y1) / (x2 - x1))) - (x3 * ((y3 - y4) / (x3 - x4)))) / (((y2 - y1) / (x2 - x1)) - ((y3 -
y4) / (x3 - x4)))

        Dim KL As Double = 0

        KL = (((y2 - y1) / (x2 - x1)) * (Ku - x1)) + y1

        "**********************************************************************

        Dim Lf As Double = 0

        Lf = (5.615 * KL * qipf * Math.Sqrt(t)) / (K * hn)


        Lf = System.Math.Round(Lf, 3, MidpointRounding.AwayFromZero)
        tb_rs_1.Text = Lf

        Dim Wfw As Double = 0

        Wfw = (12 * K * Math.Sqrt(t)) / Ku

        Wfw = System.Math.Round(Wfw, 2, MidpointRounding.AwayFromZero)
        tb_rs_2.Text = Wfw
```

```
"**********************************************************************

Dim Vbarfl As Double = 0

Vbarfl = (1.517 * K) / Math.Sqrt(t)


Vbarfl = System.Math.Round(Vbarfl, 5, MidpointRounding.AwayFromZero)
tb_rs_4.Text = Vbarfl

Dim Wbarf As Double = 0

Wbarf = (0.7854) * Wfw

Wbarf = System.Math.Round(Wbarf, 2, MidpointRounding.AwayFromZero)
tb_rs_3.Text = Wbarf

"**********************************************************************

Dim Nre As Double = 0
Dim Pac As Double = tb_af_4.Text
Dim qiac As Double = tb_af_6.Text
Dim Uac As Double = tb_af_3.Text
Dim hg As Double = tb_rd_3.Text

Nre = (140.375 * Pac * qiac) / (Uac * hg)
"**********************************************************************

Dim D8 As Double = 0

cb_af_15.SelectedIndex = 0

If cb_af_15.SelectedIndex = 0 Then

   D8 = (((6 * (10 ^ (-7))) * (Nre ^ 2)) + (0.01 * Nre) + 15.439) * (10 ^ (-5)) * 0.06

ElseIf cb_af_15.SelectedIndex = 1 Then

   D8 = (((5 * (10 ^ (-6))) * (Nre ^ 2)) + (0.014 * Nre) + 11.447) * (10 ^ (-5)) * 0.06
End If
"**********************************************************************

Dim Tr As Double = tb_rd_2.Text

Dim D82 As Double = 0S


cb_af_16.SelectedIndex = 0


If cb_af_16.SelectedIndex = 0 Then
   D82 = D8

ElseIf cb_af_16.SelectedIndex = 1 Then

   D82 = D8 * (1 - (Math.Exp((2445 / Tr) - 4.813)))

End If
"**********************************************************************

Dim Npe As Double = 0

Npe = (Wbarf * Vbarfl) / (24 * D82)
```

```
"*****************************************************************

Dim Lad As Double = 0
cb_af_7.SelectedIndex = 3

If cb_af_7.SelectedIndex = 0 Then

   Lad = (0.0167 * (Npe ^ 2)) + (0.1267 * Npe) + (3 * (10 ^ (-15)))

ElseIf cb_af_7.SelectedIndex = 1 Then

   Lad = -(0.014 * (Npe ^ 2)) + (0.305 * Npe) + (4 * (10 ^ (-16)))

ElseIf cb_af_7.SelectedIndex = 2 Then

   Lad = -(0.1326 * (Npe ^ 2)) + (0.7311 * Npe) + (3 * (10 ^ (-15)))

ElseIf cb_af_7.SelectedIndex = 3 Then

   Lad = -(0.267 * (Npe ^ 2)) + (1.0538 * Npe) + 0.0076

End If
"*****************************************************************

Dim xL As Double = 0
Dim Urac As Double = tb_af_5.Text

xL = (1.48 * qiac * Urac * Lad) / (Uac * hg * Vbarfl)

xL = System.Math.Round(xL, 0, MidpointRounding.AwayFromZero)

tb_rs_5.Text = xL
"*****************************************************************

Dim X As Double = 0

Dim C1 As Double = tb_af_2.Text

cb_af_1.SelectedIndex = 0

If cb_af_16.SelectedIndex = 0 Then

   If cb_af_1.SelectedIndex = 0 Then

      X = (0.247 * (C1 ^ 2)) + (0.5098 * C1) - 0.0002

   ElseIf cb_af_1.SelectedIndex = 1 Then

      X = (0.1017 * (C1 ^ 2)) + (0.40014 * C1) - 0.0002

   ElseIf cb_af_1.SelectedIndex = 2 Then

      X = (0.0729 * (C1 ^ 2)) + (0.2949 * C1) + 0.001

   End If

ElseIf cb_af_16.SelectedIndex = 1 Then

   If cb_af_1.SelectedIndex = 0 Then

      X = (0.2475 * (C1 ^ 2)) + (0.4298 * C1) + 0.0008

   ElseIf cb_af_1.SelectedIndex = 1 Then
```

```
    X = (0.1017 * (C1 ^ 2)) + (0.3401 * C1) + 0.0008

  ElseIf cb_af_1.SelectedIndex = 2 Then

    X = (0.0475 * (C1 ^ 2)) + (0.2598 * C1) + 0.0008

  End If

End If

X = System.Math.Round(X, 3, MidpointRounding.AwayFromZero)
'*********************************************************************

Dim Vft As Double = 0

Dim n As Double = 0

If C1 > 0.2 Then
  n = 1
ElseIf C1 > 0.15 Then
  n = 2
ElseIf C1 > 0.1 Then
  n = 3
ElseIf C1 > 0.05 Then
  n = 4
Else
  n = 5
End If

Vft = n * (0.1667 * xL * hg * Wbarf)

Vft = System.Math.Round(Vft, 0, MidpointRounding.AwayFromZero)

tb_rs_9.Text = Vft

'*********************************************************************

Dim Wa As Double = 0
Dim OI As Double = tb_rd_7.Text

Wa = (6 * X * Vft) / (xL * hg * (1 - OI))

Wa = System.Math.Round(Wa, 4, MidpointRounding.AwayFromZero)

tb_rs_8.Text = Wa
'*********************************************************************

Dim Sre As Double = tb_af_17.Text
Dim Wkf As Double = 0
Dim gob As Double = 0
Dim gf As Double = 0
Dim Pr As Double = tb_rd_1.Text
Dim Dr As Double = tb_rd_5.Text
Dim Pbth As Double = tb_af_19.Text

If rb_gd_1.Checked = True Then

  gob = tb_rd_8_1.Text
  gf = 0.5 + ((gob - 0.5) * (Pr / Dr))
Else
  gf = tb_rd_8_2.Text
End If
```

```
        Wkf =5

        If Sre <= 20000 Then
          '(2)

          Wkf = 1.764 * (10 ^ 8) * (Wa ^ 2.466) * Math.Exp(0.001 * ((-19.9) + ((1.31 * Math.Log10(Sre)) / 0.4343)
* ((gf * Dr) - Pbth))

        Else
          '(1)

          Wkf = 1.764 * (10 ^ 8) * (Wa ^ 2.466) * Math.Exp(0.001 * ((-3.8) + ((0.28 * Math.Log10(Sre)) / 0.4343) *
((gf * Dr) - Pbth))


        End If

        Wkf = System.Math.Round(Wkf, 0, MidpointRounding.AwayFromZero)

        tb_rs_10.Text = Wkf

'*********************************************************************

        Dim jsjo As Double = 0
        Dim rw As Double = tb_rd_9.Text
        Dim re As Double = tb_rd_10.Text
        Dim Ko As Double = tb_rd_6.Text
        Dim xa As Double = (37.72 * xL)
        Dim xb As Double = (Wkf * hg)
        Dim xc As Double = (Ko * hn)
        Dim xd As Double = (Wkf * hg)
        Dim xe As Double = (Ko * hn)

        jsjo = (Math.Log10(re / rw)) / ((Math.Log10((xa + (xb / xc)) / (xd / xe))) + (Math.Log10(re / xL)))

        jsjo = System.Math.Round(jsjo, 2, MidpointRounding.AwayFromZero)

        tb_rs_11.Text = jsjo

'*********************************************************************

        Dim kf As Double = 0

        kf = 7.7 * (10 ^ 12) * (Wbarf ^ 2)

        kf = System.Math.Round(kf, 3, MidpointRounding.AwayFromZero)

        tb_rs_12.Text = kf

'*********************************************************************

        Dim Af As Double = 0

        Af = 2 * Lf * hg
        tb_rs_13.Text = Af

'*********************************************************************

        Dim Pt As Double = 0

        Pt = gf * Dr

        Dim Nreb As Double = 0
```

```
        Dim ds As Double = tb_af_9.Text


        Nreb = (119115 * qiac * Pac) / (Uac * (ds ^ 2))

        Dim fs As Double = 0
        Dim ee As Double = tb_af_10.Text
        Dim ya As Double = ee / 3.7065
        Dim yb As Double = 5.0452 / Nreb
        Dim yc As Double = ((ee ^ 1.1098) / 2.8257) + (5.85 / (Nreb ^ 0.8981))

        fs = (1) / (((-4) * Math.Log(ya - (yb * Math.Log(yc)))) ^ 2)

''*******************************************************************

        Dim Dpf As Double = 0

        Dpf = (85.37 * fs * Dr * Pac * (qiac ^ 2)) / (ds ^ 5)

        ''*******************************************************************

        Dim Dps As Double = 0

        Dps = (Pac * Dr) / 144

        ''*******************************************************************

        Dim Ps As Double = 0

        Ps = Pt + Dpf + Dps

        Ps = System.Math.Round(Ps, 2, MidpointRounding.AwayFromZero)

        tb_rs_6.Text = Ps

        ''*******************************************************************

        Dim Hh As Double = 0

        Hh = 0.0245 * Ps * qiac

        Hh = System.Math.Round(Hh, 2, MidpointRounding.AwayFromZero)

        tb_rs_7.Text = Hh

''*******************************************************************

        Dim Vfrac As Double = 0

        Vfrac = 2 * Wbarf * hg * Lf
        ''*******************************************************************
        Dim Vt As Double = 0

        Vt = Vfrac + (Vft)

        Vt = System.Math.Round(Vt, 2, MidpointRounding.AwayFromZero)

        tb_rs_14.Text = Vt

      Catch ex As Exception

        MessageBox.Show("คุณยังกรอกค่าไม่ครบ", "ข้อความเตือน")
        MessageBox.Show(ex.Message)
```

```
    End Try

  End Sub
  Private Sub bt_clear_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_clear.Click
  End Sub

  Private Sub bt_pic1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles bt_pic1.Click
    Dim fmp1 As New FormP1

    fmp1.ShowDialog()
  End Sub

  Private Sub bt_report_AF_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_report_AF.Click
  End Sub

  Private Sub tb_ac_2_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_2.KeyPress

    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
      If tb_ac_2.TextLength > 0 Then
        For a = 1 To tb_ac_2.TextLength
          If Mid(tb_ac_2.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If
  End Sub

  Private Sub tb_ac_3_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_3.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
    End If
    If e.KeyChar = "." Then
      If tb_ac_3.TextLength > 0 Then
        For a = 1 To tb_ac_3.TextLength
          If Mid(tb_ac_3.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If
  End Sub



  Private Sub tb_ac_4_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_4.KeyPress
```

```
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then
            If tb_ac_4.TextLength > 0 Then
                For a = 1 To tb_ac_4.TextLength
                    If Mid(tb_ac_4.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub chb_ac_5_CheckedChanged(ByVal sender As Object, ByVal e As System.EventArgs) Handles
chb_ac_5.CheckedChanged

        tb_ac_6.Text = ""

        If chb_ac_5.Checked = True Then

            tb_ac_6.Enabled = True
        Else
            tb_ac_6.Enabled = False

        End If

    End Sub

    Private Sub tb_ac_6_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_6.KeyPress


        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
        If e.KeyChar = "." Then
            If tb_ac_6.TextLength > 0 Then
                For a = 1 To tb_ac_6.TextLength
                    If Mid(tb_ac_6.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If

    End Sub

    Private Sub tb_ac_7_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_7.KeyPress

        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If
```

```
    If e.KeyChar = "." Then
      If tb_ac_7.TextLength > 0 Then
        For a = 1 To tb_ac_7.TextLength
          If Mid(tb_ac_7.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If


  End Sub

  Private Sub tb_ac_8_KeyPress(ByVal sender As Object, ByVal e As System.Windows.Forms.KeyPressEventArgs)
Handles tb_ac_8.KeyPress

    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
      If tb_ac_8.TextLength > 0 Then
        For a = 1 To tb_ac_8.TextLength
          If Mid(tb_ac_4.Text, 8, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If

  End Sub

  Private Sub tb_ac_10_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_10.KeyPress

    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
      e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
      If tb_ac_10.TextLength > 0 Then
        For a = 1 To tb_ac_10.TextLength
          If Mid(tb_ac_10.Text, a, 1) = "." Then
            e.KeyChar = ""
            Exit For
          End If
        Next
      End If
    End If

  End Sub

  Private Sub tb_ac_11_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_11.KeyPress
```

```
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <> 
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <> 
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then
            If tb_ac_11.TextLength > 0 Then
                For a = 1 To tb_ac_11.TextLength
                    If Mid(tb_ac_11.Text, a, 1) = "." Then
                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub tb_ac_15_KeyPress(ByVal sender As Object, ByVal e As 
System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_15.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <> 
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <> 
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then

            If tb_ac_15.TextLength > 0 Then

                For a = 1 To tb_ac_15.TextLength

                    If Mid(tb_ac_15.Text, a, 1) = "." Then

                        e.KeyChar = ""
                        Exit For
                    End If
                Next
            End If
        End If
    End Sub

    Private Sub tb_ac_17_KeyPress(ByVal sender As Object, ByVal e As 
System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_17.KeyPress
        If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <> 
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <> 
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
            e.KeyChar = ""
        End If

        If e.KeyChar = "." Then

            If tb_ac_17.TextLength > 0 Then

                For a = 1 To tb_ac_17.TextLength

                    If Mid(tb_ac_17.Text, a, 1) = "." Then

                        e.KeyChar = ""

                        Exit For

                    End If
```

```
            Next

        End If
    End If
End Sub

Private Sub tb_ac_18_KeyPress(ByVal sender As Object, ByVal e As

System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_18.KeyPress, tb_ac_21.KeyPress
    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_ac_18.TextLength > 0 Then

            For a = 1 To tb_ac_18.TextLength

                If Mid(tb_ac_18.Text, a, 1) = "." Then

                    e.KeyChar = ""

                    Exit For

                End If

            Next

        End If

    End If

End Sub

Private Sub tb_ac_19_KeyPress(ByVal sender As Object, ByVal e As

System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_19.KeyPress

    If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>

"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>

"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then

        e.KeyChar = ""
    End If

    If e.KeyChar = "." Then
        If tb_ac_19.TextLength > 0 Then
            For a = 1 To tb_ac_19.TextLength
                If Mid(tb_ac_19.Text, a, 1) = "." Then
                    e.KeyChar = ""
                    Exit For
                End If
            Next
        End If
    End If
End Sub
```

```
  Private Sub tb_ac_20_KeyPress(ByVal sender As Object, ByVal e As
System.Windows.Forms.KeyPressEventArgs) Handles tb_ac_20.KeyPress
      If e.KeyChar <> "0" And e.KeyChar <> "1" And e.KeyChar <> "2" And e.KeyChar <> "3" And e.KeyChar <>
"4" And e.KeyChar <> "5" And e.KeyChar <> "6" And e.KeyChar <> "7" And e.KeyChar <> "8" And e.KeyChar <>
"9" And e.KeyChar <> "." And Asc(e.KeyChar) <> 8 Then
          e.KeyChar = ""
      End If

      If e.KeyChar = "." Then
          If tb_ac_20.TextLength > 0 Then
              For a = 1 To tb_ac_20.TextLength
                  If Mid(tb_ac_20.Text, a, 1) = "." Then
                      e.KeyChar = ""
                      Exit For
                  End If
              Next
          End If
      End If
  End Sub



  Dim rwh As Double = 0
  Dim rw As Double = 0

  Dim voh As Double = 0

  Dim pvbt As Double = 0

  Dim OI As Double = 0
  Dim S As Double = 0
  Dim Ko As Double = 0
  Dim Ks As Double = 0
  Dim rs As Double = 0
  Dim Nac As Double = 1
  Dim n As Double = 1
  Dim hn As Double = 0
  Dim Kavg As Double = 0
  Dim re As Double = 0
  Dim c_log As Double = 2.302585093
  Dim Kj As Double = 0
  Dim J As Double = 0
  Dim Uavg As Double = 0
  Dim Zavg As Double = 0
  Dim Tr As Double = 0
  Private Sub bt_ac_ok_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_ac_ok.Click

      f_check_qimax()

  End Sub

  Private Function f_checknull(ByVal str As String)

      If str = "" Then

          Return 0
      Else
          Return str
      End If

  End Function
```

```
Private Sub f_check_qimax()

    rw = f_checknull(tb_rd_9.Text)
    pvbt = f_checknull(tb_ac_8.Text)
    OI = f_checknull(tb_rd_7.Text)

    Ko = f_checknull(tb_rd_6.Text)
    Ks = f_checknull(tb_ac_6.Text)

    rs = f_checknull(tb_ac_15.Text)

    hn = f_checknull(tb_rd_4.Text)

    re = f_checknull(tb_rd_10.Text)

    If cb_ac_9.SelectedIndex = 0 Then

        rwh = tb_ac_15.Text

        voh = 7.48 * (22 / 7) * OI * ((rwh ^ 2) - (rw ^ 2)) * pvbt


        tb_ac_19.Text = cb_ac_9.Items(1)

        tb_ac_20.Text = voh

    ElseIf cb_ac_9.SelectedIndex = 1 Then

        rwh = (((rw ^ 2) + (voh) * (7 / (22 * pvbt * OI)))) ^ 0.5


        rwh = System.Math.Round(rwh, 2, MidpointRounding.AwayFromZero)

        tb_ac_20.Text = rwh

        tb_ac_19.Text = cb_ac_9.Items(0)

    End If

    If chb_ac_5.Checked = True Then

        S = ((-1) * (Ko / (2 * Ks))) * c_log * Math.Log10(((rw / rs) ^ 2) + (voh / (23.5 * (rs ^ 2) * OI * pvbt))) - (c_log
* Math.Log10(rs / rw))

        tb_ac_21.Text = S

    Else

        S = (-0.5) * c_log * Math.Log10(1 + ((voh * 7) / (22 * (rw ^ 2) * OI * pvbt)))

        tb_ac_21.Text = S

    End If

    If chb_ac_5.Checked = True Then

        Kavg = (Ko * Ks * c_log * Math.Log10(re / rw)) / ((Ks * c_log * Math.Log10(re / rs)) + (Ko * c_log *
Math.Log10(rs / rw)))

    Else

        Kavg = Ko
```

```
        End If

        Kj = Ko * (((-1 * 0.75) + c_log * Math.Log10(re / rw)) / (S - 0.75 + (c_log * Math.Log10(re / rw))))
        Kj = System.Math.Round(Kj, 2, MidpointRounding.AwayFromZero)
        tb_ac_17.Text = Kj

        tb_ac_17.Text = System.Math.Round(Kj, 5, MidpointRounding.AwayFromZero)

        Uavg = System.Math.Round(CDbl(f_checknull(tb_ac_10.Text)), 2, MidpointRounding.AwayFromZero)
        Zavg = System.Math.Round(CDbl(f_checknull(tb_ac_11.Text)), 2, MidpointRounding.AwayFromZero)
        Tr = f_checknull(tb_rd_2.Text)

        J = (Kj * hn) / (1422 * Uavg * Zavg * Tr * ((-1 * 0.75) + c_log * Math.Log10(re / rw)))

        tb_ac_18.Text = System.Math.Round(J, 5, MidpointRounding.AwayFromZero)

    End Sub

    Dim qiac_max As Double = 0

    Private Sub bt_ac_max_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_ac_max.Click

        f_ac_max()

    End Sub

    Private Sub f_ac_max()

        Dim Ko As Double = tb_rd_6.Text
        Dim hn As Double = tb_rd_4.Text
        Dim Sre As Double = tb_af_17.Text
        Dim Wkf As Double = 0
        Dim gob As Double = 0
        Dim gf As Double = 0
        Dim Pr As Double = tb_rd_1.Text
        Dim Dr As Double = tb_rd_5.Text
        Dim Pbth As Double = tb_af_19.Text
        If rb_gd_1.Checked = True Then
            gob = tb_rd_8_1.Text
            gf = 0.5 + ((gob - 0.5) * (Pr / Dr))
        Else
            gf = tb_rd_8_2.Text
        End If
        Dim Uac As Double = tb_ac_3.Text
        Dim rw As Double = tb_rd_9.Text
        Dim re As Double = tb_rd_10.Text
        f_check_qimax()
        qiac_max = (4.917 * (10 ^ (-6)) * Kavg * hn * ((gf * Dr) - Pr)) / (Uac * c_log * Math.Log10(re / rw))

        qiac_max = System.Math.Round(qiac_max, 4, MidpointRounding.AwayFromZero)

        tb_ac_13.Text = qiac_max

        '**************************************************

        Dim Ps As Double = 0
        Dim Pac As Double = tb_ac_4.Text

        Ps = 0.9 * (gf - (0.006941 * Pac)) * Dr

        Ps = System.Math.Round(Ps, 0, MidpointRounding.AwayFromZero)
```

```
        tb_ac_14.Text = Ps
    End Sub

    Private Sub gb_gd_Enter(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles gb_gd.Enter

    End Sub

    Private Sub cb_ac_9_SelectedIndexChanged(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles cb_ac_9.SelectedIndexChanged

    End Sub

    Private Sub bt_ac_save_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_ac_save.Click

    End Sub

    Private Sub TabPage4_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
TabPage4.Click

    End Sub

    Private Sub TabPage5_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
TabPage5.Click

    End Sub

    Private Sub Button5_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_tm_Export_Table.Click

    End Sub

    Private Sub bt_tm_ok_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
bt_tm_ok.Click

        Dim Q As Double = 0
        Dim Qi As Double = 200
        Dim dQ = 100
        Dim Zi As Double = 0.02
        Dim Z1 As Double = 0
        Dim Z2 As Double = 0
        Dim Z As Double = 0
        Dim Tpr As Double = 0
        Dim Ps As Double = tb_tm_0.Text
        Dim Gg As Double = tb_tm_3.Text
        Dim Ts As Double = tb_tm_4.Text
        Dim Prx As Double = tb_tm_2.Text
        Dim Pe As Double = 0
        Dim us As Double = 0
        Dim Nres As Double = 0
        Dim Dp As Double = tb_tm_7.Text
        Dim f As Double = 0
        Dim El As Double = tb_tm_16.Text
        Dim F117 As Double = Nres
        Dim C125 As Double = El
        Dim Sg As Double = tb_tm_3.Text

        Dim M As Double = 0

        Dim n As Double = 0

        Dim Lp As Double = tb_tm_8.Text
```

```
Dim Pwh As Double = 0

Dim Tr As Double = tb_rd_2.Text

Dim S As Double = 0

Dim angle As Double = tb_tm_17.Text

Dim Pi As Double = Prx

Dim Lt As Double = tb_tm_15.Text

Dim A As Double = 0

Dim D As Double = tb_tm_14.Text

Dim B As Double = 0

Dim Pwf As Double = 0

Dim K As Double = 0

Dim Hg As Double = tb_tm_10.Text

Do
  'LOOP1
'*********************************************************************************************

  Do

    Z1 = Zi + 0.001

    Tpr = (460 + Ts) / (167 + 316.67 * Gg)

    Dim Ppr As Double = 0

    Ppr = Ps / (702.5 - 50 * Gg)

    Dim pr As Double = 0

    pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))

    Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
 + (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
 + (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

    Z = Z2

  Loop While Z1 <> Z2

  us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _

 + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _

 * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *
Gg))

  Nres = 20.9 * Gg * Qi / (Dp * us)

  f = 1 / (-4 * Math.Log10((El / 3.7065) - (5.0452 / F117) * Math.Log10(((C125 ^ 1.1098) / 2.8257) + 5.85 /
```

```
(F117 ^ 0.8181)))) ^ 2

        M = ((4.195 * (10 ^ -7)) * ((Sg * Z * (Ts + 460) * Qi ^ 2) / Dp ^ 4))

        n = ((24 * f * Lp) / Dp)

        Pwh = (((M * n) + (Ps ^ 2)) ^ 0.5)
'*****************************************************************************************

        'LOOP 2

'*****************************************************************************************

        Ts = tb_tm_4.Text

        Ps = tb_tm_0.Text

        Ts = (Ts + Tr) / 2

        Ps = (Ps + Prx) / 2

        Dim round_1 As Double = 0
        Do
           If round_1 <> 0 Then
              Qi = Qi + dQ
           End If
           round_1 = round_1 + 1
           Z1 = Zi + 0.001
           Tpr = (460 + Ts) / (167 + 316.67 * Gg)
           Dim Ppr As Double = 0
           Ppr = Ps / (702.5 - 50 * Gg)
           Dim pr As Double = 0
           pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))

           Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
      + (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
      + (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

           Z = Z2

        Loop While Z1 <> Z2

        us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _

    + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _

   * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *

Gg))

        Nres = 20.9 * Gg * Qi / (Dp * us)
        f = 1 / (-4 * Math.Log10((El / 3.7065) - (5.0452 / F117) * Math.Log10(((C125 ^ 1.1098) / 2.8257) + 5.85 /
(F117 ^ 0.8181)))) ^ 2

        S = -0.0375 * Gg * (Math.Sin((angle * Pi) / 180) * Lt) / (Z * (Ts + 460))

        A = ((f * ((Z * (Ts + 460) * Q) ^ 2) * (2.685 * 0.001)) / ((Math.Sin((angle * Pi) / 180)) * D ^ 5))

        B = A * (1 - (Math.Exp(-S)))

        Pwf = (((Pwh ^ 2) * (Math.Exp(-S)) - B) ^ 0.5)

'*****************************************************************************************
```

```
        'LOOP3
'*******************************************************************************************

        Tr = tb_rd_2.Text
        Prx = tb_rd_1.Text

        Ts = Tr
        Ps = Prx
        Do
           Z1 = Zi + 0.001

           Tpr = (460 + Ts) / (167 + 316.67 * Gg)

           Dim Ppr As Double = 0

           Ppr = Ps / (702.5 - 50 * Gg)

           Dim pr As Double = 0

           pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))

           Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
      + (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
      + (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

           Z = Z2

        Loop While Z1 <> Z2

        us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _

    + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _

   * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *
Gg))


        If rb_tm_13_A.Checked = True Then

           K = tb_rd_6.Text

        ElseIf rb_tm_13_B.Checked = True Then

           K = tb_ac_17.Text

        ElseIf rb_tm_13_C.Checked = True Then

           K = (tb_rs_12.Text * tb_rd_6.Text * c_log * Math.Log10(tb_rd_10.Text / rw)) / ((tb_rs_12.Text * c_log *
Math.Log10(re / tb_rs_1.Text)) + (tb_rd_6.Text * c_log * Math.Log10(tb_rs_1.Text / rw)))

        End If

        Pe = (1.417 * Qi * (Tr + 460) * Z * us * (c_log * Math.Log10(rw / re)) / (K * Hg) + Pwf ^ 2) ^ 0.5

'*******************************************************************************************
      Loop While Prx < Pe

      tb_tm_18.Text = Qi

      Dim Penew As Double = 0

      Penew = Prx
```

```
Dim Bg As Double = 0

Dim Z3 As Double = Z

Bg = 0.2828 * Z3 * (460 + Tr) / Penew

Dim Gi As Double = 0

Dim Area As Double = tb_tm_12_5.Text
Dim porosity As Double = tb_tm_5.Text

Dim Sw As Double = tb_tm_6.Text

Gi = (43560 * Area * porosity * (1 - Sw) * hn) / (1000 * Bg)


'*********************************************************************************************
        '****calculate 2****
'*********************************************************************************************

Dim T As Double = 1

Dim dT As Double = 1

Dim Gp As Double = 0

Dim r As Double = 0

Do

  If r <> 0 Then

    T = T + dT

  End If

  Gp = (Qi * 30.4375) * T

  Do

    Z1 = Zi + 0.001

    Tpr = (460 + Ts) / (167 + 316.67 * Gg)

    Dim Ppr As Double = 0

    Ppr = Ps / (702.5 - 50 * Gg)

    Dim pr As Double = 0

    pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))


    Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
+ (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
+ (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

    Z = Z2

  Loop While Z1 <> Z2

  us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _
```

```
   + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _
   * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *
Gg))

        Nres = 20.9 * Gg * Qi / (Dp * us)

        f = 1 / (-4 * Math.Log10((El / 3.7065) - (5.0452 / F117) * Math.Log10(((C125 ^ 1.1098) / 2.8257) + 5.85 /
(F117 ^ 0.8181)))) ^ 2

        M = ((4.195 * (10 ^ -7)) * ((Sg * Z * (Ts + 460) * Qi ^ 2) / Dp ^ 4))

        n = ((24 * f * Lp) / Dp)

        Pwh = (((M * n) + (Ps ^ 2)) ^ 0.5)
        'Loop2
        '*************************************************************************

        Ts = tb_tm_4.Text
        Ps = tb_tm_0.Text

        Ts = (Ts + Tr) / 2
        Ps = (Ps + Prx) / 2

        Dim round As Double = 0

        Do

          If round <> 0 Then
            Qi = Qi + dQ
          End If
          round = round + 1


          Z1 = Zi + 0.001


          Tpr = (460 + Ts) / (167 + 316.67 * Gg)

         Dim Ppr As Double = 0


        Ppr = Ps / (702.5 - 50 * Gg)


        Dim pr As Double = 0


          pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))

          Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
      + (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
      + (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

          Z = Z2

        Loop While Z1 <> Z2

        us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _
   + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _
   * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *
Gg))
```

```
        Nres = 20.9 * Gg * Qi / (Dp * us)

        f = 1 / (-4 * Math.Log10((El / 3.7065) - (5.0452 / F117) * Math.Log10(((C125 ^ 1.1098) / 2.8257) + 5.85 /
(F117 ^ 0.8181)))) ^ 2


        S = -0.0375 * Gg * (Math.Sin((angle * Pi) / 180) * Lt) / (Z * (Ts + 460))

        A = ((f * ((Z * (Ts + 460) * Q) ^ 2) * (2.685 * 0.001)) / ((Math.Sin((angle * Pi) / 180)) * D ^ 5))



        B = A * (1 - (Math.Exp(-S)))

        Pwf = (((Pwh ^ 2) * (Math.Exp(-S)) - B) ^ 0.5)

        'Loop3
'*******************************************************************************************
******


        Tr = tb_rd_2.Text
        Prx = tb_rd_1.Text


      Ts = Tr
        Ps = Prx
        Do
            Z1 = Zi + 0.001
            Tpr = (460 + Ts) / (167 + 316.67 * Gg)
            Dim Ppr As Double = 0
            Ppr = Ps / (702.5 - 50 * Gg)
            Dim pr As Double = 0
            pr = (0.27 * Ps / (702.5 - 50 * Gg)) / (Z1 * (Ts + 460) / (167 + 316.67 * Gg))

            Z2 = 1 + (0.31506237 + (-1.0467099 / Tpr) + (-0.57832729 / Tpr ^ 3)) * pr _
      + (0.53530771 + (-0.61232032 / Tpr)) * (pr ^ 2) + (-0.61232032 * (-0.10488813) * pr ^ 5) / Tpr _
      + (0.68157001 * (pr ^ 2) / Tpr ^ 3) * (1 + 0.68446549 * pr ^ 2) * (Math.Exp(-0.68446549 * pr ^ 2))

            Z = Z2

        Loop While Z1 <> Z2

        us = (10 ^ -4) * ((9.4 + 0.62 * 28.964 * Gg) * ((460 + Ts) ^ 1.5) / (209 + 19 * 28.964 * Gg _
    + (460 + Ts))) * Math.Exp((3.5 + 986 / (460 + Ts) + 0.01 * 28.964 * Gg) _
    * (1.4926 * 0.001 * Ps * 28.964 * Gg / (Z * (460 + Ts))) ^ (2.4 - 0.2 * 3.5 + 986 / (460 + Ts) + 0.01 * 28.964 *
Gg))

        If rb_tm_13_A.Checked = True Then



       K = tb_rd_6.Text


       ElseIf rb_tm_13_B.Checked = True Then

            K = tb_ac_17.Text

        ElseIf rb_tm_13_C.Checked = True Then
```

```
            K = (tb_rs_12.Text * tb_rd_6.Text * c_log * Math.Log10(tb_rd_10.Text / rw)) / ((tb_rs_12.Text * c_log * Math.Log10(re / tb_rs_1.Text)) + (tb_rd_6.Text * c_log * Math.Log10(tb_rs_1.Text / rw)))

        End If

        Pe = (1.417 * Qi * (Tr + 460) * Z * us * (c_log * Math.Log10(rw / re)) / (K * Hg) + Pwf ^ 2) ^ 0.5

        Dim Pe2 As Double = 0

        Pe2 = ((Penew * Gp / (Z3 * Gi)) + (Penew / Z3)) * Z

      Loop While Pe < Penew


'**********************************************************************************************

   End Sub

End Class
```

BIOGRAPHY

Miss Vimontha Janbumrung was born on the 5th of June 1987 in Bangkok, Thailand. She earned his high school diploma in science-math from Benjamarachalai School Under the Royal Patronage of the King in 2005 and She earned her Bachelor's Degree in Chemical Engineering from King Mongkut's University of Technology North Bangkok (KMUTNB) in 2009. After graduation, she continued with her master's degree in the School of Geotechnology, Institute of Engineering at Suranaree University of Technology (SUT) with the major in Petroleum Engineering. During 2010-2014 (SUT) in, she was a teacher assistant and laboratory assistant at SUT. Her strong background is in the areas of acid stimulation, reservoir simulation, and reservoir management.