CHAPTER I
INTRODUCTION

1.1 Introduction

Zeolite has been studied with the respect to its structure-property relationships, which are significantly dependent on synthesis conditions. To summary, Zeolites are hydrated aluminosilicates, which created from tetrahedral alumina (AlO4)5- and silica (SiO4)4- through the interlinkage of oxygen atoms. Zeolites contains high crystalline, porous aluminosilicate minerals with a three-dimensional network of tetrahedral SiO4 and AlO4 units, allowing cations to be located within the material's pores. In this framework, these cations neutralize the lattice's negative charge. Therefore, this cation mobility results from the unique ion-exchange and catalytic properties of zeolites. Zeolite has different applications. It can be used as a highly efficient catalyst (Y. Liu et al., 2019), adsorbent (Ramya et al., 2019), ion exchanger (Król, 2019), and detergent (Cardoso et al., 2015) for contaminated water treatment and other chemical processes. Moreover, zeolites is important for the process of biomass conversion, thermal energy storage, water purification, fuel cells, and air pollution remediation.

In the ordinary method, most synthesis methods require sodium aluminosilicate gel for both simple and complex methods. Especially the hydrothermal treatment, which involves a multiphase reaction-crystallization process (Cundy & Cox, 2003a) involving amorphous or crystalline phases, which is a liquid and a solid phase. The hydrothermal method has a significant impact on the synthesis of zeolites since its introduction by Barrer in 1948 (Kerr, 1983). Hydrothermal synthesis was described as an in situ reaction that occurs above room temperature and pressure in an aqueous solution. Synthesizing aluminosilicate zeolites under hydrothermal conditions is always preferable. This method has several advantages, including low energy consumption, reduced air pollution, and a high tendency to form reactive products, as well as metastable and condensed phases. Synthetic zeolites are typically used than natural zeolites due to their higher purity and uniform particle size, which are particularly suitable for most engineering applications and scientific purposes. Most synthetic zeolites are synthesized from chemical sources integrated from silica and alumina in an aqueous alkaline medium at temperatures ranging from 8 to 200 °C for durations of 1 to 20 days. However, preparing synthetic zeolites from chemical sources of silica and alumina is relatively expensive (Johnson & Arshad, 2014). High-temperature, high-pressure, and long-period hydrothermal reactions are typically not considered “green” due to their low efficiency and potential for water pollution. The use of ecological materials, agro-waste, natural raw materials, and manufacturing waste has been studied and used as starting materials for synthesizing zeolite. For example, coal fly ash, rice husk ash, oil shale ash, bagasse fly ash, paper sludge, waste sandstone cake, waste porcelain, lithium slag, and kaolin. In general, there are two phases in the synthesis of zeolite from kaolin. The initial phase is calcination, which converts kaolin into a metastable phase through hydrothermal activation, as illustrated in Equation (1).

$$2Al_2Si_2O_5(OH)_4 \longrightarrow 2Al_2Si_2O_7 + 2H_2O \qquad (1)$$

The second stage is hydrothermal treatment using an aqueous alkali solution to convert the product ($Al_2Si_2O_7$) obtained from the first stage into zeolite, as shown in Equation (2).

$$6Al_2Si_2O_7 + 12NaOH \longrightarrow Na_{12}(AlO_2)_{12}(SiO_2)_{12}27H_2O + 6H_2O \qquad (2)$$

Therefore, this study aims to present an overview of current developments in the synthesis of zeolite from ball clay, with particular emphasis on identifying the optimum calcination temperature and alkaline solution concentration for hydrothermal treatment. This study also examines the chemical and physical properties of the synthesized zeolite as a molecular sieve and evaluates its potential to enhance the performance of oxygen concentrator devices, leading to more efficient oxygen generation to achieve medical-grade concentration requirements.

1.2 Research objective

1.2.1 To synthesize the Li-A zeolite using ball clay as a starting material by hydrothermal treatment

1.2.2 To investigate the optimum calcining temperature of metastable phase ball clay and the concentration of the alkaline solution for hydrothermal treatment.

1.2.3 To study the chemical and physical properties of the synthesized zeolite as a molecular sieve.

1.2.4 To examine the efficiency of the synthesized zeolite as a molecular sieve in a Pressure swing adsorption (PSA) oxygen concentrator.