CHAPTER I

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I.1. Background

Petroleum-based fuel has been in used as a main energy source in human civilization for centuries. Nowadays, the demand of petroleum-based fuel is increasing even more significant than ever because of the rapid growth of industrial and technology. However, since the raw material for the fuel, the petroleum, is a non-renewable resource, this increasing demand would cause the depletion of petroleum reserve. This condition will also lead to other problems, such as escalating crude oil prices and a global energy crisis.

Aside from those future possible problems, the utilisation of petroleum-based fuel also has its own disadvantages. Using the petroleum-based fuel would results in a gas emission, such as carbon dioxide, nitrogen, and sulfur compounds. These gases are the main cause for air pollution and green house effect [1]. Therefore, petroleum-based fuel also gives a great contribution to the global warming.

The scarce of new petroleum resources and environmental problem is caused by the intense use of petroleum-based fuel has lead to the research of alternative fuel as a new energy source replacing the petroleum-based fuel. Biofuel is one of those alternative fuels that currently being studied. Biofuel is defined as liquid or gaseous fuel that can be produced from the utilization of biomass substrates [2]. Vegetable oils can be used as a raw material for an alternative fuel because it is renewable and also free of nitrogen and sulfur compounds [2, 3]. Therefore, biofuel obtained from vegetable oils can be used as a substitute for fuel or fuel additive to reduce gas emission [4].

Among all of the vegetable oils available, palm oil is an option that can be used as a raw material for the biofuel [2-7]. Palm oil is one of the most produced vegetable oil in the world, and Indonesia is one of the large palm oil producers in the world with the production capacity is near 15,000,000 tons/year, probably second only to Malaysia [5]. Palm oil is commonly used only as cooking oil and raw material for oleochemical industries [2-5, 8]. At present, several studies have been conducted to convert palm oil into biofuel such as gasoline and diesel fractions through the catalytic cracking of this cooking oil [2-7]. In their study, they used different type of catalysts such as zeolites and other mesoporous silica materials. One of the effective catalyst for the catalytic cracking process are zeolites, such as HZSM-5, as the catalytic cracking over HZSM-5 gave high yield of gasoline fraction [2, 4, 6-10]. The main drawback in using HZSM-5 as a catalyst is the selectivity for gaseous product obtained from the catalytic cracking process which was also high, and it tends to produce more liquid products. Therefore, the mesoporous catalyst MCM-41 can be used as an alternative instead of HZSM-5 to improve the total yield of organic liquid products (OLP) and also production of gasoline range hydrocarbons [5-7].

To solve the global energy crisis problem, it is important to bring the laboratory scale production of biofuel to the higher level scale production and if possible to mass production one. However, the C/O (catalyst/oil) ratio used in previous experiments was too high, from 1: 6 to 1: 10, and the yield obtained from those experiments was 67.3 to 98.3, and the yield of OLP obtained was 42.3 to 62.8 [2]. Even though the high conversion value was obtained, the use of high C/O values are not efficient if this technology be applied in industrial scale since a huge amount of catalyst needed to convert hundred tons of palm oil into liquid hydrocarbon fuel. Another study using lower C/O ratio was also has been conducted by Nasikin et al. In his experiment he used C/O ratio was at 1: 75, and the conversion of 21.36% was obtained [5].

The conversion of palm oil into liquid hydrocarbon depends on many process parameters such as the type of catalyst, C/O ratio, reaction temperature and WHSVs (weight hourly space velocities). Here we used MCM-41 as the catalyst, since this mesopores material has narrow pore size distribution and ordered pore characteristic. To scale up the catalytic cracking reactor it is necessary to obtain complete feature of the reaction kinetic during the catalytic reaction occurs. This feature usually presented as a reaction model. In the preliminary studies conducted by our other fellows, the product's composition at the optimum C/O ratio and various WHSVs condition at the fixed reaction temperature had been obtained. The optimum C/O ratio was then used to obtain the data of product's composition at various WHSVs and reaction temperature. The main objective of this study is to determine the reaction kinetic of catalytic cracking of palm oil into liquid hydrocarbon fuel using the optimum operating condition obtained by Dessy and Giyanto [12].

I.2. Problem Formulation

What is the order of reaction kinetics of the catalytic cracking of palm oil over MCM-41?

What kind of available models is suitable to present our kinetic reaction data?

I.3. Aim of the Study

To determine the reaction kinetics of the catalytic cracking of palm oil over mesoporous silica MCM-41.

I.4. Problem Limitations

1. The palm oil used in this research was the palm oil that had been refined, bleached, and deodorized.
2. The catalyst used in this research was MCM-41 which is synthesized at the optimum condition obtained by Wibisono [11].
3. The C/O ratio used in this research was the optimum ratio obtained by Dessy and Giyanto [12].