Separation of Red Palm Oil from Crude Palm Oil Using Ceramic Membrane from Clay and Bentonite

Siti Chodijah(✉), Erwana Dewi, and Jaksen M. Amin

Department of Chemical Engineering, Sriwijaya State Polytechnic, Palembang, Indonesia
chodijahsiti@gmail.com

Abstract. Filtration or filtration is a method of separating particles of solid substances from a fluid by passing the fluid through a filter medium; solid substances will be retained. The palm fruit consists of 80% pericarp parts (epicarp and mesokarp) which produce crude palm oil *Crude Palm Oil* and 20% seeds (endocarps and endosperm) which produce palm kernel oil *Palm Kernel Oil*. In making this red palm oil, it uses a ceramic-based membrane filtration consisting of 60% clay and 30% zeolite rocks. The purpose of this study was to determine whether the red palm oil products produced from the filtration membrane met the red palm oil standards. For treatment in this experiment, sulfuric acid and Sodium Hydroxide were added as *degumming* and neutralization with variations in time (2, 4, 6 min) and temperature (40, 60 C and 80 °C) with an operating pressure of 5 bar. The results of the study found that the temperature of 60 °C is the optimum temperature in proses filtration membrane to obtain red palm oil with standard quality.

Keywords: First Keyword · Second Keyword · Third Keyword

1 Introduction

In industry, process filtration includes a wide range of operations ranging from simple filtration to complex separation. The filtered fluid can be a liquid or a gas, the flow that escapes the filter may be a liquid, a solid, or both [1].

In 2019 Indonesia was the world's largest palm oil producer with palm oil production reaching 36.17 million tons [2]. Palm oil is the only vegetable oil with almost 50% of the composition of saturated and unsaturated fatty acids. The CPO fraction produced is mainly palm olein liquid fraction and solid palm stearin fraction. This fraction has different physical and chemical properties. CPO containing oleic and stearin is an important constituent of several food products in the industry such as shortening, ice cream, cosmetics, candles, toothpaste and biodiesel [3].

The process technology in CPO so that it is not colored or clear, odorless and tasteless, in the process of making cooking oil has been growing. In particular palm oil red color contains micronutrients antidote to chronic degenerative diseases is still present in palm

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oil is actually deliberately discarded part of it and some of it is wasted by using certain materials.

With the increasing popularity of the use of natural compounds for health supplement ingredients, the carotenoid and palm oil tocopherol have very good prospects for development, among others by producing red palm oil that retains these bioactive components. During this time in the oil refining process, the red color of palm oil was deliberately removed to obtain clear cooking oil [5].

In this study, the process of extracting red palm oil from crude palm oil that will be carried out is to use ceramic membrane filtration, ceramic membranes are made from a mixture of zeolite and clay rocks in a ratio of 70: 30. In this study, it can be seen that the performance of the ceramic membrane to separates red palm oil from CPO so that it meets the standards for foodstuffs and medicines.

2 Research Methods

2.1 Materials and Instruments

Instruments: Membrane filtration apparatus, stirred tanks, pump, heater, and UV-VIS spectrophotometer.
Materials: Crude palm Oil, NaOH, H_2SO_4.

2.2 Procedure

a. CPO at temperature 40 °C while stirring, then add Sulfuric Acid (H_2SO4) 0.1%wt of the CPO, then stir and heated at 40 °C for 15–30 min.
b. After the degumming process, CPO is then added NaOH 10% wt. stirring is carried out continuously during the heating process.
c. The neutralized CPO is added NaOH until pH = 6, then flowed to the membrane by turning on the pump by adjusting *the flow* variation so that the pressure works in the process of squeezing the CPO into Red palm oil escaped.
d. The viscous of CPO flowed to be recycled back to the stirred tank.
e. Then red palm oil products have quality analysis are free fatty acid content, peroxide number and water content.
f. If at the CPO stage in the tank is very saturated or the content was concentrated, then replace the new feed or stop the experiment.

3 Results and Dsicussion

3.1 Degumming and Neutralization Process of CPO

Degumming process is carried out by adding H2SO4 85% and the neutralization process by adding NaOH 0.1 M. Then the separation of the coagulant formed with the clean CPO from gum (Tables 1 and 2).

Table 1. Degumming and Neutralization process of CPO

Test Parameters	Result
Color	Orange-Red (cloudy)
Construction	Typical of Palm Oil
Density	0.9233 gr/ml
Viscosity	15,70 cp
pH	6
Air Up	0,40%
Free Fatty Acids	6,144%
Peroxide Number	9,9374 mEk O_2/kg
β-Carotene	907,03975 ppm

Table 2. Data of the Red Palm Oil Filtration Process, at pressure (P = 50kg/cm^2 sec)

Temp (^{o}C)	Time (minutes)	VP (S)	VR (S)	VF total (S)
40	30	0,119	0,55	0,669
	40	0,081	0,37	0,451
	50	0,083	0,35	0,433
60	30	0,081	0,35	0,431
	40	0,062	0,30	0,362
	50	0,060	0,35	0,410
80	30	0,055	0,25	0,305
	40	0,055	0,20	0,255
	50	0,045	0,20	0,245

All solids such as sap, free fatty acids, unwanted odors and other compounds have been eliminated. Testing product samples in the form of color, odor, pH, density, moisture content, viscosity, free fatty acids, peroxide number, and β-Carotene Proses filtration *of crude palm oil* to obtain red palm oil that meets the standards is carried out with various temperature variations with constant pressure. Furthermore, the CPO sample is included in heating tank for variable temperatures used 40, 60 and 80 °C. Natural proses filtration to obtain red palm oil pressure regulated optimum for continuous flow. The temperature variable has been determined, the next process is that the filtrate from this tank is flowed to the filtration unit in form of a housing containing zeolite rocks, ceramic membranes, and *filter cartridges*. Turn on the pump keep flow constant at a pressure of 5 Bar, *Permeate* is accommodated as a result of filtration and retentate is collected and measured in a period of time each 20 min i.e. to determine the magnitude of the oil flux. Furthermore,

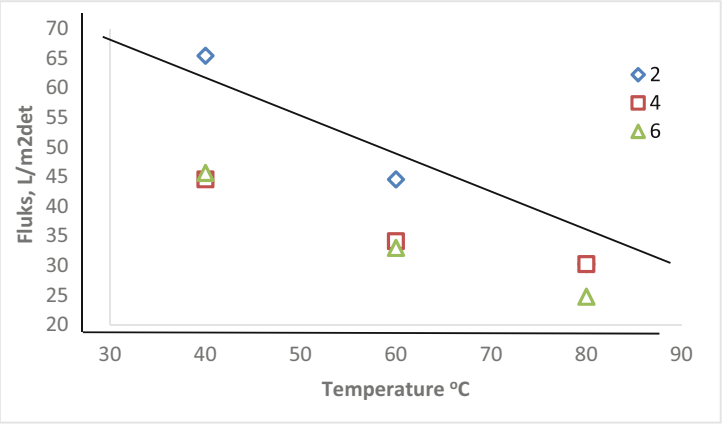

Fig. 1. Effect of Flux Temperature of CPO to RPO using membrane Ceramic

analyst tests were carried out on red palm oil products based on the standards of red palm oil sold in the market.

Flux Analysis

From Chart 1. Effect of Flux at Temperature, it can be seen that the longer the filtration time lasts, the flux value obtained decreases. This is caused by the pores on the ceramic membrane starting to shrink or narrow, making the volume of permeate that comes out or escapes the membrane decrease. The ceramic membrane used repeatedly makes the pores on the membrane begin to shrink and become covered by material or solids dissolved in the sample that cannot through the membrane. It can be seen that the longer the process goes on, the lower the flux value on each membrane used with different temperature variables. Where the higher temperature in this experiment, it was seen that the flux also increased. The Viscosity Content Analysis.

From the Chart 2, it can be seen that there is a decrease in the viscosity value of red palm oil products after passing through the filtration device. The factors affecting the viscosity test are temperature, solution concentration, and pressure. From graph the effect of temperature on the viscosity value above shows that the greater the temperature, the decrease in the viscosity value of the noodles k. According to Dong, S., et al. (2017). states that the temperature affects the viscosity of cooking oil the lower it is. A decrease in the viscosity value is caused by a decrease in the force of molecular cohesion due to a rise in temperature. In this study, it produced a clear red palm oil product, this is due to the decreased viscosity, the levels of impurities, gum, and others in red palm oil products have been lost.

Density Analysis

From the Chart 3, it can be seen that it does not show specific changes in CPO which after *degumming* and neutralization with red palm oil products that have been philomalized with membranes, there is almost no change. Seen at 40 °C in sample 1 has a viscosity value that exceeds the red palm oil standard. This analysis test is one of the functions

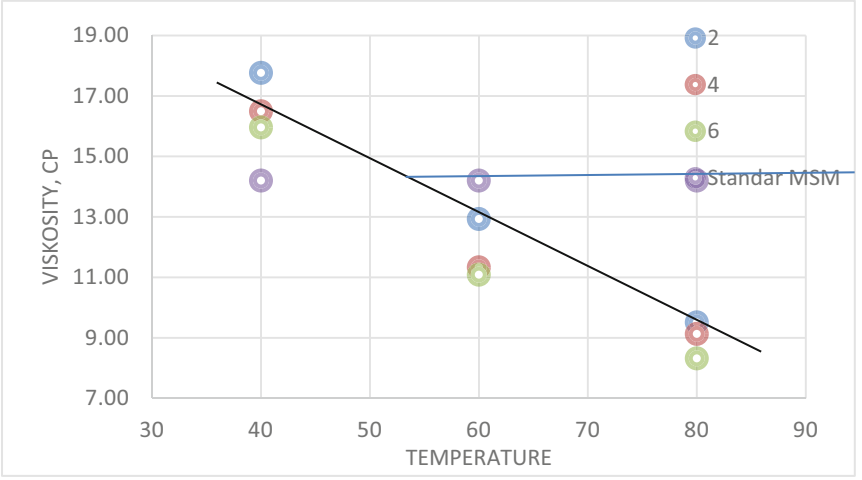

Fig. 2. Effect of Temperature separation on the Viscosity Red Palm Oil

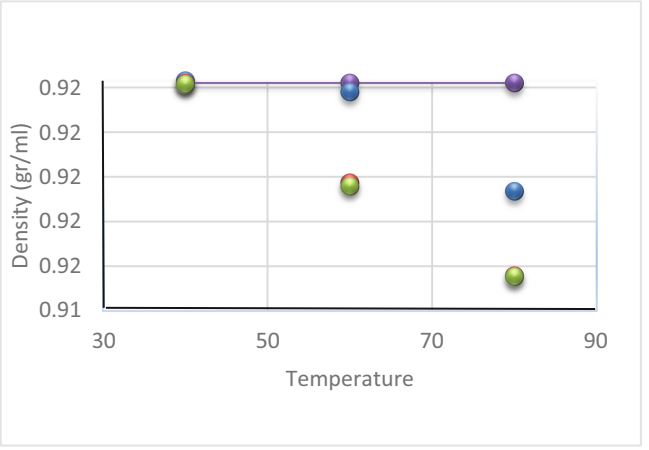

Fig. 3. Effect of Density of Red palm Oil on Temperature of Filtration

of temperature. This means that any change in temperature will cause a change in the density value. (Febrian et al. 2019). Therefore, for this analysis test based on processing temperature, it has an effect in this density test.

Water Content Analysis

The graph of the effect of water content on filtration temperature shows that at 40 °C Y.1 a shows the moisture content in red palm oil products passing through or smaller is below the standard limit of red palm oil sold on the market. The decrease in water content after passing through the filtration process using zeolite, ceramic membranes and filter cartridges limits the very minimal moisture content that can escape the membrane. In addition, the factor of decreasing water content is due to the increase in temperature

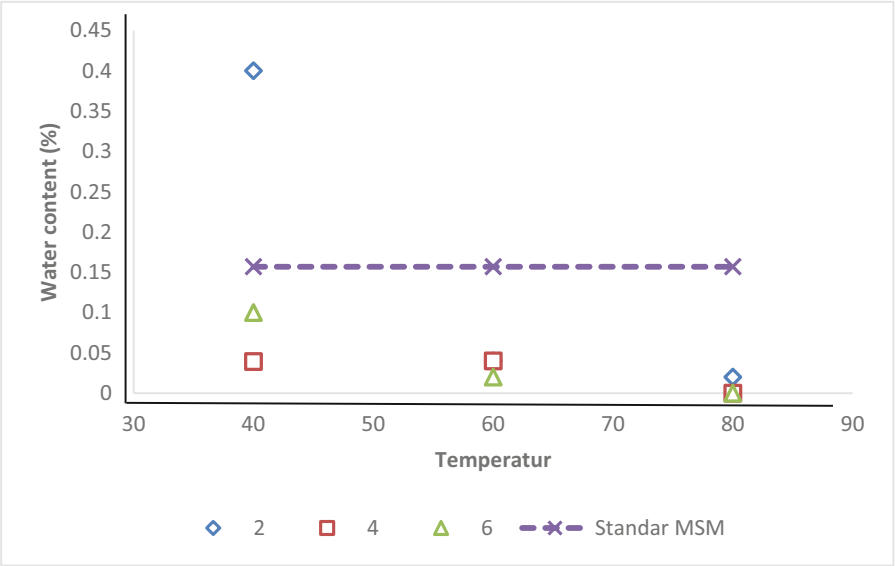

Fig. 4. Effect of Moisture Content Values on Filtration Temperature

in this study, the water content at a temperature of 60 °C obtained from the results of the three samples showed a significant decrease in water content. At a temperature of 80 °C shows as many as the last 2 samples the water content is 0.00%, the higher the temperature will make the water content drop even more (Fig. 4).

4 Free Fatty Acid Analysis

From the graph the influence of filtration temperature on the content of free fatty acids shows that fatty acids show a decrease. In red palm oil samples, it is below the maximum limit because the neutralization process because in refining red palm oil is quite effective in reducing the content of free fatty acids. The high content of free fatty acids indicates poor-quality oils or fats. The high content of free fatty acids can lead to the risk of further oil damage due to oxidation [9] (Fig. 5).

Peroxide Number Analysis

In the Chart 6, it shows the results of research on the processing of red palm oil, it can be seen that all the amount of peroxide obtained exceeds the standard of the peroxide number of red palm oil sold in the market. Judging from the data obtained, the red palm oil product in this study shows the degree of damage to oil or fat.

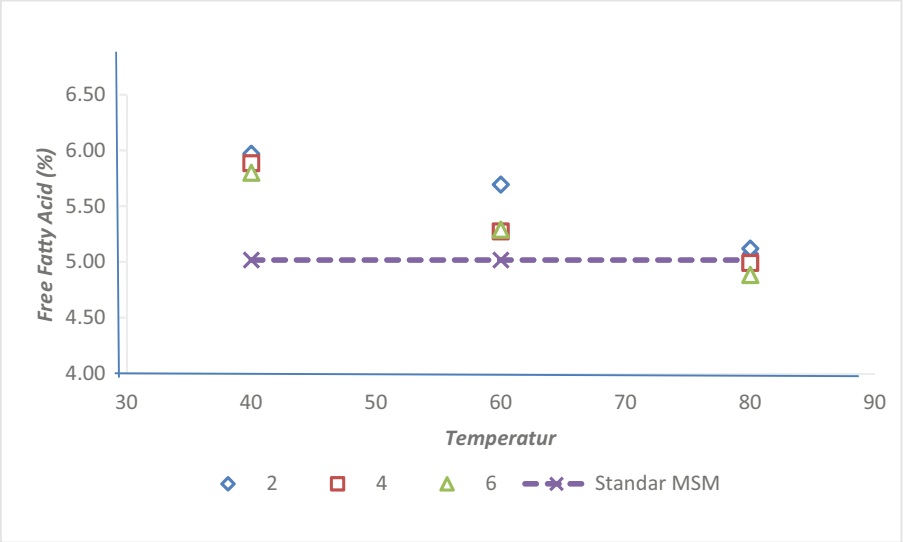

Fig. 5. Effect of Filtration Temperature on MSM-Free Fatty Acid Levels

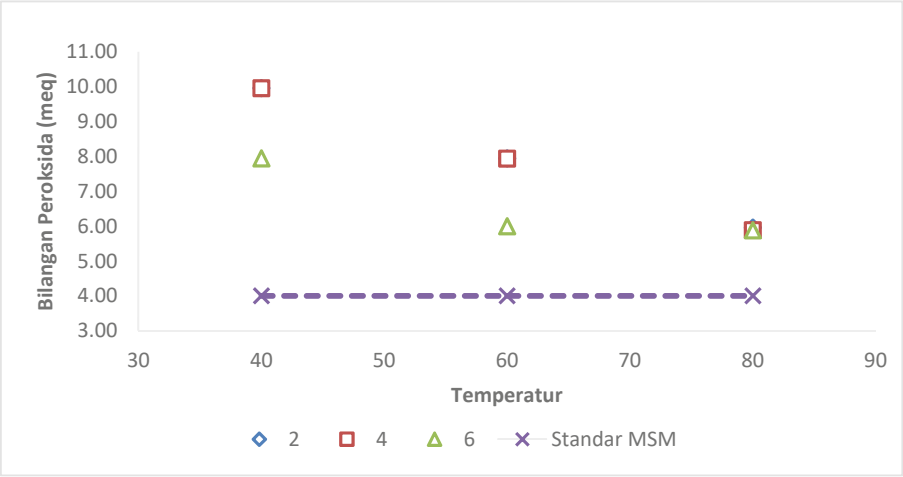

Fig. 6. Effect of Peroxide Number Values on Temperature

5 Analysis β-Carotene

Effect of Filtration temperature on the value of beta carotene of MSM product, it can be seen that in the analysis of this beta carotene test at a temperature of 40 °C shows high levels of carotene that exceed the standard of beta carotene of red palm oil sold on the market. Beta carotene was a decrease in the high temperature, this indicates the influence of temperature and filtration passing through ceramic membranes. The substandard beta

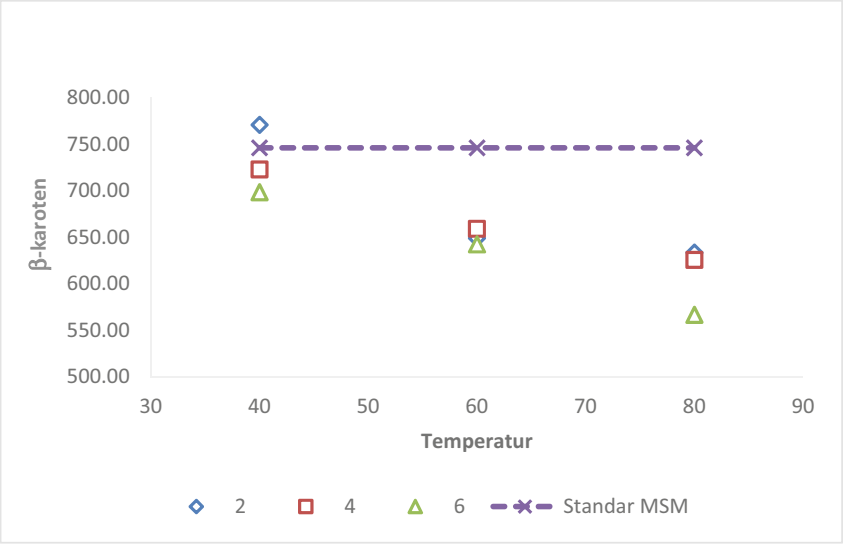

Fig. 7. Effect Filtration Temperature on the Value of Beta Carotene MSM products

carotene levels of red palm oil beta carotene sold on the market are due to the temperature used in this study (Fig. 7).

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