CHAPTER III
METHODOLOGY

3.1 Materials

3.1.1 Surfactant

Types of nonionic surfactant used in the research were 1) methyl oleate as a fatty ester 2) sorbitan monooleate, Span 80 (is renewable sugar based surfactant) and 3) biodiesel or palm oil methyl ester. The properties and the structure of surfactants are showed in Table 5.1 and Figure 5.1, respectively.

3.1.1.1 Methyl Oleate

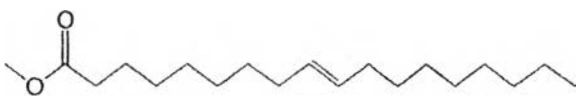
Methyl oleate, methyl ester, contains the C18 carbon chain length with a double bond in the structure. It was selected because this surfactant had provided the least used concentration of surfactant to form single phase microemulsion and microemulsion fuel with methyl oleate system indicating closely and suitably the properties to the standard No.2 diesel. Methyl oleate with 70% purity (technical grade) was purchased from Aldrich Chemistry Company.

3.1.1.2 Span 80

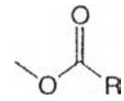
Span 80 or sorbitane monoleate is renewable sugar based surfactant. Span80 (Rheodol SP-O10) was obtained from the Kao Chemical Company (Thailand) Co., Ltd.

3.1.1.3 Biodiesel (Palm Oil Methyl Ester, PME)

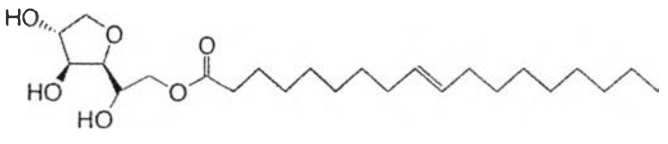
Biodiesel based palm oil is fatty acid methyl ester (FAME) which is derived from palm oil. Biodiesel (B100) was received from Werasuwan Co., Ltd.



Methyl oleate



Palm oil methyl ester

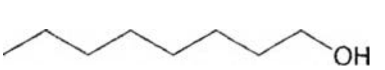


Span 80

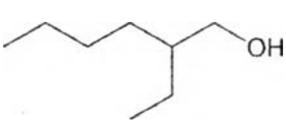
Figure 3.1 Structure of surfactants.

3.1.2 Cosurfactant

Two cosurfactants used in this study were 1-Octanol 99.0% of purity (purchased from Acros Organic) and 2-ethyl-1-hexanol 99.6% of purity (purchased from Aldrich Chemistry). 2-Ethyl-1-hexanol was used to identify the branched effect and comparing with 1-octanol that both have the same carbon chain length but differ on their sturcture. The properties and the structure of cosurfactants are showed in Table 3.1 and Figure 3.2, respectively.



1-Octanol



2-Ethyl-1-Hextanol

Figure 3.2 Structure of cosurfactants.

Table 3.1 Properties of the studied surfactants and cosurfactants

Materials	Molecular Weight (g/mol)	Density (g/mL)	Purity (%)
Surfactant			
Metyl oleate	296.49	0.874	70.0
Span 80	428.60	0.985	99.0
PME	283.37	0.890	65.5
Cosurfactant			
1-Octanol	130.23	0.825	99.0
2-Ethyl-1-hexanol	130.23	0.833	99.6

3.1.3 Palm Oil, RBDPO and Diesel

Food-grade palm oil and commercial-grade diesel were purchased from Morakot industries PCL and PTT Public Company Limited, respectively. Moreover, refined bleached deodorized palm oil (RBDPO) was supported by Bangchak Biofuel Co., Ltd. Table 3.2 shows the fatty acid compositions of palm oil and RBDPO.

Table 3.2 Fatty acid compositions of palm oil and RBDPO

Materials	Fatty acid composition (%)	
	Palm oil	RBDPO
Myristic acid (C14:0)	0.89	0.92
Palmitic acid (C16:0)	41.54	46.30
Stearic acid (C18:0)	3.51	3.52
Oleic acid (C18:1)	43.63	39.58
Linoleic acid (C18:2)	10.43	9.68

The data from Che Man *et al.*, 1999

3.1.4 Ethanol

Ethanol with 95% was used as a viscosity reducer and a polar liquid phase in microemulsion system. Ethanol can dissolve completely in water and flash point of ethanol is 12-15°C (Hansen *et al.*, 2005).

3.2 Experimental Methods

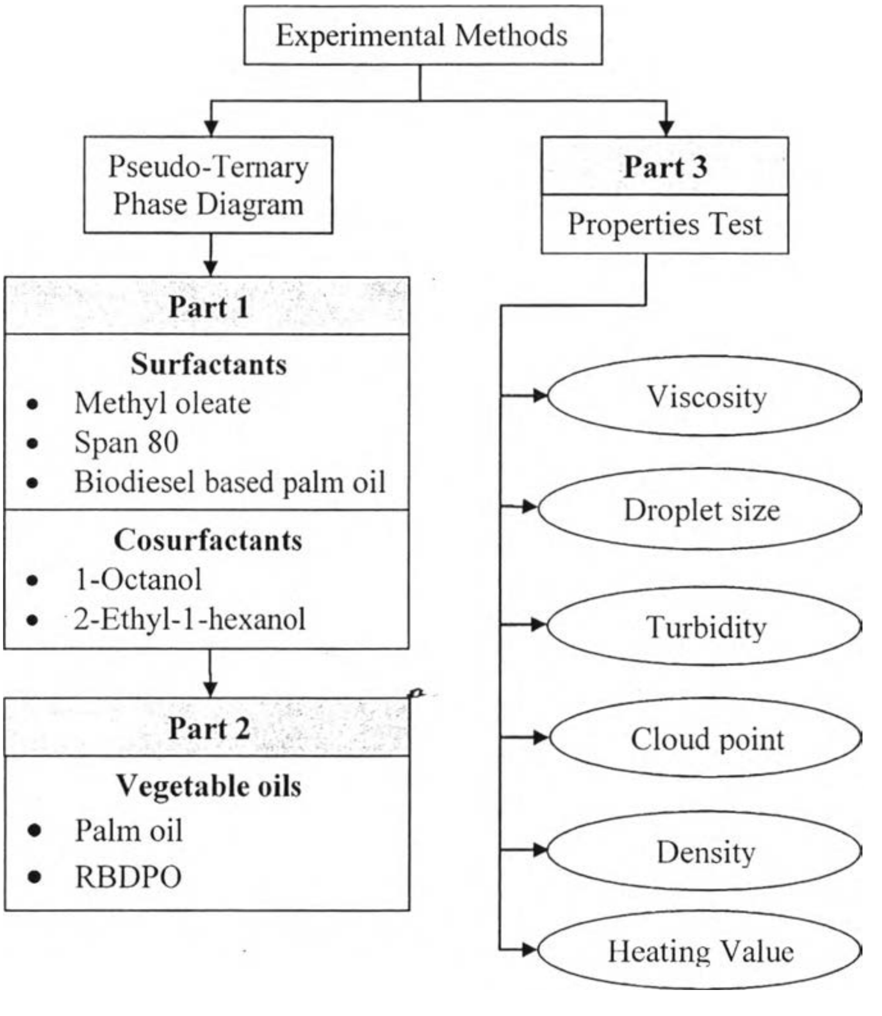


Figure 3.3 Experimental methods flow diagram.

3.2.1 Microemulsion Preparation

Composition of microemulsion fuel contained surfactant/cosurfactant blended with ratio of 1:8 by molar, vegetable oil/diesel mixture at 1:1 by volume and ethanol. Each microemulsion fuel sample was prepared in a 15 mL glass vial. Amounts (1, 2, 3, 4 and 5 mL) of ethanol with 5 mL of palm oil/diesel blend was added into surfactant and cosurfactant mixture to formulate reverse micelle microemulsion. Likewise, the fixed amount of ethanol at 5 mL and varied palm oil/diesel blends in 1, 2, 3, 4 and 5 mL were conducted. Finally, all mixtures were then hand-shake and placed at the room temperature for 48 hours.

3.2.2 Pseudo-ternary Phase Diagram

Pseudo-ternary phase diagram which is a triangle diagram consists of three components in the system for phase behavior study of microemulsion. The upper vertex represents the surfactant and cosurfactant mixture at a constant ratio. The vertex at the bottom in the left hand side represents vegetable oil and diesel blend at a constant ratio, and the right hand side represents ethanol. This system was controlled at a given temperature. Each point in a pseudo-ternary phase diagram was calculated based on three components in volume percentage.

3.2.3 Fuel Properties Determination

3.2.3.1 Kinematic Viscosity

The kinematic viscosity can be measured by Cannon-Fenske Routine viscometer follows ASTM D 445. The measurement requires a 10 mL of single phase microemulsion fuel sample volume approximately. Next, count a time for finding flow rate in cSt/sec unit at constant temperature water bath of 40°C and then, the kinematic viscosity can be calculated by equation (2.1). In this study, the kinematic viscosity of the microemulsuion fuels are compared with neat diesel fuel followed the ASTM No.2 diesel fuel at 40°C and the standard kinematic viscosity at 4 cSt.

3.2.3.2 Droplet S ize

Droplet size and size distribution of the microemulsion fuels can be determined by dynamic light scattering (DLS). A 0.45 μm PTFE membrane filters was used to remove dust particles and impurity. Nano Zetasizer (Malvern) is performed the samples that are transferred to a cylindrical light-scattering cell of 10 mm outer diameter, set temperature at 25°C and a scattering angle of 173° and light source is a He-Ne laser (λ=633 nm; 4mW)

3.2.3.3 Turbidity

Turbidity of the microemulsion fuels is determined by UV spectroscopy using photometric mode. Acetone and the samples of microemulsion fuels are filled in reference and sample cell, respectively. The absorbance is recorded for comparison of the samples.

3.2.3.4 Cloud Point

Cloud point is the temperature at the fuel which is initial to form crystals. In this study, the cloud point can be measured by using cooling bath. The fuel was observed for the cloudiness as the temperature is decreased every in 2°C

3.2.3.5 Density

Density of the samples is measured using the weighing of mass per unit volume at 25°C. The fuel density was weighted 4-digit digital analytical balance.

3.2.3.6 Gross Heat of Combustion

Heating values can be measured by oxygen bomb calorimeter (model AC-350, LECO Corporaiton, USA) following to ASTM D 240. Biofuel is placed in a crucible inside calorimeter to the heating value and to collect carbon residuals after testing fuel. The heat of combustion was calculated by the measured temperature increase of the water bath surrounding the bomb.