CHAPTER 1.0

INTRODUCTION

1.1 Background of the study

Natural phenomena such as global warming, rising sea level, retreat of glaciers and El Nino as well as extreme weather such as drought and flood are closely related to greenhouse emissions by human activities (Ithnin, Noge, Kadir, & Jazair, 2014). Fossil fuel combustion became the main contributor of greenhouse emission, accounting for 57% of the total greenhouse gases with most of them is produced from transportation and industrial sectors (Bernstein et al., 2007). Taking a close look in the transportation sector which contribute 25% of total anthropogenic emissions, both gasoline engine and diesel engine are internal combustion engines which operate in a similar principle which is the four-stroke combustion cycle (Cofala, Amann, Klimont, Kupiainen, & Höglund-Isaksson, 2007). Diesel engines have become the dominant class of engines in mass transportation, heavy industries and agricultural sectors due to their higher brake thermal efficiency (Fahd, Wenming, Lee, Chou, & Yap, 2013). Despite its higher fuel to power conversion efficiency, it becomes one of the major contributor of pollutants to the environment as the diesel exhaust are composed of noticeable amount of particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO_x), carbon dioxide (CO_2), hydrocarbons (HC), volatile organic compounds, sooty smoke and various chemicals that are classified as "hazardous air pollutants" under The Clean Air Act. Besides, exposure to emissions from diesel engine has also been classified by International Agency for Research on Cancer (IARC) as possible carcinogen to human. Besides, researchers also found out that there was a 2-fold increase in the odds of rectal cancer with exposure to diesel exhaust (Kachuri, Villeneuve, Parent, Johnson, & Harris, 2016; Parent, Rousseau, Boffetta, Cohen, & Siemiatycki, 2007).

1.2 Motivation

Hence, there is a pressing need to produce a cleaner energy by reducing the emissions of greenhouse gases and hazardous elements from diesel fueled machineries without altering its performance and combustion effectiveness (S. A. Issaka, Nour, & Yunus, 2015b). By mixing water and diesel in the presence of surfactant, water-in-diesel emulsion fuel has become one of the very sustainable solution since it is readily combustible in the existing diesel engines without any prior or post modification (Yahaya Khan, Abdul Karim, Hagos, Aziz, & Tan, 2014)

1.3 Problem Statement

Recently, researches in the topic of water-in-diesel emulsion fuel has been actively conducted. Most of previous studies are focusing on the feasibility of water-in-diesel emulsion fuel, types of surfactant used, stability, and performance of engine as well as reduction of greenhouse gases capability (Abu-Zaid, 2004; S. A. Issaka et al., 2015b; Kannan & Udayakumar, 2009; Maiboom & Tauzia, 2011; Nadeem et al., 2006a; Park, Huh, & Park, 2000; Samec, 2002; Selim & Elfeky, 2001; Selim & Ghannam, 2009). However, the results obtained by different researchers are inconsistent. Besides, the formulated diesel emulsion fuels are not economically feasible due to the high costing of commercial surfactant. On top of that, researchers from Universiti Malaysia Pahang (UMP) had produced a series of W/D emulsion using their own formulated natural polyol based surfactant which is more economical. However, not much research focusing on characterization of best condition W/D fuel in terms of low economic cost and high stability over time had been carried out so far. Hence, this research is employed to formulate and thus thoroughly characterize the W/D fuels.

1.4 Objectives

The objectives of this research are

i. To formulate and characterize W/D emulsion as environmental friendly fuel.

ii. To produce an efficient and sustainable diesel oil stabilization method through process intensification and integration based on the application of UMP surfactant.
iii. To optimize the stability and economic cost of W/D emulsion.

1.5 Scopes of study

This research is an experimental study to formulate and characterize the physio-chemical properties of W/D emulsion fuel. The scopes are:

i. Formulation of W/D emulsions with different water compositions (10%, 15%, 20% and 25%), types of surfactants (Span 80, Triton X-100 and UMP surfactant) and surfactant concentrations (0.5%, 1.5% and 2.5%).
ii. Experimental analysis of stabilities of formulated W/D emulsions using gravitational stability test.
iii. Physio-chemical characterization of formulated W/D emulsions using Brookfield viscometer for viscosity, shear rate, shear stress and torque at different rpm (100 rpm, 150 rpm, 200 rpm and 250 rpm) and temperature (30°C, 40°C, 50°C, 60°C and 70°C); Microscopy test for water droplet sizes.