International Journal of Automotive Technology, Vol. 24, No. 5, pp. 1349–1358 (2023)
DOI 10.1007/s12239–023–0109–3

pISSN 1229–9138/ eISSN 1976–3832

IMPLEMENTATION OF A NON-SURFACTANT WATER-IN-DIESEL EMULSION FUEL IN A COMMON RAIL DIRECT INJECTION DIESEL VEHICLE

Hasbullah Abdul Rahman[1,2)], Md. Mujibur Rahman[1)], Wira Jazair Yahya[1)*], Tamanna E Kaonain[1)], Hasannuddin Abd Kadir[3)], Mohamad Qayyum Mohd Tamam[1)], Ahmad Muhsin Ithnin[1)], Fauzan Ahmad[1)], Mohd Fareez Edzuan Abdullah[4)], Hirofumi Noge[5)], Chungpyo Hong[6)], Takeshi Otaka[6)] and Eiji Kinoshita[6)]

[1)]Advanced Vehicle System, Malaysia-Japan International Institute of Technology, Universiti Teknologi Malaysia, Jalan Sultan Yahya Petra, Kuala Lumpur 54100, Malaysia
[2)]RTES Technology (M) Sdn. Bhd., Jalan Kebun, Klang Selangor 41000, Malaysia
[3)]College of Engineering, Universiti Teknologi MARA Cawangan Johor, Kampus Pasir Gudang, Masai Johor 81750, Malaysia
[4)]School of Engineering and Physical Sciences, Heriot-Watt University Malaysia, Putrajaya 62200, Malaysia
[5)]Graduate School of Education, Okayama University, Okayama 770-8530, Japan
[6)]Department of Mechanical Engineering, Kagoshima University, Kagoshima 890-8580, Japan

(Received 20 February 2023; Revised 24 June 2023; Accepted 27 June 2023)

ABSTRACT–Water-in-diesel emulsion fuel has become a popular alternative fuel for diesel engines. The main limitation is related to its stability, whereby it relies heavily on surfactants to remain homogeneous, therefore causing production costs to rise. This paper highlights the application of real-time non-surfactant emulsion fuel supply system (RTES), a water/diesel emulsifying device without surfactants, to produce water-in-diesel emulsion fuel in a common rail direct injection diesel engine powered vehicle. In this study, RTES was installed near to the diesel fuel pump to ensure water-in-diesel emulsions were continuously fed to the engine. The test vehicle was set up on a roller dynamometer and operated following a modified West Virginia University (WVU) 5-Peak cycle. Fuel consumption and exhaust emissions were measured to determine the optimum water percentage of emulsion fuel and suitable timing for emulsion fuel to be introduced into the fuelling system based on the vehicle speed. The results revealed that the optimum water percentage of the emulsion fuel for the test vehicle is 10 wt%, as it was capable to reduce fuel consumption as well as nitrogen oxides and smoke emissions of a common rail direct injection diesel engine powered vehicle.

KEY WORDS : Emulsion fuel, Non-surfactant, Common rail diesel engine, Diesel emissions, Water-in-diesel

NOMENCLATURE

CO : carbon monoxide
CO_2 : carbon dioxide
D2 : Malaysian low grade diesel Euro 2m
ECU : engine control unit
E10 : 10 wt% water-in-diesel
E15 : 15 wt% water-in-diesel
E6.5 : 6.5 wt% water-in-diesel
FTP : federal test procedure
HC : hydrocarbon
HWFET : highway fuel economy test
NOx : nitrogen oxides
OH : hydroxide ion
RTES : real-time non-surfactant emulsion fuel supply system
SUV : sport utility vehicle
W/D : water-in-diesel
WVU : West Virginia University

*Corresponding author. e-mail: wira@utm.my

1. INTRODUCTION

Scientists are carrying out different approaches to minimize harmful emissions from diesel engines such as the implementation of after-treatment, exhaust gas recirculation, multiple fuel injection strategies, and the use of alternative fuels (Pan *et al.*, 2019; Venu *et al.*, 2019; Zhang *et al.*, 2020). Water-in-diesel (W/D) emulsion fuel or written here as emulsion fuel has become one of the favoured alternative fuels for diesel engines because of its ability to lower down exhaust emissions without any minimal drawbacks in engine performance (Khatri and Goyal, 2020). Since emulsion fuel is made from two or more immiscible liquids that will separate with time, stability becomes the major