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# WATER-FUEL MICROEMULSIONS INFLUENCE ON FUEL CONSUMPTION AND EXHAUST GAS EMISSIONS

**Michał Cieńciała, Piotr Haller**

*Wroclaw University of Technology*
*Faculty of Mechanical Engineering*
*Wyspianskiego Street 27, 50-370 Wroclaw, Poland*
*tel.: +48 71 3477918, fax: +48 71 3477918*
*e-mail:michal.cienciala@pwr.wroc.pl, piotr.haller@pwr.wroc.pl*

**Antoni Jankowski**

*Institute of Aviation*
*Krakowska Av. 110/114, 02-256 Warsaw, Poland*
*tel.:+48 22 8460011; fax: +48 22 8464432*
*e-mail: ajank@ilot.edu.pl*

**Piotr Kardasz**

*Wroclaw University of Technology*
*Faculty of Mechanical Engineering*
*Wyspianskiego Street 27, 50-370 Wroclaw, Poland*
*tel.: +48 71 3477918, fax: +48 71 3477918*
*e-mail:piotr.kardasz@pwr.wroc.pl*

***Abstract***

*Combustion in a diesel engine is a complex physicochemical process, changing the time at which the events take place simultaneously heat and mass transfer and chemical reactions. The development of internal combustion engines goes towards meeting the increasingly stringent requirements for toxic exhaust emissions, reducing fuel consumption and therefore reduce carbon emissions and protect the Earth's natural resources. The problem to solve in modern combustion engines is the emission of NOx. One way to reduce the emission of toxic $NO_x$ combustion engine power is water-hydrocarbon emulsions [1]. Research combustion engines water-hydrocarbon emulsions has been its tradition. So far, attempts were carried out using an emulsion obtained by a chemical. Emulsions of oil and water can be obtained by adding various detergents to prevent delamination of the oil and water.*

*In this article, we consider the possibility of applying a mixture of water and oil as an alternative fuel used to power internal combustion engines used in heavy road transport. This work is preliminary work, also having to check whether this is the future direction of the work. The measurements of emissions of exhaust gases and fuel consumption. After analysing the test results confirmed that the improvement of the economic and environmental performance of modern diesel engines, it can be achieved by supplying synthetic diesel or gas oil water emulsions. It was found that the use of emulsion leads to a reduction of fuel consumption and $NO_x$ emissions.*

***Keywords:*** *combustion engine, diesel engine, microemulsions, fuel consumption, emissions*

## 1. Introduction

The first car appeared in the nineteenth century. He was to facilitate the work of replacing the human and animal power, mechanical power. Initially, the car was good unattainable for the average citizen, because the number of vehicles was limited. A few decades later, the situation has changed dramatically. Today it is hard to imagine a life without a car. Road transport is a huge amount of goods transported over various distances, is a way to move people in urban areas and beyond, it is often a source of jobs and a base on which to develop tourism. Therefore, combustion of fuels is and will be in the near future, the primary means of generating energy, including for transportation purposes.

Generally can be called a fuel material (solid, gas, liquid), which during the combustion (oxidation) emits large quantities of heat energy. This energy is usually used for heating purposes, and a process to convert it into mechanical energy, as it is in heat engines.

In the nineteenth century, began the search for increased research into fuel for powering internal combustion engines, which were gradually replaced by steam engines. Proved to be the most useful liquid fuels. Nikolaus Otto was one of the first applied liquid fuels. My brother gave evaporation of alcohol on a prototype developed by ourselves today carburettor. Sadly resigned from alcohol as a fuel after failing to patent his invention. He returned to the use of gas after discovering that the way to increase the engine power is the initial compression of the air-fuel mixture in the cylinder [2, 6]. Liquid fuels are still important, however, and were further developed. In 1853, Ignatius Lukaszewicz obtained from the refining of crude oil, kerosene. Significantly began to develop after the oil industry. Gasoline from the beginning it was a by-product of refining and had very little use. You could buy it in pharmacies mainly as a cleaning agent [3, 4].

## 2. Microemulsions

Microemulsions are liquid systems composed of an aqueous phase, an oil phase and lowering the connection between the surfactant. The degree of dispersion of high internal phase affects their transparency. The droplets of the dispersed phase in these liquids are less than 1 micron, which makes them nanodyspersions systems. Low value of the surface tension between the phases of which they affect its high thermodynamic stability. Reduction of the interfacial tension of the surfactant is a task that the amphiphilic compound of structure locates at the interface [5, 7].

The microemulsions water and oil fractions form interpenetrating structures separated by a layer of surfactant component. The most important factors determining the type of microemulsion forming a ratio of between fractions and geometry of amphiphilic molecules comprising the film invested at the interface. The main problems associated with the production of the microemulsion water – diesel to prevent delamination of the two immiscible liquids. To prevent this, the following various kinds of surfactants. A very important factor to be taken into account in the preparation of this type of liquid is the cost of these additives and their biodegradability [8-10]. One way to produce a microemulsion is to use ultra-sound, the second way is to centrifugation, during which they are added to the appropriate surface-active agents, which reduce the surface tension at the interface of water-oil, and water microdroplets formed on the connection layer preventing microdroplets into larger drops. This allows us to obtain an alternative liquid water content of from 5 to 20% by volume of diesel fuel. In the production of fuel, it is necessary that the mixing device may be able to generate turbulent flows, which are homogeneous and give control of turbulence intensity [11, 12]. Transmission method for the preparation of the microemulsion consists of water drops mechanical grinding to a size suitable for the microemulsion. Obtaining such an effect is possible in devices with counter-rotating disks at very high speeds [13, 14].

## 3. Researches

Effect of powered combustion engine water – diesel oil emulsion on his work was determined by measuring fuel consumption; exhaust smoke D and NOx emissions in the exhaust gases. For the study, two types of microemulsions were prepared having a water content of 10% and 20%.

The study was conducted at the Department of Motor Vehicles and Internal Combustion Engines Technical University of Wroclaw on an engine dynamometer, using a research engine SB31. Motor load characteristics were determined for selected values of speed and torque of the crankshaft.

The results are summarized and presented graphically. The figures compared to the content of the individual components of toxic fumes and fuel consumption as a function of engine torque obtained with the engine operating conditions on the characteristics of stress, at a speed of 1600 rpm and 2000 rpm. The engine was operated with diesel fuel, respectively, microemulsion containing 10% of water and the microemulsion containing 20% of water. The graphs can be compared to changes in the content of toxic components in the exhaust and fuel consumption when powered by fuels with water content for diesel.

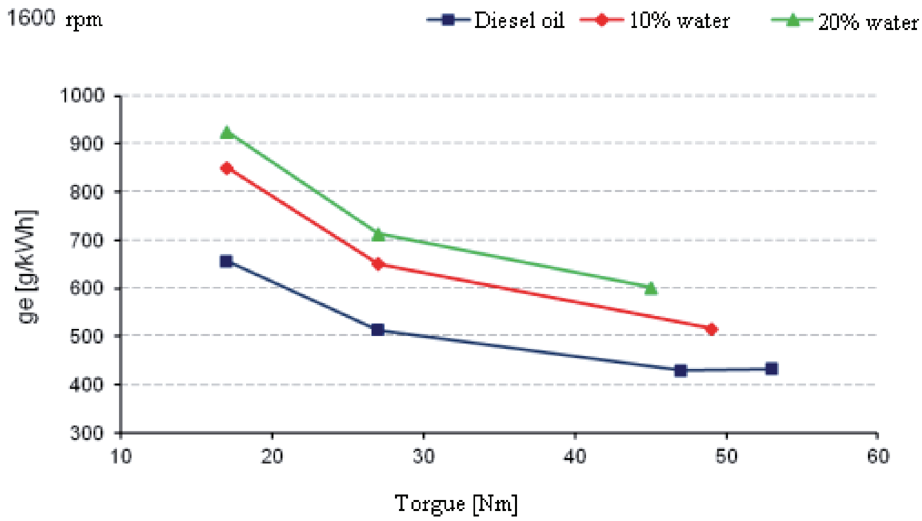


*Fig. 1. Runs unit specific fuel consumption ($g_e$) for the characterization of stress at a speed of 1600 rpm engine powered with diesel fuel, a microemulsion containing 10% water and microemulsion containing 20% water*

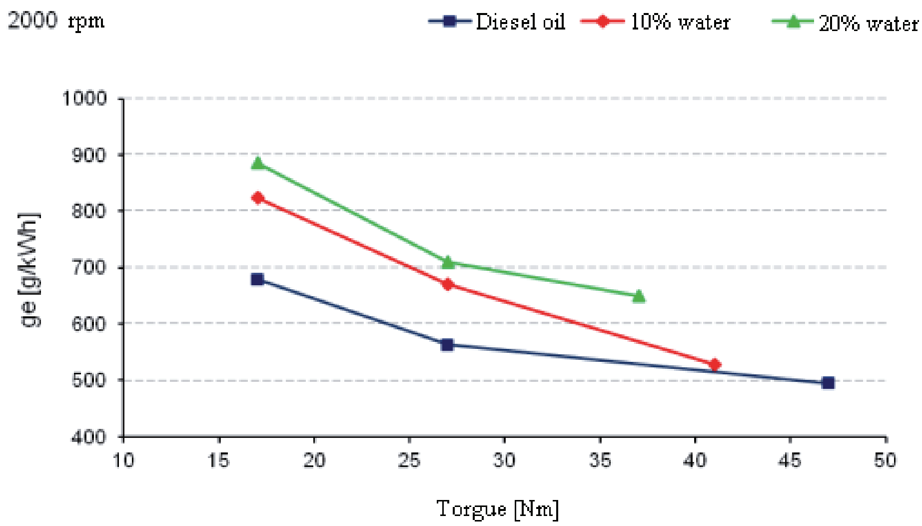


*Fig. 2. Runs unit specific fuel consumption ($g_e$) for the characterization of stress at a speed of 2000 rpm engine powered with diesel fuel, a microemulsion containing 10% water and microemulsion containing 20% water*

## 4. Summary

The results are summarized and presented graphically. Then compared the toxic exhaust emissions and fuel consumption by volume, as a function of engine torque at crankshaft speed 1600 rpm and 2000 rpm. The engine was operated with diesel fuel, respectively, microemulsion containing 10% of water and the microemulsion containing 20% of water.

Diesel engine powering microemulsion $NO_x$ reduction was observed over the entire range of engine operation. The concentration of $NO_x$ in the exhaust gas is reduced by up to 60% of the initial state. At a speed of 1600 rpm, maximum level of $NO_x$ for diesel-powered engine is 1562 ppm

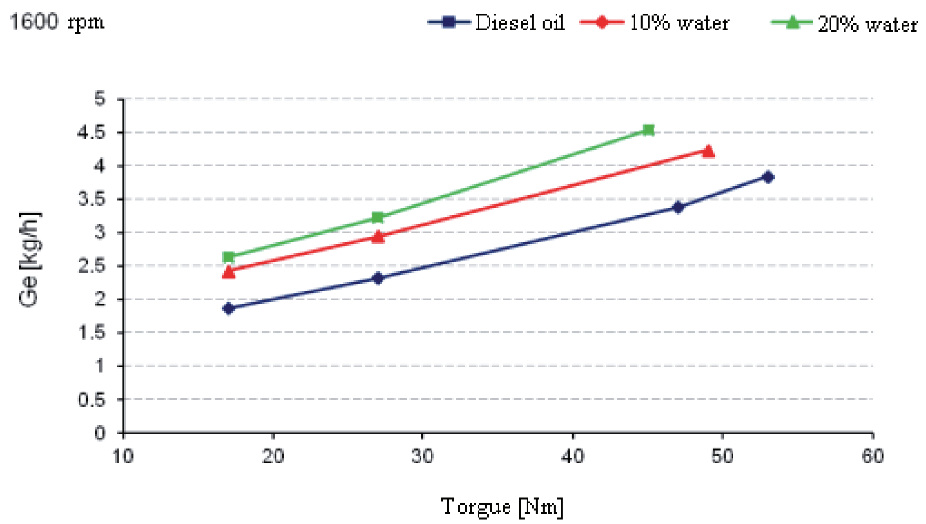


*Fig. 3. Runs unit fuel consumption ($G_e$)for the characterization of stress at a speed of 1600 rpm engine powered with diesel fuel, a microemulsion containing 10% water and microemulsion containing 20% water*

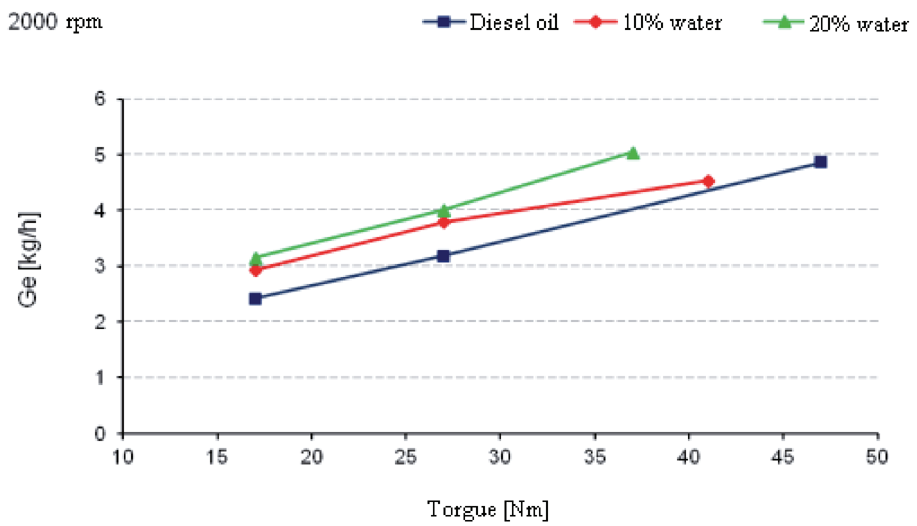


*Fig. 4. Runs unit fuel consumption ($G_e$) for the fuel load characteristics at the speed of 2000 rpm engine powered with diesel fuel, microemulsion containing 10% of water and the microemulsion containing 20% of water*

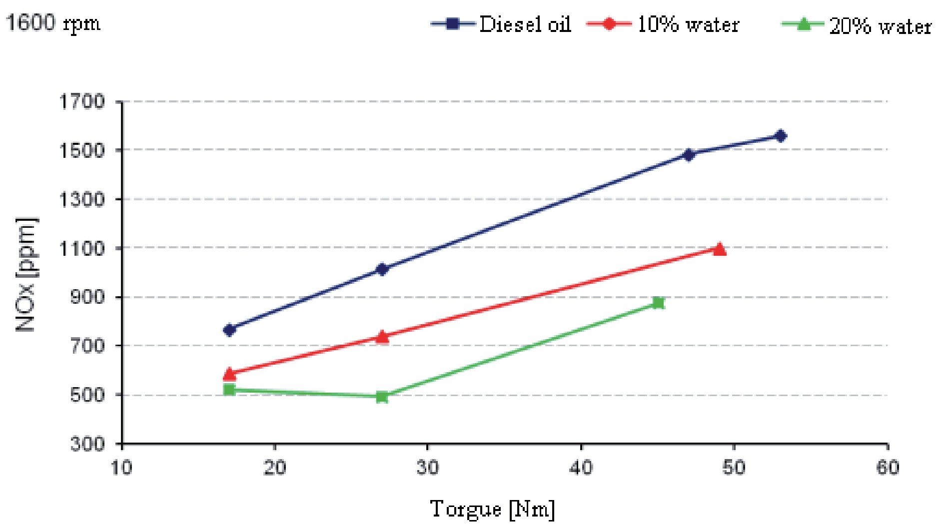


*Fig. 5. The concentration trace of nitrogen oxides ($NO_x$) for the characterization of stress at a speed of 1600 rpm engine fuelled with diesel, a microemulsion of 10% and a microemulsion containing 20% water*

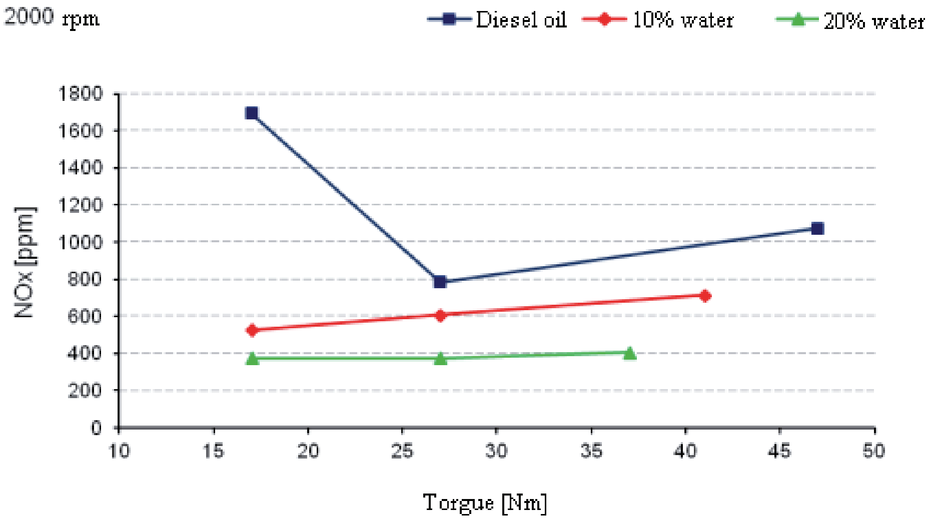


*Fig. 6. The concentration trace of nitrogen oxides ($NO_x$) for the characterization of stress at a speed of 2000 rpm engine fuelled with diesel, a microemulsion of 10% and a microemulsion containing 20% water*

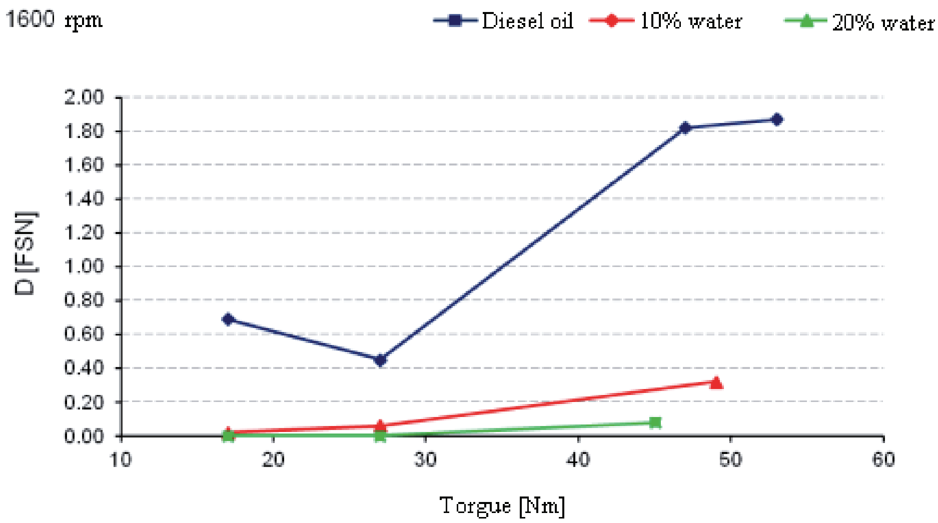


*Fig. 7. Engine Runs smoking (D) for the characterization of stress at a speed of 1600 rpm engine fuelled with diesel, a microemulsion of 10% and a microemulsion containing 20% water*

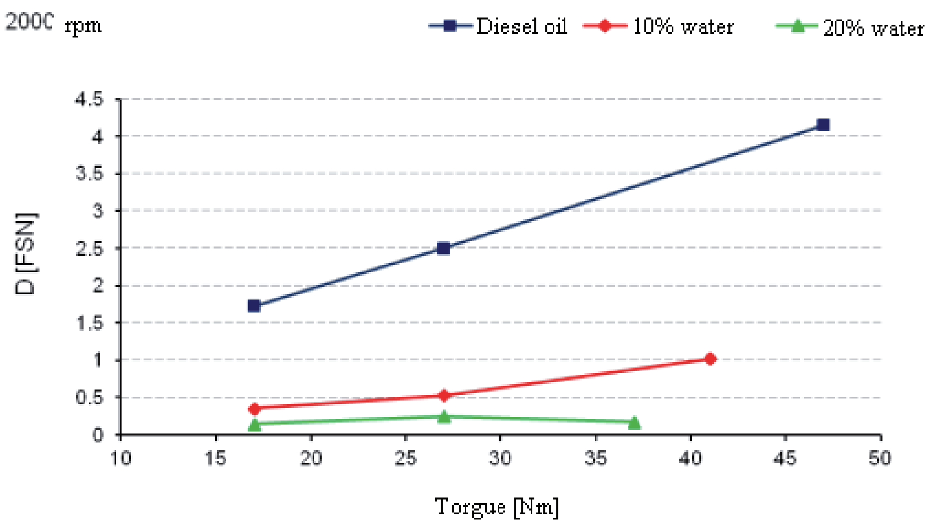


*Fig. 8. Engine Runs smoking (D) for the characterization of stress at a speed of 2000 rpm engine fuelled with diesel, a microemulsion of 10% and a microemulsion containing 20% water*

for 10% of the microemulsion is 1100 ppm and 20% microemulsion 875 ppm. For those turnovers maximum reduction in the level of nitrogen oxides occurred at a torque of 27 Nm (Fig. 5). When $n$ = 2000 rpm peak reduction of $NO_x$ is observed at low torques (Fig. 6).

Analysing the results, I noticed that the use of a microemulsion as fuel results in significant decreases emissions of nitrogen oxides over the entire range of engine operation. As the amount of water reduces the $NO_x$ level. The concentration of nitrogen oxides in the exhaust gas is reduced by up to 60% of the initial state.

Power microemulsion diesel engine has the greatest impact is smoking. Studies have shown that the level of smoke is reduced by up to 90% using a microemulsion containing 20% by volume of water (Fig. 7 and 8).

Studies have shown that power output when using water microemulsion – diesel oil slightly decreases, while the fuel consumption increases (Fig. 1-4). Power reduction depends on the speed and amount of water in microemulsion. The use of the microemulsion fuels causes obvious reduction in total engine efficiency, but to a lesser extent than that of the water in the fuel.

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