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# The water content in the engine oil by using E85

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**Abstract.** The European Union adopted a decision to achieve by 2020 at least 20% reduction in greenhouse gas emissions. To fulfill this task, the EU proposed in 2020 binding targets - further improve energy efficiency by 20%, achieving a 20% share of renewable energy and a 10% share of biofuels in the fuel market. One of the most widely used biofuel in the automotive industry is bioethanol. Bioethanol can be used on low-percentage blending into petrol, which is governed by European Directive 2003/30/EC, and on high-blend bioethanol mixture, particularly E85 consists of 85% bioethanol and 15% petrol BA95. But in recent years, increasingly demonstrating opinions, that biofuels do not produce nearly as much effect as was propagated. This paper deals with the concentration of water in the engine oil with using biofuel E85. The water in the engine oil significantly affects its parameters (especially viscosity). How measurement results demonstrated the use of bioethanol in the fuel increases the concentration of water in the engine oil.

**Key words:** biofuel, oil, concentration, water.

## INTRODUCTION

In recent years the European Union has devoted increasing attention to the possibility of the use of biofuels as an energy source for transportation. The main requirements for biofuel include a requirement to its similarity of chemical and physical properties with conventional fuels.

As the most widely used the reimbursement of fossil fuels, which covers most of the energy consumption in the transport sector, particularly in the automotive industry, is currently biofuel E85.

Fuel E85 is a type of biofuel which has a characteristic mixture. E85 consists of 85% ethanol and 15% BA95. This ratio is possible under various seasonal of conditions to change, but a minimum proportion of ethanol have to be 70% (G7–pohonné hmoty, 2014).

Several studies have examined the effects and emissions of different concentrations of ethanol in the fuel mixture FFV (Flexi Fuel Vehicle) gasoline engines, which significantly differed. Concentrations were mixed in proportions under the names E5 (5% ethanol–i.e. winter mixture), E85 (85% ethanol–called. summer mixture), E75 (75% ethanol–i.e. winter mixture), (Graham et al., 2008; De Melo et al., 2011; Cordeilo de Melo et al., 2012; Karavalakis et al., 2012; Clairotte et al., 2013; Environmental Protection Agency, 2014).

Biofuel E85 is most used In Europe, concretely in Sweden, where it operates more than 16,000 vehicles FFV (Flexi Fuel Vehicle–Motor to which it is possible to refuel BA95 and also biofuel E85). Automobiles brand The Saab with FFV engines are manufactured since 2000 and the number of filling stations with E85 is higher than 250th (West et al., 2007; Flexcar, 2008–2012).

The raw material for the production of E85 may be any biomass lignocellulose–containing e.g. wood, sawdust or waste in the production of pulp and paper (IP Dsignation).

The target of this paper is detection of water concentration in engine oil with using biofuel E85. The values E85 were compared with values of engine oil with using fossil fuel BA95. Measurements were performed on the cars of brand Saab 95, concretely the engines B235, 2.3 liter Turbo. From each car were taken a total of 7 samples of oil. The first part of the samples was from a car driven by biofuel E85 and the second part from engine operating on fossil fuel BA95. The cars rode in urban traffic with the few days to week parking.

## MATERIALS AND METHODS

One of the basic parameters of quality oils in terms of tribotechnology is water content. For water determination was proposed many physical, chemical and physic-chemical methods. In the area of tribotechnical diagnostics but most commonly used method of coulometric titration (IP Dsignation) shown in (Fig. 1).

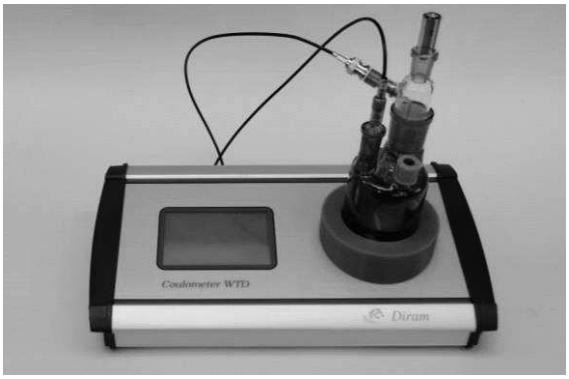


**Figure 1.** Coulometer WDT (Diram).

This is a design of fully automated apparatus with using coulometry. The passage of flow of electrochemical container on the platinum anode is formed from present iodine the elemental iodide which is the titrant agent. Its amount is proportional pass charge, i.e. the integral of current over time. The unit charge is the coulomb, which is formed a current of one ampere for one second. A simple relationship according to Faraday's law of electrolysis can be express amount of substance analyzing of compound, in this case water (Podhajecky, 2011).

Basic parameters of measurements such as the current of indicator circuit, end point of titration, timing of start, time of extraction or times of distillation, the stirring speed and others, can be set through a touch screen or with help of computer connected via a USB interface. On the display and on the computer is then depicted the progress of the titration and results measuring of water concentration (Diram), as shown on (Fig. 2).

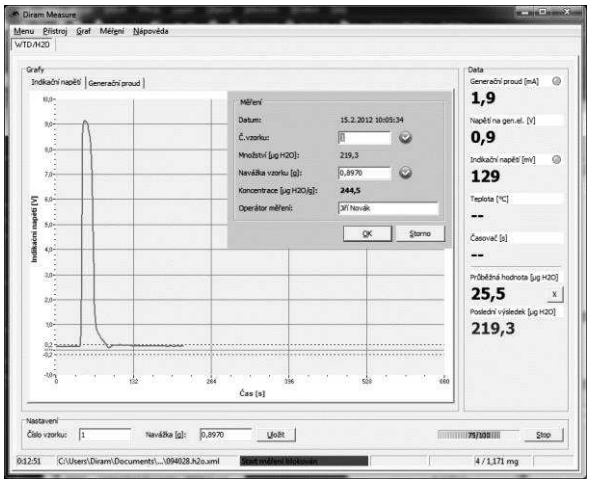


**Figure 2.** The course of titration (Diram).

Into titration flask of coulometric apparatus Karl Fischer is injected weighed sample. In the collecting flask is formed on the anode the coulometric iodine for the reaction Karl Fischer. After titration of the all water is detected the excess of iodine with electromotive detector of ends of titrations and the titration is terminated. On the base of stoichiometry one mole of iodine reacts with one mol of water, and therefore Faraday's law says that the amount of water is directly proportional to the total integrated current. The result of measurement is always the total quantity of water in the sample in micrograms (Torbacke et al., 2014).

The calculation of the water content using a coulometer WTD is represented of relationship (1).

$$C_s = \frac{m_2}{m_1 \cdot 10^4} \tag{1}$$

where: $C_s$ – water content of the sample (µg $g^{-1}$); $m_1$ – mass of the test sample in grams (g); $m_2$ – water weight, expressed on a titrator apparatus, expressed in micrograms (µ g) (CSN EN ISO 15489, 2008).

## RESULTS AND DISCUSSION

To monitor of state the oil was selected vehicles which have a similar mode of ride. Especially such vehicles, where time is often interspersed with longer driving time without traffic load, which is a standard family vehicle with weekend traffic. Due to the function of the internal combustion engine it is not possible to completely prevent

contact of engine oil with air humidity. The humidity then may cause a number of problems under unfavorable operating modes of the internal combustion engine, between which the faster impairment of the properties of motor oil. Current values of the water in the engine oil varies at internal combustion engines of road vehicles in to 0.2%, and do not cause major problems. When the amount of water in the oil approaching 0.5%, so it no longer indicates improper operation, and when the value of 1–2% is already a defect, especially leak in the cooling system of the internal combustion engine. Measured values of water concentration when using fossil fuels BA95 and biofuels E85, the percentage differences in the concentration of water of new oil are listed in (Table 1). From the values it is clear that when using fuel BA95 concentration of water in the engine oil is below 0.2%, whereas E85 is already approaching 0.5%, which corresponds to the improper operation of the combustion engine. Water content of new oil was needed to be measured only one time, before adding it to engine.

**Table 1.** The concentration of water in use of fossil fuel BA95, biofuel E85 compared with the concentration of water of new oil

| Time of operating | Water concentration BA95 | Water concentration E85 | % difference BA95 to new oil | % difference E85 to new oil |
|---|---|---|---|---|
| Concentration before adding oil to engine | 1,357 μg $g^{-1}$ | | 0% | |
| 34 km | 1,295 μg $g^{-1}$ | 1,449 μg $g^{-1}$ | 4.6% | **6.8%** |
| 2,000 km | 1,314 μg $g^{-1}$ | 2,334 μg $g^{-1}$ | 3.2% | **72.0%** |
| 4,000 km | 1,336 μg $g^{-1}$ | 1,503 μg $g^{-1}$ | 1.5% | **10.8%** |
| 6,000 km | 1,373 μg $g^{-1}$ | 2,028 μg $g^{-1}$ | **1.2%** | **49.4%** |
| 8,000 km | 1,363 μg $g^{-1}$ | 3,241 μg $g^{-1}$ | **0.4%** | **138.8%** |
| 10,000 km | 1,379 μg $g^{-1}$ | 2,419 μg $g^{-1}$ | **1.6%** | **78.3%** |
| 12,000 km | 1,397 μg $g^{-1}$ | 3,601 μg $g^{-1}$ | **2.9%** | **165.4%** |

From (Table 1) it is evident that when using fossil fuel BA95 the concentration of water was in the engine oil in order to comparing the concentration of the new engine oil. In three instances during the time of operation 34, 2,000, and 4,000 km was measured at lower water concentrations as compared to the new engine oil. In other times of operation, traffic concentration was approximately at the same level as the new engine oil, level concentrate was not changed by more than 3%. The values of the concentration of water using fossil fuels BA95, it is possible to say that reaching a normal level, which does not affect the trouble-free operation of this petrol engine. A different situation occurred when using biofuel E85. The water concentration in this biofuel was at time of operation 12,000 km about 2.5 times higher than the concentration of water with new engine oil. Higher water concentrations above 30% was noted already at the time of operation of 2,000 km, where the difference in water concentration E85 and new oil was 72%. This jump occurred due to a 14–day break between journeys. Another value of the concentration of water decreased as it was partially evaporated, then the car again stood for several weeks and the concentration of the water continues to increase.

The cause high concentrations of water for biofuel E85 is its hygroscopicity in combination with prolonged standing of petrol engine. The longer stall of the engine was, the higher the concentration of water which due to its mode of operation already wasn't evaporated. Liquid water is then accumulated in the engine oil, which was vigorously stirred, and created the emulsions of water in oil, which is deposited on the cap of the oil pan. The concentration of water depending on the time of operating of the engine oil, using fossil fuel BA95 and biofuel E85 is shown in (Fig. 3).

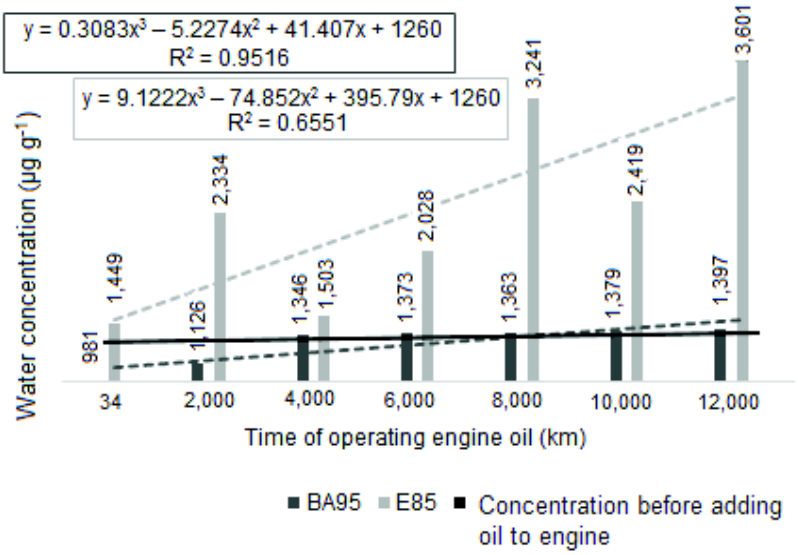


**Figure 3.** The concentration of water in the engine oil when using fossil fuels BA 95 and biofuels E85.

## CONCLUSIONS

The presence of water in the oil is a reversible phenomenon. Water can, if it is not too much in the oil due to a malfunction, re-evaporate in the longer run the warmed up engine. Nevertheless, water in oil and after evaporation leaves traces. At a time when the oil was in contact with excess water, there may be some reactions that may change additivities oil. Water may cause e.g. precipitation of certain additives in the form of sediments or sludge or hydrolysis and impairment of other additives (typical of detergents).

From Analyses of water concentration when using biofuels implies that the engine oil is constantly exposed of effect water. This phenomenon is due to hygroscopicity biofuel E85 and irregular operation with long parking time.

In comparison to commonly using of fuel BA95 with biofuel E85 occurred in engine oil of ignition internal combustion after driving 12,000 km an increase in water concentration. The amount of water in the motor oil was up to 2.5 times higher when using E85 than when using fuel BA95 and the same driving mode.

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