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I-4. BIODIESEL (FAME) IMPACT ON THE WORK OF DIESEL INTERNAL COMBUSTION ENGINE

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Upon emergence of the first internal combustion engines, they started developing and gaining popularity so rapidly, that today we cannot even imagine living without them. However, along with the continuous technologic and industrial development, negative aspects also appeared. Environmental pollution is rapidly and continuously increasing throughout the world, and natural resources are depleting fast, which led to the need to start searching for alternative energy sources, which could prevent or at least delay the impending crisis.

R. Diesel, the inventor of the diesel engine, himself tried to use pure oil as fuel in his engine. However, it turned out that peanut oil used at that time was too viscous and was no longer suitable for rapidly developing engines. Austrian scientist M. Mitelbach resolved this problem in the eighth decade. He came up with the idea to inter-esterify oil and methanol, adapting it for standard engines. The first biodiesel plant was built soon afterwards, but more intense production of biodiesel started only in the next decade.

All innovations bring winds of change. Biodiesel is a new type of fuel for internal combustion engines, thus its impact on the vehicle and engine characteristics is worth examining.

The aim of the research is to examine the impact which biodiesel has on the performance of internal combustion engines considering economic and environmental characteristics.

The used biodiesel may either be blended with mineral diesel in different portions or pure. Pure biodiesel is an excellent solvent, therefore all the particles that come in contact therewith must be resistant to it. Thus replacement of certain elements of systems of fuel filling or the supply of fuel to the engine may be required in vehicles of older generation. The body of the vehicle requires particular protection, because biodiesel may damage paint. Being a good solvent, biodiesel dissolves sediment accumulated in the fuel tank and fuel supply system, which may lead to clogging fuel filter immediately after having started to use biodiesel. Replacing it with a new filter will help solving such problems. Countries where temperature falls to – 20° in the winter time usually switch to mineral diesel or diesel partially blended with fatty acid methyl esters (FAME). In such a case, the filter is once again likely to clog when switching to biodiesel.

Some biodiesel gets to engine oil through piston rings. Mineral diesel evaporates quickly, while the temperature of biodiesel evaporation is high and thus dilutes the oil. However, lubrication properties of biodiesel itself are good enough and at least partially compensate changed properties of engine oil. The comparison of mineral diesel and biodiesel reveals that the calorific value of biodiesel is by about a tenth lower. On the other hand, cetane number of biodiesel is higher, contains oxygen, thus it burns better in the engine. Consumption of biodiesel is expected to stay below 10% compared to mineral diesel; moreover, a lower price of biofuel should completely cover this difference. A diesel engine has been observed in certain cases to use almost the same amounts of biofuel and mineral diesel.

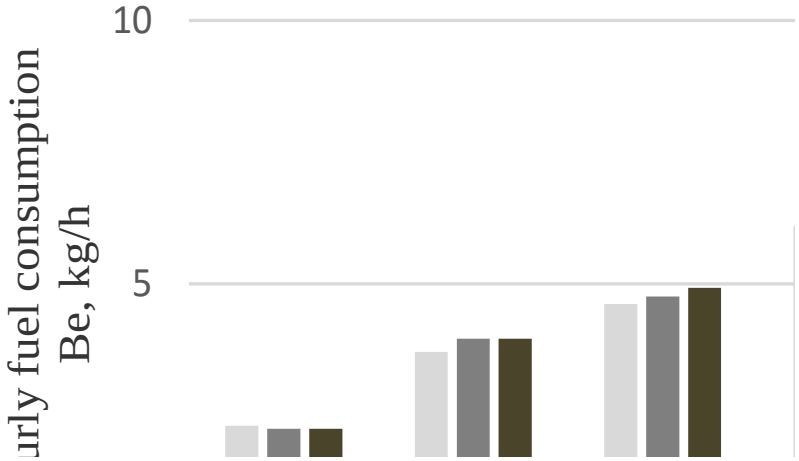

Fig. 1. Fuel consumption in diesel engine in AUDI 80 TDi

When using the blend (consisting of 30 % of biodiesel and 70 % of mineral diesel), fuel consumption remains unchanged compared to pure mineral diesel. When using pure diesel, fuel consumption increase by 2,2–7,6 % depending on the load. Biodiesel blends with mineral diesel improve fuel lubricity.

From the environmental perspective, rapid disintegration of biodiesel under neutral conditions in the natural environment is considered a positive property of biodiesel (fatty acid methyl esters (FAME)). Only the fuels, at least 90 % of which disintegrate within 21 days, are considered to be biofuels, and it has been determined that up to 98 % of pure FAME and only up to 60 % of mineral diesel disintegrate within 21 days.

Different methods for determining biodegradability are applied in the US. One of them is the measurement of CO_2 emitted by microorganisms. CO_2 emissions are proportional to the amount of carbon used by microorganisms. When measuring CO_2 emissions, the relative amount (of theoretical amount) of accumulated CO_2 in case of FAME accounted for 70–89 % in 28 days, while in case of mineral diesel it was a mere 18 %. This allows attributing FAME to easily disintegrating compounds. The rate of biodegradability of FAME blends with mineral diesel is proportionate to FAME content in the blend.

Gas emissions into the environment in operation of AUDI 80 TDi engine were examined using the following fuels:

- fuel A – 100 % mineral diesel;
- fuel B – 75 % (by volume) of mineral diesel and 25 % of FAME;
- fuel C – 50 % (by volume) of mineral diesel and 50 % of FAME;
- fuel D –25 % (by volume) of mineral diesel and 75 % of FAME;
- fuel E – 100 % FAME.

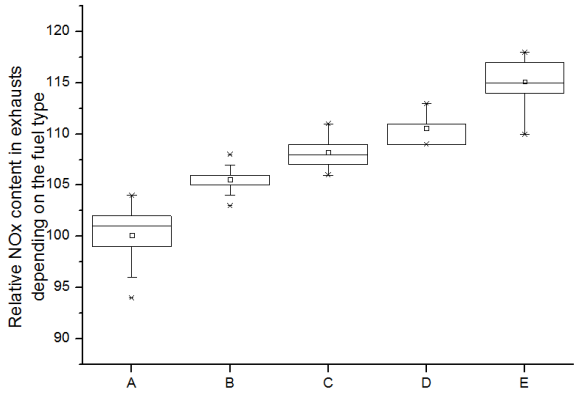

Fig. 2. Relative NO_x content in exhausts depending on the fuel type

The summarising test results, considering the impact of the used fuel on the environment, were received calculating relative NO_x and CO emissions, when mineral diesel emissions are equated to 100 %. The relative NO_x content (in percent) in exhausts working with different fuels is presented in Figure 2, while relative CO content (in percent) in exhausts is presented in Figure 3.

The obtained data reveals that having replaced mineral diesel with pure FAME, higher NO_x amounts (about 13 %) are emitted into the environment, while the relative CO content in exhausts when working with pure FAME decreases by 5,7 % compared to mineral diesel.

In summary of the presented results, it can be concluded that the assessment of relative NO_x and CO emissions revealed that FAME can be characterised as having better impact on the environment. Compared to mineral diesel, FAME lags behind solely in terms of NO_x emissions into the environment with engine exhausts. This problem may be solved by respectively regulating the engine, installing a catalytic converter in the exhaust system or using FAME and mineral diesel blends. When using biodiesel, increased consumption should not exceed 10%. Moreover, a lower price of fuel should completely outweigh this difference.

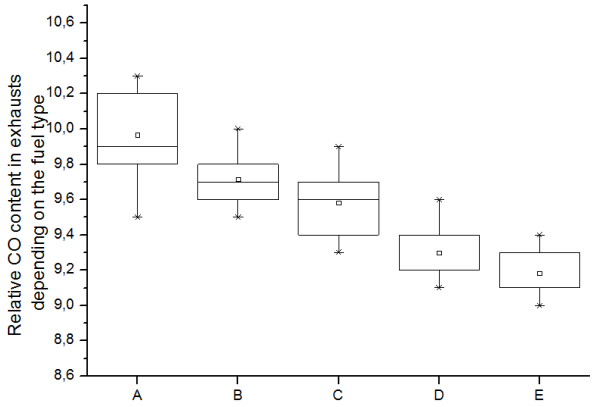

Fig. 3. Relative CO content in exhausts depending on the fuel type

When using a blend (of 30 % of biodiesel and 70 % of mineral diesel), fuel consumption remains unchanged compared to pure mineral diesel. When using pure biodiesel, fuel consumption increases by 2,2–7,6 % depending on loads. Considering the above, biodiesel can be stated to be alternative fuel, which can replace mineral diesel in the future.

РЕФЕРАТ

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ВПЛИВ БІОДИЗЕЛЮ (МЕЖК) НА РОБОТУ ДИЗЕЛЬНОГО ДВИГУНА ВНУТРІШНЬОГО ЗГОРАННЯ

Світове виснаження запасів нафтової сировини вимагає пошуку нових альтернатив. Одним з таких є виробництво біодизелю з біомаси та його використання у чистому вигляді або у вигляді сумішей з мінеральним дизельним паливом. У роботі розглянуто вплив біодизелю на роботу дизельного двигуна внутрішнього згорання, його екологічні та економічні характеристики. У статті також проаналізовано витрату палива та зміну викидів NO_x та CO за використання у двигуні паливних сумішей з різним вмістом біозиделю (МЕЖК).

Ключові слова: біодизель, мінеральне дизельне паливо, витрата палива, відпрацьовані гази двигунів.

РЕФЕРАТ

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ВЛИЯНИЕ БИОДИЗЕЛЯ (МЭЖК) НА РАБОТУ ДИЗЕЛЬНОГО ДВИГАТЕЛЯ ВНУТРЕННЕГО СГОРАНИЯ

Мировое истощение запасов нефтяного сырья требует поиска новых альтернатив. Одним из таких является производство биодизеля из биомассы и его использование в чистом виде либо в виде смесей с минеральным дизельным топливом. В работе рассмотрено влияние биодизеля на работу дизельного двигателя внутреннего сгорания, его экологические и экономические характеристики. В статье также проанализировано расход топлива и изменение выбросов NO_x и CO при использовании в двигателе топливных смесей с разным содержанием биодизеля (МЭЖК).

Ключевые слова: биодизель, минеральное дизельное топливо, расход топлива, отработанные газы двигателей.

ABSTRACT

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BIODIESEL (FAME) IMPACT ON THE WORK OF DIESEL INTERNAL COMBUSTION ENGINE

The worldwide depletion of oil resources requires searching for new alternatives. One of the options is producing biodiesel from biomass and using it pure or mixing it with mineral diesel. This article examined the impact that biodiesel has on the work of diesel internal combustion engine, its environmental and economic characteristics. The article also analyses fuel consumption and the change of NO_x and CO exhausts when supplying various fuel blends with biodiesel (FAME) to the engine.

Key words: biodiesel, mineral diesel, fuel consumption, engine exhaust emissions.