INFLUENCE OF RME FUELS ON CHOSEN VARIABLES OF DIESEL ENGINE SUPPLY PROCESS

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INTRODUCTION

Research on making use of alternative fuels including rape fuel (RME), consist usually of comparing the performance of diesel engine with performance of the same engine, which is supplied with diesel fuel. The expected decrease of working parameters, resulting mainly from the difference of chemical features of RME fuel compared to diesel fuel should amount to 10 – 12%. However, in practice the values are considerably lower [2]. It should be determined which elements, which features of RME fuel decide about the difference between the practical and the expected parameters of engine work.

One of the methods is comparing the process of supplying the engine with different kinds of fuels (diesel and RME). An assumption should be made that the key meaning in the injection process belongs first of all to the physical properties of the fuel such as: density, absolute and kinematical viscosity and surface tension. Comparing the supply process of both fuel alternatives you can expect an answer to the question: In what extent physical properties of the RME fuel influence the variables of diesel engine supply?

TARGET, ASSUMPTIONS, RESEARCH METHODS

The target of the research was to determine and compare the characteristics of injection pumps supplied with two fuels: diesel and RME. An assumption was made that the different physical properties of the examined fuels have a significant influence on fuel injection process parameters, especially on the quantity of the dose of the fuel supplied to injectors. According to the relation (1) the quantity of fuel dose Q pumped by one section of an injection pump during one working cycle is:

$$Q = V - q \tag{1}$$

where:

V – volume being the result of geometrical dimensions of the cylinder,
q – quantity of fuel leak between the small piston and cylinder.

We can assume that the volume of fuel resulting from geometrical dimensions of the cylinder is similar for both fuels and amounts to:

$$V = k \cdot \frac{\Pi D^2}{4} \cdot l \tag{2}$$

where:

k – coefficient determining fuel compressibility,
D – piston diameter,
l – working length of the small piston.

Only the quantity of fuel leakage between the small piston and the cylinder changes in the way shown by the relation:

$$q = \frac{\Phi \cdot \Delta p}{\eta} \tag{3}$$

where:

Φ – coefficient determining geometrical dimensions of the port,
Δp – differential pressure in front of and behind the port,
η – dynamic viscosity of the fuel.

So the quantity of fuel dose Q supplied to the injector depends first of all on the quantity of leakage q, which appears between the elements of the pair of precise injection pump, assuming that in the supplying system injectors without draining leakage were used [1].

RME fuel usage is the reason of an average increase by 10% of maximum injection pressure [3]. That is why during the experiments the injectors were readjusted, which has lowered the pressure of the RME fuel injection, to keep the proportion:

$$\Delta p_d \approx \Delta p_{RME} \tag{4}$$

where:

Δp_d – differential pressure in front of and behind the port when supplied with diesel fuel,
Δp_{RME} – differential pressure in front of and behind the port when supplied with RME fuel.

Assuming constant coefficient for both fuels determining geometrical dimensions of the port Φ and close to each other coefficients of fuel compressibility k we can write down, that:

$$q = c_q \cdot \frac{1}{\eta} \tag{5}$$

$$Q = c_Q \cdot \eta \tag{6}$$

where:

c_q, c_Q – coefficients of proportion.

Resulting from this is that the quantity of dose *Q* depends only on dynamic viscosity η. Which is an absolute measure of resistance of the flowing fuel, independent of its density. Because of the substantial dynamic viscosity η dependence on the temperature *t*, viscosity characteristics of both fuels were adjusted to the standards by means of the rotating viscometer PN–94/C–04098. It was decided that the research works on the test stand would be made in constant temperature $t = 20°C$.

The measuring on the test stand was started after an establishment of the rotational speed of the pump roller *n* and temperature *t*, according to the assumed guidelines for a given point of characteristics according to the Branch Standard BN–88/1301–16, concerning an examination of self-driven injection pumps. A four-section injection pump used in a S-4002 engine was assigned for examination.

In each examining cycle three repetitions for each rotational speed of the pump roller *n* were made. The quantity of doses *Q* of the injected fuel were measured by a volumetric measure through an assessment of 100 injections of fuel by means of graduated glass with which the testing table was equipped.

RESULTS

In Fig.1 the characteristics of the dynamic viscosity η of the examined fuels are shown. Because of the steepness of the curves, on the Y-axis a logarithmic scale was used.

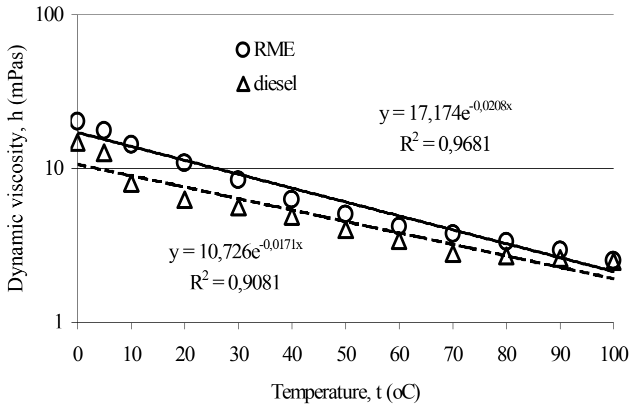

Fig. 1. Dynamic viscosity η of the examined fuels dependence on temperature *t*

It can be seen on the diagram that RME fuel has a higher viscosity in the whole range of the examined temperatures. In the examination temperature on the test stand, that is 20°C, the RME fuel dynamic viscosity η is 11 mPas and it is by 43% higher than the examined winter diesel fuel. For instance the difference is only 2% in the temperature of 100°C.

Fig. 2 shows how the value of the examined fuels doses *Q* changes.

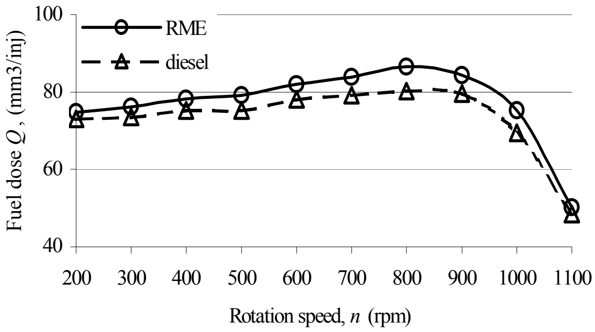

Fig. 2. Dependence of values of the examined fuels doses Q of the rotational speed n of a pump roller at the maximum settings of the adjusting devices

According to the made assumptions, higher values of Q doses at equal settings of the adjusting devices (with the exception of the injectors opening pressure setting) have been achieved by an injection pump supplied with RME fuel. On average, in the whole range of the tested rotational speed n of the pump roller, were higher by 5.3% in comparison with the values achieved with diesel fuel. This difference is caused by the higher dynamic viscosity η of RME fuel, which provides better leak-tightness of the pair piston – cylinder than the diesel fuel, and lowers the quantity of leaks q according to relation (5).

Analysis of the course of the curves, the trend for increasing the quantity of doses of both fuels Q along with the rising speed n of the pump roller can be noticed. This phenomenon can be explained by partial suppression of the fuel in the orifice filling the pumping section at higher rotation of the pump and shorter time of pumping fuel, which is the reason for lowering inner leakage q of pair piston – cylinder. At the same time it should be said that the course of the curves in Fig. 2 would be steeper in case of work without the multipurpose speed governor, which is present in the examined pump type [4].

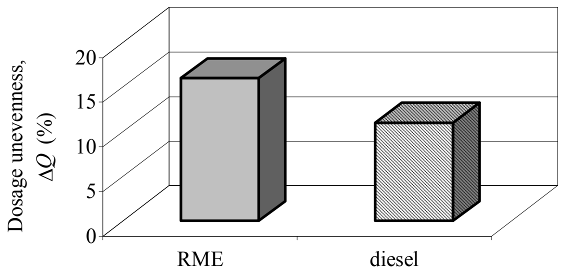

Fig. 3. Dosage unevenness ΔQ of injection pump supplied with tested fuels

After completing the research work it can be said that the dosage unevenness of the pump ΔQ supplied with RME fuel is 16% and is higher than in the pump supplied with diesel fuel by 5%. The relation is shown in Fig. 3.

CONCLUSIONS

On the basis of the achieved results it can be stated that:

1. The usage of RME fuel to supply a diesel engine influences an increase of the quantity of fuel dose supplied to the injector on average by 5.3% in comparison to diesel fuel

2. The quantity of the dose is directly proportional to the dynamic viscosity of the used fuel where geometrical dimensions of the pair piston–cylinder are not changed and the injection pressure of both fuels is close.

3. Dosage unevenness in the tested injection pump supplied with RME fuel rises to 16%, while for diesel fuel it amounts to 11%

REFERENCES

1. **Galbarczyk A., Marek G.**: Optymalizacja pracy wtryskiwacza bezodpadowego. Unpublished Master's Thesis, AR Szczecin 1990.
2. **Kiernicki Z.**: Przebieg wtrysku paliwa ropopochodnego o właściwościach biopaliwa rzepakowego. Conference Materials, Konsspal. Wrocław 2000, s. 90-95.
3. **Salamour F.**: Procesy zużycia elementów silnika spalinowego napędzanego paliwami odnawialnymi. Unpublished Doctor's Thesis, Politechnika Wrocław 1994.
4. **Wajand J. A., Wajand J. T.**: Tłokowe silniki spalinowe, WNT, Warszawa 2000.

SUMMARY

In this article comparative results of chosen research works on the injection process of RME fuel and diesel oil have been presented. The raw characteristics of a sectional pump supplied with the examined fuels and the characteristics of the basic rheological features have been described.