TRIBOLOGICAL EFFECTS OF USING VARIOUS KINDS OF DIESEL OIL AS LUBRICANTS

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INTRODUCTION

Growing requirements concerning natural environment protection lead to working on the introduction of new fuels for internal combustion engines.The chemical constitution of these fuels is modified compared with traditional fuels on the market, which results in the reduction of harmful fuel components emission [2].

A modification of either chemical constitution or (and) some physical properties of such fuels usually influences the course of tribological processes of the fuel apparatus working elements, particularly precise pairs of injection systems [1].

Professional literature is deficient in detailed data relating to the influence of fuel kind on tribological processes modification as an effect of using fuels with modified chemical constitution.

Studies concerning the character of friction pairs wear under conditions of lubrication with ON and ONM "Standard" , following laboratory tests, were the reason why the research into the wear of precise pairs of fuel apparatus used in the actual operation conditions seemed necessary.

DESCRIPTION AND CHARACTERISTICS OF PIN-ON-DISK TEST STAND

The pin-on-disk test stand used for measuring wear and the value of coefficient of friction between the revolving sample and countersample (under both dry friction and friction with lubrication conditions), equipped with special software, made it possible to determine friction coefficient value and also enabled sample wear measurements. In the case of the test stand piece on which tests were done, measurements were carried out continuously with sampling frequency determined by the person conducting the experiment. Values of cross-sectional areas of sample and countersample mating traces determined from profilograms were assumed as a measure of wear.

Microscopic pictures of wear areas of samples lubricated with tested ON and ONM "Standard" fuels were a supplementary source of information concerning wear.

In order to obtain distinct sample and countersample mating traces (high values of sample wear) and to shorten test duration, a sample made of Armco iron and a countersample made of tungsten carbide were used.

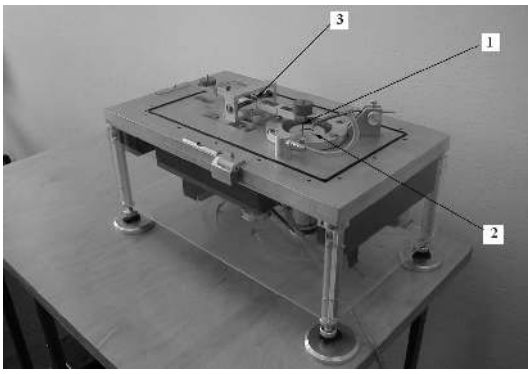

Fig. 1. View of pin-on-disk test stand: 1 – pin, 2 – disk, 3 – dynamometer

The process of lubrication was carried out by bringing constant volume of ON or ONM "Standard", forming about 1 mm thick lubricating layer (experimentally determined before the beginning of each test cycle, equal for all measurements), to the tested sample surface.

The view of the pin-on-disk test stand is presented in Fig. 1.

DESCRIPTION AND CHARACTERISTICS OF FALEX TEST STAND

The Falex (shaft – V-block) test stand was used to compare oils and plastic lubricants lubricating properties as well as wear resistance of outer layers of materials working in friction nodes. The test consists in registering values of forces and moments of continuously loaded friction node (sample with countersample), immersed in lubricant (or without lubrication), up till the the moment of total seizure [3].

A computer system with full measurement automation makes it possible to control the test stand. The system enables the determination of resistance to motion in a frictional node by means of the calculation of friction resistance moment, force putting the friction node under load, duration of particular friction phases. The value of maximum sample and countersample load in the friction node, at which total seizure (destruction of countersample pin) happens, has been assumed as a measure of lubricating properties in the tested fuels. Additional source of information concerning the influence of lubricating agent's kind on the course of the friction process were pictures of seizure areas on a countersample under conditions of lubrication with tested ON and ONM "Standard"

fuels. Both sample and countersample were made of tool steel NC10C, friction surfaces sliding speed was 0.095 m/s.

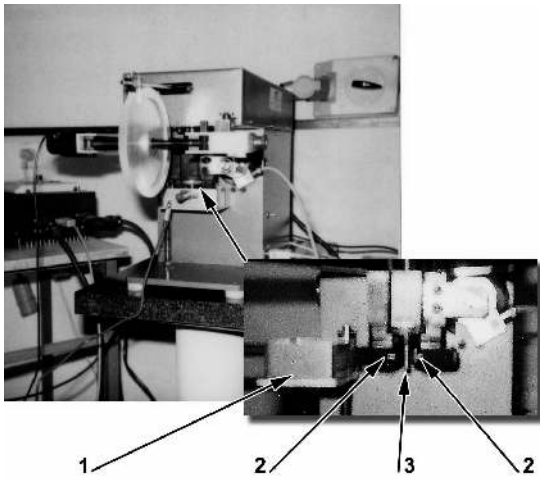

Fig. 2. View of Falex test stand: 1 – lubricating liquid container, 2 – sample, 3 – countersample

Friction surfaces lubrication on the Falex test stand was accomplished by immersing the friction pair in the tested fuel. The view of the test stand is presented in Fig. 2.

RESULTS OF TESTS ON PIN-ON-DISK TEST STAND

The results of measuring changes of friction coefficient values dependent upon thenumber of cycles (i.e. friction distance) for samples lubricated with tested fuels have been graphically presented in Fig. 3.

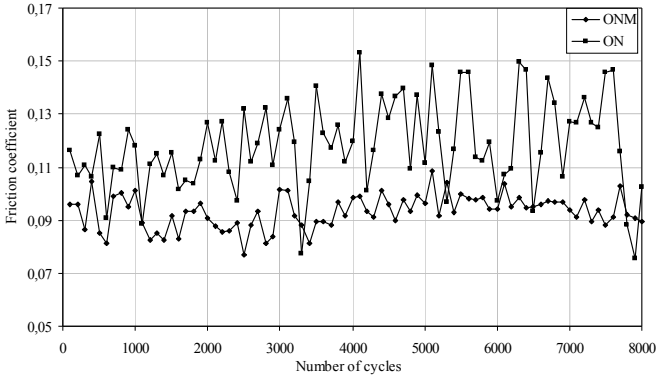

Fig. 3. Then course of friction coefficient value changes dependent upon the kind of lubricant (ONM "Standard", diesel oil ON) for samples made of Armco iron

Values of cross-sectional areas of sample and countersample mating traces determined from profilograms were assumed as a measure of sample wear. Profilo-

graph Taylorond made by Taylor Hobson was used for profilometric measurements. Exemplary profilograms of sample-countersample friction pair mating traces on samples are presented in Fig. 4.

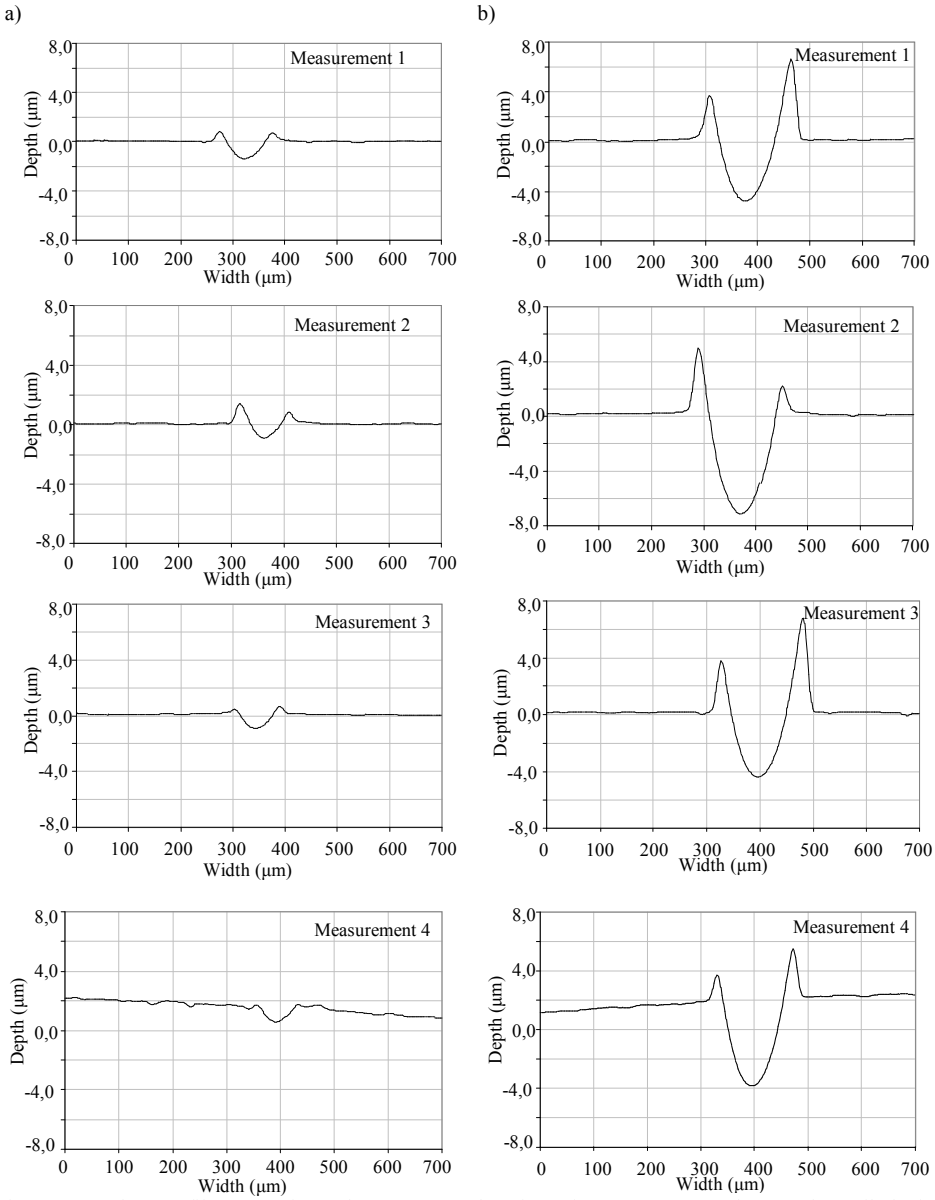

Fig. 4. Exemplary profilograms of sample-countersample pair mating traces on samples tested on tribological pin-on-disk test stand: a – samples lubricated with ONM "Standard", b – samples lubricated with ON fuel

The characteristics of both microscopic pictures of sample-countersample mating traces in both kinds of fuel after tests on the pin-on-disk test stand, obtained from

metallographic microscope Neophot 2, equipped with digital camera Elemis K-45R, are shown in Fig. 5.

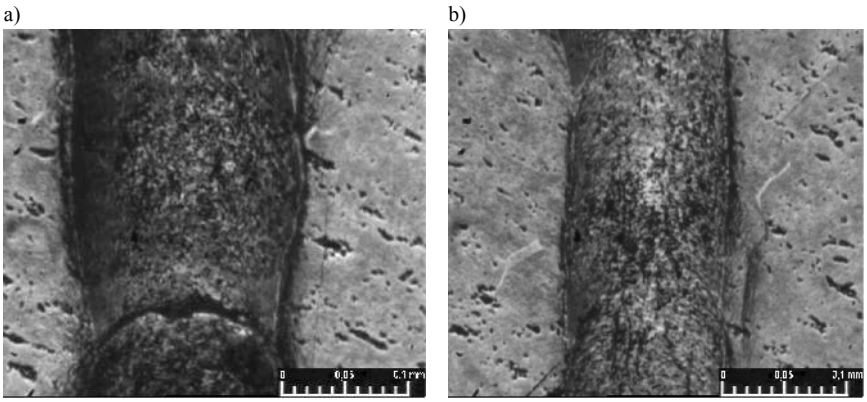

Fig. 5. Microscopic pictures of sample-countersample mating traces on sample surface after tests on pin-on-disk test stand: a – sample lubricated with ON oil, b – sample lubricated with ONM "Standard" fuel

The obtained results were subject to statistical analysis (with the use of *STASTISTICAL 6 PL* program). Results of the analysis are presented in Fig. 6.

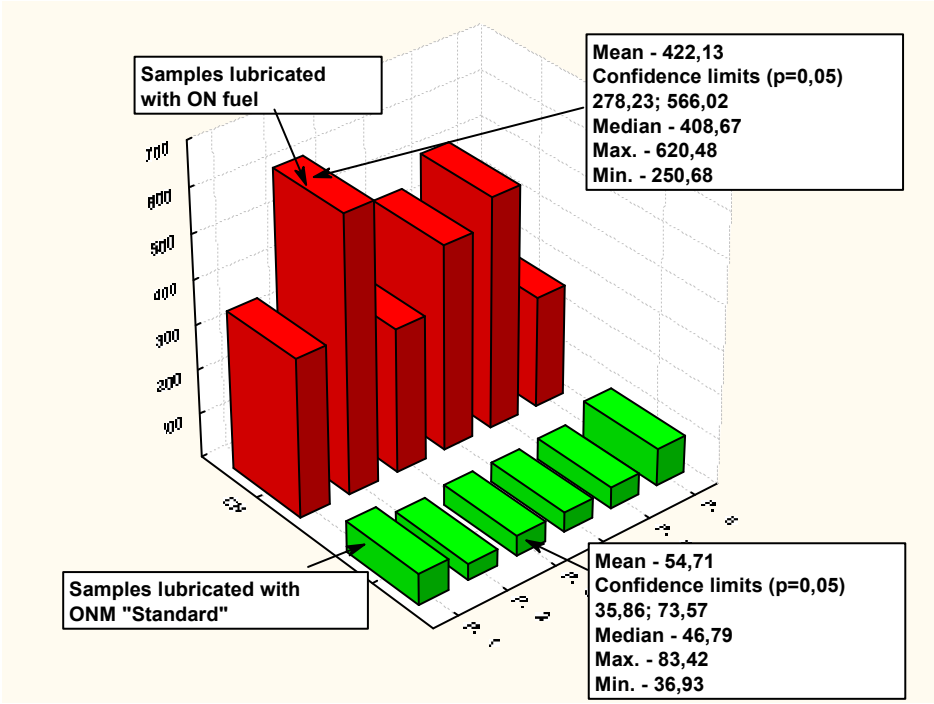

Fig. 6. Comparison of samples lubricated with ON and ONM "Standard" wear degree

RESULTS OF TESTS ON FALEX TEST STAND

Averaging sample and countersample load values dependent upon the duration of the measurement cycle (i.e. friction distance) for samples lubricated with tested ON and ONM "Standard" fuels are presented in Fig. 7.

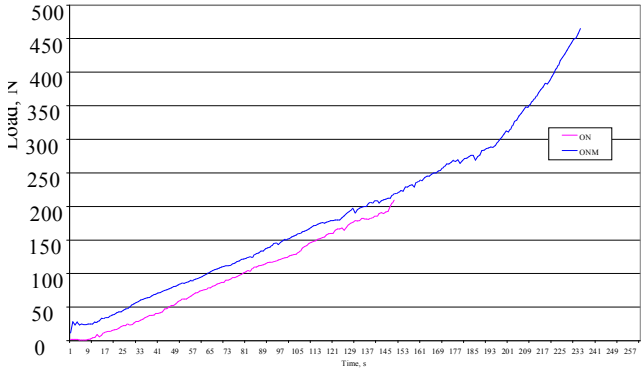

Fig. 7. Averaging course of load changes in the time up till the moment of seizure for two kinds of agents lubricating the friction node: ONM "Standard" fuel and diesel oil ON

Outcome of the statistical analysis of measurement results is presented in Fig. 8.

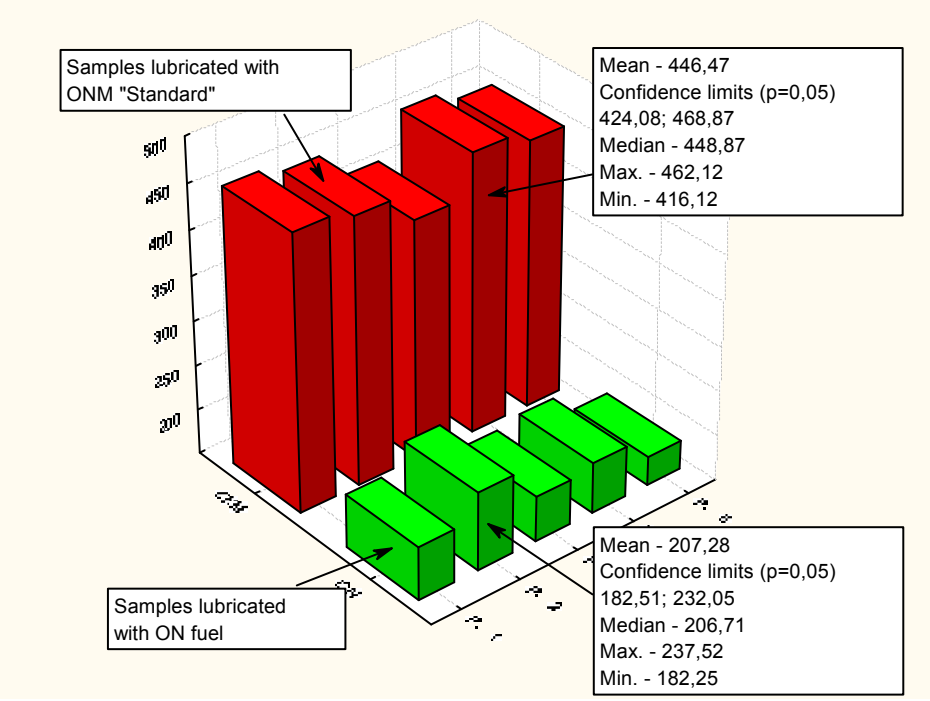

Fig. 8. Comparison of friction node maximum load values for samples lubricated with tested fuel: ON and ONM "Standard"

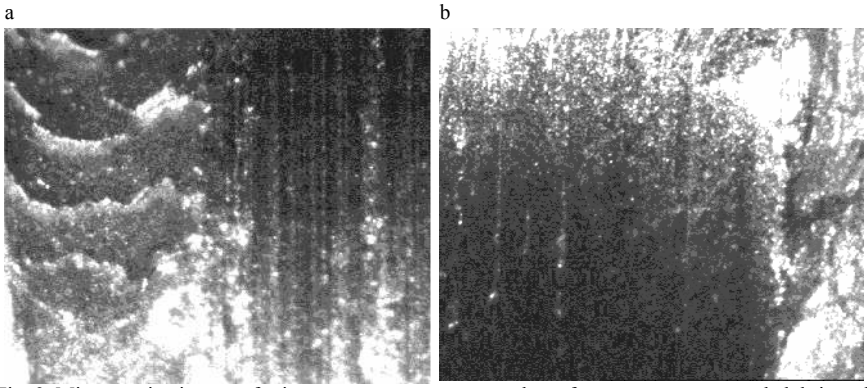

Fig. 9. Microscopic pictures of seizure traces on countersample surfaces: a – countersample lubricated with ON fuel, b – countersample lubricated with ONM "Standard"

Exemplary microscopic pictures of sample-countersample mating areas with distinct seizure traces on countersamples after tests on the Falex test stand, obtained from the metallographic microscope Neophot 2, equipped with the digital camera Elemis K-45, are shown in Fig. 9.

CONCLUSIONS

On the basis of the obtained results of preliminary tests concerning the influence of ecological fuel ONM "Standard" on wear processes, the following observations and conclusions can be made.

The use of ONM "Standard" fuel as a lubricant in tribological tests against the use of diesel oil ON causes the following effects:

In the case of pin-on-disk test

– the decrease of friction coefficient values and the reduction of their fluctuation amplitude,

– drop of the mean value of cross-sectional areas of friction pairs mating traces on the sample being a measure of samples wear value (for samples lubricated with ONM "Standard" fuel – 54.71 μm^2, for samples lubricated with ON fuel – 422.13 μm^2, respectively),

– clearly smoother, narrower and of approximately constant width sample and countersample mating traces,

In the case of Falex test

– an increase of the mean value of maximum load causing the total seizure of samples (for ON fuel – 207.28 N, for ONM "Standard" – 446.47 N, respectively),

– obtainment of better quality surfaces in the seizure area (more homogenous and smoother),

On the basis of the presented above observations and conclusions the following general conclusion concerning the tests results can be made:

1. The use of ONM "standard" fuel as a lubricant against the use of diesel oil ON causes wear effects reduction in the case of both tests, i.e. the test on the pin-on-disk test stand and on the Falex test stand, for various combinations of samples and countersamples materials.

2. The presented general conclusion justifies the beginning of operation research concerning the effect of diesel oil kind on the wear of self–ignition engine system's precise pairs in actual operation conditions.

REFERENCE

1. **Tarkowski P.**: Zagadnienia trwałości warstw implantowanych jonowo. Prace Naukowe Politechniki Lubelskiej. Lublin 1993 r.
2. **Skręt I.**: Światowe i europejskie tendencje zmian jakości olejów napędowych. Nafta Gaz nr 4/93 Kraków.
3. Norma.: PN-75/M.- 04308. Badania odporności na zużycie metali przez tarcie na maszynie Falex.

SUMMARY

The results of laboratory comparative tests concerning the influence of fuel kind on friction and wear processes have been presented in the paper. Tests were carried out on pin-on-disk and Falex test stands under conditions of lubrication with standard diesel oil (ON) and modified fuel (ONM "Standard") introduced for supplying municipal transport buses.