RESEARCH ON PURIFICATION OF THE MARINE ENGINE OIL WITH CHEMICAL INTERACTION PREPARATION

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Abstract

Owing to additives, the lubricating oils are characterized by constantly improving properties. Nevertheless, in extreme hard working conditions of the tribological systems (high pressures, velocities and temperatures, temporary lubricating lack during starting) the machine elements are not secured enough. In connection with the above mentioned the idea to introduce the additional substance - operating preparation into tribological systems (with the lubricating oils) was put forward.

Now the chemical interaction preparations have the widest application. These preparations are characterized by big molecular weight and high thermal and chemical stability. Besides filtering, lubricating oils used in marine engines are purified. In connection with it the question arises if the operating preparations (which have higher density then oils and water) are able to join permanently with lubricating oil in order not to separate in the purifying process and what influence they have on lubricating oil ability to separate the water. The lubricating oil with operating preparation MOTOR LIFE PROFFESIONAL and water purifying research were presented in the article so as to answer the above questions. The test stand consisted of two WESTFALIA purifiers. One of these purifiers was working in UNITROL, the other in SECUTROL system. In the research the UNITROL system purifier was used. The research object was MARINOL RG 1240 lubricating oil used in marine diesel engines.

Keywords: *marine diesel engines, lube oils, operating preparations, water, purification*

1. Introduction

Forming the quality of recent heavy loaded marine diesel engines lubricating oils is as an important process as design process of the engines parts. It is carried out by the base oil selection and proper pack of the additives in respect of quality and quantity. Owing to additives, the lubricating oils are characterized by constantly improving properties. Nevertheless, in extreme hard working conditions of the tribological systems (high pressures, velocities and temperatures, temporary lubricating lack during starting) the machine elements are not secured enough. In connection with the above mentioned the idea to introduce the additional substance - operating preparation into tribological systems (with the lubricating oils) was put forward.

Scientific research does not result in unequivocal assessment of the operating preparations. Different opinions about operating preparations functioning can be found in the professional literature [1, 3-10] - from harmfulness or weak effectiveness to good efficiency and big technical, economical and ecological meaning. Such different opinions come from big variety of operating preparations and their various principles of operation. Now the chemical interaction preparations have the widest application. These preparations join permanently with lubricating oil, so they do not precipitate on the filters and do not create heat-insulating layers unlike the preparations which contain molecules of solid lubricants. The chemical interaction preparations improve antiwear and antiseizure properties considerably and the boundary layers created on cooperating elements surfaces are able to carry bigger load. The movement resistances, temperature in friction area decrease and consequently wear of the machines elements decreases as well. The functioning efficiency of the operating preparations is usually the highest in case of deteriorating technical condition of tribological systems elements.

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2. Test stand and research method

The test stand consists of two WESTFALIA purifiers OSA 7-36-066 type which is characterised by the following technical parameters [11]:

- bowl revolutions n = 8250 rev/min,
- maximum output $Q_{max} \approx 2700$ l/h.

One of these purifiers is working in UNITROL, the other in SECUTROL system. In the research the UNITROL system purifier was used. This purifier is able to separate fluid impurities and solid impurities heavier than lubricating oil. The research object was MARINOL RG 1240 lubricating oil used in marine diesel engines. This oil came from SULZER 6AL20/24 engine which is in Laboratory of Marine Power Plant in Gdynia Maritime University. The scheme of the test stand was presented in Fig. 1, whereas the view of the WESTFALIA purifier's test stand was presented in Fig. 2.

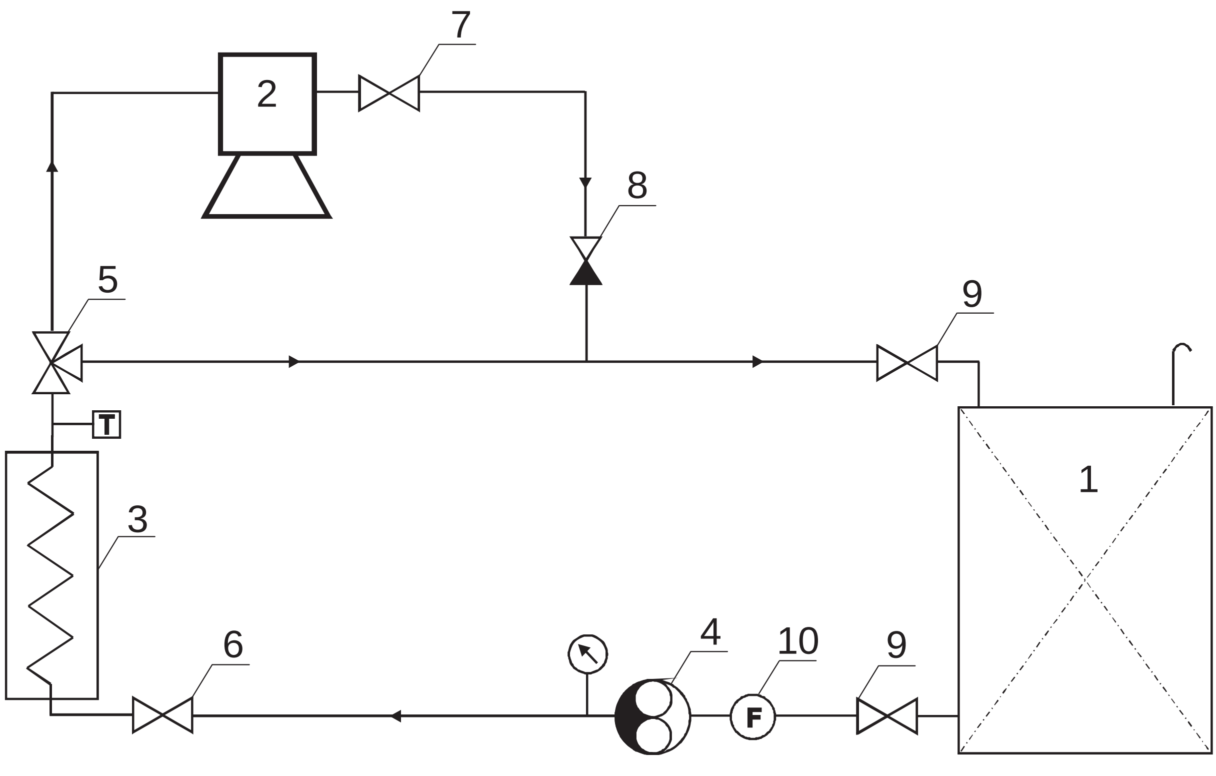

Fig. 1. The scheme of the test stand: 1 - lubricating oil tank, 2 - lubricating oil centrifuge, 3 - electric heater, 4 - delivery pump, 5 - three-way valve, 6 - flow regulating valve, 7 - pressure regulating valve, 8 - check valve, 9 - cut-off valves, 10 - filter

Fig. 2. The view of the WESTFALIA purifiers test stand: 1 - lubricating oil centrifuge working in UNITROL system, 2 - lubricating oil centrifuge working in SECUTROL system, 3 - electric heater, 4 - control panel, 5 - three-way valve

The research aim was to determine if operating preparation added to lubricating oil will not be separated during purifying process and what influence it has on lubricating oil ability to separate the water. The following purifying parameters were accepted:

- purifier output - $Q \approx 0,15\ Q_{max} \approx 400$ l/h,
- purified oil temperature - $t \approx 85°C$.

Research project was divided into three series:

- series I – lubricating oil with water content of approximately 1% in volume, oil samples taken before purifying (sample no. 1) and after purifying (sample no. 2),
- series II – lubricating oil with water content of approximately 1% in volume and Motor Life Professional operating preparation content of approximately 5% in volume, oil samples taken before purifying (sample no. 3) and after purifying (sample no. 4),
- series III – lubricating oil with water content of approximately 2% in volume and Motor Life Professional operating preparation content of approximately 5% in volume, oil samples taken before purifying (sample no. 5) and after purifying (sample no. 6).

In each series the whole amount of oil in the lube oil system (200 l) was purified twenty times (Fig. 1).

3. Research results

Lubricating oil samples were put to the comparative spectroanalysis and quantitative analysis to determine the content of water, Motor Life Professional operating preparation and soot. The analyses were done using FITR 1725X spectrophotometer by Perkin Elmer. The computer program Spectrum ver. 5.0.1 was used for spectrograms analysis whereas Spectrum Beer's Law was used for quantitative analysis of the water and Motor Life Professional operating preparation. Measuring accuracy for water was 0.15% m/m, for operating preparation 0.5% v/v. Additionally all samples were put to quantitative analysis to determine soot content. This analysis was done according to DIN 51 452 norm. Research results were presented in Tab.1 and Fig. 3-7.

Tab. 1. The analyses of the lubricating oil samples

Sample no.	Water content [% m/m]	Operating preparation content [% v/v]	Soot content [% m/m]
1	0.9884	-	0.38
2	0.9228	-	0.35
3	1.0713	5.25	0.34
4	0.5239	5.22	0.34
5	1.9971	5.52	0.31
6	0.7628	5.81	0.23

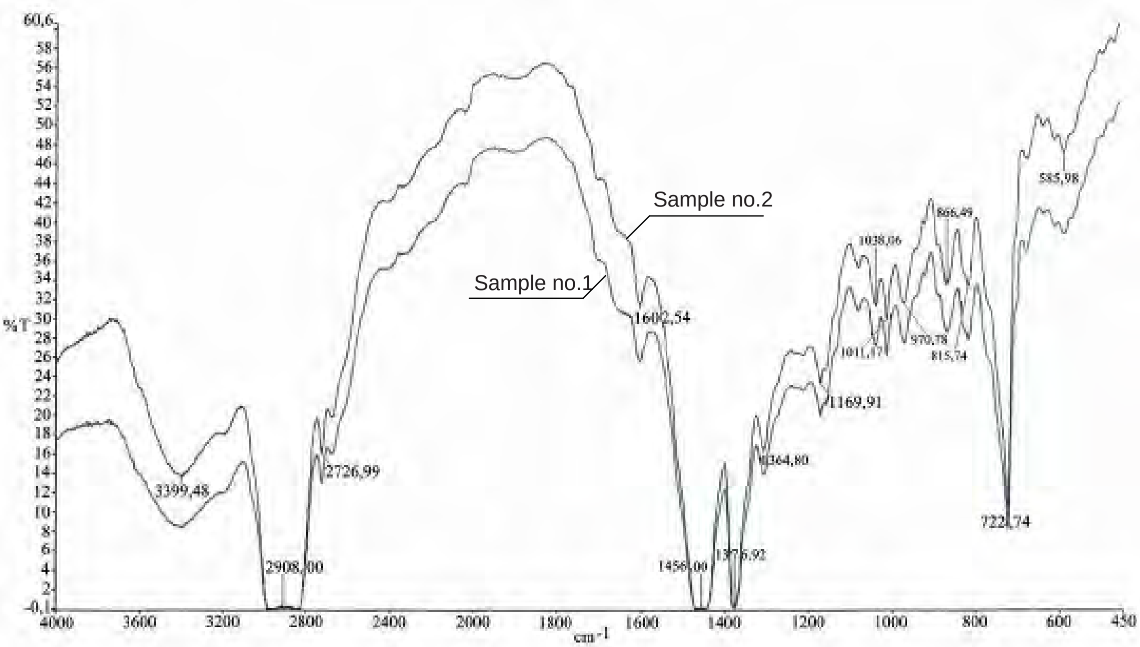

Fig. 3. Comparative spectrogram of MARINOL RG 1240 lubricating oil samples taken in series I: sample no. 1 - lube oil before purifying, sample no. 2 - lube oil after purifying

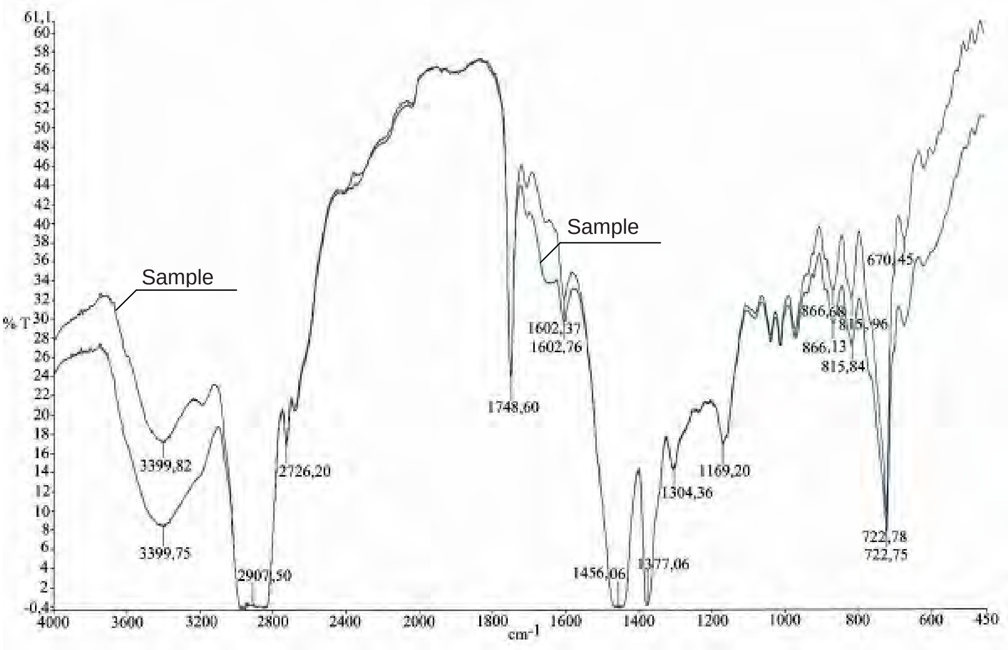

Fig. 4. Comparative spectrogram of MARINOL RG 1240 lubricating oil samples taken in series II: sample no. 3 - lube oil before purifying, sample no. 4 - lube oil after purifying

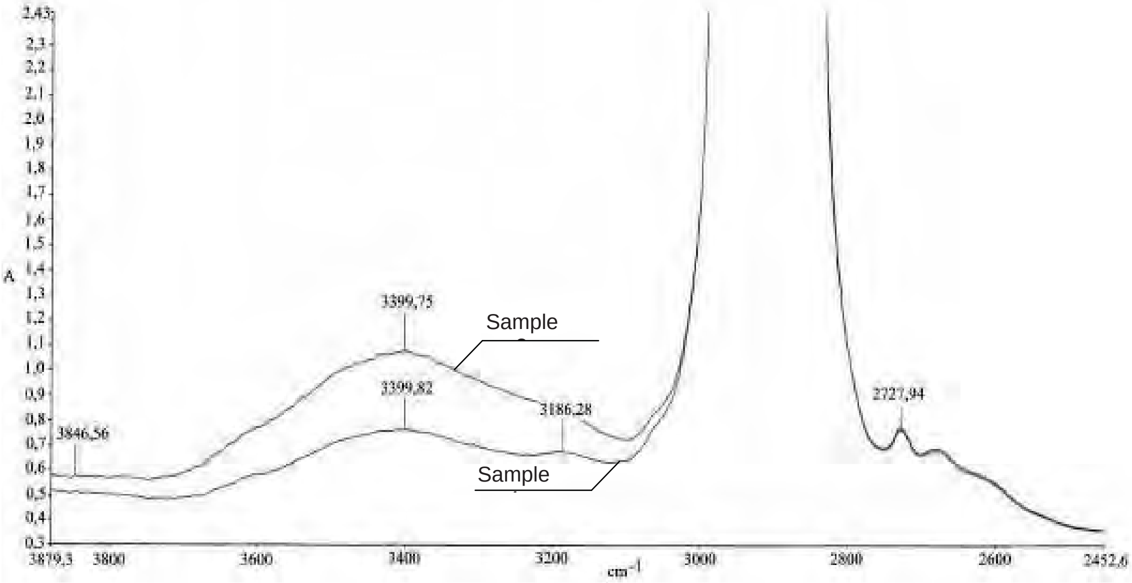

Fig. 5. Comparative spectrogram of MARINOL RG 1240 lubricating oil samples taken in series II in characteristic range for water presence (3400 cm-1): sample no. 3 - lube oil before purifying, sample no. 4 - lube oil after purifying

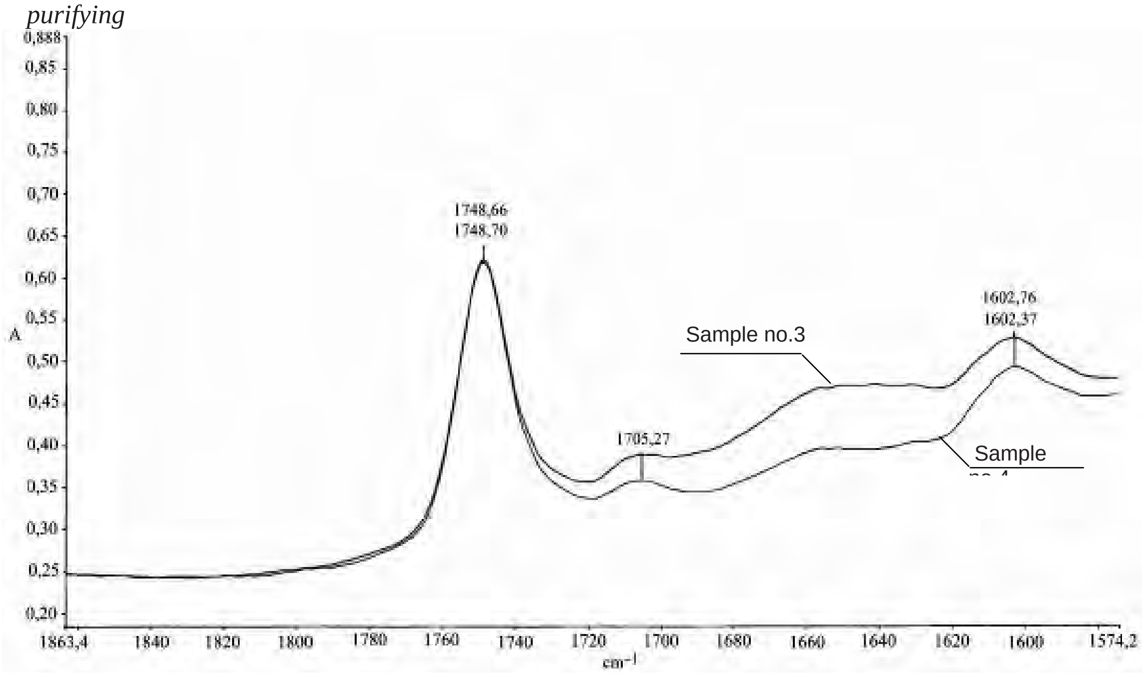

Fig. 6. Comparative spectrogram of MARINOL RG 1240 lubricating oil samples taken in series II in characteristic range for operating preparation presence (1748 cm-1): sample no. 3 - lube oil before purifying, sample no. 4 - lube oil after purifying

Infra Red (IR) spectrophotometry is very effective method to determine type and amount of the additives improving lubricating oil properties. It results from the fact that these substances usually have complicated chemical constitution and consequently clearer IR spectrum.
MOTOR LIFE PROFESSIONAL operating preparation have two characteristic absorption bands: 1748 cm^{-1} and 673 cm^{-1} whereas water has one absorption band 3400 cm^{-1}. Measuring these bands can determine contents of the operating preparation and water in lubricating oil.

Comparative spectroanalysis and quantitative analysis for lubricating oil samples taken in series I show that water content in samples no.1 and no. 2 has practically not changed as a result of purifying (Tab. 1, Fig. 3). Minor drop of the water content in sample no. 2 (after purifying) is within the limits of determination error. It is probably due to the fact that lubricating oil was considerably fouled by soot formed as the result of the fuel incomplete combustion (Tab. 1). Flake of soot has about 1μm in diameter and is composed of plenty smaller particles whose size does not exceed 0.1μm [2]. Soot strongly absorbs water which makes centrifuging of the water difficult.

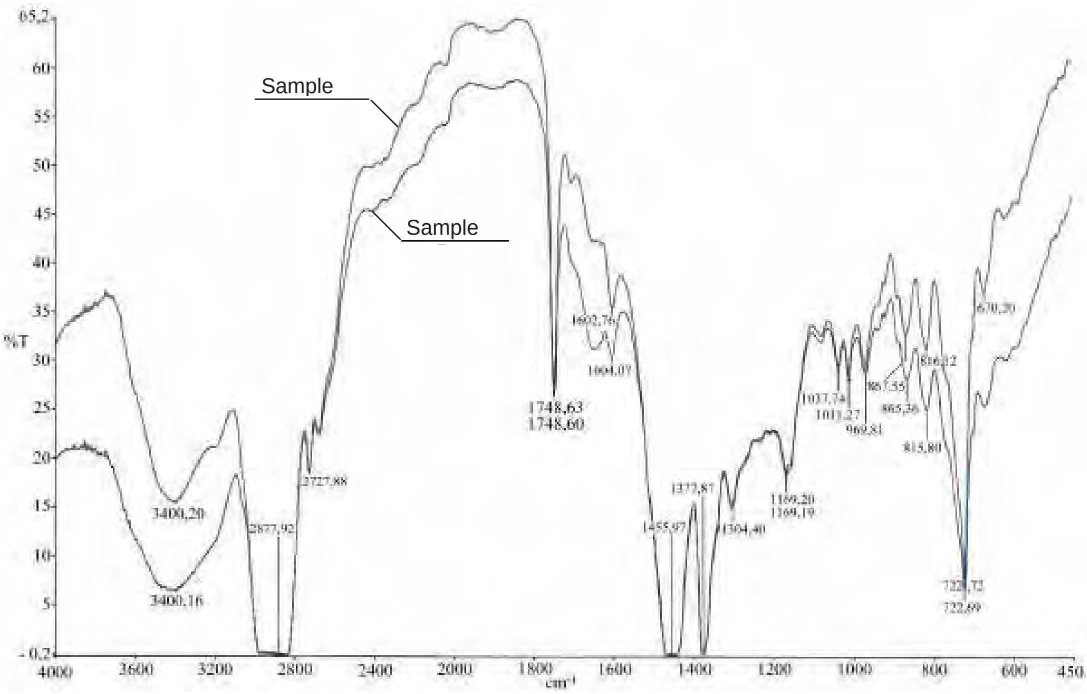

Fig. 7. Comparative spectrogram of MARINOL RG 1240 lubricating oil samples taken in series III: sample no. 5 - lube oil before purifying, sample no. 6 - lube oil after purifying

Comparative spectroanalysis and quantitative analysis for lubricating oil samples taken in series II show the water content level drop from 1.07% in sample no.3 to 0.52% in sample no. 4 (Tab. 1, Fig. 4,5), whereas the MOTOR LIFE PROFESSIONAL operating preparation content practically has not changed in the consequence of purifying (Tab. 1, Fig. 4, 6). Minor drop of the operating preparation level content from 5.25% in sample no. 3 to 5.22% in sample no. 4 (after purifying) falls within the limits of determination error.

Similar results were obtained for lubricating oil samples taken in series III. The water content level drop from 2% in sample no. 5 to 0.76% in sample no. 6 and negligible (within the limits of determination error) increase of the Motor Life Professional operating preparation level content from 5.52% in sample no. 5 to 5.81% in sample no. 6 (Tab. 1, Fig. 7).

4. Conclusions

1. Operating preparation Motor Life Professional was not separated from lubricating oil as a result of purifying. Lubricating oil and operating preparation form homogeneous solution. This enables application of the Motor Life Professional operating preparation in marine diesel engines.
2. Soot strongly absorbs the water which makes it difficult to centrifuge water from lubricating oil. Soot content in tested oil was 0.38% which practically resulted in the loss of water separation ability. After adding Motor Life Professional operating preparation to lubricating oil the water content dropped twice in the consequence of purifying. It is probably caused by strong displacement of the water particles by operating preparation molecules.
3. Research results presented in the article are preliminary. Tests should be repeated for different marine lubricating oils with various water contents, soot contents and other, possible in operation, lubricating oil impurities for example: fuel, metal particles, silica etc.

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