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ENGINE TESTS FOR COKING AND CONTAMINATION OF MODERN MULTI-INJECTION INJECTORS OF HIGH-PRESSURE FUEL SUPPLIES COMPRESSION-IGNITION ENGINE

BADANIA SILNIKOWE DOTYCZĄCE KOKSOWANIA I ZANIECZYSZCZENIA NOWOCZESNYCH WIELOOTWOROWYCH WTRYSKIWACZY WYSOKOCIŚNIENIOWEGO UKŁADU ZASILANIA PALIWEM SILNIKÓW ZS*

The paper presents the results of engine tests for contamination and coking of modern multi-injection injectors of high-pressure fuel supplies compression-ignition engines. The subject of research is base diesel fuel with 7% (v / v) FAME, and effectiveness of the detergent-dispersant additives plays a key role. The engine tests were performed according to the CEC procedure F-98-08 PSA DW-10, it was essential for the coking and contamination of modern multi-injection injectors of high-pressure fuel supplies compression-ignition engines and for the conclusions.

Keywords: *engine, injector, fuel, detergent-dispersant additive.*

W pracy przedstawiono wyniki badań silnikowych dotyczących zanieczyszczenia i koksowania nowoczesnych wielootworowych wtryskiwaczy wysokociśnieniowego układu zasilania paliwem silników o zapłonie samoczynnym (ZS). W zapobieganiu tym zjawiskom wiodącą rolę odgrywa skuteczność działania dodatków detergentowo-dyspergujących o odpowiednim poziomie dozowania. Przedmiotem badań jest bazowy olej napędowy z udziałem 7%(v/v) FAME. W celu sprawdzenia skuteczności działania badanych dodatków wykonano testy silnikowe zgodne z procedurą CEC F-98-08 PSA DW-10 pod kątem koksowania i zanieczyszczenia nowoczesnych wielootworowych wtryskiwaczy wysokociśnieniowego układu zasilania silników o ZS oraz sformułowano wnioski.

Słowa kluczowe: *silnik, wtryskiwacz, paliwo, dodatek detergentowo-dyspergujący.*

1. Introduction

The development of motorisation features intensive research in the field of engine fuels improvement, including packages of improvers. Fuels for compression-ignition engines (D), satisfying high requirements of modern drives, equipped with high pressure common rail systems (HPCRS) and catalytic multifunctional exhaust gas cleaning systems, must feature appropriate physicochemical and practical properties.

The optimisation of the charge combustion process in a compression-ignition engine at a multi-stage injection of hydrocarbon fuel and of biocomponents-containing fuel in the Common Rail system determines the main directions of research work in the field of technology and thermooxidising stability of biofuels and of engine design development, including the fuel feed system.

The course of blend combustion in the working space of the engine decides about its practical efficiency and about a positive ecological effect – reduction of harmful compounds emission to the air.

2. Factors shaping the process of nozzles fouling in high-pressure fuel injection HPCRS

The introduction to the automotive market of modern compression-ignition engines equipped with direct fuel injection systems named ‘High Pressure Common Rail System’ (HPCRS) increased the tendency of multi-nozzle high-pressure injectors to coke.

In this case a small diameter of nozzles – less than 150 μm – is the main problem as well as a high temperature of the injector tip situated in the combustion chamber [2]. The design of the aforementioned fuel injection systems and extreme working conditions (high temperature of injector tips, exceeding 300°C, high working pressure of up to 250 MPa for injectors with hydraulic amplification, small diameter of fuel nozzle orifices) cause the formation of hydrocarbon deposits (coke) originating at the outlet of injector nozzles [3, 5].

According to [1] the following factors have a significant impact on injector tips coking:

- physicochemical properties of the fuel, component composition, heat and oxidation resistance;
- temperature of injector tip and resistance to the thermal degradation of fuel;
- design of injector tip, the inner diameter and geometrical shape of the nozzle as well as wettability of internal surfaces of the injector by the fuel.

Temperature has a significant influence on the process of nozzles coking [18], Leperhoff has shown that temperatures higher than 300°C cause a quick deposition of coke on injector tips, resulting from the diesel fuel cracking and from the kinetics of thermal condensation reaction of cracking products [6]. To ensure cleanness and efficiency of HPCRS injection systems the diesel fuel should meet not only minimum requirements related to its quality acc. to PN-EN 590:2013-12 standard, but also guidelines of injection systems

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(*) Tekst artykułu w polskiej wersji językowej dostępny w elektronicznym wydaniu kwartalnika na stronie ***www.ein.org.pl*** manufacturers, presented in the form of a common position declaration 'Fuel Requirements for Diesel Injection System – Diesel Fuel Injection Equipment Manufacturers – Common Position Statement 2012'. Also the guidelines of the Worldwide Fuel Charter for category 4 diesel fuel – edition 5 from September 2013 – are a necessary condition.

Some properties of the fuel, such as high viscosity, low volatility, content of olefins, aromatic compounds, content of biocomponents (FAME) facilitate formation of carbon deposits and coke on the injector tips. The progress in the field of detergent-dispersant improvers technology and the levels of their dosing allow to resolve many design issues of injectors themselves and also to influence positively the kinetics of fuel combustion kinetic reactions in a compression-ignition engine.

3. Engine tests in the field of fouling assessment of modern multi-nozzle injectors

In the modern compression-ignition engines, manufactured now, their complicated system of operation control and also a precise dose of injected fuel depend more and more on the presence of deposits in the fuel, and also on the deposits formed during the process of fuel combustion in the engine [12].

In March 2008 the European Standardisation Committee (CEC) formalised and implemented a new engine testing procedure CEC F-98-08 'Direct Injection Common Rail Diesel Engine Nozzle Coking Test' related to coking and fouling modern multi-nozzle injectors as a standard test for the assessment of the fuel quality and of effectiveness of detergent additives action.

A Peugeot DW-10 compression-ignition engine with direct injection was chosen, meeting requirements of Euro 4 exhaust gas emission standard, widely used on the European market in Peugeot 407 2.0 HDi 16V cars, equipped with injectors meeting requirements of Euro 5 exhaust gas emission standard.

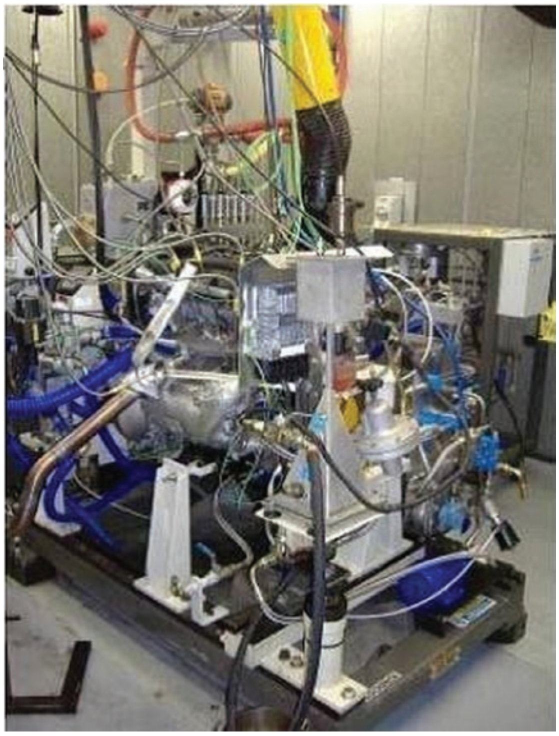

Fig. 1. PSA DW-10 engine test bed Experimental tests in the field of injectors fouling were carried out based on the CEC F-98-08 procedure, on a PSA DW-10 engine, which featured:

An engine test bed designed to carry out tests based on the CEC F-98-08 procedure was chosen, using a turbocharged four-stroke PSA DW-10 compression-ignition engine with direct injection. (Fig. 1.)

- direct injection;
- four valves per cylinder;
- capacity of 1998 cm^3;
- turbocharging with exhaust gas recirculation (EGR) and a particulate filter;
- rated power of 100 kW at 4000 rpm;
- maximum torque of 320 Nm at 2000 rpm;
- Siemens VDO, Euro 5 injectors;
- 'Common Rail' type injection system of 160 MPa pressure;
- piezoelectrically controlled 6-nozzle injectors with spray nozzles 110 µm in diameter.

The Worldwide Fuel Charter (WWFC 2013) introduced the procedure CEC F-98-08 to the assessment of cleanness of both pintle injectors and to the assessment of cleanness of high-pressure multi-nozzle injectors for category 4 and 5 diesel fuels acc. to the Worldwide Fuel Charter, apart from the procedure CEC F-23-01. Fig. 2 presents relative spray nozzle diameters for injectors used to assess the fuel tendency to foul the injectors. [17]

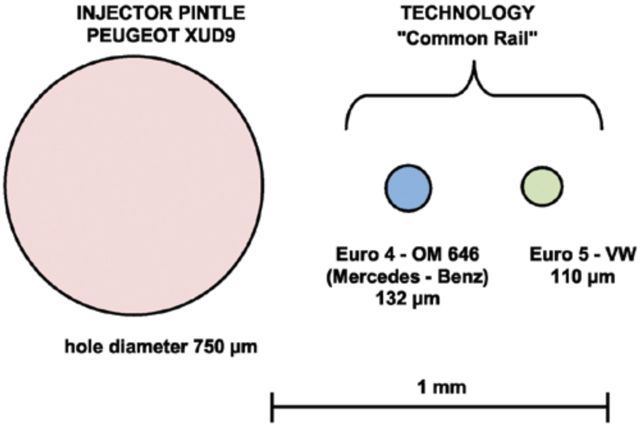

Fig. 2. Relative diameters of various injectors spray nozzles

According to the Worldwide Fuel Charter (WWFC 2013) for category 4 and 5 of diesel oils maximum 2% of engine power loss is allowed after testing acc. to the procedure CEC F-98-08. The PSA DW-10 engine test simulates the conditions of driving on a road. The engine tests were carried out at defined engine rotational speeds and loads, including 60-minute cycles consisting of 12 phases. Table 1 presents parameters of individual phases, while Fig. 3 presents a load-rotation profile of the course of one 60-minute test cycle.

For each performed test a new set of injectors is installed, which are checked in a 16-hour test on a reference fuel not fouling them. The observed power is checked, as well as the amount of engine gases blowthrough to the crankcase versus the engine torque and the fuel consumption in comparison with known values. Also the lubricating oil consumption is monitored before tests start and end. The test procedure comprises alternating four 8-hour sequences of the engine operation acc. to the load-rotation profile presented in Fig. 3 and three sequences of 4-hour engine standstill. So the total test time is 16 + 32 + 12 = 60 hours.

Table 1. Parameters of 12 phase test cycle on a PSA DW-10 engine

Phase	Time [min]	Engine rotations [rpm] ± 20 rpm	Load [%]	Torque [Nm] ± 5 Nm
1	2	1750	(20)	62
2	7	3000	(60)	173
3	2	1750	(20)	62
4	7	3000	(80)	212
5	2	1750	(20)	62
6	10	4000	100	*
7	2	1250	(10)	25
8	7	3000	100	*
9	2	1250	(10)	25
10	10	2000	100	*
11	2	1250	(10)	25
12	7	4000	100	*
	Σ = 60			

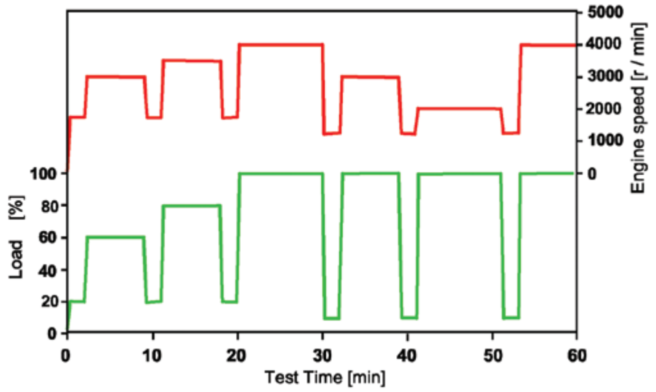

Fig. 3. Load-rotation profile of one testing cycle on a PSA DW-10 engine

4. CEC F-98-08 PSA DW-10 procedure for testing the detergent-dispersant additives action effectiveness

The CEC F-98-08 PSA DW-10 procedure enables also testing the effectiveness of detergent-dispersant additives action in the field of their properties related to removing the fouling from injectors after approx. 16-hour dirtying in the 'dirt-up' test. The engine 'dirt-up' test is carried out using a reference diesel fuel CEC RF 06-03 without any FAME as a certified fuel for legislation testing of engines meeting requirements of Euro 4 and Euro 5 exhaust gas emission standards. To accelerate the injectors fouling in the 'dirt-up' procedure 1 mg/kg of zinc in the form of zinc neodecanoate is added to the fuel. Table 2 presents properties of the reference fuel CEC RF 06-03

After an engine test comprising a 'dirt-up' cycle a 32-hour 'clean-up' test is performed using a fuel containing effectively acting detergent-dispersant additives with admixture of 1 mg/kg Zn in the form of zinc neodecanoate. The engine tests of 'Power Diesel' diesel fuel

Table 2. Properties of the reference fuel CEC RF 06-03

Properties	Unit	Results of test	
		minimum	maximum
Cetane number		52.0	54.0
Density at 15°C	kg/m^3	833.0	837.0
Fractional composition: - to 245°C distilled - to 350°C distilled - distillation end temperature	 % (V/V) % (V/V) °C	 50.0 95.0 -	 - - 370
Ignition temperature	°C	55.0	-
Cold filter plugging point	°C	-	-5
Kinematic viscosity at 40°C	mm^2/s	2.3	3.3
Sulphur content	mg/kg	-	10.0
Content of polynuclear aromatic hydrocarbons	% (m/m)	3.0	6.0
Resistance to oxidation, total insoluble deposits	g/m^3	-	25.0
Fatty acids methyl esters (FAME) content	% (V/V)	none	none
Lubricity, corrected trace diameter	µm	-	400
Acid number of strong acids	mg KOH/g	-	0.02
Water content	mg/kg	-	200

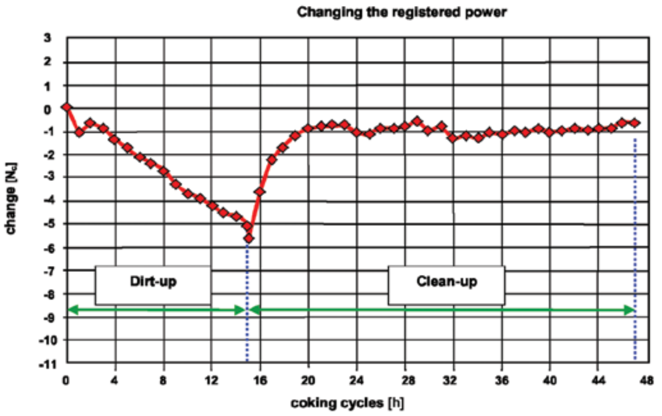

Fig. 4. The course of engine power variability in the 'dirt-up' cycle and in the 'clean-up' cycle

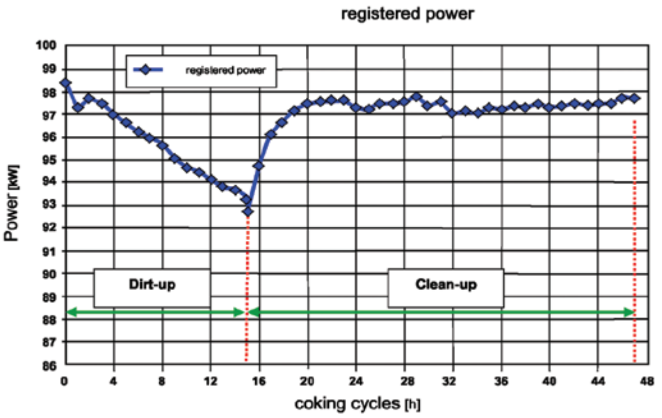

Fig. 5. The course of engine power variability in percent after the 'dirt-up' cycle and 'clean-up' cycle

containing 500 mg/kg of Petropak® and 1200 mg/kg of Energocet® were carried out according to the CEC F-98-08 PSA DW-10 'dirt-up' and 'clean-up' procedure and performed in the Engine Laboratory of the SGS Drive Technology Centre in Austria.

Fig. 4 presents the course of engine power loss in percent after 16-hour cycle of 'dirt-up' test, while Fig. 5 is related to the power recovery after a 32-hour 'clean-up' test cycle. The power loss after the 'clean-up' test was below one percent.

5. Compatibility of multi-function detergent-dispersant and cetane-detergent additives with engine oils

The compatibility with engine oils, lubricating radial and axial piston fuel pumps, used in delivery vans and lorries, is an important issue for multi-function detergent-dispersant and cetane-detergent additives. Such tests are carried out based on the German Society Petroleum and Coal Science and Technology DGMK 531-1 'Test for engine oil compatibility' procedure. They consist in mixing the SAE 15W/40 'Super High Performance Diesel Oil' SHPDO engine oil with a package of diesel oil additives in the proportion of 50:50, storage at 90ºC during 72 hours, then cooling the sample down to 20ºC during 1 hour, and a visual assessment of deposits, gels, turbidities formed in it. In the field of sample homogeneity the visual assessment was expanded with turbidimetric analyses. The sample was diluted, supplementing to 500 ml with the basis diesel oil, mixed, and the solution appearance was assessed. After 2 hours the solution was mixed again and filtered at a pressure of 800 hPa, through a filter with pores 0.8 micrometer in average diameter, and the filtration time of 500 ml of the solution was measured. The filtration time should not exceed 900 s, and the final solution should be clear and without any deposits. Table 3 presents the results of tests of engine oil compatibility with packages of Petropak® and Energocet® additives to the diesel oil.

Table 3 Results of tests of packages of Petropak® and Energocet® additives compatibility with the SHPDO SAE 15W/40 engine oil acc. to the DGMK 531-1 procedure

Tested package	Filtration time [s]	Solution appearance
Petropak®	106	clear no deposit
Energocet®	187	clear no deposit

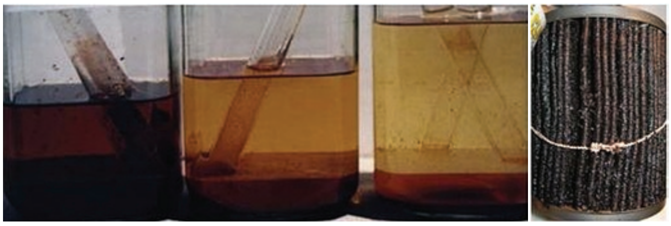

Fig. 6. Microbiological infection of diesel fuel and a fouled fuel filter a) microbiologically infected diesel fuel b) fuel filter fouled with a deposit after microbiological degradation of fuel

The experimental tests were related also to the assessment of the fuel propensity to the development of microbiological contamination. The application of diesel fuel with ultra-low sulphur content (below 10 mg/kg) with 7 % (V/V) FAME content resulted in increased fuel propensity to microbiological contamination. Fatty acids methyl esters as a renewable component of the diesel oil with hygroscopic properties easily biodegrade, being an excellent nutrient medium for the development of microbiological life. Fatty acids methyl esters biologically degrade four times faster than a conventional diesel fuel originating from oil [10]. Moreover, in the temperature range from 4ºC to 35CºC fatty acids methyl esters absorb 15 to 25 times more water than the conventional diesel fuel. These factors are favourable to the development of microbiological life during such fuel storage and distribution. A microbiological infection of the fuel results in turbidity, colour change, increased pollution in the form of deposits and slurries, increase in viscosity and deterioration of the fuel filterability.

Fig. 6 presents pictures of microbiologically infected diesel fuel and a fuel filter fouled with a deposit after fuel microbiological degradation.

Biocidal additives play a crucial role in preventing and eliminating problems related to micro-organisms presence in the diesel fuel. In the presented paper a multi-function detergent-dispersant additive Petropak® contained biocides compatible with the applied polyisobutylene succinic imides described in detail in inventions PL 217137 and PL 218043 [8, 9]. The effectiveness of their biocidal action was determined in a preventing test acc. to the ASTM E-1259:10

Table 4. Results of testing the biocides action effectiveness in the field of microbiological protection in a preventing test acc. to the ASTM E-1259:10 method

No	Test duration (weeks)	Tested fuel	Examined material	Microbes content in the fuel (cell/l) and water (cell/l) phase		
				aerobic bacteria	yeast	mould fungi
1	1	Summer diesel fuel, grade B +7%(V/V) FAME 'Premium' (500 mg/kg Petropak®	fuel	< 200	< 200	< 200
			water	< 200	< 20	< 20
2	2	Summer diesel fuel, grade B +7%(V/V) FAME 'Premium' (500 mg/kg Petropak®	fuel	< 200	< 200	< 200
			water	< 200	< 20	< 20
3	3	Summer diesel fuel, grade B +7%(V/V) FAME 'Premium' (500 mg/kg Petropak®	fuel	< 200	< 200	< 200
			water	< 200	< 20	< 20
4	4	Summer diesel fuel, grade B +7%(V/V) FAME 'Premium' (500 mg/kg Petropak®	fuel	< 200	< 200	< 200
			water	< 200	< 20	< 20
*	At the amount of less than 200 cells per litre of fuel it is considered free of microbiological life					
**	At the amount of less than 200 cells/ml in water for aerobic bacteria and below 20 for yeast and mould fungi, the water is considered not infected by microbes					

Table 5. Results of tests of a multi-function detergent-dispersant package and detergent-cetane package in diesel fuels

Basis diesel fuel summer grade B +7 %(V/V) FAME			Packages	
			Petropak®	Energocet®
Dosing mg/kg			500	1200
Lubricity, acc. to PN-EN ISO 12156-1, μm	max. 460		399	427
Compatibility acc. to DGMK 531-1 filtration time, s	max. 300		106	87
Cetane number	min. 51/55		52	59.8
Nozzles patency reduction index, % acc. to CEC F-23-01	max. 60		31	-
Nozzles patency reduction index, % acc. to CEC F-23-01 (500 mg/kg Petropak® + 1200 mg/kg Energocet®)	max. 30		-	11
Power loss after 'dirt-up / clean-up' testing acc. to CEC F-98-08, %	max. 2		-	< 1
Resistance to oxidation (Rancimat), h	min. 40		60.0	56.7
Corrosion acc. to ASTM D665A	max. B^{++}		A	-
Foaming acc. to NF M07-075 - foam volume, cm^{3} - foam decay time, s	max 100 max 15		30 4.8	- -
Interaction with water acc. to ASTM D 1095 - change of water layer volume - interface appearance - degree of phase separation	± 3.0 max 1b max 2		1.0 1b 2	1.0 1b 2
Microbes content in the fuel (cell/l) and water (cell/l) phase after four-time fuel contacts with the contaminated water phase:				
- aerobic bacteria	fuel	< 200	< 200	-
	water	< 200	< 200	-
- yeast	fuel	< 200	< 200	-
	water	< 20	< 20	-
- mould fungi	fuel	< 200	< 200	-
	water	< 20	< 20	-

'Evaluation of Antimicrobials in Liquid Fuels Boiling Below 390ºC' method, determining the microbes content in the fuel phase by the IP385 'Determination of viable aerobic microbial content of fuel components boiling below 390ºC' method. The applied methodology reflects a four-time pumping of the fuel in the distribution chain with a contaminated water phase at the ratio of fuel to water phase of 400: 1. The test lasts four weeks. Table 4 presents the results of testing the biocides action effectiveness in the field of microbiological protection in a preventing test [13].

Table 5 presents selected test results of practical assessment of multi-function detergent-dispersant package and detergent-cetane package in 'Premium' diesel fuel containing 500 mg/kg of Petropak® and 'Power Diesel' diesel fuel containing 500 mg/kg of Petropak® and 1200 mg/kg of Energocet®.

6. Summary

In the modern compression-ignition engines, manufactured now, their complicated system of operation control, and a precise dose of injected fuel depend more and more on the presence of deposits related to the course of many occurring chemical reactions of the fuel and hydrocarbons decomposition products existing in the injector nozzle and on the outside nozzle surface [7].

The knowledge related to deposits formation mechanisms in IDID (Internal Diesel Injector Deposits) injectors, and also to their chemical composition is still insufficient. The number and complexity of factors initiating the formation and build-up of internal IDIDs in HPCR systems injectors in compression-ignition engines still require carrying out research determining their importance and the interaction mechanisms [8,9,15,16].

The explanation of IDID deposits formation mechanisms and also of coke formation on the nozzles is difficult due to the lack of appropriate testing tools simulating very difficult conditions existing inside the combustion chamber and inside high-pressure injectors.

In this field a significant testing tool consists of engine tests carried out according to procedures suggested and agreed by injection systems and compression-ignition engines manufacturers. They are presented in the Worldwide Fuel Charter (WWFC 2013) according to CEC F-98-08 for compression-ignition engines with direct fuel injection to the combustion chamber for category 4 of diesel fuel, edition five, September 2013 [19].

Progressing design and technological development of piston combustion engines and fuel injection systems applied in them, and also the changing fuel technologies will require developing and applying more and more effective detergent-dispersant additives of multidirectional action.

The IDID type deposits produced in simulation engine tests resulted in characteristic, occurring during real vehicles operation, dysfunctions of HPCR type fuel injection systems, frequently making their operation impossible.

The conclusions formulated by the Authors based on experimental tests during engine tests comprising a 'dirt-up' and 'clean-up' operation cycle prove the importance of improvers action effectiveness and their compatibility, which is confirmed by other authors [4,7,9,14,16,17].

A biocidal action preventing and removing microbes fouling the fuel is an important element of practical assessment of a multi-function additive.

References

1. Birgel A, Ladommatos N, et al. Deposit Formation in the Holes of Diesel Injector Nozzles: A Critical Review. SAE Paper 2008-01-2383, https://doi.org/10.4271/2008-01-2383.
2. Caprotti R, Bhatti N, et al. Deposit Control in Modern Diesel Fuel Injection Systems. SAE Paper 2010-01-2250, https://doi.org/10.4271/2010-01-2250.
3. Caprotti R, Breakspear A. Injector Deposit Test For Modern Diesel Engines. 5th International Colloquium Fuels TAE Esslingen 2005.
4. Fuel Requirements for Diesel Fuel Injection Systems Diesel Fuel Injection Equipment Manufacturers Common Position Statement 2012.
5. Leedham A, Caprotti R, et al. Impact of Fuel Additives on Diesel Injector Deposits. SAE Paper 2004-01-2935, https://doi.org/10.4271/931032.
6. Lepperhoff G, and Houben M. Mechanisms of Deposit Formation in Internal Combustion Engines and Heat Exchangers. SAE Paper 931032, https://doi.org/10.4271/2009-01-0848.
7. Matzke M, Litzow U, et al. Diesel Lubricity Requirements of Future Fuel Injection Equipment. SAE Paper 2009-01-0848.
8. Mazanek A. Ocena parametrów użytkowych wtryskiwaczy piezoelektrycznych na podstawie badań wizualizacyjnych procesu rozpylania paliwa. Nafta - Gaz 2016; 4: 279-284, https://doi.org/10.18668/NG.2016.04.07.
9. Oleksiak S, Łukasik Z. Nowoczesne układy wtrysku paliwa w silnikach Diesla i ich wpływ na jakość paliw i dodatków detergentowo - dyspergujących. Nafta - Gaz 2009; 1: 58-64.
10. Patent PL 217137 "Uniwersalny pakiet do bioestrów", 2014, 30.06.2014.
11. Patent PL 218043 "Wielofunkcyjny pakiet dodatków biobójczo-stabilizujących", 2014, 30.09.2014.
12. Sorensen G, Dennis V, et.el Microbial growth studies in biodiesel blends. Bioresource Technology 2011; 103: 5259-5264, https://doi.org/10.1016/j.biortech.2011.02.017.
13. Stanik W, Jakóbiec J, Wądrzyk M. Design factors affecting the formation of the air-fuel mixture and the process of combustion in compression ignition engines. Combustion Engines 2013; 52(3): 40-50.
14. Stanik W. Badania poliizobutylenobursztynoimidów w zakresie oceny użytkowej dodatków detergentowo - dyspergujących do paliw silnikowych",Monografia - Praca Naukowa Instytutu Nafty i Gazu - Państwowego Instytutu Badawczego 2015; 26, https://doi.org/10.18668/PN2015.206.
15. Stępień Z. Przyczyny i skutki tworzenia wewnętrznych osadów we wtryskiwaczach silnikowych układów wysokociśnieniowego wtrysku paliwa. Nafta - Gaz 2013; 3: 256-262.
16. Stępień Z. A study of factors influencing the formation of harmful deposits in the diesel engine injectors. Eksploatacja i Niezawodnosc - Maintenance and Reliability 2017; 19 (3): 331-337, https://doi.org/10.17531/ein.2017.3.3.
17. Velaers A, and de Goede S. The Properties and Injector Nozzle Fouling Performance of Neat GTL and GTL/EN590 Diesel Blends in Various Diesel Engines. SAE Paper 2012-01-1692, https://doi.org/10.4271/2012-01-1692.
18. Watkinson A P, Wilson D I. Chemical reaction fouling: A review. Experimental Thermal and Fluid Science 1997; 4: 315-469, https://doi.org/10.1016/S0894-1777(96)00138-0.
19. Worldwide Fuel Charter, Fifth Edition, 2013, September 2013.

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