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SOME ISSUES RELATING TO THE MAN K8SZ 70/150 CLe NAVAL DIESEL ENGINE OPERATION

AL. DRAGALINA[1] T. FLOREA[1] A. PRUIU[1]
T. V. FLOREA[2]

Abstract: *This paper presents the results of some tests of functional parameters of a naval propulsion engine. The checks were necessary to determine the accuracy of performance on board maintenance, including adjustment of the injection advance angles and cleaning of the exhaust gas spaces.*

Key words: *engine, diesel, naval, propulsion, running.*

1. Preliminary Considerations

In a comprehensive research program, we want to find some solutions for improving the efficiency of naval engines operation. For this purpose, we have been conducted various experimental determinations in the various operational conditions.

In this paper, will be presented a series of items relating to a situation where, while making a long voyage, it was necessary to stop the propulsion engine and to perform some maintenance and repair works.

2. Measurements on the 11.07.2005 and 12.07.2005

At this time, between 11.07 and 13.00 LT, it was necessary to stop the main engine, because of overly large pressure variations that occurred in the water circuit of cylinders cooling. To detect the causes that led to this failure, were executed the following control operations:

- have parts the visiting covers of the combustion chambers from cylinders No.7 and No.8;
- were observed water infiltrations in the combustion chamber of the cylinder No.7;
- has parts the cylinder cover of the cylinder No.7;
- have not noticed cracks or deteriorations to the cylinder cover No.7;
- the cylinder liner No.7 shows in the collar area, the entire circumference, aspect of "scorched earth", with irregular vertical cracks in the area of Tb (3 cracks opening of about 4 ... 5 mm).

Due to difficult weather conditions (Sea grade 4 to 5), could not make the cylinder liner replacement. In these circumstances, was taken the decision to operate the engine without cylinder No.7 (with one suspended cylinder). To do this, have executed the following operations:

[1] Mircea cel Bătrân" Naval Academy, Constanta, Romania
[2] S.C. Delatreid, Constanta, Romania

- has mounted the cylinder cover;
- was suspended the injection from cylinder No.7 (it was decoupled the injection pump);
- have opened the safety valve and the sampling cock form the cylinder No.7;
- has been isolated the cylinder liner cooling circuit;
- was started the main engine with cylinder No.7 suspended.

Continued to march in the crash, until the ship arrived in a secure area for anchorage. Maximum speed at which the engine can operate with a suspended piston shall be calculated with the formula

$$n_1 = n_{nom} \cdot \sqrt{(i-1)/i} \qquad (1)$$

where n_{nom} is the rated engine speed at maximum load, and i - the number of cylinders. Therefore, for MAN K8SZ 70/150CLe, the maximum speed was

$$n_1 = 114 \cdot \sqrt{(8-1)/8} = 106{,}6\text{rpm}. \qquad (2)$$

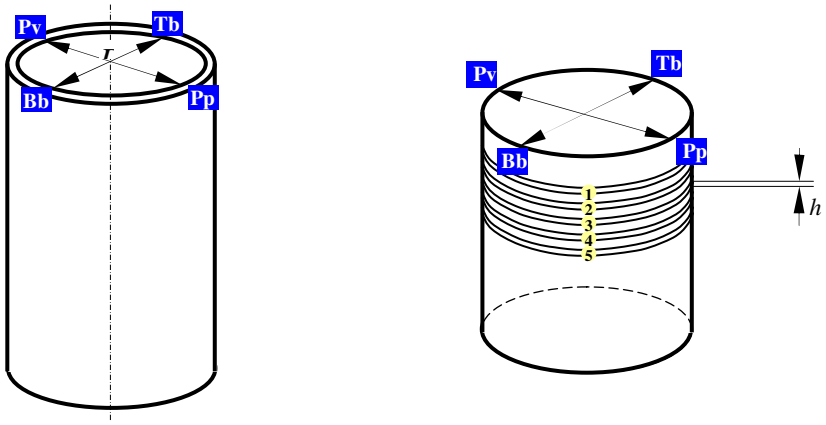
At 17.00 LT came into the anchor area and began the work of replacing the cylinder liner No.7. It was considered also the request supply to the first port with a new cylinder liner. The replacement operations were developed in the following order:

- have been isolated the cyilinder and piston water cooling circuits;
- has cleared the water;
- were parts the following components of the cylinder cover: injector, high-pressure piping, injector coolant piping, starting air piping, thermocouples for cooling water and exhaust gas temperatures;
- was dismantled the cylinder cover from the engine;
- have attachments parts the nuts of the piston rod and the crosshead;
- to seal parts of the piston rod (stuffing box);
- was extracted the piston from the cylinder liner;
- have parts the cylinder lubricators;
- depression the cylinder liner from the block;
- has been cleaned of the deposits in cooling areas of the block;
- has prepared the reserve cylinder liner;
- was prepared the new sealing gaskets set;
- has pressed the new cylinder liner in the block.

Further, after the cylinder mounting in the block, were performed measurements of the diameters. Determinations were made on two perpendicular directions (Pv-Pp and Bb-Tb), the corresponding position of the piston rings, in PMS (fig.1.a). Results are presented in Table 1 (first part).

Values of measurements Table 1

Ring channel No.	**Cylinder liner diameter** [mm]			
	Pv-Pp		**Bb-Tb**	
1	699,73		699,72	
2	699,74		699,71	
3	699,67		699,67	
4	699,67		699,66	
5	699,67		699,66	
Ring channel No.	**High of the piston ring channels** [mm]			
	Pv	**Pp**	**Bb**	**Tb**
1	13,60	13,60	13,60	13,50
2	13,60	13,60	13,60	13,50
3	13,60	13,60	13,60	13,50
4	13,60	13,60	13,60	13,60
5	13,70	13,80	13,60	14,00



a b

Fig.1 *Measurements made at the cylinder liner (a) and at the piston ring channels (b)*

After examining the state of old piston rings, they found that:

- Ring No.1 has good elasticity and can be reused to assembly;
- Ring No.2 shows reduced elasticity and requires replacement with a new one;
- Ring No.3 present sharp edges and it is necessary to replace with a new one;
- Rings No.4 and No.5 have reduced elasticity and pronounced wear, requiring their replacement.

Before mounting, were cleaning the piston, the ring channels and the rings. Were conducted then measured at the ring channels on the piston and have obtained the values shown in Table 1 (second part).

On entering the piston in the new cylinder liner, was imposed the alignment making, by changing the cams position of the crosshead. The values of taken measurements, before and after the alignment, are included in Table 2.

Values of functional clearances Table 2

Parameter	**Initial values** [mm]			
	Pv	**Pp**	**Bb**	**Tb**
The clearance between the piston and the cylinder liner [mm]	1,20	0,25	0,65	0,70
The clearance in the guide shoe of the crosshead [mm]	0,15	0,05	0	0,20
Parameter	**Final values** [mm]			
	Pv	**Pp**	**Bb**	**Tb**
The clearance between the piston and the cylinder liner [mm]	0,60	0,60	0,60	0,65
The clearance in the guide shoe of the crosshead [mm]	0,15	0,05	0	0,20

3. Conclusions

Replacement work was completed on 12.07.05 at 06.00 LT. Then passed to the completion with water of the cooling system of cylinders and the engine heating for two hours, until the temperature of cooling water reaches 60°C.

After heating, the engine was started, without producing any incident. At 08.15, the engine was ready to maneuver and the ship was able to resume his voyage. The cylinder No.7 operates under the damage, with an additional oil lubrication.

Measured values of the parameters are satisfactory, except for maximum combustion pressures that are too large. In order to reduce the maximum combustion pressure, was imposed the adjustment of the injection advance angles.

Values of functional parameters Table 3

Parameter		Power	Cylinder No.							
			1	2	3	4	5	6	7	8
Maximum combustion pressure [bar]	Det.No.1	6184 kW	96	91	93	95	93	94	96	90
	Det.No.2	9096 kW	111	110	111	109	109	111	113	106
Compression pressure [bar]	Det.No.1	6184 kW	55	49	49	51	50	52	55	49
	Det.No.2	9096 kW	63	65	62	63	61	65	64	61
Pressure at the injection moment [bar]	Det.No.1	6184 kW	68	63	68	66	68	65	65	64
	Det.No.2	9096 kW	83	79	84	77	81	80	82	74
Injection advance angle [°RAC]			10	10	9	10	9	10	11	10

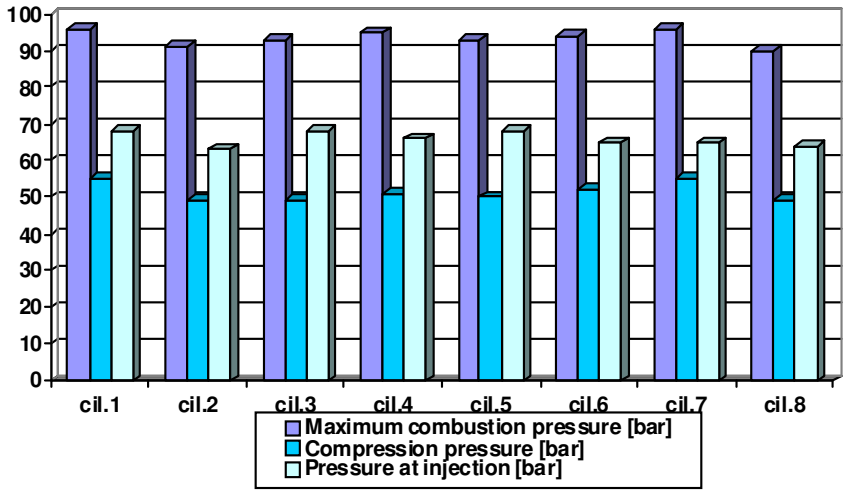


Fig.2. *Values of functional parameters in the first determination (P_e=6184 kW)*

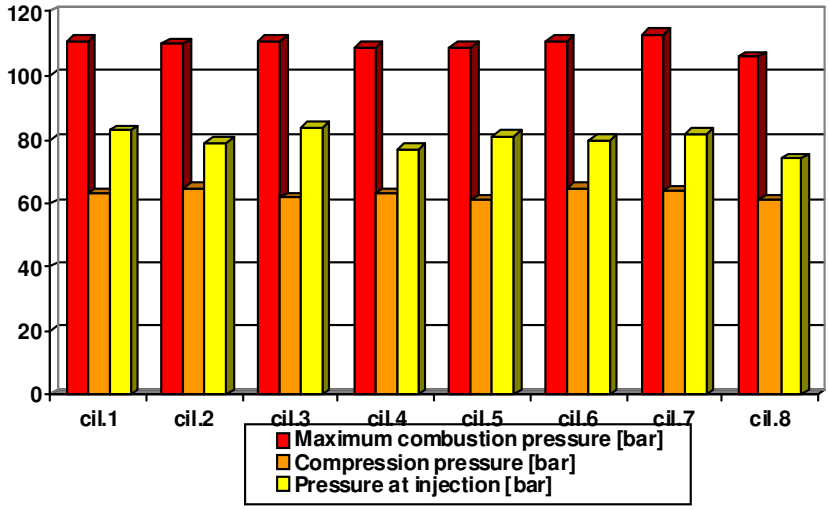


Fig.3. *Values of functional parameters in the second determination (P_e=9096 kW)*

The percentage deviations of some functional parameters Table 4

Percentage deviation of:		Mean value [bar]	Cylinder No.							
			1	2	3	4	5	6	7	8
the maximum combustion pressure Δp_{max} [%]	Det.No.1	93,5	+2,674	–2,674	–0,535	+1,604	–0,535	+0,535	+2,674	–3,743
	Det.No.2	110	+0,909	0	+0,909	–0,909	–0,909	+0,909	+2,727	–3,636
the compression pressure Δp_c [%]	Det.nr.1	51,25	+7,317	–4,390	–4,390	–0,488	–2,439	+1,463	+7,317	–4,390
	Det.nr.2	63	0	+3,175	–1,587	0	–3,175	+3,175	+1,587	–3,175
the pressure at injection moment Δp_{inj} [%]	Det.nr.1	65,875	+3,226	–4,364	+3,226	+0,190	+3,226	–1,328	–1,328	–2,846
	Det.nr.2	80	+3,750	–1,250	+5,000	–3,750	+1,250	0	+2,50	–7,500

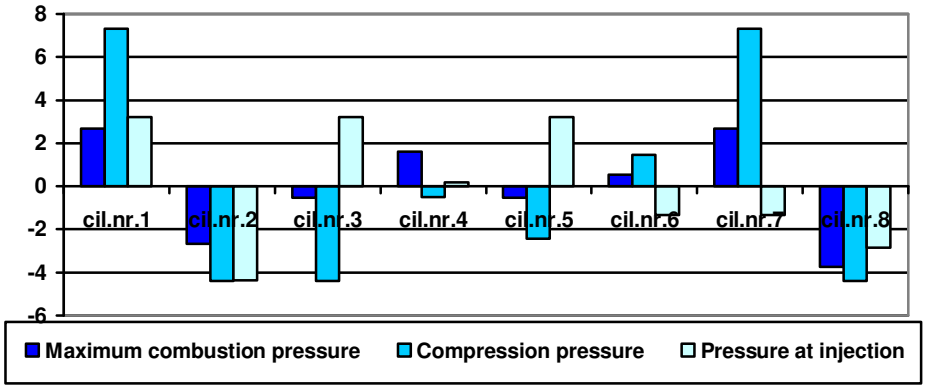


Fig.4. *The dispersion of percentage deviations from some functional parameters in the first determination (P_e=6184 kW)*

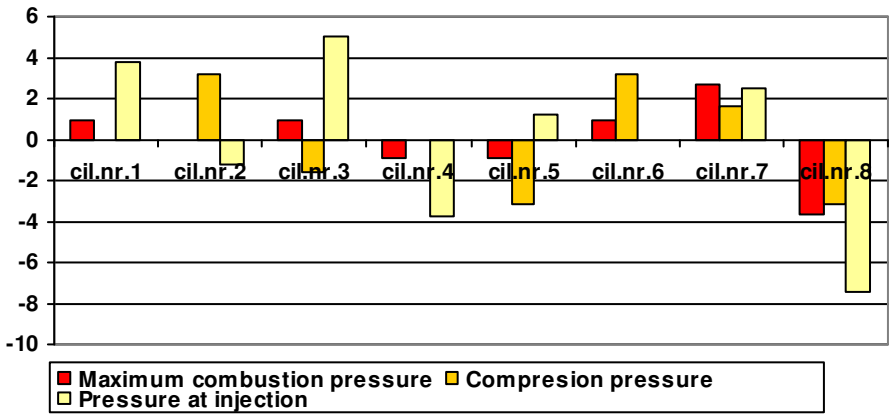


Fig.5. *The dispersion of percentage deviations from some functional parameters in the second determination (P_e=9096 kW)*

It was found, also, that the supercharging pressure in the scavenging air receiver is too small. Has checked the pressure drop of turbocharging air in coolers. After that, has moved to the coolers cleaning, so that pressure drop should not exceed 30 mmH_2O.

Table 3 and Figure 2 and 3 are presented the values of functional parameters determined in the two regimes of operation of main engine.

For these parameters were determined the percentage deviations (Table 4), whose dispersions are shown in Figure 4 and 5.

All these results are only a small part of a rich documentary material, which sought to establish how the behavior of a naval engine in various operating conditions. The examinations and the measurements were made during 2005-2008 and led to the proposal of a set of measures aimed at improving the functioning of naval diesel engines with heavy residual fuel.

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