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RESEARCHES ON A TURBOBLOWER PERFORMANCES AS PART OF NAVAL DIESEL ENGINES AFTER BEING REPAIRED

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Abstract: *Although many different power sources are used not only for shipping and carriage but also in other branches of the economy heat engines continue to be the main alternative to nuclear, aeolian, hydro or thermo - electrical powers.*
Being aware of pneumo – hydraulics and dynamics phenomena, knowing the technical and functional particularities specific to turboblowers – used in civilian and military ships, we can get some experimental results comparable with the ones in the technical manual.Alike other power sources, propulsion devices on board ships break down and pollute the environment, especially when they work in an insertion process.
Although means of water transport pollute the environment with less than five percent of the total emissions, we must not neglect the fact that the pollution effects make ozone get thinner, a matter that has a terrible impact on human health.
Concluding, the present paper discusses measures that lead to increased power and energy savings by repair works made to supercharged diesel engines, that supposes a decrease of pollution which is beneficial to everybody.
Keywords*: ship, diesel engine surcharge, repairs, research, tests/try, insertion process performance, dynamic, efficient, high performance, low fuel consumption, noxious.*

1. SPECIFIC RESEARCH ON THE TRANSITIONAL ARRANGEMENTS FOR OPERATING THE DIESEL ENGINES MARINE SURCHARGE

Experimental investigation of the transitional arrangements for operation of marine diesel engines is characterized by an extremely complex due to high variation in the fast time of a large number of parameters [1]. In this case, for the first phase of research is clearly necessary to establish the theme and issues investigated in close accordance with the ultimate goal, optimizing engine operation aggregate naval heat – turbo blowers acceleration transient. The difficults completion of experiments in this area are related to the fact that the evolution of the phenomena taking place during this procedure is very fast.

Specifically, the major problems are related to the fact that:

a) process parameters change from one cycle to another operation;

b) speed variation of specific size is very high, which involves measuring equipment performance - registration (display), data;

c) impossible to measure the performance of aggregate, the concentration of pollutants in the exhaust, the usual means;

d) difficulty reproducing the actual conduct of cycles aggregate functioning of transitional arrangements to acceleration [7].

Another issue is the purchase of apparatus, equipment and facilities necessary to carry out calculations.

Finally, for data acquisition and processing requires a computer through an analog converter - digital, should be read and recorded rapid and simultaneous changes of several parameters.

2. ENGINE – TURBOBLOWERS, ABNORMAL FUNCTIONING TROUBLES

While marching the ship´s propulsion aggregate registered abnormal values, strange noise and nonspecific vibrations. It was decided that the engine and related equipment needed revisions and repairs. Main troubles that occured while engine exploiting are listed in table 1.

Table 1 Main troubles that occured while engine functioning

No. Crt.	Mulfunction	Effects	Remedies
1.	Engine stalls;	Fuel supply stops, The fuel has water in it, The device is not properly tightened.	Tank refueling, Fuel filtering, Joints check.
2.	Unusual noise of the engine;	Engine overloading, Too big advance, Injectors (pumps), while work defectisely, Cylinder – piston jamming, Components unusual looseness.	Load decreasing, Advance adjustment, Pump flow adjusting, Engine stopping, Loose components adjustment.
3.	Sudden increased engine speed;	Not thightened propeller, Out of water propeller (at the pitch side), Broken parts.	Engine stalling, Checkings.
4.	Speed adjuster works unproperly;	Failure in the hydraulic-mechanical regulator, Loads under/over limits.	Regulator fuel pump transmission checks, Spring checks, Pump power checks.
5.	Safety valves gas explosion;	Fuel pump flow disturbance (abundant at injectors), weakened valves, burned injectors.	Checkings, adjustment, checking and replacements.
6.	Blue colour in burned gases;	Too much oil in the combustion chamber or bath oil, Admision air has oil.	Rotten parts are replaced, Level of bath oil and pump scan are corrected.

7.	Turboblower vibrates and makes noise while working;	Bearings with axial and radial movements, Chemical and mechanical wears, Untightened components, Low temperature of lubricating oil (35 ... 300°C).	Measurement and tightening adjustments, Oil temperature adjustments, Replacement of wear components, Joints tightening.
8.	Turboblowers do not generate the optimate supercharger pressure for air intake;	Turbine delay, Resistance on the intake air course, Leakages.	Shortening the period of change of the functioning engine, Lowering the resistances, Tightness restoration..

A proof that shows wear palettes turbine through *erosion* (thinning due to friction), is the representation (shown in turbine-type TS diesel engine which fitted ALCO), see figure 1.

Fig. 1 The shown representations of erosions palettes turbine

The rolling friction bearings are specific for small turboblower (fig. 2). For taking over the radial and the axial forces, rolling bearings must be loosen in both directions. Therefore the rolling bearings of the two bearings are mounted in their bodies through many plates of a cylindrical package which provides a direct stake of 0.25...0.45 mm. The axial friction bearings ball has in surplus a package of flat plates of both sides, which provides an axial play of 0.12...0.18 mm. These packages provide rolling bearings margin expansion in both directions, having a certain role in damping vibration [6].

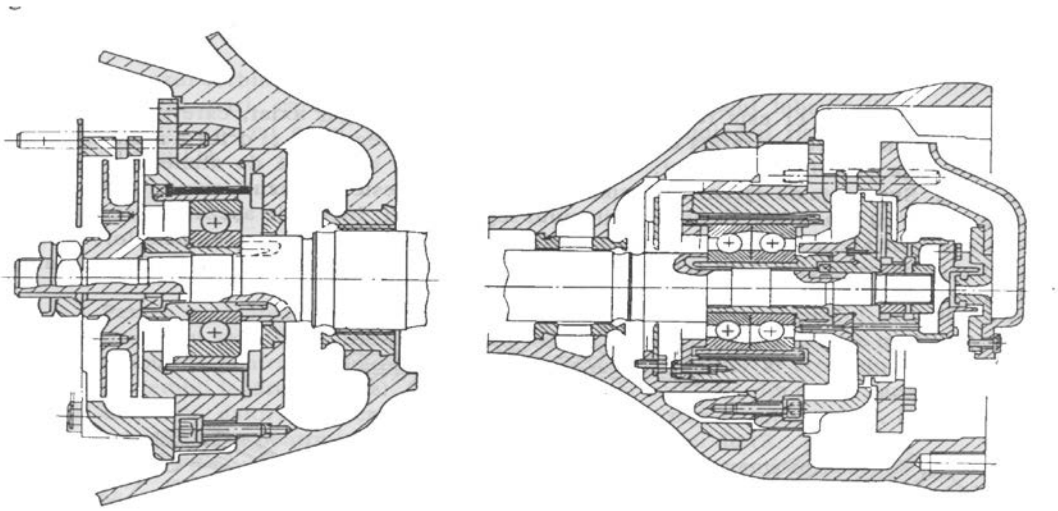

Fig. 2 Radial and axial rolling bearing of the TS type turbo blower represented by a longitudinal - vertical section

By executing the maintenance of the turboblower the thick coat of carbon from the interior of the turbine has been remuved, the main cause being the long service with a damaged fuel mixture ratio at the aggregate running at the insertion process of speed, the source of this condition beeing the incongruity between the turbine and the blower. Let us unwind the specific actions of optimating the activities of the engines running after executing the maintenance and repairings.

3. TURBOBLOWER ENGINES OPTIMIZATION

For the study of optimating the half fast and overcharged diesel nautical "ALCO" engines running with 12 cylinders and a 12,5 compression ratio, fitted with a TS supercharger type, at the insertion process of speed, an experimental research was made on the assay stand situated in "Hidromecanica" factory in Braşov, in case of an constructive modification of the turbocharger (making an orifice with flapper valve on the airs admission gallery, so as to generate an non- stabilized running on the turbines running).

The purpose is to record and face experimental functional rates of the technical book and detect possible inaccuracies of repair. After being started, speed was increased gradually until the maximum allowable. The values obtained durind the experiment are shown in the schedule control (table 2). The experiment was performed under the following conditions: barometric pressure = 735,5 mmHg, ambient temperature = 15°C, duration = 20 min., sample for free off the speed of 1600 rpm = 120 sec.

Table 2 Experimental results

Speed		N [rot/min]	17000	19500	21000	22500	27000	32000	34000
AIR	Difference in pressure diaphragm	Δp_2 [mmHg]	35	55	70	85	95	105	115
	Depression at entry	Δp_1 [mmH_2O]	65	110	130	145	155	170	185
	Pressure turbine exit	p_2 [MPa]	0.53	0,79	0,93	1,02	1,11	1,19	1,28
	Exit temperature	t_2 [°C]	66	84	91	103	114	126	132
	Temperature at the entrance	t_1 [°C]	6	8	11	13	15	19	22
GAS	Temperature at the entrance	t_3 [°C]	600	610	630	640	650	675	685
	Pressure at the turbine entry	p_3 [MPa]	0,44	0,55	0,73	0,91	1,08	1,17	1,29
	Exit temperature	t_4 [°C]	310	330	340	350	460	570	650
	Pressure exit	p_4 [MPa]	0,18	0,2	0,22	0,24	0,28	0,31	0,32
OIL	Pressure at entry	p_u [MPa]	0,47	0,49	0,51	0,53	0,58	0,64	0,65
	Temperature at the entrance	t_{1u} [°C]	45	50	55	58	62	70	75
	Exit temperature	t_{2u} [°C]	70	75	77	80	85	92	95
WATER	Pressure at entry	p_a [MPa]	0,05	0,05	0,05	0,05	0,05	0,05	0,05
	Temperature at the entrance	t_{1a} [°C]	50	52	54	59	64	67	70
	Exit temperature	t_{2a} [°C]	70	75	77	79	81	85	87
Total pressure		p_{2t}/p_{1t}	1,59	1,83	1,97	2,06	2,11	2,15	2,2
Volumetric flow		Q_v [m^3/sec]	1,01	1,54	1,96	2,38	2,74	3,52	4,12
Mass flow		Q_M [kg/sec]	1,23	1,75	2,37	2,88	3,11	3,22	3,35
Blower´s adiabatic efficiency		[%]	69	70	72	72,5	73	74	75
Turbine´s adiabatic efficiency		[%]	68	69	70	71,5	72	72,5	73
Vibration speed		[mm/sec]	0,7	1	0,9	1,1	1,2	1,35	1,51

The graphic expression of the values listed in table 2, is shown in fig. 3. Note the existence of a direct proportionality between the pressure and temperature of the working fluid in aggregate on the one hand and the speed on the other hand. (admissible error).

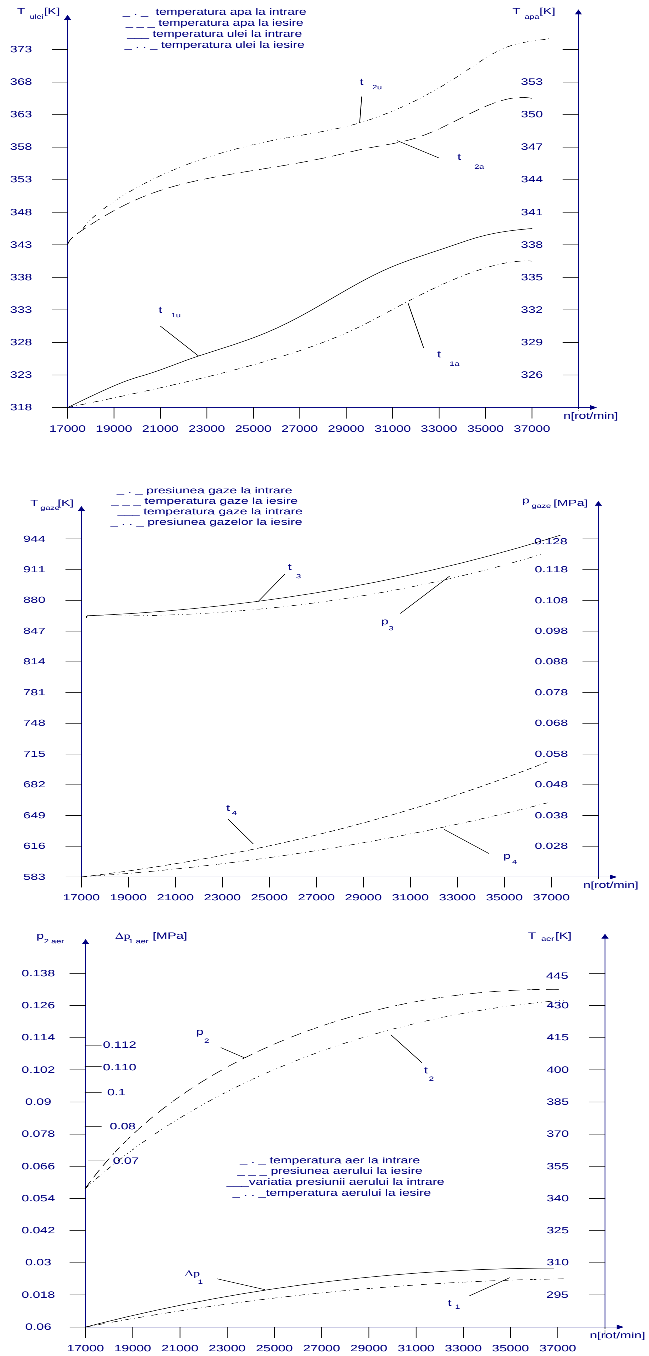

Fig. 3 Graphical representation of pressure and temperature variation for agencies working from a repaired turbo blower, depending on the speed of the drive

These units processing has allowed the determination of qualitative indicators (duration and minimum speed idle), the transitional arrangements for acceleration turbo blowers, which are very close to those indicated in the technical manual. The principle scheme of experimental installation is shown in fig. 4, which consists of: tubing-1, suction of air in the compressor (attempts to "number"), recirculation tubing-2, the combustion chamber - 3, tubing exhaust gases-4, suction tubing of the air intake (for attempts "type") -5; tubing exhaust air from the compressor -6; compressor-C and turbine-T.

According to norms, the factory standard is given by the shown equation (1),

$\eta_{TOT} = \eta_c * \eta_t * \eta_m = 0{,}82 * 0{,}8 * 0{,}94 = 0.61$ (1)

which is a good rate for this aggregate tried by "Hydro-1" installation..

For better performance, the designers and manufactures should take into account the following: number of blades, their length and width, and angle rotors blocks in layout and range of their attachment. Because of the pressure and temperature before, during and after combustion fuel mixture for turbo blowers, to the stand, the specific transitional arrangements for acceleration, can not be made. This was achieved after the engine was equipped with blower and the grant was made to the functioning of transitional acceleration.

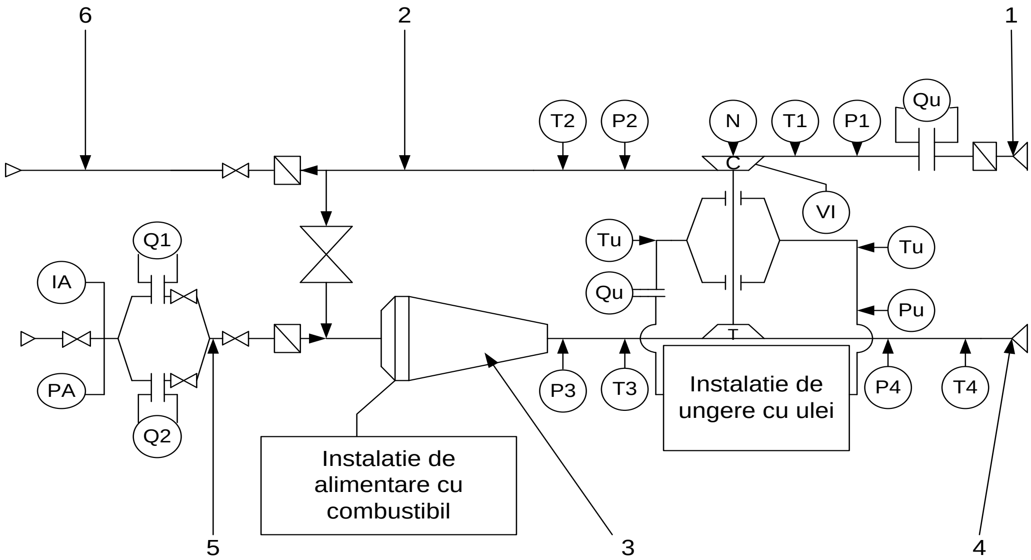

Fig. 4 Schedule an installation test after repair of aggregates of TS

Table 3 contains values recorded in the operation of the engine - turbo blowers after repairs, the boat parade, a progressive load increase. Such as in Fig. 5 are functional changes engine parameters "ALCO " propulsion of a vessel in the port of Constanta, over powered with turbo blowers type "TS", after it was repaired by the factory "Hidromecanica" of Braşov in terms of increasing load from 50% to 95%.

After repair jobs, tests showed significant improvement; the engine became more efficient, the combustion was better, gas consumption decreased reducing polutants emission.

Table 3 Functional ALCO engine load sizes increase from 50% to 95%, obtained after capital repairs and after forcing the fixed point

Nr. Crt.	Time / Parameter	0	0,4	0,8	1,2	1,6	1,8	Obs.
1.	speed, n [rot/min]	890	920	940	980	990	1000	
2..	power, P [CP]	2460	2465	2470	2520	2600	2710	
3.	adition air variation α_{adm} [^{0}rac]	0	0,015	0,03	0,04	0,045	0,05	
4	specific consumption fuel $-c_{inj}$ [g/ciclu]	0,05	0,07	0,09	0,11	0,13	0,15	
5	Indicated efficiency η_i	0,025	0,03	0,035	0,4	0,42	0,45	
6	Efective efficiency η_e	0,2	0,25	0,3	0,31	0,33	0,35	
7	Engine torque M_m [Nm]	200	250	300	350	400	500	
8	Resistance torque M_r Nm]	190	240	290	340	390	450	
9	speed turboblower n_{ts} [rot/min]	17000	19500	22500	27000	32000	34000	
10	air excess ratio α	0,95	1,02	1,5	1,75	2	2,45	
11	burn max. p. $p_{max\ ard}$ [MPa]	5,5	6,2	7,3	8,4	9,1	10,3	
12	exhaust gas temp. t_{gev} [K]	581	601	640	750	840	920	
13	fuel pres. p_{cb} [MPa]	0,31	0,32	0,33	0,34	0,35	0,36	

In graphic, the curves are represented by continuous lines which mean variations got after repair jobs and after equipment with automatic controllers. The curves reprezented by interrupted lines mean variation registered before engine repairs and before equiping it with automatic controllers and adjusters. We can see that adjusment of c inj. According to the principle (to ensure that a ≥ 1), reduces the average fuel consumption with over 10% [4,8].

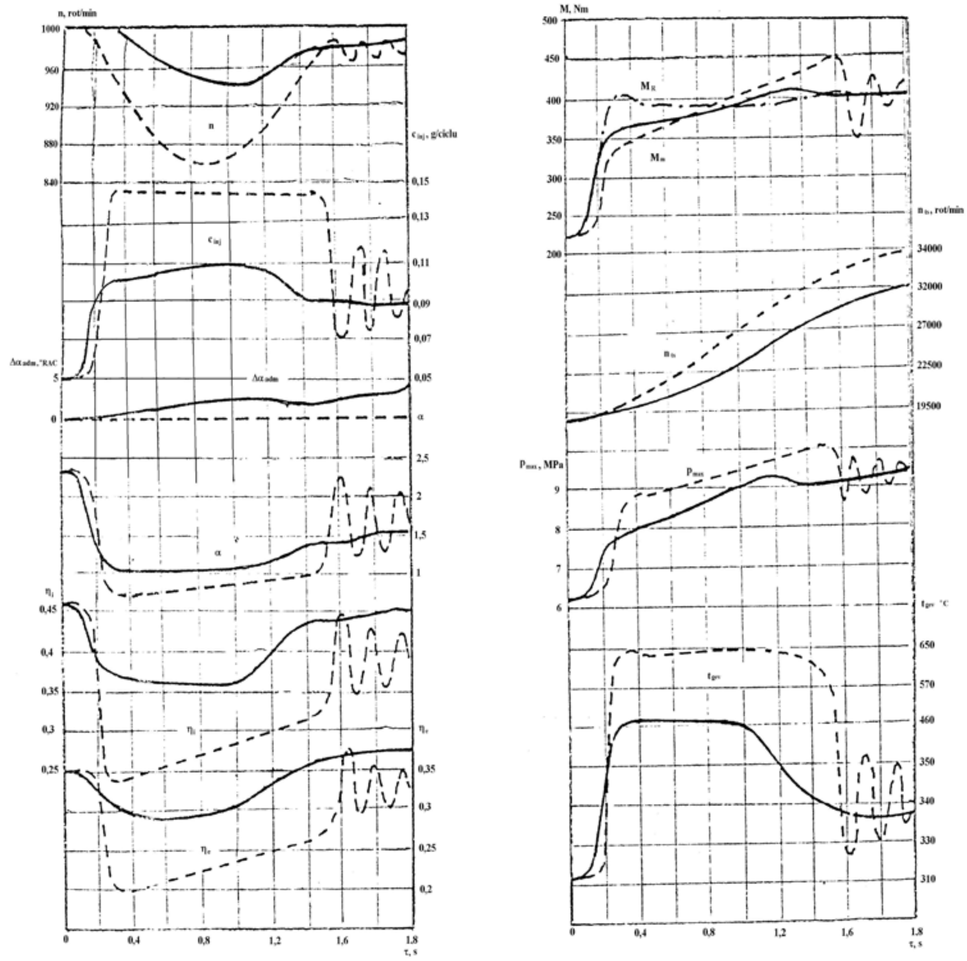

Fig. 5 Changing parameters of a functional diesel propulsion naval task when increased from 50% to 95%.

Reduction can be made due to engine key functional parameters improvement such as temperature and exhaust gas pressure at the entrance ($t_{g.ev}$), temperature and inlet air pressure, maximum combustion pressure (p_{max}), the timing motor (M_m), indicated efficiency (η_i), effective efficiency (ηe) and air excess coefficient (α).

4. CONCLUSIONS:

1. This method of optimum fuel - air mixture achievement after repairs jobs, proved to improve the engine functioning system;
2. If these jobs are correlated with aggregate equipment with variable turbine geometry and continuous control of the valves, movements, best functional parameters are obtained and pollutants are reduced;
3 A correct manufacturing process technology is the basic condition for optimal functioning and duration of the propulsion system in transitional arrangements.

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