IMPROVING ENERGETICAL AND ENVIRONMENTAL PERFORMANCE OF DIESEL ENGINES, BY THE EFFICIENCY SUPERCHARGE PROCESS

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ABSTRACT – The work objectives are part of current concernes of manufactures of automobile engines, wich aims to simultaneously improve the economy of environmental parameters and improving performance while maintaining the torque and power.

The mechanical work product of a specific internal combustion engine is directly proportional to the mass of fuel burned in the cylinders, so is all the greater as the quantity of fresh charge is higher, which can be achieved by increasing its specific weight in the process supercharge.

This work highlights the advantages and disadvantages use to supercharge, an aggregate type Comprex pressure waves, versus classical turbocharger.

The main disadvantage is the difficulty of supercharge with Comprex granting of engine operating conditions. To optimize operation of Comprex entire range of engine speed and load, aggregate require auxiliary devices giving effective control over its rotor dynamic phenomena, which can be achieved by Comprex's involvement with a speed independent of engine.

The proposed solution, which takes account of these considerations, is to lead aggregate Comprex, with a variable speed by an electric motor, which provides flexibility and control over an aggregate speed of charge at each engine operating mode.

This paper presents torque versus energy parameters and the ecological economy and the engine C.I. 392 DT L4, Romanian construction, the supercharged turbocharged version offered by the manufacturer and the modified version of an aggregate type supercharger Comprex.

INTRODUCTION

The objectives of this work are part of the current concerns of manufacturers of engines for automotives, designed to simultaneously improve ecological parameters, economicity while maintaining and improving the torque and power performance. Fuel economy has become severely as a result of alarm signals released by the fuel crisis of petroleum origin, which led to its tremendous and expensive, and combating pollution of this products due to the effects of exhaust pollution on human health. The specific work product of a internal combustion engine is somewhat proportional to the mass of fuel burned in the cylinders, so is all the greater as the quantity of fresh charge is higher, which can be achieved by increasing its specific weight in the process boost (1).

So considering the above mentioned reasons, it seems justified to look ahead to the improvement of environmental and energy performance of diesel engines with turbocharger process.The paper aims to highlight the advantages obtained through 392 L4 DT diesel engine turbocharger *(table 1)*, produced in Romania, with aggregate type supercharger Comprex compared with those obtained for its original turbocharging system.

EXPERIMENTAL

Experimental 392 L4 DT engine research on the test bench, was conducted in conformity with Romanian STAS 6635-87, on the test laboratory of the Department of Motor Vehicles and Engines of Mechanical Engineering Faculty, Transilvania University of Brasov. Side experimental work consisted of fitting 392 L4 DT diesel engine with direct injection (equipped, with supercharge equipment original version offered by the manufacturer, Holset type H11B-8557 manufactured under licence at Hidromecanica Brasov) with a boost Comprex and optimize their joint operation. The whole system was subjected to experimental investigation properly dealt with sensors and systems for data acquisition and processing.

General characteristics of the engine 392 L4 DT

Table 1.

No. Crt.	Parameter	Value	Unit
1.	Stroke number	4	[-]
2.	Number of cylinders	4, in line, vertical	[-]
3.	Bore	D=102	[mm]
4.	Stroke	S=120	[mm]
5.	S/D	1,17	[-]
6.	Compresion ratio	17,5	[-]
7.	Engine capacity	3922	[cm^3]
8.	Maximum power/speed	80/2600	[kW/min^{-1}]
9.	Maximum torque/speed	325/1600	[Nm/min^{-1}]
10.	Minimum specific consumption	212/2000 min^{-1}	[g/kWh]
11.	Type injector	KBEL-BOSCH-hydraulic control	[-]
12.	Nozzle type	DLLA 150 P 44	[-]
13.	Injection pump type	RO-PES 4A 90D 410 RS 2240	[-]
14.	Number four sections of injection	4	[-]
15.	Type regulator	RO-EP-RSV 250..1400A	[-]

Turbocharger compressor pressure waves Comprex type is an efficient process that eliminates the disadvantages of turbocharger boost process-most-used nowadays, and which has a potential in terms of performance has not been exploited to maximum.(3),(5)The main drawback of turbocharging is the difficulty with Comprex granting of engine operating conditions (4). To optimize operation the waves supercharge equipment entire range of engine speed and load, requires some auxiliary command giving effective control over its rotor dynamic phenomena, which can be achieved by Comprex's involvement with a speed independent of the engine. Seek a solution to optimize effective and efficient functioning of the common system engine-Comprex site, bringing the one hand as high performance supercharged process and secondly to provide low cost and complexity of achieving acceptable. The solution adopted, which takes into account the considerations mentioned above, is to lead compressor type Comprex pressure waves with independent variable speed through an electric motor, which provides flexibility and a very good control over aggregate speed boost every engine operating regime.

For equip 392 L4 DT engine with a Comprex compressor should be made the drive system adaptation. In *fig.1* are the components of such systems, namely:

1–pressure compressor where Comprex type; 2–collector connection of discharge;
3–connecting the intake manifold;
4–rubber sleeve; 5–stand support Comprex site; 6–stand in support of the intake manifold connection; 7–stand support arm; 8–support the electric motor; 9–pulley; 10–electric motor; 11–belt; 12–exhaust gallery.

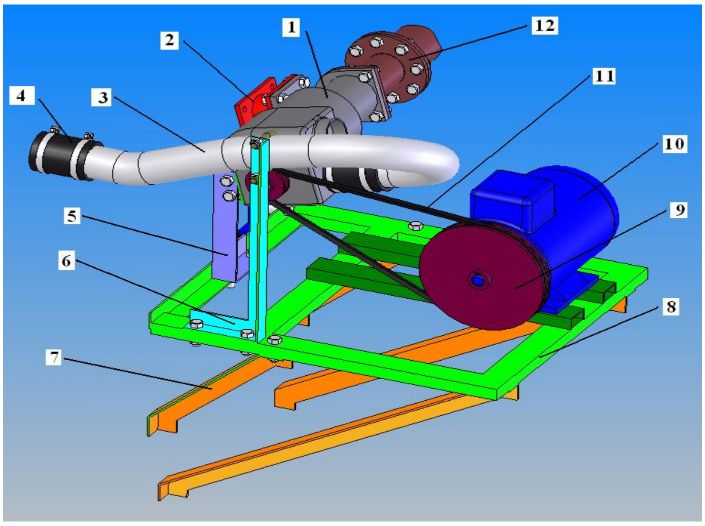
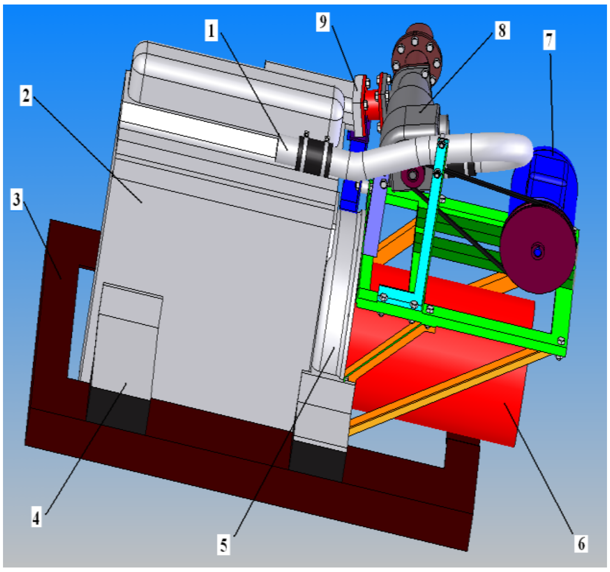
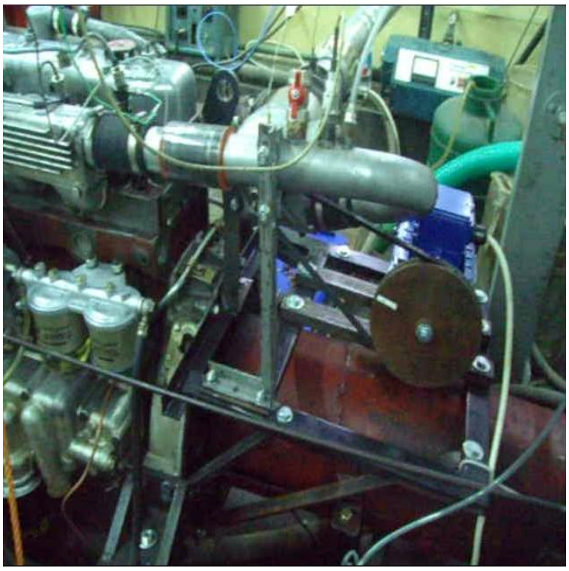


Fig.1: The adaptation and training system of comprex with 392 L4 DT engine

To ensure an optimal process to boost Comprex's location to be considered, especially the following aspects: connecting the discharge manifold to preserve high enthalpy exhaust gas entering the compressor and the intake manifold connection to provide resistance gasdynamic minimized because the process of admission should not be influenced in a negative way. Placement and training system to adapt to the engine's Comprex 392 L4 DT can be seen in *fig.2 a. and b.*.



a.



b.

Fig.2: Placement and training system to adapt to the engine's Comprex 392 L4 DT

Equipment Comprex's command, shown in *fig.3*., allows adjustment of engine speed electric continuously through an integrated potentiometer control unit. It is composed of the following components:
1-frequency-converter; 2-box;
3-box cover; 4-button start; 5-screen; 6-stop button; 7-fader.

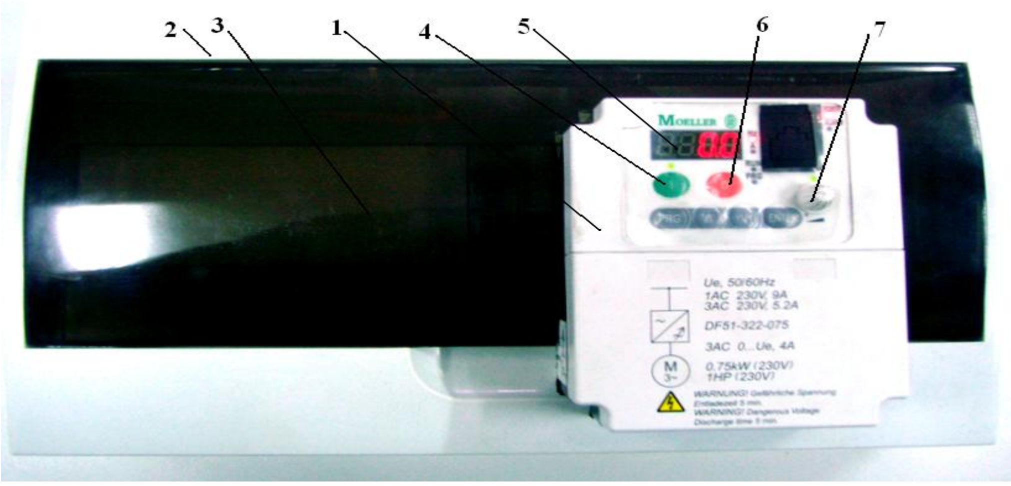


Fig.3: Equipment Comprex's command

EXPERIMENTAL RESULTS

The internal combustion engines operate most of the time characterized by transient partial loads, the energy parameters are reduced in power intentionally to achieve a low-speed adapted to the conditions imposed by the operating conditions change process was considered in assessing energy performance of economy in such schemes, to raise load characteristics by changing the quantity of fuel injected per cycle at a constant speed for speeds *(n_M)*: 1400, 1600, 1800 and 2000 [min-1], which was drew the curves of variation of hourly *(C)* and specific *(c)* fuel consumption and the emission of smoke from tasks *(F)*: 49, 98, 196 and 294 [N] according to the power *(P_e)*.

Following experimental investigation of 392 L4 DT turbocharged engine with aggregate type Comprex trained independent variable speed *(n_C)* motor, which were carried out according to *table 2*, reached the following conclusion: the higher the energy and environmental performance of 392 L4 DT engine obtained during these experimental investigations carried out with both supercharged installations, taking into account construction costs and operational simplicity are obtained when turbocharged engine with constant speed Comprex to **10000 min^{-1}**.

Experimental investigation of matrix 392 L4 DT turbocharged engine with aggregate type Comprex

Table 2.

n_M	F	n_C=7000	n_C=8500	n_C=10000	n_C=11000	n_C=12500
[min^{-1}]	[N]	[min^{-1}]				
1400	49	1	1	1	0	0
	98	1	1	1	0	0
	196	0	0	1	1	1
	294	0	0	1	1	1
1600	49	1	1	1	0	0
	98	1	1	1	0	0
	196	0	0	1	1	1
	294	0	0	1	1	1
1800	49	0	1	1	1	0
	98	0	1	1	1	0
	196	0	0	1	1	1
	294	0	0	1	1	1
2000	49	0	1	1	1	0
	98	0	1	1	1	0
	196	0	0	1	1	1
	294	0	0	1	1	1
1	- measuring point;		0	- anmeasuring point.		

Experimental results obtained from investigations on 392 L4 DT turbocharged engine with turbocharger and Comprex succession are shown in table 3*.*

Experimental conditions whilst investigations were:

- ambient temperature: $t_0 = 23^o C$;
- atmospheric pressure: $p_0 = 712{,}5$ torr (0,95 bar).

Effective power of the engine corrected the condition that the standard air by multiplying the correction factor, given the mathematical expression (2):

$$\alpha \equiv \frac{p_0'}{p_0} \cdot \sqrt{\frac{273+t_0}{273+t_0'}} = \frac{760}{712{,}5} \cdot \sqrt{\frac{273+23}{273+20}} = 1{,}07 \qquad (1)$$

In *table 3* are obtained by experimental engine speed of 2000 [min^{-1}], 294 load [N], because all the other measurement regimes characterized by operating speeds 2200, 2400 and 2600 [min^{-1}], is needed engine cooling air admitted to a value that ensures optimal engine operation.

Experimental results obtained from investigations on 392 L4 DT turbocharged engine with turbocharger and Comprex succession

Table 3

n_M	F	P_e	P_s	P_s	T_s	T_s	C	C	c	c	Smoke	Smoke
			Turbo.	Comp.	Turbo.	Comp.	Turbo.	Comp.	Turbo.	Comp.	Turbo.	Comp.
min^{-1}	N	kW	bar	bar	^oC	^oC	kg/h	kg/h	g/kWh	g/kWh	mg/m^3	mg/m^3
1400	49	5,1	1,02	1,06	25	57	2,22	2,18	404	396	4,48	2,78
	98	10	1,02	1,19	27	63	3,21	3,16	292	287	5,17	4,01
	196	21	1,07	1,38	29	75	5,14	4,78	233	217	23,35	7,53
	294	31	1,14	1,50	36	82	8,18	6,78	248	205	224,9	66,63
1600	49	5,9	1,03	1,08	26	53	2,69	2,52	427	400	3,38	2,29
	98	12	1,04	1,22	28	75	3,60	3,47	286	275	4,83	5,18
	196	24	1,09	1,45	31	89	5,63	5,38	223	214	23,71	4,43
	294	35	1,19	1,65	40	103	9,00	8,30	238	220	160,5	92,83
1800	49	6,6	1,05	1,13	27	78	3,10	3,17	438	448	2,7	2,57
	98	13	1,07	1,29	28	94	4,62	4,15	326	293	5,27	5,53
	196	26	1,13	1,54	34	114	7,20	6,63	254	234	26,05	9,24
	294	40	1,26	1,79	45	140	10	7,53	235	177	106,7	115,7
2000	49	7,4	1,07	1,17	31	83	3,60	3,63	458	461	2,9	3,02
	98	15	1,10	1,33	33	99	4,86	4,71	309	299	5,65	5,59
	196	29	1,19	1,59	38	123	7,83	7,69	249	245	18,81	9,3
	294	44	1,34	1,87	50	144	10	10,04	212	213	56,2	208,3

P_s - turbocharged pressure, T_s - air temperature admitted

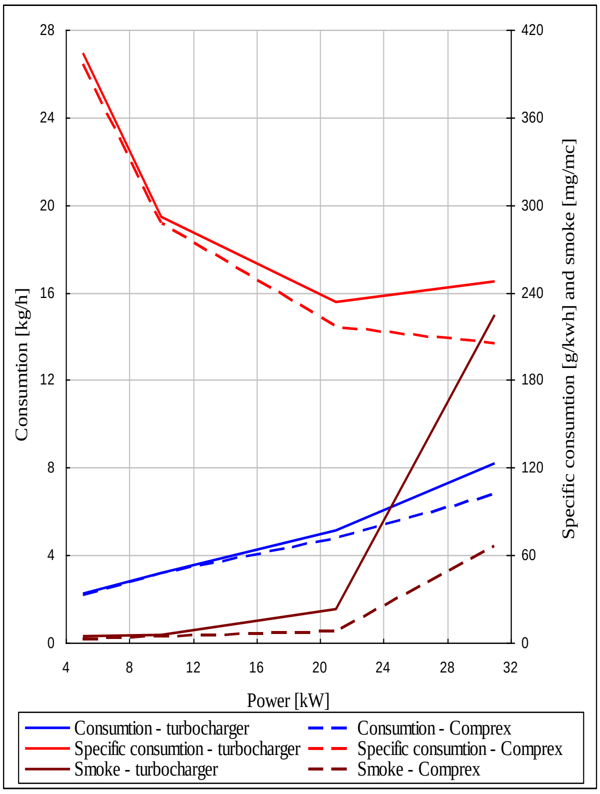


Fig.4.The load characteristics of 392L4 DT engine, to speed: 1400 [min^{-1}]

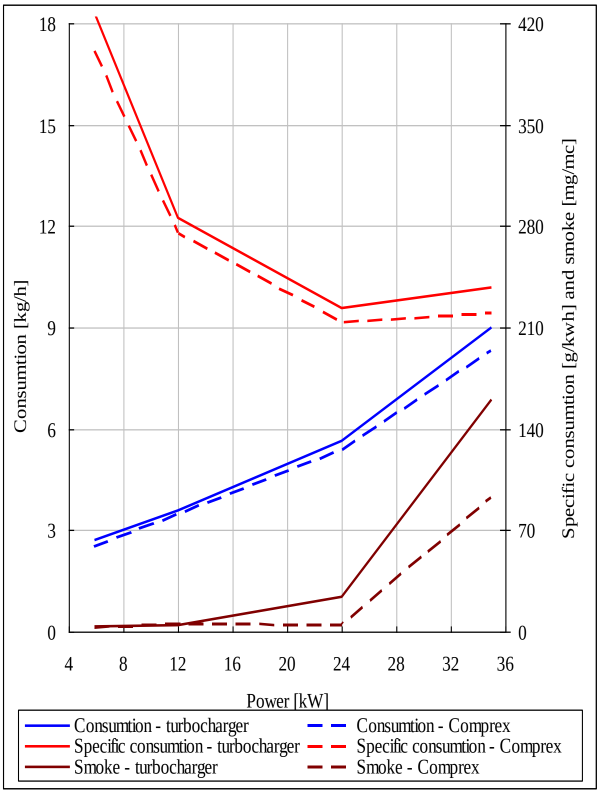


Fig.5.The load characteristics of 392L4 DT engine, to speed: 1600 [min^{-1}]

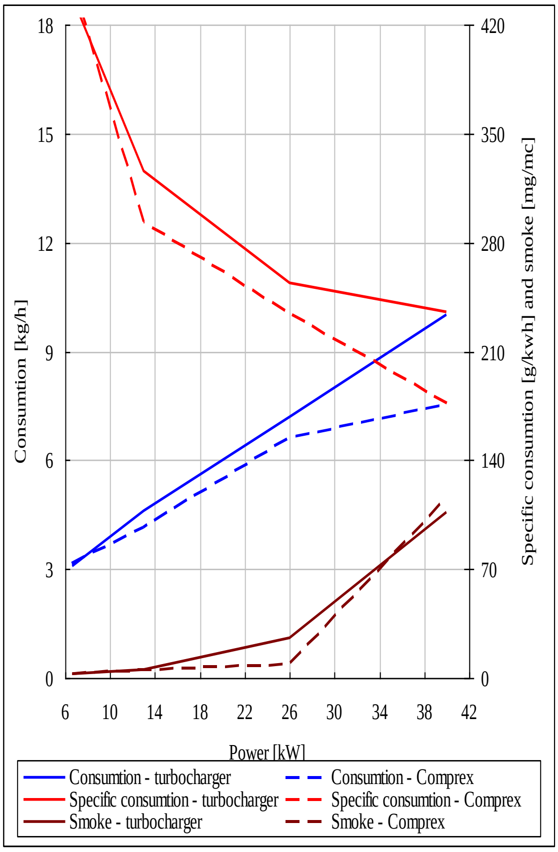


Fig.6.The load characteristics of 392L4 DT engine, to speed: 1800 [min^{-1}]

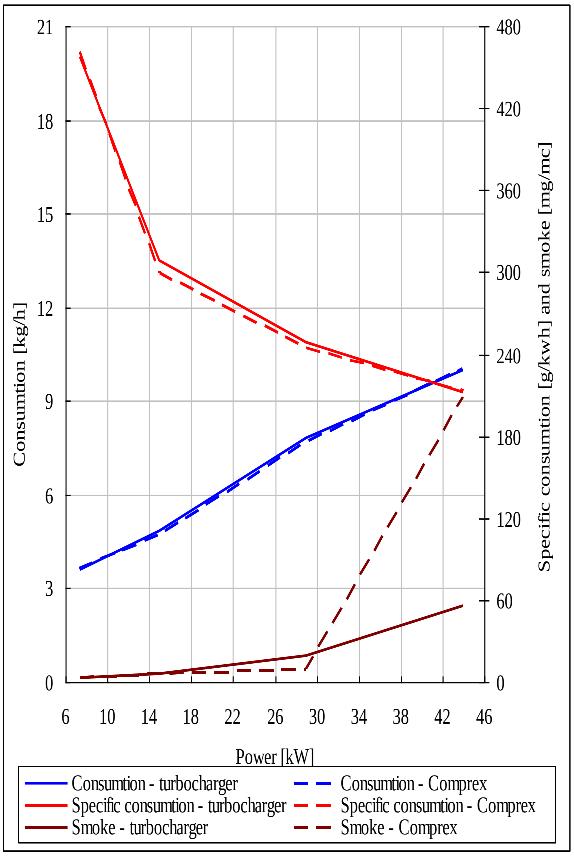


Fig.7.The load characteristics of 392L4 DT engine, to speed: 2000 [min^{-1}]

As can be seen from *table 3* and *figures 6 and 7* the degree of improvement in environmental and energy performance of the engine operating regimes in which the value of air temperature admitted exceeds 110°C *(Ts<110°C).* At this value the performances of engine are reduced considerabil, this phenomenon can counteract by the introduction of an air cooler to keep the engine intake air temperature to a permissible value.

The supercharge of 392 L4 DT engine with an pressure waves aggregate type Comprex after the as noted, the process turns out to be a better boost than that provided by the manufacturer engine with turbocharging system. In addition this method of supercharge, gives us confidence that by continuing this line of experimental research can obtain a higher degree of optimization and boost aggregate Comprex type compression ignition engine, improvement and greater energy and environmental performance than those achieved so far.

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