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NOISE REDUCTION OF AIR-COOLED DIESEL ENGINE F 6L 413 V

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INTRODUCTION

There is an obvious influence of the combustion engine on the existing limiting values of external noise of utility cars. In utility cars with reduced noise influence of different noise sources come more and more stronger to the fore. These are: transmission, the rolling noise of tyres, vehicle body, vibrations etc.

THE MOST IMPORTANT DATA ABOUT THE ENGINE F 6L 413 V

The combustion engine is a six-cylinder Diesel engine F 6L 413 V. The technical data of this air-cooled engine with direct injection are put together in Table 1. Compared to the given data the maximum engine speed of 2840/min was slightly higher. Hence an avarage piston speed of 11,83 m/s followed.

Table 1: The technical data of Diesel engine F 6L 413 V

Automotive rating to DIN 70020	125	kW_3
Displacement	8482	cm^3
Bore/Stroke	120/125	mm
Max. engine speed	2650	1/min
Max. torque	500	Nm
Mean piston speed	10,4	m/s

POTENTIALITIES OF NOISE REDUCTION

Generally a distinction is made between inner and external noise sources of engines. The most important inner noise sources of the combustion engine are: combustion, strokes of the piston, motor control, driving cogwheels etc. The most important external noise sources of the combusti-

on engine are: the suction system, the exhaust gas conduct, the cooling fan, the motor surface, the motor brake, auxiliary aggregates etc.

A necessary improvement of combustion engines can be achieved by a noise reduction of every single inner and external noise source of the engine [1] as well as a complete encasing.

After thorough investigation there was a general consent that in the first place work should be done on the external noise sources of the engine. Possible alterations in series could be put into praxis most quickly and without much effort. By works on the suction and exhaust system of the engine, its cooling, in the engine compartment, etc., but without encasing the engine, the external noise of passing vehicles, i.e. coaches, busses and suburban traffic busses, has been reduced to values according to ISO of 80-81 dB(A) [1] . The noise level of the standing busses measured at a distance of 7m is given in Figure 1. In the rear of the bus it corresponded with the noise level of the driving engine, whereas the distance of 7,5m at the sides was slightly higher. The measured values were taken at maximum engine speed.

ENCASING OF THE ENGINE

Many countries and federations regard the encasing of engines as the only future solution of the noise reduction in vehicles. A partial and complete encasing of the engine was made in order to judge correctly the gained results of our own work in different vehicles without encasement of the engine F 6L 413 V. Thus almost ideal conditions were aimed at, that is, conditions which cannot be achieved in production cars and above all still less kept up.

The capsule consisted of 2 parts, Figure 2. The two parts were to be connected by a thick rubber joint. The capsule consisted of a 2mm strong outside metal sheet, 30mm isolation and a perforation. At the side of the engine where the cooling was installed, a larger opening in front of the cooling fan and two joinings for the two suction pipes were positioned in the capsule. A ca. 3m long pipe was attached to the opening for the cooling, the inner surface of the pipe was covered with absorption material and perforation. By this means the influence of the cooling on the noise level of the engine was to be kept low without stronger decrease of pressure in the fan. Two openings for the exhaust gas pipes were positioned at the side of the fly wheel. These openings were a bit larger in order to let the heated cooling air escape. Alternatively they were

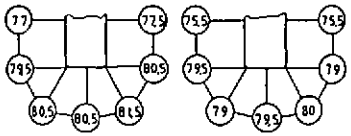

Fig. 1: Noise of stationary busses a and b [1]

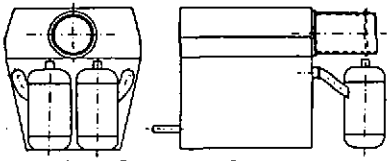

Fig. 2: Capsule

to be closed tight to the exhaust gas pipes. In the process of the experiments a number of alterations on the suction and exhaust system as well as the engine cooling were made. In every stage the noise level was measured at a distance of 7m. The best results were achieved at the capsule under optimum conditions of the suction, exhaust and cooling system. Figure 3 shows the noise level of the encased and not encased engine in dependence of the engine speed. As it is to be seen, the noise level at maximum engine speed was below 80 dB(A). At 2400/min the noise level was between 76-78 dB(A), at 1500/min 67-68 dB(A) and at idle running 55 dB(A). The long pipe in front of the fan cannot be installed in a vehicle. That is why an elbow was attached in front of the fan, its inlet showed in ground direction. Additionally, the openings at the exhaust pipes were narrowed down. Figure 4 shows the noise level of the encased and not encased engine in dependence of the engine speed. All measured values were slightly higher than in Figure 3. Partially this was due to the fact that the engine temperature was higher and the fan ran at maximum speed.
Comparing Figure 1 and 3, one can see that the noise level of busses was lower than that of the encased engine. The result is the more interesting, because in the busses not all opportunities had been exhausted.

CONCLUSIONS

A necessary noise reduction of the combustion engine in vehicles can be achieved by a noise reduction of different inner and external noise sources as well as by a complete encasing of the engine. An encasing of the engine only reduces the influence of inner noise sources of the engine, its surface and of the auxiliary aggregates, whereas the influence of the external noise sources has to be solved additionally. Further negative aspects of this solution are, besides high costs of production connected with it, a higher noise level of the engine in the capsule, the fact that the engine keeps up its noise level over a rather long time, and last but not least the increased fuel

consumption. The increased fuel consumption is attributed to a more intensive work of the cooling fan. But there are also opinions which state that a fuel saving can be achieved by encasing the engine. But this can only hold true in the cold season and is only limited to urban traffic, i.e. a drive with frequent interruptions.

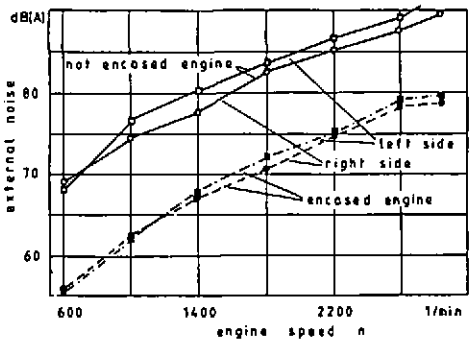

Fig.3: Noise of engine F 6L 413 V

Considering all experience, the aimed at limiting values of external noise of passing utility vehicles of ≤80 dB(A) according to ISO appear probable for the second half of the eighties. But a further reduction of the limiting values seems to be less practicable, at least not at the moment, till the other noise sources can be affected more effectively. Here one mainly thinks of transmission, the rolling noise of tyres, and last but not least road covering. At the present methods of testing (low travelling speed) the driving engine is definitely in disadvantage compared with the rolling noise of tyres and the road covering. Certain improvements of the method of testing which should pay attention to all mayor noise sources seem to be necessary and recommendable.

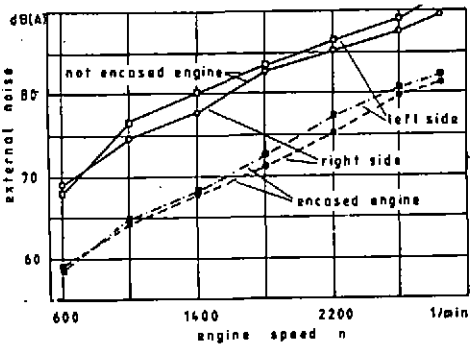

Fig.4: Noise of engine F 6L 413 V

REFERENCE

[1] V. Tandara, "Lärmminderung bei Nahverkehrsbussen und der Einfluß der Transmission", Fortschritts-Bericht der VDI-Zeitschriften Nr. 34, Reihe 12.