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INTEGRATED DEFLECTOR FOR ATTENUATION OF THERMAL RADIATION COMING FROM THE INTERNAL COMBUSTION ENGINES COOLING RADIATORS

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ABSTRACT: *The paper presents an experimental study conducted with the support of the Laboratory of Internal Combustion Engines belonging to the Road Motor Vehicles specialization within "Politehnica" University of Timisoara, Engineering Faculty of Hunedoara. The purpose of this experiment is to test concepts of some devices conceived and made by the authors, awarded at numerous invention rooms, both inside the country and abroad. By the interposition of these devices on the intake route of internal combustion engines it is aimed to optimize the air intake process into the engine cylinders by two methods: 1, increasing air pressure into cylinders by reducing pressure losses due to the air filter, and 2, increasing the amount of air let into the cylinders by increasing its density due to lowering the temperature of the intake route. The experimental measurements have been made on different vehicles running in real traffic conditions, and on a stand holding a spark engine - and its afferent apparatuses – conceived by the authors. The experimental results have been processed and compared with the ones obtained during the operation without these devices.*
KEYWORDS: *Integrated deflector, thermal radiation, thermal losses, internal combustion engine*

INTRODUCTION

The piston internal combustion engine is a thermal engine that converts the chemical energy of the engine fluid fuel into mechanical energy. Engine fluid developments are achieved by means of a piston. The alternative movement of the piston inside a cylinder becomes rotating movement due to the crank gear.

For an internal combustion engine, the gas changing process encloses the intake and exhaust, which condition each other. The intake process is the process during which fresh fluid (air) enters the engine cylinders. The intake (or filling) determines the amount of fresh fluid retained in the cylinder after closing the last filling body and thus the mechanical energy developed during relaxation. The exhaust determines the purification degree of the cylinder with a view to a subsequent fill. In other words, the bigger the amount of fresh fluid (respectively air) retained into the engine cylinders, the higher the engine performance. The large amount of air in the engine cylinders means high pressure and low temperature on the inlet. This is the origin of the idea for this study which seeks ways to maximize, as much as possible, the amount of air introduced into the engine cylinders (by increasing pressure and decreasing temperature into cylinders), during an operating cycle, the costs for this goal being minimal. Cylinder filling can be normal or forced (supercharging). Normal filling, or normal inlet, typical of only 4-stroke engines, is achieved due to the piston's movement in the cylinder, in the sense of volume increase. Volume growth is recorded in the intake stroke, the fresh fluid with atmospheric pressure on the inlet.

Forced filling is achieved when the inlet pressure is greater than atmospheric pressure, indispensable in the 2-stroke engine without gas exchange bound drives. Forced filling can be achieved by supercharging when special equipment prepares the fresh fluid to enter the engine inlet at a pressure greater than the atmospheric one.

The cylinder filling process is strongly influenced by gas-dynamic losses on the engine intake route. There are two kinds of losses:

- *Thermal losses due to heating the fluid through the inlet route walls, thus the final temperature being T + ΔT, the temperature increase resulting in diminishing density and hence the filling penalty.*
- *Pressure losses caused by the existence of hydraulic resistances on the intake route and fluid friction with the pipe walls. These can be quantified according to the well-known formula (1):*

$$\Delta p = \xi \cdot \rho \cdot \frac{w^2}{2} \qquad (1)$$

where ξ is the pressure loss coefficient, w is the flow speed of the fresh fluid and ρ is its density.

Due to these losses, the amount of fresh charge retained in the engine cylinders, while providing information on the filling conditions, cannot serve as a comparison standard for different engines, but *only for the same engine (the size of the losses mentioned above differs from one engine to another). This is why we introduce the notion of filling degree, or filling coefficient, or filling efficiency as a criterion for assessing filling perfection [1]:*

$$\eta_v = \frac{C}{C_o} \tag{2}$$

where C is the amount of fresh fluid actually retained in the cylinder, and C_o is the amount of fresh fluid that could be retained in the cylinder, under the state conditions of the engine inlet, i.e. without taking into account the losses mentioned above.

Proper filtering of the air that enters the internal combustion engine cylinder is essential to extend its operation. Preventing the intake of various impurities along with atmosphere air significantly reduces the wear and tear of engine parts in relative movement.

Unfortunately, besides the function of filtering air drawn from the atmosphere, the air filter – as a distinct part in engine composition - is a significant gas-dynamic resistance interposed on the suction route. If it is not cleaned regularly and the vehicle is driven frequently in dusty areas, the suction pressure p_a is reduced consistently and the filling efficiency η_v suffers penalties [1].

INTEGRATED DEFLECTOR (ID) FOR ATTENUATION OF THERMAL RADIATION COMING FROM THE COOLING RADIATOR

The thermal radiation and warm air from the engine cooling radiator extra heat the air filter and intake manifold. The absorbed air is also heated thus decreasing its density, the engine performance diminishing especially in hot weather. The air filter and intake manifold temperatures vary, in this case, between 60 and 85°C, depending on the car speed.

The cooling radiator's integrated deflector is designed to reduce these shortcomings, being mounted behind the radiator fan to direct the air flow beneath the inlet level (downwards). The deflector is thermally insulated (Figure 4), the filter and manifold temperatures falling within the range 25...37°C when the deflector is used. As already mentioned, the purpose of the integrated deflector is to direct downward the hot airflow passing through the engine cooling radiator (Fig. 6, b).

Figure 1. Illustration of thermal radiation orientation towards the air filter

Figure 2. Filter assembly without the cooling radiator's integrated deflector

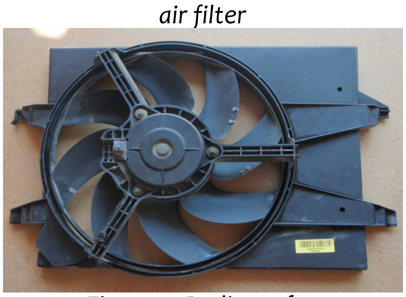

Figure 3. Radiator fan

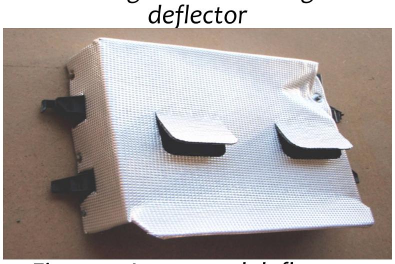

Figure 4. Integrated deflector - physical model

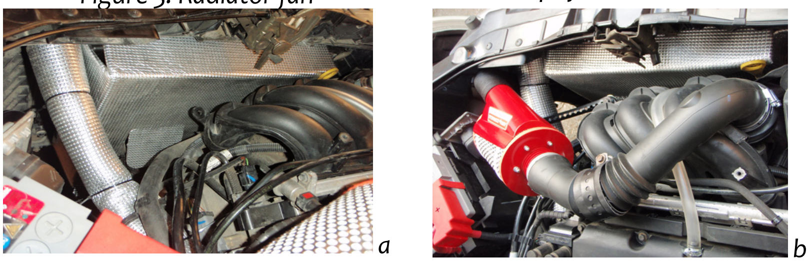

Figure 5.a,b - Overview of radiator with mounted deflector

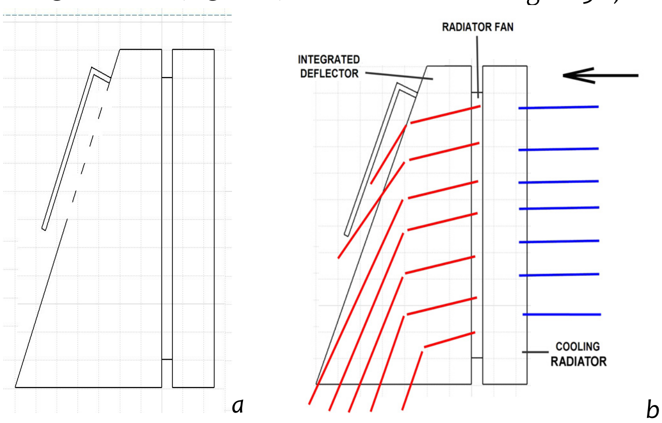

Figure 6. Integrated deflector: a - sketch, b - operation principle

The technical problem solved consists in protecting the intake manifold and air filter from the heat radiation coming from the engine cooling radiator.

By use of the deflector integrated the following advantages are obtained:

- ☐ *downward direction of the hot airflow coming from the cooling radiator (thermal radiation), outside the engine compartment;*
- ☐ *maintaining an optimum temperature of the intake manifold and air filter (to avoid overheating them).*

The integrated deflector is provided with a deflector wall (Figure 7), which has a rectangular concentration area (2) fixed on the upper end. The concentration trapezoidal surfaces (3) and (4) are fixed on the lateral ends of the deflector wall (1), with the large trapeze end at the bottom. The deflector wall (1) has two or more directional windows (5).

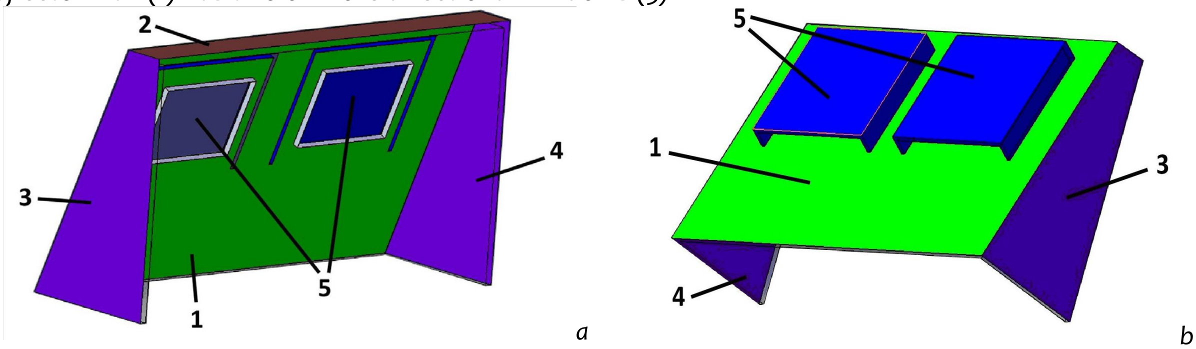

Figure 7. Integrated deflector - virtual model, made in Autodesk Inventor: 1 - deflector wall, 2 - rectangular concentration area; 3, 4 - trapezoidal concentration surfaces; 5 - directional windows

The bottom surface between bases (3), (4) and the bottom edge of the deflector wall (1) is open (free) to allow the evacuation of most hot airflow coming from the cooling radiator.

The directional windows (5) allow additional exhaust of the hot airflow coming from the cooling radiator.

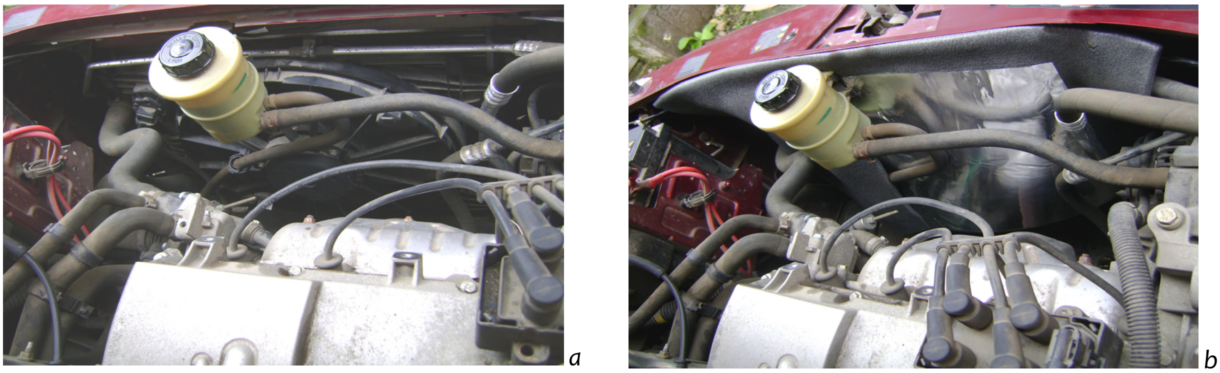

Figure 8. Overview of engine radiator tested: a - without integrated deflector, b - with integrated deflector mounted

The deflector is not bad for engine cooling, the operating temperature of the coolant remaining within normal operating parameters.

Further experimental measurements are shown for comparative temperatures of intake air in the presence and absence of the deflector. Please note that in summer tests were made on 4 different cars, drawing the conclusion that the deflector has no adverse effect on engine cooling, the operating temperature of the coolant remaining within the parameters specified by the manufacturer.

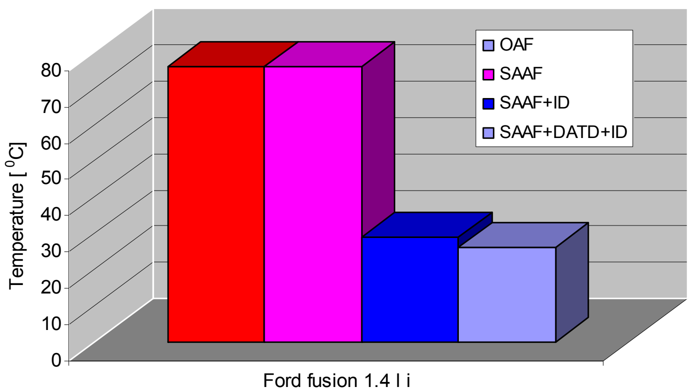

Figure 9. Intake air temperature values in the proximity of the air filter

As illustrated in Figure 9, the intake air temperature values for the original air filter (OAF) and the super absorbing air filter (SAAF) are similar in size and relatively high, leading to low density of the fresh load in the cylinders and thus to reducing the filling efficiency.

Conversely, the temperature values recorded in the presence of the super absorbing air filter with integrated deflector (SAAF+ID) and to which the dynamic air transfer device is added (SAAF+DADT+ID) are much lower than the previous ones, which favors the improvement of the filling efficiency.

CONCLUSIONS

In conclusion, we can say that the dynamic air transfer device together with the integrated heat deflector, lead on the one hand to increasing the fresh fluid intake pressure, and on the other hand to lowering its temperature, both solutions contributing to increasing the filling efficiency η_v of the engine cylinders.

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