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To cite this article: C Birtok-Băneasă *et al* 2018 *IOP Conf. Ser.: Mater. Sci. Eng.* **393** 012074

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# The dispersion of heat flow in the engine compartment. Case study: drift engines

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**Abstract.** This work presents a study regarding the influence of the heat glow dispersion upon the intake system of the internal combustion engines. The data were registered with a real time thermal imaging camera at various working regimes, in the case of cars destined to Drift competitions, equipped with internal combustion engines having cylindrical capacities between 2.0l and 6.0l. The propeller groups are placed longitudinal, classic constructive solution (the engine in the front and axle engines in the rear). The engines used are DOHC (double overhead camshaft) type supercharged, the gas flow being of cross flow type. This study wants to determine the influence of the emplacement, and of the used materials for the construction of the air filter and of the intake manifold upon the performance of the internal combustion engine. The obtained results after the tests allow to establish the optimum parameters regarding the efficiency of the heat flow transfer on the inlet path.

## 1. Introduction

The study is aimed towards the engines for Drift race cars (Figure 1) due to the specific dynamics of controlled side-slip which leads to a poor air flow circulation through the cooling engine compartment.

The hot air flow, and the thermal radiations that come from the cooling radiator of the engine, intercooler, exhaust manifold and the supercharge groups over heat the intake manifold and the air filter. The temperatures of the air filter and the intake manifold vary, in the case of Drift cars between 60...150°C, depending on the speed and the emplacement of the heat sources in the engine compartment.

An increase in the inlet temperature of the mixture increases the temperature at the end of compression, which in turn increases the temperature of the last part of the charge to burn, thus shortening the delay period and greatly increasing the tendency to knock. Therefore is preferred to keep the inlet temperature low but not too low so it can prevent fuel start to vaporize before [1].

Effects on engine performance due to the changes in the temperature of the engine coolant and intake air have been previously investigated, when operated with fossil fuels [2]. It was reported that the HC emissions were 25% lower and NOx emissions were 7% higher when the coolant temperature was increased [3]. Increased air temperature influenced NOx and HC emissions – NOx gas emission increased at high temperatures for all loads and HC emissions decreased at low temperatures [4]. It was reported that lower coolant and air temperature may reduce NOx emissions by up to 30%; with minor improvements to specific fuel consumption, Carbon monoxide (CO) and HC emissions [5].





**Figure 1.** Cars destined for DRIFT competitions.

## 2. Conditions and measurements

The comparative measurements have been made after reaching the regime temperature of the engine at the level of the engine compartment, on the surface of the intake manifold and in the air filter region.

The *intake manifold* (Figure 2) is positioned in longitudinal side (left or right side) in the case of engines with the cylinders placed in a line and in central longitudinal plan in the case of engines with cylinders placed in V shape. The materials used in the making of intake manifolds are plastics **PA66 GF35** (Figure 2a) and Aluminium alloys **AL319F** (Figure 2b) [6].



(a)



(b)

**Figure 2.** Intake manifolds.

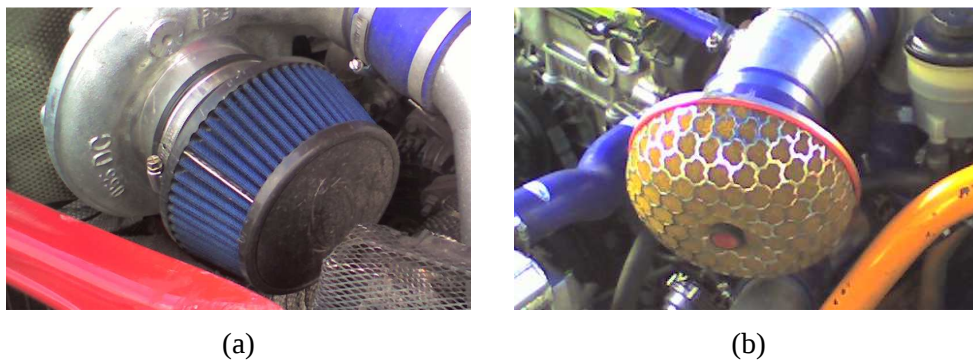
### Air filter

The air filter (Figure 3) is of sport conical type (Figure 3a) or the spherical cap (Figure 3b) with the filter element from textile or sponge, placed longitudinal or transversally to the motor axis[7].

### Heat sources

The heat sources of the intake manifold and of the air filter for drift engines are the following:

- exhaust manifold ;
- supercharging group
- engine (cylinder head, engine block);
- cooling radiator;
- intercooler.

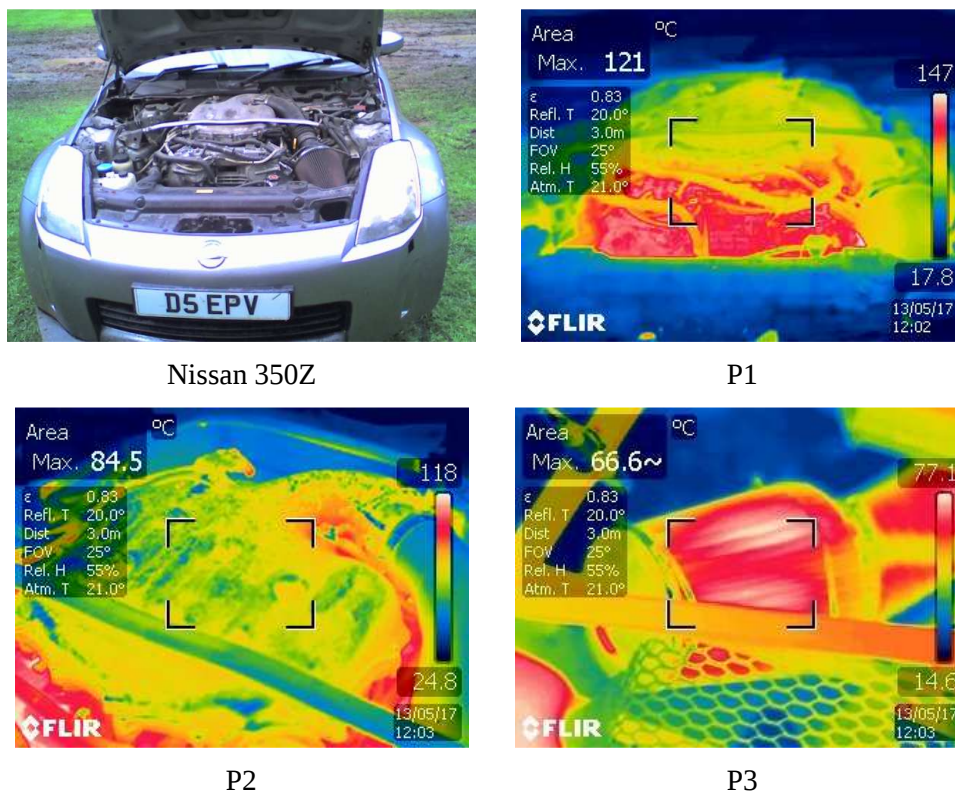


**Figure 3.** Air filters [8].

### 3. Thermographic measurements of the heat flow dispersion

Next, comparative temperature measurements are presented from the engine compartment (over view) (P1), on the intake manifold surface (P2) and in the air filter region (P3) for the 6 study cases. Using the thermal imaging camera one can emphasize the areas which are influenced by the thermal transfer, as a result of the heat dispersion through the engine compartment.

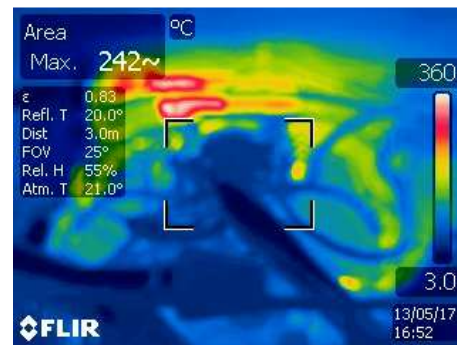
- Case I – Nissan 350Z aspirated engine V 6 with cylindrical capacity of 3,5l, equipped with air filter of sport conical type;
- Case II – Nissan Silvia supercharged engine V 8 with cylindrical capacity of 4,0l, equipped with air filter of sport conical type;
- Case III – Toyota Celica supercharged engine L 4 with cylindrical capacity of 2,0l, equipped with air filter of spherical cap type;
- Case IV – BMW E 36 supercharged engine V 8 with cylindrical capacity of 4,0l, equipped with air filter of sport tronconic type;



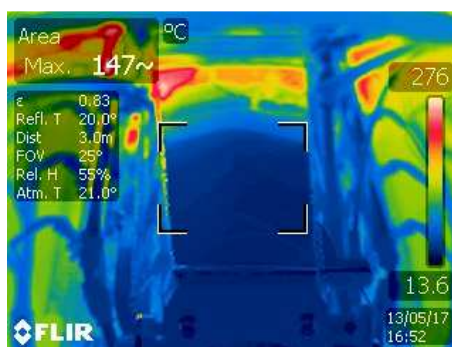
**Figure 4.** Case I.



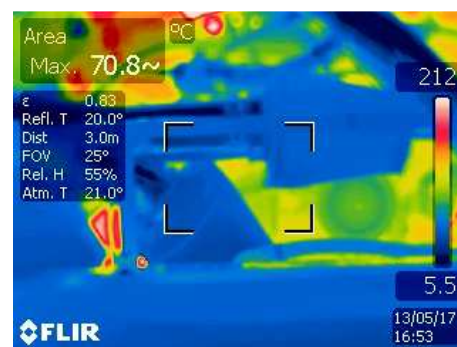
Nissan Silvia



P1



P2



P3

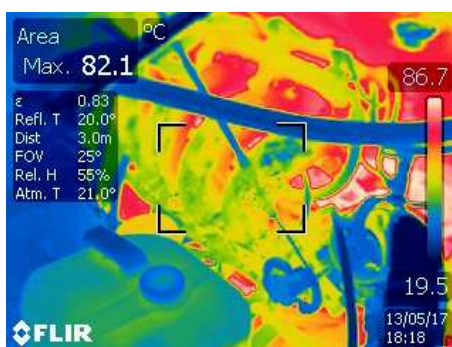
Figure 5. Case II.



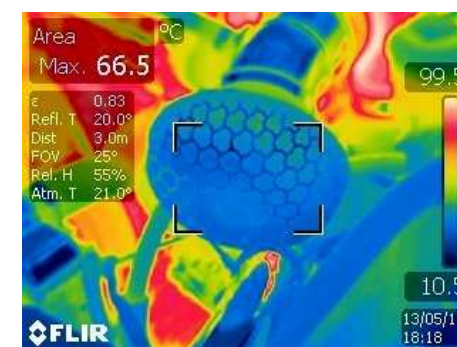
Toyota Celica



P1



P2



P3

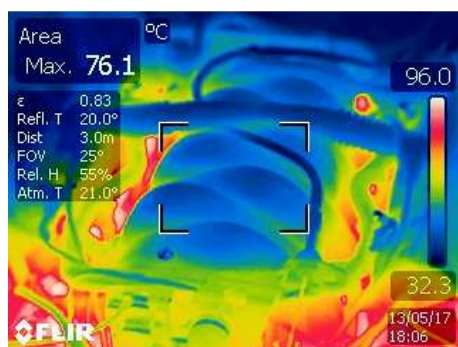
Figure 6. Case III.



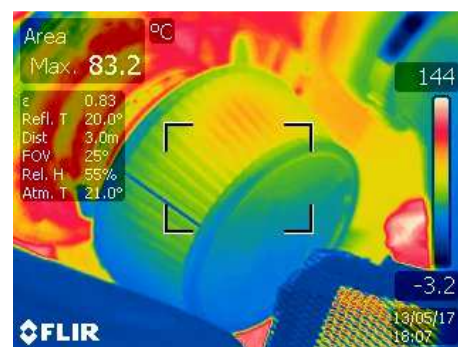
BMW E 36



P1



P2

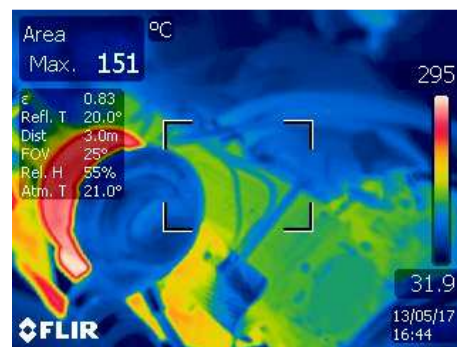


P3

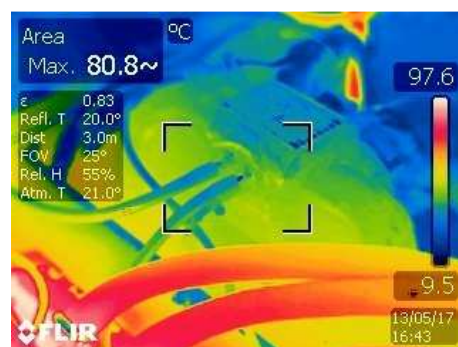
Figure 7. Case IV.



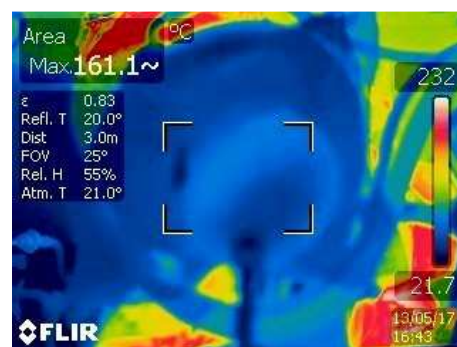
BMW E 46



P1

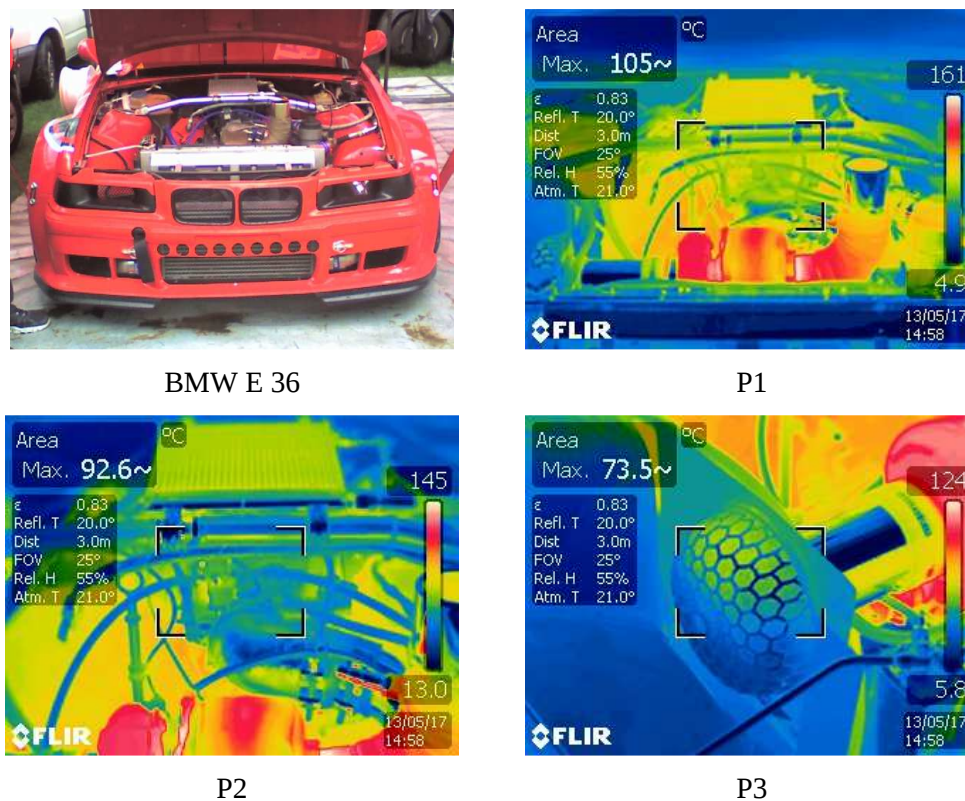


P2



P3

Figure 8. Case V.

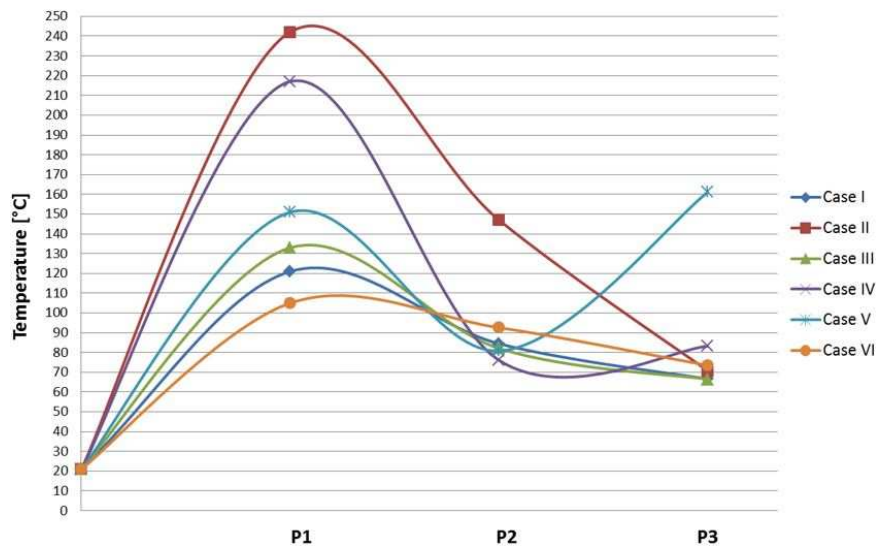
**Figure 9.** Case VI.

- Case V – BMW E 46 supercharged engine L 6 with cylindrical capacity of 3,2l, without air filter;
- Case VI – BMW E 36 supercharged engine V 8 with cylindrical capacity of 4,4l, equipped with air filter of sport type with spherical cap;

**Table 1.** Results.

| STUDIED CASE | Maximum temperature at the engine compartment level [°C] | Maximum temperature on the surface of the intake manifold [°C] | Maximum temperature in the air filter region [°C] |
|--------------|----------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------|
| I            | 121                                                      | 84,5                                                           | 66,6                                              |
| II           | 242                                                      | 147                                                            | 70,8                                              |
| III          | 133                                                      | 82,1                                                           | 66,5                                              |
| IV           | 217                                                      | 76,1                                                           | 83,2                                              |
| V            | 151                                                      | 80,8                                                           | 161,1                                             |
| VI           | 105                                                      | 92,6                                                           | 73,5                                              |

The variation of the recorded temperatures at the engine compartment level (P1), on the surface of the intake manifold (P2) and from the air filter region (P3) for each case are presented graphic in Figure 10.



**Figure 10.** The variations of temperature for each case; **P1**– engine compartment (over view), **P2** – surface of the intake manifold, **P3** – air filter region.

#### 4. Conclusion

From the studied data one can emphasize the fact that the emplacement of the air filter and of the intake manifold in case II favours a relatively large variation of temperatures as opposed to the situation from case VI. So, from the point of view of the thermal transfer, this case is preferred because the emplacement of the air filter in the engine compartment is more efficient. The relatively high variation of the temperature in case V (BMW E46), in the air filter region, can be explained by its absence.

Excessive heating the air destined to the functioning of the engine leads to the appearances of the engine's overheating phenomenon, at the trend of combustion detonation (knocking phenomenon), abnormal wear etc., having negative influences upon the performance of the internal combustion engine.

In order to improve the heat transfer path inlet, thermal insulation protection of heat sources and of Aluminium alloy intake manifold is recommended. The emplacement of the air filter must be outside the heat affected areas by the heat sources or the region of the filter must be further protected by implementing a thermal deflector.

#### References

- [1] Gupta H 2013 *Fundamentals of Internal Combustion Engines*, PHI Private Ltd
- [2] Yoshizaki K N and Hiroyasu H 1993 Approach to Low NO<sub>x</sub> and Smoke Emission Engines by using Phenomenological Simulation, SAE Paper no. 930612
- [3] Ogawa K R, Ilizuka K and Miyamoto N 1999 *Cycle-to-Cycle Transient Characteristics of Diesel Emissions during Starting*, SAE Paper no. 1999-01-3495
- [4] Torregrosa A, Olmeda P, Martín J and Degraeuwe B 2006 Experiments on the Influence of Inlet Charge and Coolant Temperature on Performance and Emissions of a DI Diesel Engine, *Experimental Thermal and Fluid Science* **30**(7) 633-641
- [5] Pang H, Brace C and Akehurst S 2004 Potential of a Controllable Engine Cooling System to Reduce NO<sub>x</sub> Emissions in Diesel Engines, SAE Paper no. 2004-01-0054
- [6] Birtok Băneasă C 2017 The Dispersion of the Heat Flow in the Engine Compartment. Case Study Fiat Panda 1.2i, *Annals of Faculty Engineering Hunedoara* **XV**(4) 215-219
- [7] Birtok Băneasă C and Rațiu S 2011 *Admisia aerului în motoare cu ardere internă – Filtre supraaspirante – Sisteme dinamice de transfer*, Editura Politehnica Timișoara
- [8] www.corneliugroup.ro