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DESIGN OF AN AIR COOLED CYLINDER HEAD FOR TWO FAMILYS OF DIESEL ENGINES WITH DIRECT INJECTION (HAVING THE STROKE OF 65 mm AND 80 mm, 82 mm BORE)

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ABSTRACT: When designing a cylinder head for two families of stationary diesel engines, air cooled, direct injection, to consider these issues: the BMEP, which is limited to these engines to value 3.8-5.2 bar. To optimize gases exchange process and obtain a desired swirl number, different solutions are studied geometry galleries, speed location of valves and gas fields developed in the process for each proposed solution. The paper presents the optimal solution found in the following constructive analysis made for a program Fluent single cylinder engine and one engine family bi-cylinder mentioned, looking at for each case of cooling air flow. Another aspect to be taken into account when designing the cylinder heads is to determine the thermal regimes of the cylinder head, piston, cylinder, valve and nozzle, in order to define the development of heat per cycle. From our experience in designing and attempts stationary air cooled engines and the development of injectors and new combustion chambers, a combustion code, written in C++, I simulate the heat release rate per cycle serving to define data plating to determine required heat transfer. The objectives of this paper are to define an optimum construction solutions for a cylinder head for two families of air-cooled diesel engine with direct injection, having the stroke of 65 and 80 mm for 82 mm bore.
KEYWORDS: cylinder head, analysis, heat release, direct injection, stationary engine

INTRODUCTION

The cylinder head is designed for two families of direct injection diesel engines, which include mono and poly-cylinder, we proposed the solution inlet and outlet channel placement on the same side of the cylinder head, those the opposite distribution size. For this reason, the injector should be placed between the rocker arm, which brings the advantage of shortening the injection pipe.

Also, this solution provides a large surface design of the cooling air reception, and the thermal regime of the injector is much better controlled than in other types of air-cooled cylinder heads, because the injector is not in contact with a wall of the hot channel. We present in Table 1 the main features of the engine cylinder head which has designed this.

Table 1 -The engines specifications

Bore mm	82	82
Stroke mm	65	8
Compression ratio	19	19
Displacement volume cm3	343,26	422,48
Engine speed min-1	3000	3000
BMEP bar	5,5	5,5

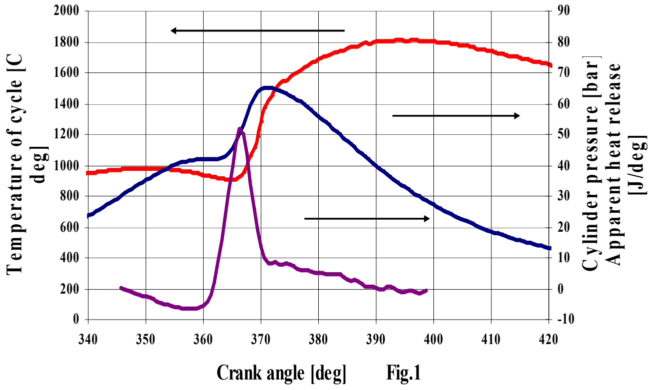


Figure 1.Cilinder pressure, temperature of cycle and apparent heat release

For the 5.5 bar BMEP wish we got in our combustion code simulations the evolution of pressure, temperature and apparent heat release, as shown in Figure 1.

In figure 2, the evolution of apparent heat release is present and cumulative heat release.

To validate the heat transfer coefficient of the chamber apply Woschni correlation:

hc=3,26B-2P0.8T0.55W0.8 [W/m2K] (1)

where: B - bore of cylinder [m], P - average pressure [kPa], T - temperature [K], W- average of gas velocity [m/s]

The average heat coefficient is shown in Figure 3.

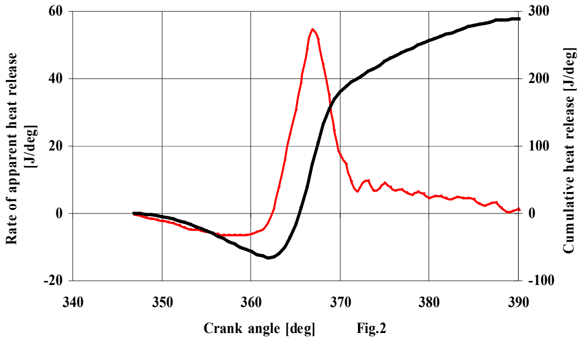


Figure 2. Heat release characteristics

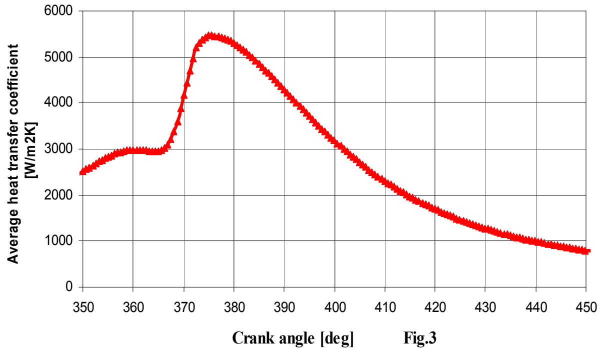


Figure 3.Average heat transfer coefficient

To analyze the gas flow channels and the determination of temperature and stress fields have resulted the cylinder head in Catia V5, as shown in Figure 4.

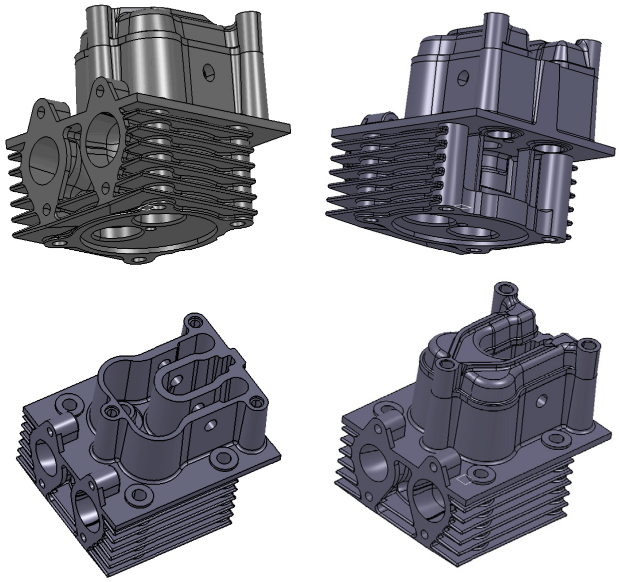


Figure 4. The gas flow channels – Catia V5

ANALYSIS OF FLOW THROUGH INLET

To analyze the flow we generated in CATIA V5 inlet located on a cylinder with a length of 1.75 diameter, just like the installation to determinate the average swirl number. Flow simulation program was done in Fluent, and initial flow conditions are: 101325 Pa, 293 K, output 98873.3375 Pa, 293K. The results after mesh 1mm – 563008 tetrahedral, can be seen in Figure 5. Air intake occurs at the bottom of the cylinder to the depression of 0,025 Mpa.

Table nr.2

Nr. Crt	Hv/Dv	Hv mm
1	0	0
2	0,04	1,12
3	0,08	2,24
4	0,12	3,36
5	0,16	4,48
6	0,2	5,6
7	0,24	6,72
8	0,28	7,84

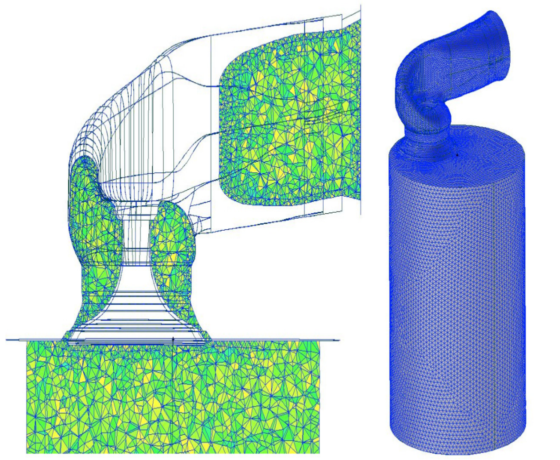


Figure 5. Flow simulation – Fluent

In Figure 6 we can see the volume of the cylinder intake duct and prepared for analysis.

The duct was placed on the cylinder just like the cylinder head. Inlet valve could be moved like in table nr.2, where Hv – lift of valve, Dv – Diameter of the intake channel. Dv=28 mm. In Figure 8 we can see the pressure field for flow conditions.

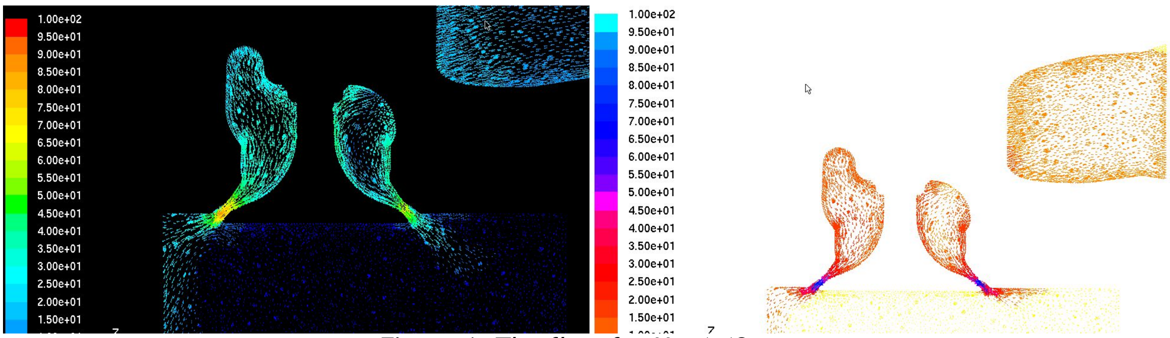


Figure 6. The flow for Hv=1,12 mm

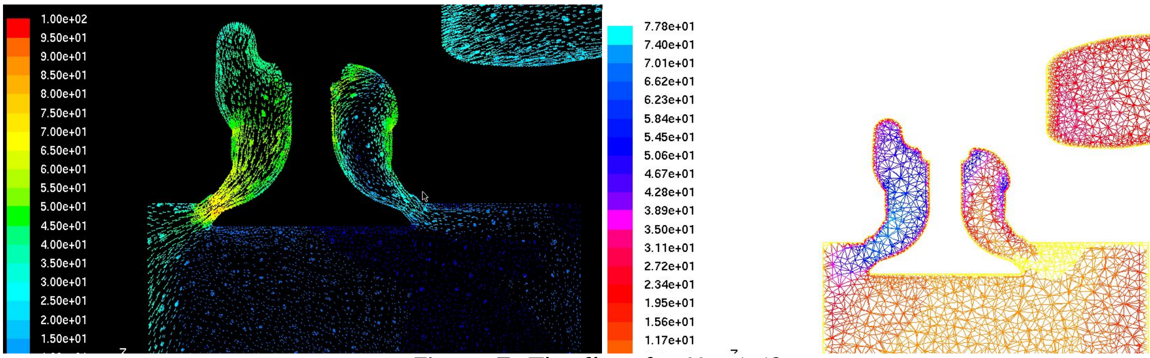


Figure 7. The flow for Hv=4.48 mm.

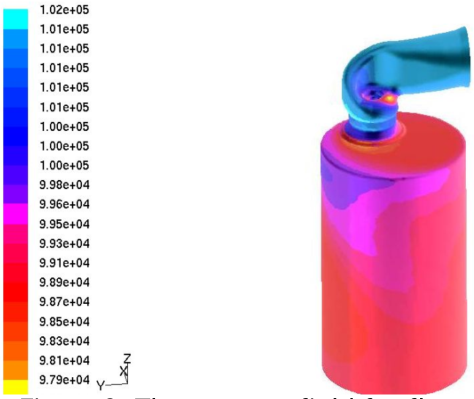


Figure 8. The pressure field for flow conditions

STRESS ANALYSIS OF ORIGIN FIELDS TEMO-MECHANICS

The item type is used for thermal analysis DC3D10 coding. It is a typical thermal analysis. It is an element of order 2 with 10 nodes tetrahedral type. Thermal analysis was run with the idea of obtaining the temperature field structure analysis. The thermal field was loaded over static analysis. For static analysis we used two-order tetrahedral elements with 10 nodes. Coding element in Abaqus is C3D10. The analysis of static stress field was obtained on the structure analyzed.

Number of elements in the analysis: 262 509

Number of nodes in the analysis: 451 281.

Based on heat transfer coefficient we obtained the plot temperature and stress distribution, which can be seen in Figure 9.

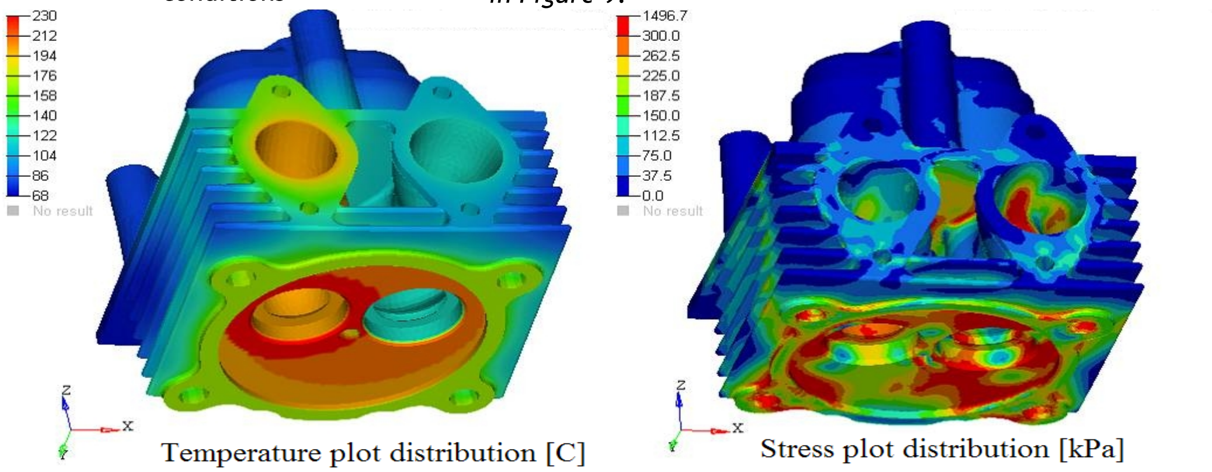


Figure 9. Plot stress and temperature distribution

Plot stress and temperature distribution for inlet can be seen in Figure 10, and for exhaust duct is presented in Figure 11.

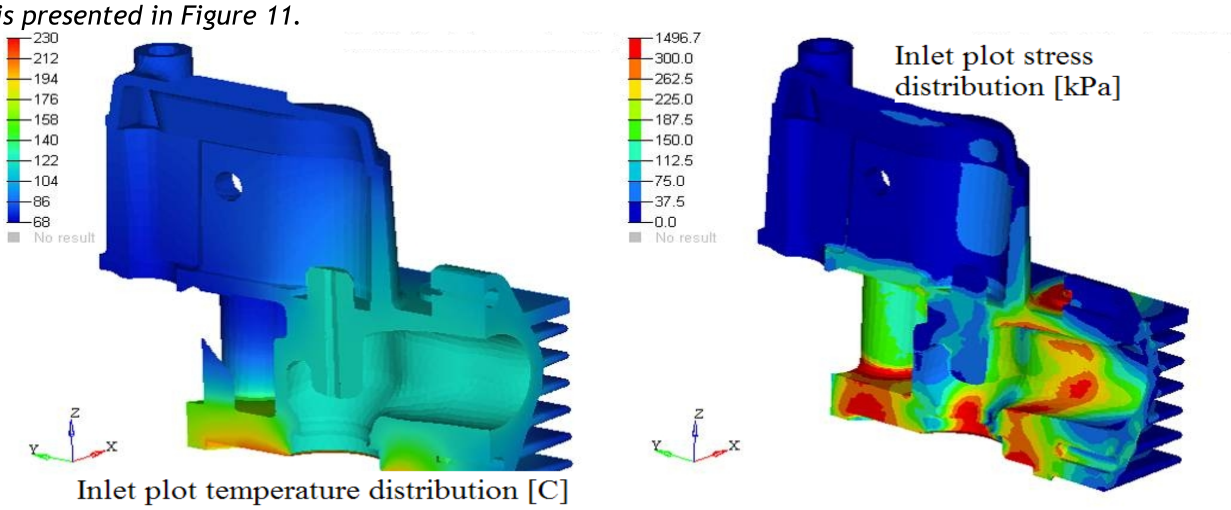
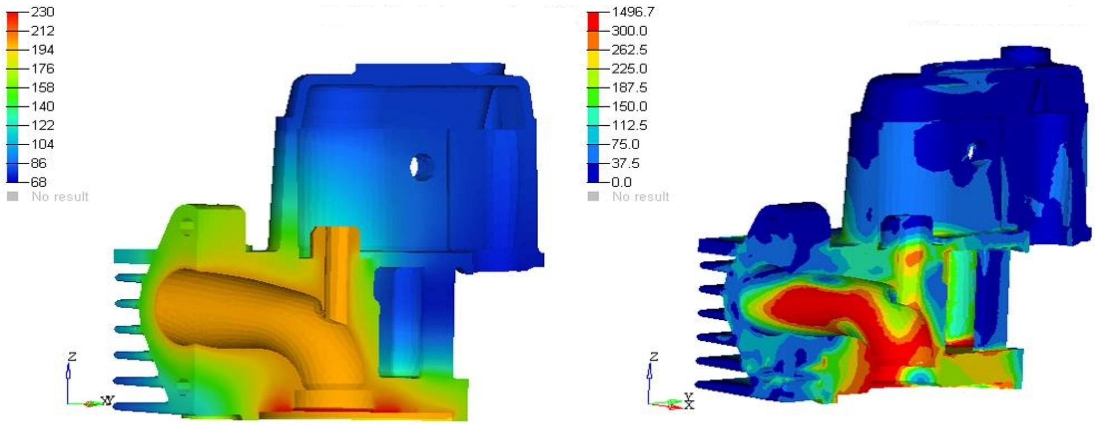


Figure 10. Plot stress and temperature distribution for inlet



Exhaust plot temperature distribution [C]   Exhaust plot stress distribution [kPa]

Figure 11. Plot stress and temperature distribution for exhaust duct

CONCLUSIONS

The present work its goal by being a fast presentation of a result that could be used as a preliminary step in a development of two families of diesel engines, just in terms of the main parameters of the cylinder head, performances. Our goal was to create a team to develop this project, which was not publicized, now, specific issues such as fuel injection, combustion chamber, the type of nozzle. This cylinder head can be a variant for the development of two families of direct injection diesel engines for stationary air cooled.

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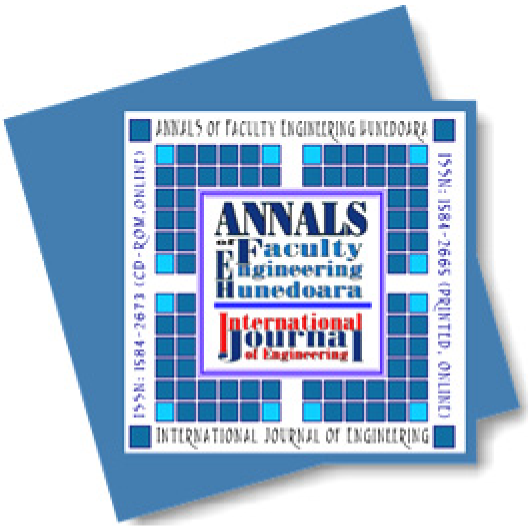

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