# SOMME ASPECT REGARDING THE THERMAL TRANSMISSION IN SOME SUBASSEMBLY OF AN INTERNAL COMBUSTION ENGINE

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**Abstract.**

In this paper is presented the calculus mode of thermal transmission in a cylinder cover of an internal-combustion engine.

The thermoconvection coefficient will be determined using the differential equation. Also, the heat flow will be determined using the method of finit differential.

**Key words:** Cylinder head, valve, bridge between valves, thermal transmission, finit element, engine.

## INTRODUCTION

During the engine's functioning the breech stands a strong thermal and mechanical tension, determined mostly by the gases pressure force. The flat heating between different zones of the breech, like the one between the hot escape valve and the cold inlet valve, produces big thermal tensions that deforms or splits the breech.

The thermal tension's character depends on the temperature field that draws him. A stationary temperature field will generate static tensions, and in the case of the temperature field's variation in time, the speed of the variation is very important. For lower speeds of temperature variation, the thermal tensions could be considered quasistatic. For bigger temperature variation speeds, the variable thermal tensions will evolve in time.

If during the effort, the displacements stay into the elastic domain, tensions are thermo-elastic, and if the displacements pass into the elastic-resilience domain, the tensions will become thermo-resilience. The cyclical variation of the temperature could provoke the crack of a machine part (analogical with the bursting caused by the variation of the external force's effort), action called thermal fatigue. Unlike the thermal fatigue which can appear after a relatively big number of effort cycles, there can appear the thermal-shock (thermal effort drawn into a body at the contact with a fluid that has different temperature) that sometimes provokes the damage of the machine part after a relatively small number of cycles.

Inside this paper, we will analyze the calculation of the thermo-resilience tensions into a variable domain. We will set out unitary the examination results performed throughout the world, regarding the thermal effort calculation, their practical relations, and constructive indications for a correct design of different forms of internal combustion engines parts, turbines, boilers, etc. From a multitude of machine parts, we have chosen the thermal effort calculation for the bridge between the valves of a sparkle ignition engine. For any other parts, the thermal efforts can be resolved similarly, with the particularization of the fundamental thermo-resilience equations.

The mechanism and the conditions of thermal tension shaping

The increase of the volumetric power of the engines, by increasing the compression ratio, the engine revolution and the engine supercharge, leads to the increasing of the thermo-mechanical efforts, especially for the parts that separates the burning-chamber of the engine.

Consequences of these efforts are the thermal tensions, which can appear owing to the temperature differences in the parts. The temperature differences depend on the speed and the heating transmission in the parts type, the parts shape, their thermal conductivity, their system and the intensity of the cooling devices, etc. During the engine operating time, because of the temperature differences, there can appear momentary thermal efforts, which, usually overlaps the residual thermal efforts, appeared sequel to former thermal efforts. The action's mechanism is presented in the stress-strain diagram (fig. 1)

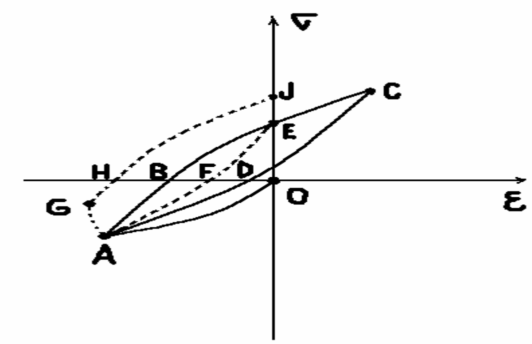



**Fig. 1** *Stress-strain diagram*

It is thought that a part, i.e. a part of the engine's breech, hot in the central part, her extension will be deterred by the front-fixed part of the cylinder block. Because of the high-temperature effect, into the central-part of the part, will appear a compression-effort, after the OA curve. When cooling, it will follow the ABC curve, and at a new heating, the CDA curve. When the cooling stops, into the E point, at a new heating it will follow the EFA curve. If the part is maintained at constant temperature, there will appear the "yield" phenomenon, represented by the AG curve. At another cooling of the part, it will follow the GHJ curve, and if a new heating will appear, there will be a similar curve with the EFA curve, where the final point will be between A and G points.

The OE and OJ segment are proportional with the residual thermal-effort's values from the part. It is possible that because of the repeatedly heating and cooling, as for the abnormalities produced there will be an overtaking of the resilience limit of the material, to appear plastic-abnormalities, and into that particular part, cracks to be produced. Notable is the fact that the crack appearances could be favored by the cooling effect of the parts.

This could be an explanation of the fact that onto some parts that equip vehicle engines, because of the differences of the functioning thermal regimes, the crack appearance is increased towards the stable functioning regimes of other vehicle engines.

A sight of the two valves of a Dacia 1300 engine's breech is restorable in the fig. 2


**Fig. 2** *The bridge between valves*

## EXPERIMENTAL ANALYSIS FOR BREECH TEMPERATURE MEASURING

The mode of the thermal converter assembling for the breech temperature measuring is presented in the fig. 3

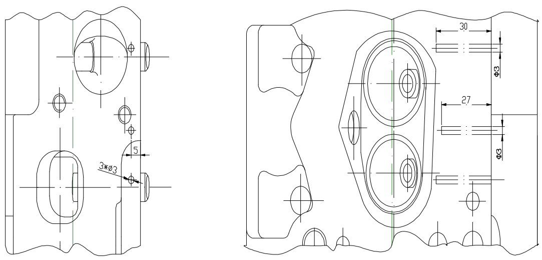



**Fig. 3** *The assembling mode of thermal converter in the cylinder head*

In order to measure the temperature it should be used a digital multimeter. MAS345 uses a software (MAS-VIEW Version 1.1 For Windows 95 & 98) (fig.4) which can be characterized by a multitude of options for measured data treating and for options saving.

This software has the possibility to represent into a graphical mode, the temperature variation within the thermocouple's limits, limits that can be preset or defined by the user, the only condition being that that these limits should not exceed numerically the measured temperature value, value that can be measured for definable periods of time.

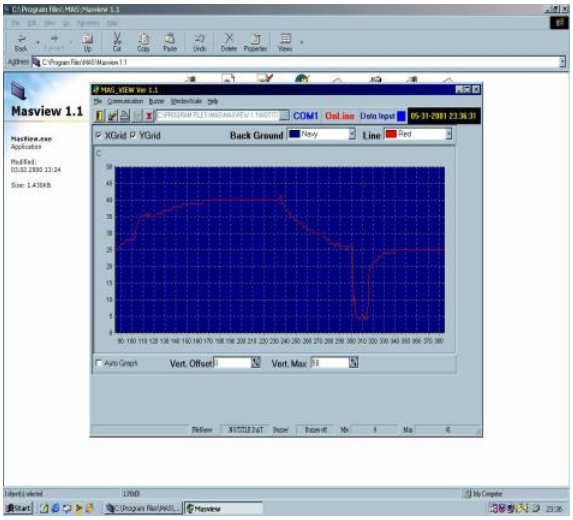



**Fig. 4** *The measured temperature value*

To determine the amount of heat taken up by the intake air from the chamber wall during compression. In order to facilitate the calculation let us assume a swirl chamber with an unequivocal air movement. In first approximation, the heat transfer coefficient $\alpha$ may be calculated from the general similarity equation valid for tubes which, in the case of s turbulent flow, will assume the following from

$$Nu = 0.018 Re^{0.8}$$

from which the value of the heat transfer coefficient will be

$$\alpha = 0.018 \frac{\lambda}{d_e} \left( \frac{w d_e}{\nu} \right)^{0.8}.$$

If we consider that

$$\lambda = 7.36 \cdot 10^{-5} T$$

and

$$\mu = 3.3 \cdot 10^{-8} T^{0.7}$$

then the $\alpha$ heat transfer coefficient can be calculated from the following equation

$$\alpha = 0.01386 \frac{p^{0.8} w^{0.8}}{d_e^{0.2} T^{0.36}}.$$

The equivalent diameter $d_e$ in the above equations is of the value

$$d_e = \frac{4V}{F} = \frac{2}{3}d$$

here d is the diameter of the swirl chamber.

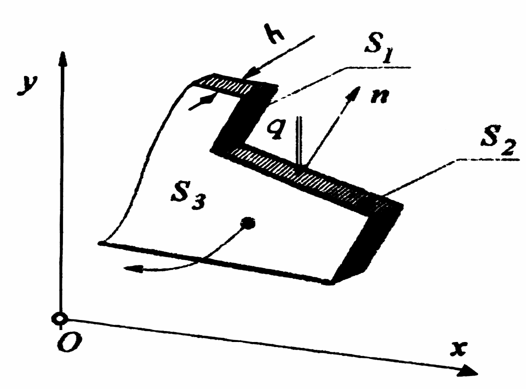



**Fig. 5** *The intensity of the normal thermal flux at the surface and heat*

**THE FINITE ELEMENT METHOD UTILIZATION FOR THERMAL-EFFORTS DETERMINATIONS**

The thermal transfer problem resolving involves knowledge and constraint of the line conditions, in order to obtain unique solutions for the resulted equation systems. Thus, for some body parts, we can command the temperature, the intensity of the normal thermal flux, and heat-exchanging by convection. (fig. 5.1).

Therefore, $T_{S1} = f(x,y)$ represents the assessed temperature for the body surface of $S_1$.

$q = \lambda \cdot (\frac{\partial^2 T}{\partial x^2} \cdot n_x + \frac{\partial^2 T}{\partial y^2} \cdot n_y)$ represents the thermal flux assessed into the $S_2$ surface positioned by $n_x$ and $n_y$ director cosinuses;

$\alpha \cdot (T - T_E)$ means the heat-exchanging using convection where $\alpha$ is the convection coefficient for $S_3$ surface and $T_E$ is the temperature of the exterior environment. The solving of the differential equation is being possible for relatively simple geometrical corpuses. For the majority of real corpuses, the differential equations solving is rather hard, and sometimes impossible, being necessarily the approach by numerical methods, finite element methods in this case.

The using of the equation indulges the approximation of the temperature field

approximation at the level of a finite element using the J functional where were assessed the outline formerly presented.

$$J = \sum_{i=1}^{n} \cdot \left\{ \int_{V_{ei}} \frac{1}{2} \cdot \lambda \cdot \left[ \left( \frac{\partial^2 T(x,y)}{\partial x^2} \right)^2 + \left( \frac{\partial^2 T(x,y)}{\partial y^2} \right)^2 \right] \cdot dV - \int_{V_{ei}} M \cdot T_{ei} \cdot dV - \int_{S_{2ei}} q \cdot T(x,y) \cdot dS \right\} +$$

$$+ \sum_{i=1}^{n} \cdot \left[ \int_{S_{3ei}} \alpha \cdot \left( \frac{T_{ei}^2}{2} - T_{ei} \cdot T_e \right) \cdot dS \right]$$

For function the bridge between values used softare programe finit element Algor and RDM (fig.6,7,8,,9,10)

**Fig. 6** *Pattern digitization*

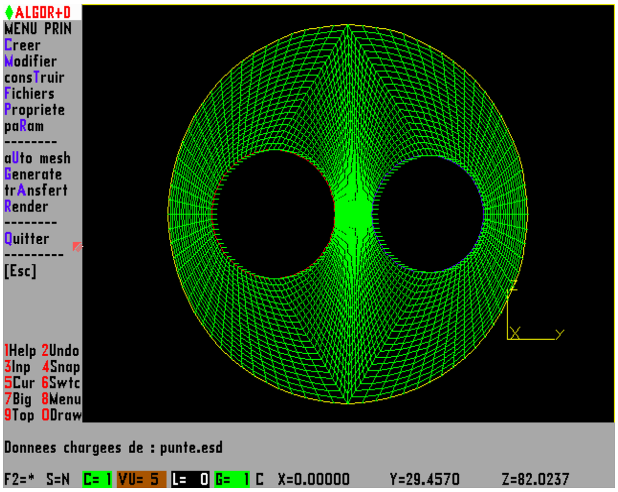
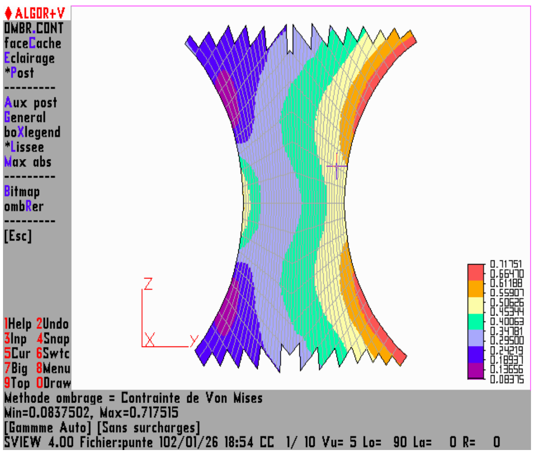



**Fig. 8** *Stress*



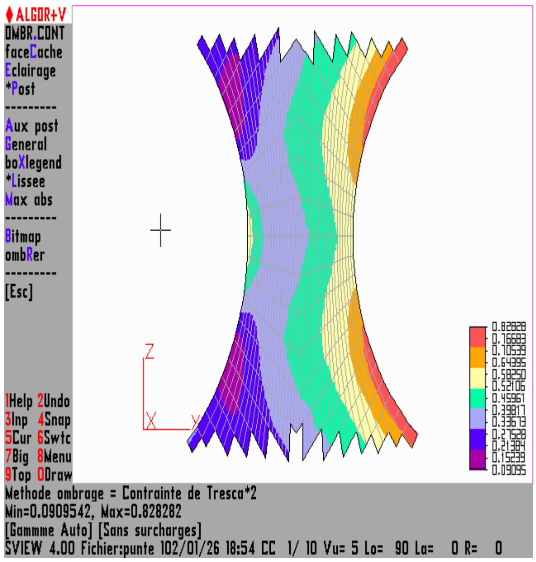
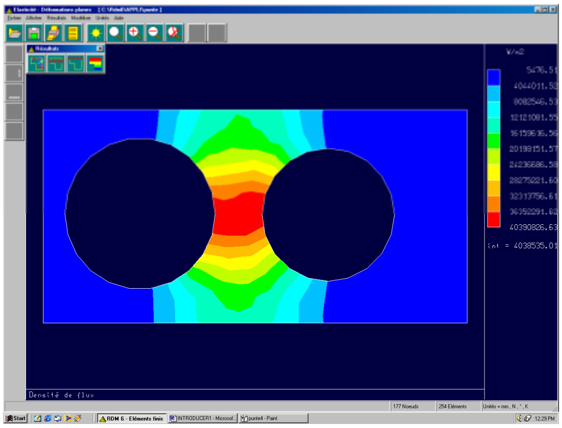




**Fig. 7** *Stress*

**Fig. 9** *Temperature distribution*



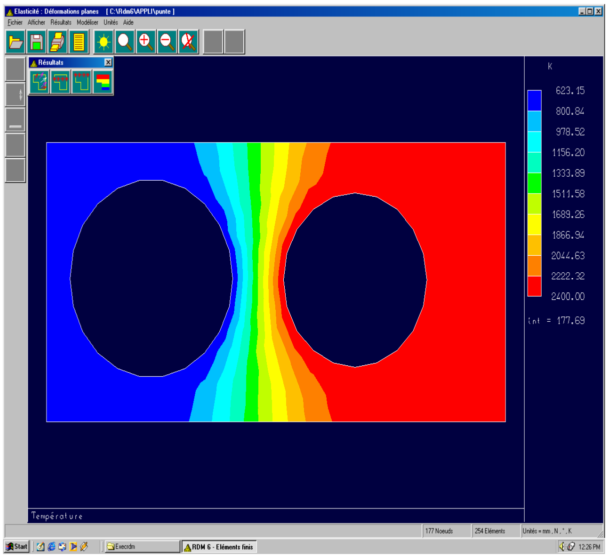



**Fig. 10** *Flux density*

## 4. CONCLUSIONS

Based on the inferable relations, we successfully shaped the breech's efforts, focusing onto the breech's bridge, as well as the value of the convection's coefficient. The obtained results enable the taking of some orders to prevent the crack appearance as well as the abnormal overheating of some areas in the breech. The obtained results will be compared to experimental test results.

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