THE OPTIMIZATION OF THE ELECTRONIC CONTROLLED INJECTION

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ABSTRACT

The authors propose a personal model for the calculation of pressure regulator and electromagnetic injection, the volume of fuel injected in cycle and the duration of the injection with the number of rotation at the total full charge load. This kind of mode can be used in the modeling system of electronic gasoline injection monounit or multiunit. To carry out this model it is necessary modeling engines with spark ignition cycle with gasoline injection with a model helping cycle proposed by the authors.

1.THE OPTIMIZATION OF THE PRESSURE REGULATOR

Pressure regulator maintains constant pressure injection in supplying installation. [3; 5].

Calculation scheme of the pressure regulator is presented in figure 1.

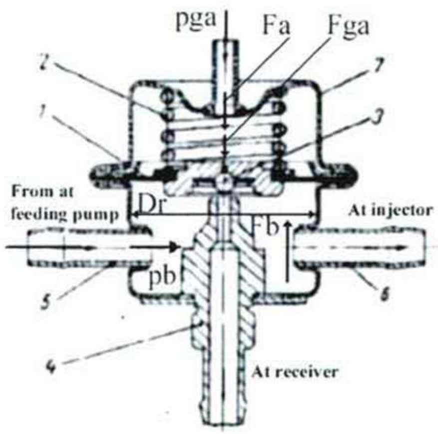

Figure 1. Scheme of pressure regulator: 1-membrane; 2- springs; 3- valve; 4- connection to the tank; 5- entrance connection; 6- exit connection; 7- housing.

Static balance equation of regulator membrane is given by the following relation:

$$F_a+F_{ga}=F_b \qquad (1)$$

where: $F_a = K_a \cdot f$; $F_{ga} = \frac{\pi \cdot D_r^2}{4} \cdot p_{ga}$; $F_b = \frac{\pi \cdot D_r^2}{4} \cdot p_b$;

and K_a is elastic constant springs; f- spring arrow; D-diameter of the regulator membrane; F_a-power pressure of spring;

F_{ga} –pressure power from manifold; p_{ga} –pressure from the manifold; p_b –gasoline pressure in masterly of the injection; F_b –the gasoline injection power.

$$\frac{\pi \cdot D_r^2}{4} \cdot p_b = K_{a \cdot f} \cdot \frac{\pi \cdot D_r^2}{4} \cdot p_{ga},$$

After the changing, relation (1) become :

$$p_b = \frac{4}{\pi \cdot D_r^2} \cdot K_{a \cdot f} \cdot p_{ga};$$

or:

$$p_b = K_r + p_{ga} \quad ; \qquad (2)$$

where:

$$K_r = \frac{4 \cdot K_a \cdot f}{\pi \cdot D_r^2} \quad ; \quad K_r = 1..4$$

K_r – is the constant regulator.

2. THE OPTIMIZATION OF THE ELECTROMAGNETIC INJECTION

The injector proposed by the author are with electronic command Renix type, with conic top needle with four holes of pulverization or Mono-Motronic with conic top of needle with three holes of pulverization.

The volume of gasoline injected in cycle is proportional with the injection pressure and the duration of injection. [3;6].

The section of the passing pulverization hole is determined by the following relation: [6]

$$A_a = \pi \cdot A_c \left[\frac{d}{2} + \left(\frac{d}{2} - A_c \right) \right] = \pi \cdot s_a \sin\left(\frac{\beta}{2}\right)\left(\frac{d-1}{s_a \cdot \sin\beta}\right); \qquad (3)$$

Where: A_l-passing section offered by conic top needle; s_a-raising up needle; d_v-diameter of the needle in top zone; β-cone angle tight; d_p-sack diameter.

Raising up needle s_a is considered to be constant.

It was marked with A_l the area of the leaking section near the needle top of injector with conic top.

$$A_l = f(s_a, \beta, d) = ct$$
$$A_l = \pi(d_p - 0,5\, s_a \sin\beta) s_a \sin \beta/2;$$
$$s_a = 0,15\ mm;\ d_p = 1 \dots 1,2\ mm;\ \beta = 60^0.$$

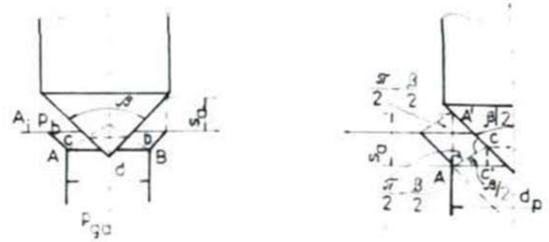

Figure 2. The calculation scheme of electromagnetic injector

Discharge of gasoline which passes the injector leaking section is calculated by the relation:

$$Q_b = \mu_i \cdot A_i \sqrt{\frac{2(p_b - p_{ga})}{\rho_b}}; \qquad (4)$$

where μ_I coefficient of discharge in the section offered by the needle; μ_i = 0,8 - 0,93; Taking in consideration relation (2):

$$Q_b = \mu_i \cdot A_i \sqrt{\frac{2K_r}{\rho_b}} \qquad (5)$$

where: A_i is the leaking section at the injector; p_b – gasoline pressure at the entrance of injector; p_{ga} – air pressure from the manifold; ρ_b – gasoline density; K_r - constant regulator pressure; Q_b- discharge of the gasoline.

In the other hands it is lanown from the relation of the discharge definition, that is the leaking fuel volume during a time unit.

Maybe written :

$$Q_b = \frac{V_b}{t_i} = \frac{m_{cb}}{\rho_b \cdot t_i} \qquad (6)$$

From the equality of relation (5) and (6) results un duration of the injection, t_i:

$$t_i = \frac{m_{cb}}{\rho_b} \cdot \frac{1}{\mu_i \cdot A_i \cdot \sqrt{\frac{2K_r}{\rho_b}}} = \frac{m_{cb}}{\mu_i \cdot A_i \cdot \sqrt{2K_r \cdot \rho_b}}; \quad d = \frac{1}{\lambda \cdot L_o} = \frac{m_{cb}}{m_{aer}};$$

$$m_{cb} = \frac{m_{aer}}{\lambda \cdot L_o} = \frac{m_{aer}}{m_{ad}} \cdot \frac{m_{ad}}{\lambda \cdot L_o} = \xi \cdot d \cdot m_{ad}; \quad \xi = \frac{m_{aer}}{m_{ad}};$$

where ξ is the coefficient which represents the ratio between necessary air quantity for burning moor and the mixed quantity fuel accepted m_{ad}.

Results: $$t_i = \frac{\xi \cdot d \cdot m_{ad}}{\mu_i \cdot A_i \cdot \sqrt{2K_r \cdot \rho_b}} \text{ [s]} \qquad (7)$$

where: m_{cb} is the volume of the fuel; m_{aer} – the volume of the air aspirated by the engine; m_{ad} – quantity of mixed fuel admitted; d – proportioning.

In figure 3 is represented the variation of the duration of injection t_i with the engine speed and the ambient temperature.

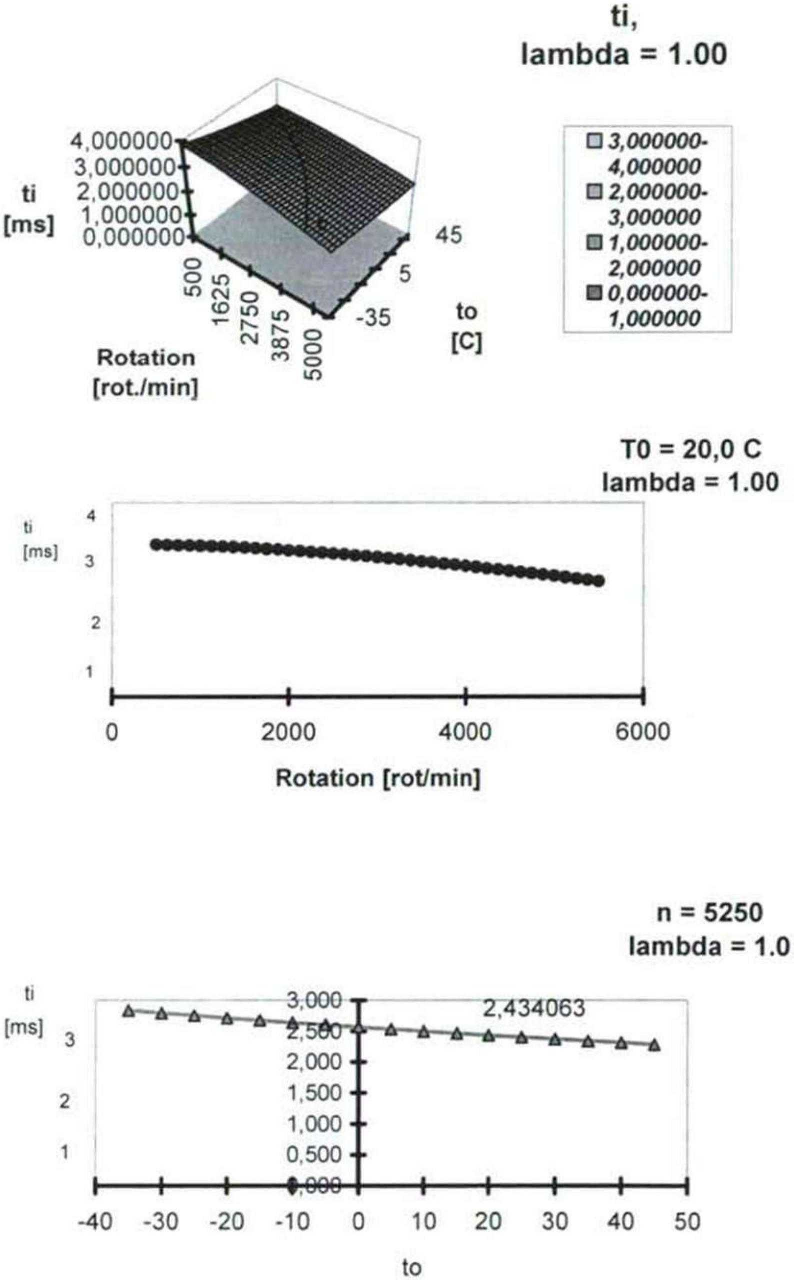

Figure 3. The variation of the duration of injection t_i with the engine speed and the ambient temperature.

The working of the curbed engine with lambda sensor and catalyst, makes coefficient λ to be mentioned as close as possible to $\lambda=1$ (stoechiometric dosage).

On the base of a personal model the author realized analytic calculation of pressure in the manifold p_{ga} and the admission pressure p_a, the calculation of engine pressure regulator and the duration t_i of the electromagnetic injector.

The equation of working engine by spark equipped with electronic engine injection were determined and introduced into the electronic control unit.

For the modeling cycle engines with spark ignition with engine injection are noticed the initial dates, pressure expression from un manifold p_{ga} and the pressure of air at the end of the admission p_a, the thermal volume charging q_{cb}, the filling efficiency η_v, the raising ratio of the pressure in α, at volume constant burning, raising ratio of the after burning volume δ, the temperature of the evacuated gasoline T_e, the coefficient of the residual burning gasoline γ_r, the temperature at the end of the admission T_a.

All these expression were analytic calculated and correlated among them in order to be introduced into the electronic control unit . The calculator gets the command to repeat this operation till the getting of the imposed error of the engines with spark lighting parameters.

It is calculated the mechanical theoretic work proposed L_{tp}, the average pressure proposed p_{tp}, theoretical proposed efficiency and the mechanical losses of the cycle.

The calculation of engines with spark ignition parameter, was sectioned in 10 proceedings and functions. Near the declared constant values at the beginning of the program, it is considered as initial dates, presumed to be known choosing arbitrary from the statistical dates of engines with spark ignition cycle: T_{ao}=322 K; T_{zo}=2530 K; T_{uo} =2660 K and k_{co} =1,3; k_{vo} =1,3; k_{uo} =1,2; k_{do}=1,3; k_{eo}=1,3; without them are not possible to calculate in general way all others coefficients and the other temperature and the physical size which characterize the cycle. In this way the size above will play the parameter role, variable will the temperature in which thermal process evaluate. These temperatures depend on the adiabatic coefficients which in fact are stability by going though many times of the cycle until these coefficients become constant with 0,000009 error.

This exit decision from the cycle for a certain revolution is given by the diminish of the constant error of temperature T_a under 1,5 K.

3.CONCLUSIONS

It is conceived the calculation of the pressure regulator and of the electromagnetic injector. It was made the calculation of the injection duration t_i with the engine speed and load which represents the model proposed by the author.

It was effectuated an engine with spark ignition program for the calculation of parameters with the gasoline injection with the under- program:

- the calculation program of engines with spark ignition parameters (depending on n and λ at t_o=-35...+45°C and $p_o=1\cdot10^2$ kPa) [3].
- the calculation program of engines with spark ignition parameters (depending on n and t_o at λ=1 and $p_o=1\cdot10^2$ kPa) presented in annex B;[3].

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