EXPERIMENTAL RESEARCH REGARDING THE DEPOLLUTION OF THE FORMATION AND THE IMPROVEMENT OF TOP DYNAMIC PERFORMANCES OF CARS THROUGH THE OPTIMIZATION OF THE FINAL MOMENT OF INJECTION

Daniel LITA[1], Ion TABACU[1], Florian IVAN[1]
[1]University of Pitesti, Romania

Abstract: *Besides the post-treatment means of exhaust gases and those of the depollution of formation through mechanic changes, an efficient means of depollution is represented by the optimization of the injection moment by the agency of electronic control unit, ECU. The aim is to control rigorously both the quality of the mixture (the quantity of injected fuel as to the air quantity that enters the cylinder) and the control of the final moment of the gas injection in the intake valve. This paper highlights the fact that this parameter plays a decisive part both in the case of diminishing the concentration of Noxa, especially the unburnt hydrocarbons, HC and in the case of improving the top dynamic performances.*

Key words: depollution of formation, final moment of the gas injection, unburnt hydrocarbons .

1. THE OBJECTIVES OF THE PAPER

It is well known that the burning process is strongly influenced by the quality of the mixture and by the duration of the intake process in the intake valve. Experience shows that the choice of the final moment of injection also plays an important part, especially regarding Noxa. As concerns the positioning of the injection cycle, one distinguishes two important moments, as follows:

a) the final moment of injection which influences significantly the dynamic performances (maximum couple), named the “final moment of performance injection”.

This moment occurs when the intake valve is open to foster a better air filling of the cylinder (the volume of the fuel is lower).

b) the final moment of injection which is decisive to reduce HC, named the “final moment of pollution injection”.

This moment occurs when the intake valve is closed, its aim being to ensure a better vaporization and homogenization of the mixture.

The choice of the final moment of injection for performances has certain difficulties because it has to be correlated with the state factors (the temperature of the coolant, the temperature of the air, etc).

The injecting of the fuel when the intake valve is open (final moment of performance injection) is not recommended when the engine works under thermal conditions because the vaporization and homogenization of the mixture is critical, the fuel reaching the mirror of the cylinder and diluting the oil film. This leads to the increase of the unburnt hydrocarbons emissions and to a relatively unstable running of the engine.

The completion of the injection moment when the intake valve closes is also inconvenient especially in the case of big charges (even in the case of stoichiometric mixtures) because it does not have enough time to vaporize and homogenize.

The final moment of injection for pollutants does not suppose a special position in comparison with the moment of the opening of the intake valve, but one recommends that the injection should be completed before the opening of the intake valve (even with almost 90°RAC) for the time of vaporization and homogenization of the mixture should be big enough.

The convenient positioning of the final moment of injection is called injection phasing. Figure 1 shows an example of the choice of the injection phase.

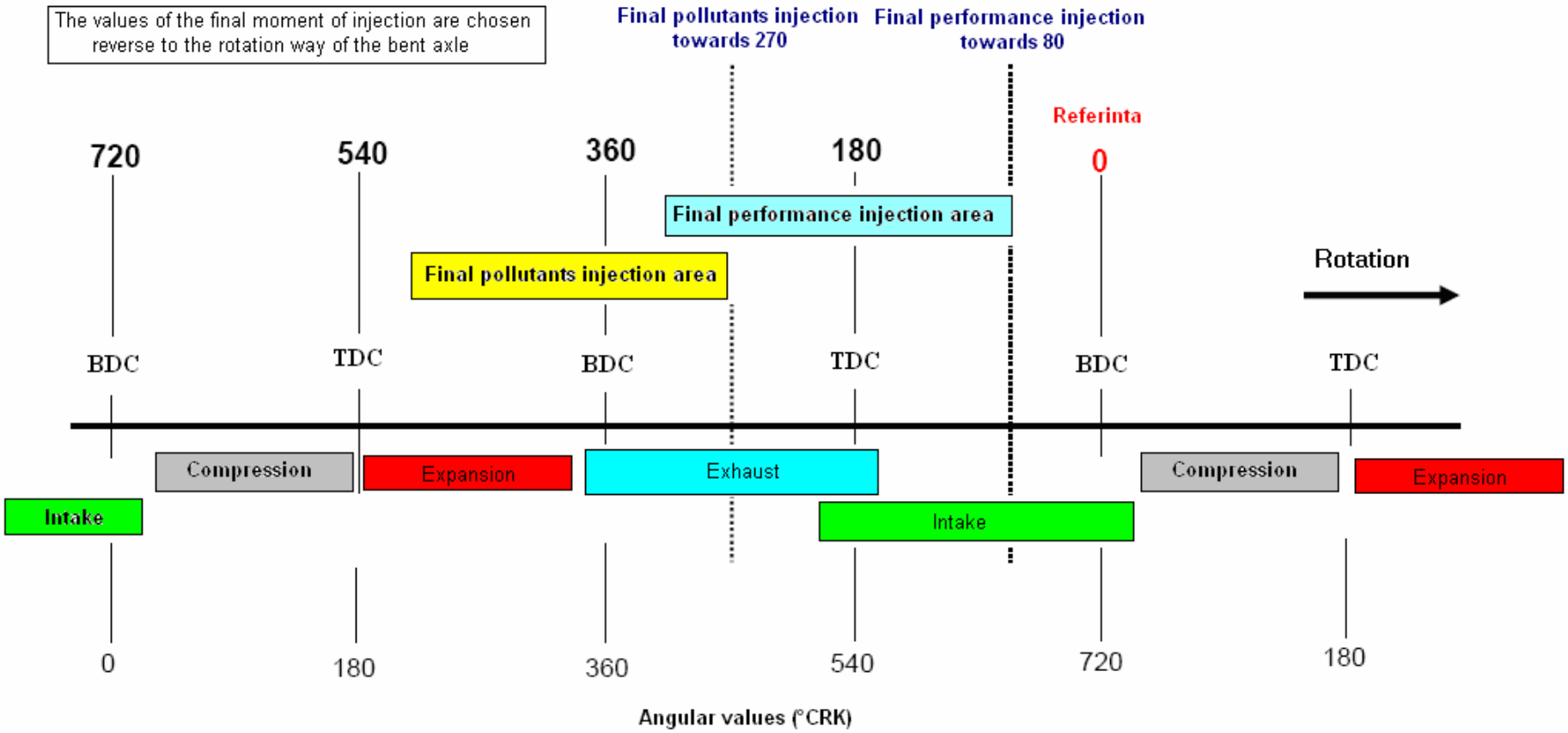

Fig 1. The positioning of the injection within the running engine cycles

The validation of the injection phasing is recognized only on vehicle testing (in the street or in the factory). The paper has as objective the establishing of the injection phasing for a MAS which equips medium class vehicles, highlighting its effect on the hydrocarbon concentrations or on performances.

2. RESEARCH METHODOLOGY

In order to highlight the effect of the injection phasing on the HC concentrations and on performances one did a scan of the final moment of injection at 50°RAC up to 350°RAC with 50°RAC on different ranges of functioning (rotation and charge), as follows:

Table 1

Range	rotation rot/min	Charge (mbar)		
R1	750	idling regime		
R2	1500	400	800	Total charge
R3	3000	400	800	Total charge
R4	4500	400	800	Total charge

For each range one measured the concentrations of hydrocarbons as regards the positioning of the injection phasing. The measurements were made on a stand engine which allowed to establish the top dynamic performances (Power, Torque).

3. ANALYSIS OF RESULTS

The results are shown in figures 2, 3, 4, 5 and 6. Figure 2 presents the evolution of the concentration of HC for the idling regime, and in figure 3 shows the evolution of the HC concentration over the constant rotation of 1500 rot/min and for three corresponding charges of negative pressure in the intake manifold of 400 mbars (low charge), 800 mbars (midle charge) and total charge. It comes out that the best injection phasing has to be chosen at about 200°RAC (figure 3); a case in which the HC concentration is minimal for low and middle charges.

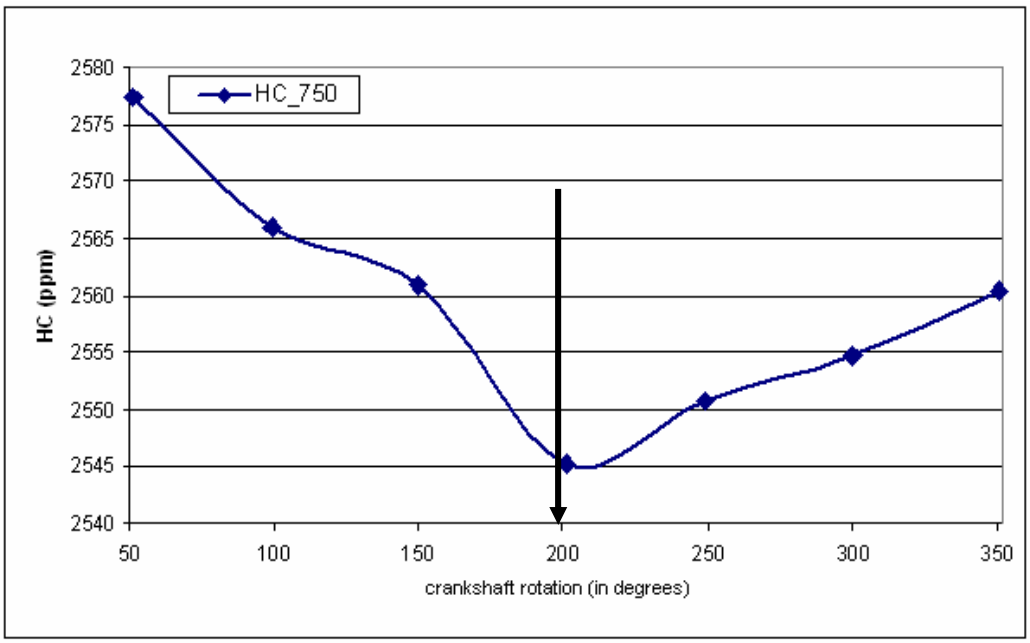

Figure 2

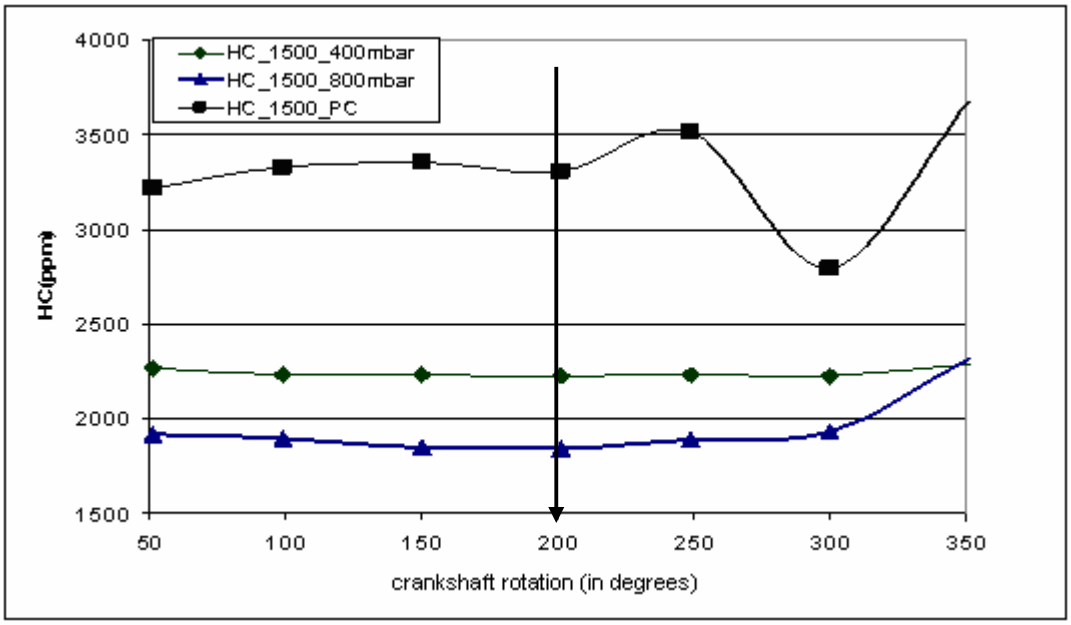

Figure 3

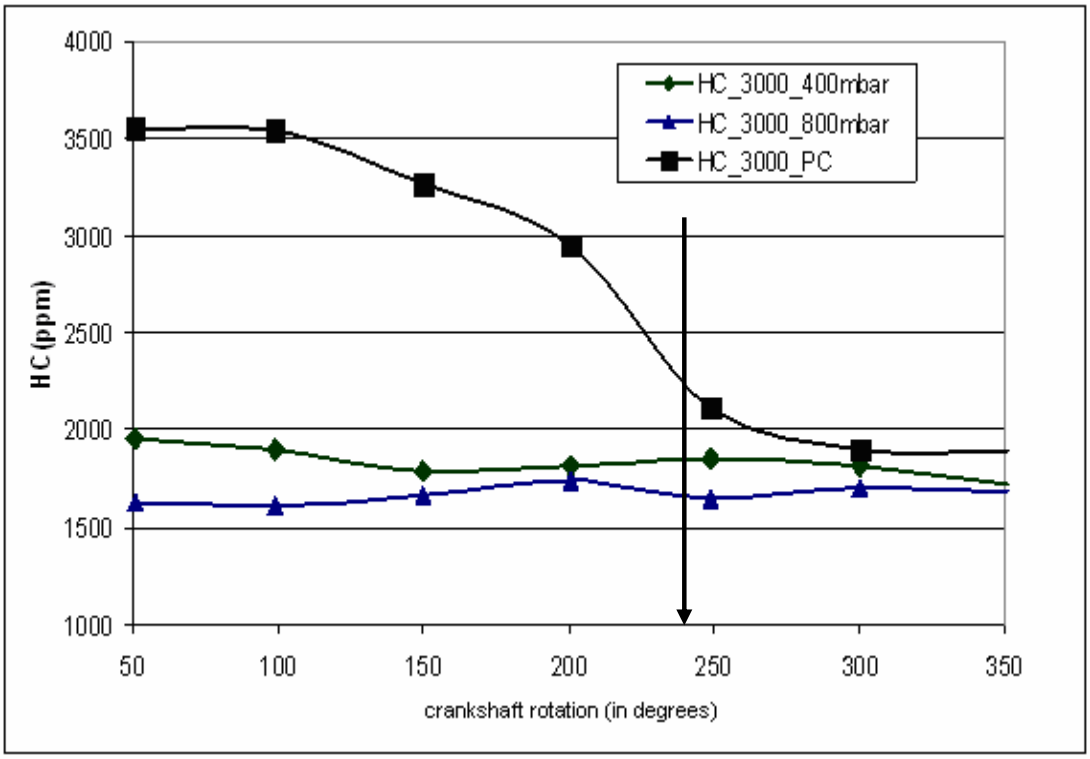

Figure 4

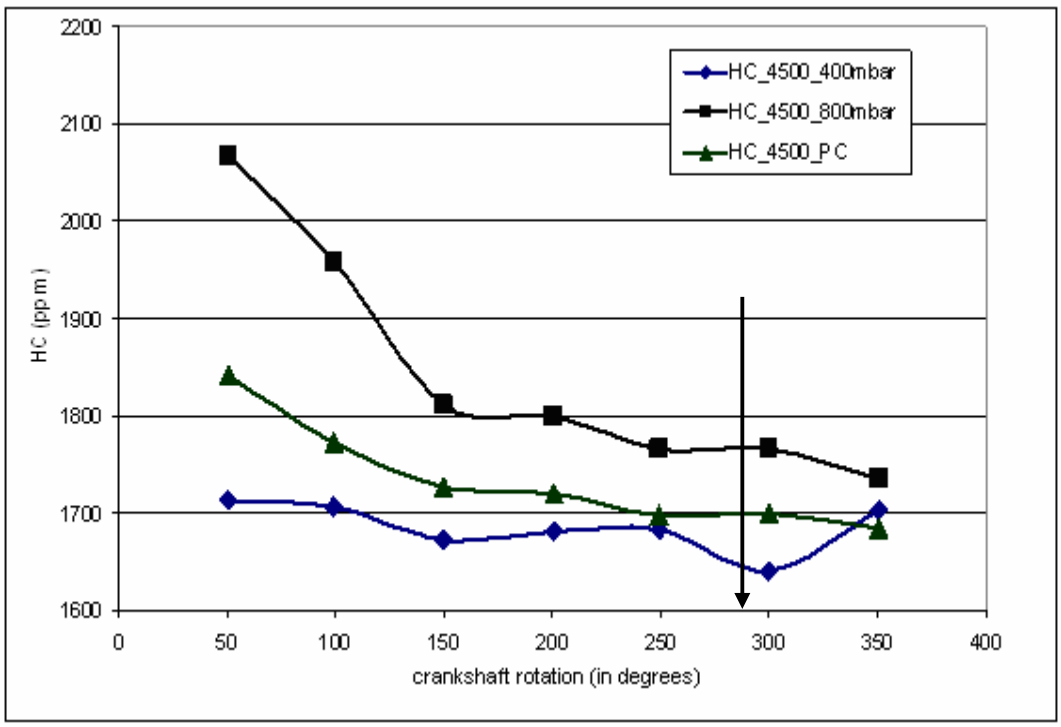

Figure 5

In figure 4 one sees that the best injection phasing is at about 240°RAC in the case of 3000 rot/min and of the three charges mentioned above. When the rotation reaches 4500 rot/min (figure 5) the best value of the injection is found at about 270°RAC.

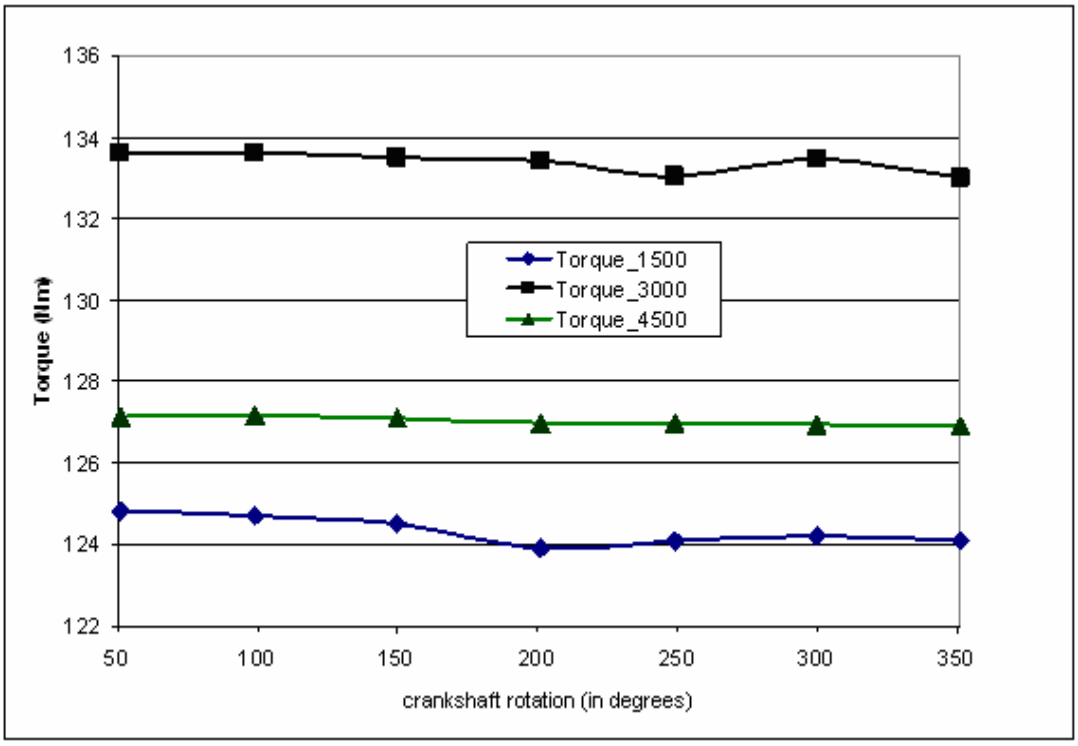

Figure 6

In the case of the total charge one chooses the injection phasing which ensures the maximum torque (figure 6). One sees that the best injection phasing is at about 100°RAC, value which satisfies all the three rotations. As one observes in figure 1 the final injection moment is at about 100°RAC which is characterized by injecting fuel in the open intake valve.

4. COCLUSIONS

The best injection phasing is strongly related to the engine working conditions, namely it depends on charge and rotation. The choice of a minimum pollution level and the improvement of the top dynamic performances supposes obligatorily detailed experimental research to establish the best correlation between the final moment of injection-charge-rotation, correlation which must be ensured by the electronic control unit ECU.

5. BIBLIOGRAPHY

[1] Heisler H., *Advanced Engine Technology*, SAE, Hardbound, 2005
[2] Plint, J., Martyr, T., *Engine testing , Theory & Practice*, SAE, Casebound,2007
[3] Khair, M., Majewski, A., *Diesel emissions and their control*, SAE, Hardbound,2006
[4] *** ENSPM, *Course notes*, 2009

NOTE: The theme has been done in co-operation with the University of Pitesti for the doctorship scholarship programme POSDRU/88/1.5/S/52826.