VARIATION OF THE SAUTER MEAN DIAMETER DEPENDING ON AIR SPEED AT INJECTION IN SIE

BENIUGA Marius Constantin[1], MIHAI Ioan[1]

[1] *Department of Mechanical Engineering, Stefan cel Mare University, Suceava, Romania*

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Abstract:

On the internal combustion engines with spark ignition engines (SIE) in four-stroke equipped with multipoint injection system (without supercharging system) multiple research topics have been developed to obtain optimal operation.
The structure of the atomized liquid fuel jet using injectors that have been extracted from internal combustion engines with spark ignition engines (SIE) equipped with multipoint injection system, is the main topic of this study. Fuel leakage through the nozzles of injection devices create fluid accumulations in the area and implicitly decrease the pressure in the high pressure installation (caused by the lack of tightness inside the injector), a phenomenon that delays the start of the engine.

Keywords: Drops, atomization, jet, gasoline, air speed, Souter Mean Diameter (SMD).

Introduction

Compared to the form of the graph made for the gas speeds V_g obtained in the supercharged engines [1], namely V_g=13÷83 [m/s], in this work you can read the moment of deformations of the fuel drops atomized due to the lower gas speeds, respectively V_g = 1 ÷ 10 [m/s]. Negative values versus the positive values of the Souter Mean Diameter (SMD) found in graphs 3. and 4. exemplifies the meaning of the fuel drop deformation studied. Determining the Souter Mean Diameter (SMD) using the Rayleigh-Taylor method, can be done using the relationships obtained on account of the experimental determinations. Christopher Varga and the collaborators [3] propose the use of the following empirical equation:

$$SMD \cong \frac{0,68\sqrt{\gamma\sigma}\left(\rho_l v_g\right)^{\frac{1}{4}}}{\rho_g^{\frac{3}{4}}\left[V_g\left(1+\sqrt{\frac{\rho_g}{\rho_l}}\right)-V_L\right]V_g^{\frac{1}{4}}} \tag{1}$$

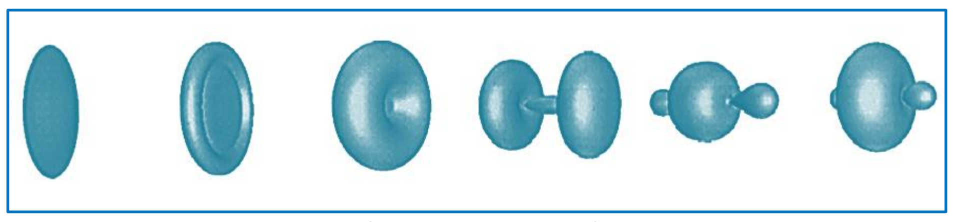

Fig.1. Principles of the drop liquid deformation, example.

When making the graph that indicates the deformation of the drops depending on the gas speed, the speeds found in table 1 were used.

V_L [m/s]	0, 0.5 ... 10
V_g [m/s]	1,2 … 10

Tab. 1. Speeds used in experimental calculation.

Deformation of liquid drops depending on gas speed

To exemplify the shape of the deformation graph of fuel drop atomized fig.4. I used the values in table 1., and for fig.3. gas speed values, namely V_g = 1 ÷ 10 [m/s] [4], comfort of the images in the figure.
The images in figure 3. present the size of the Souter Mean Diameter (SMD) for each deformation stage of the atomized fuel drop depending on the air speed that surrounds the atomized liquid jet during the aspiration during operation.

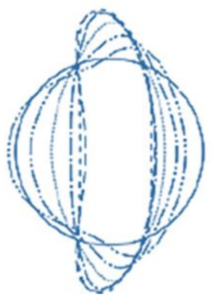

Fig. 2. Deformation of the liquid drop, [2].

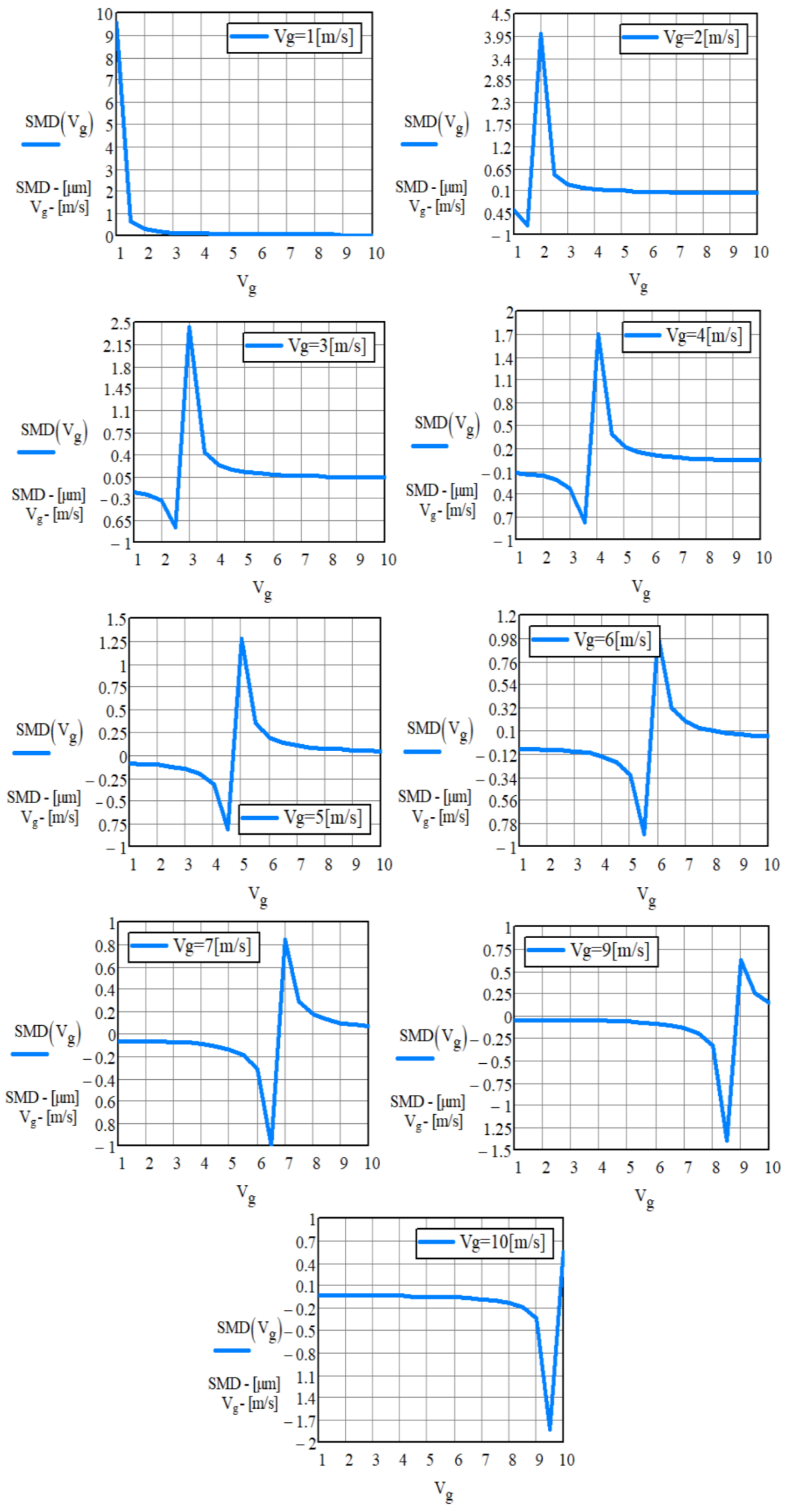

Fig. 3. Deformation of the liquid drop at different gas speeds [4].

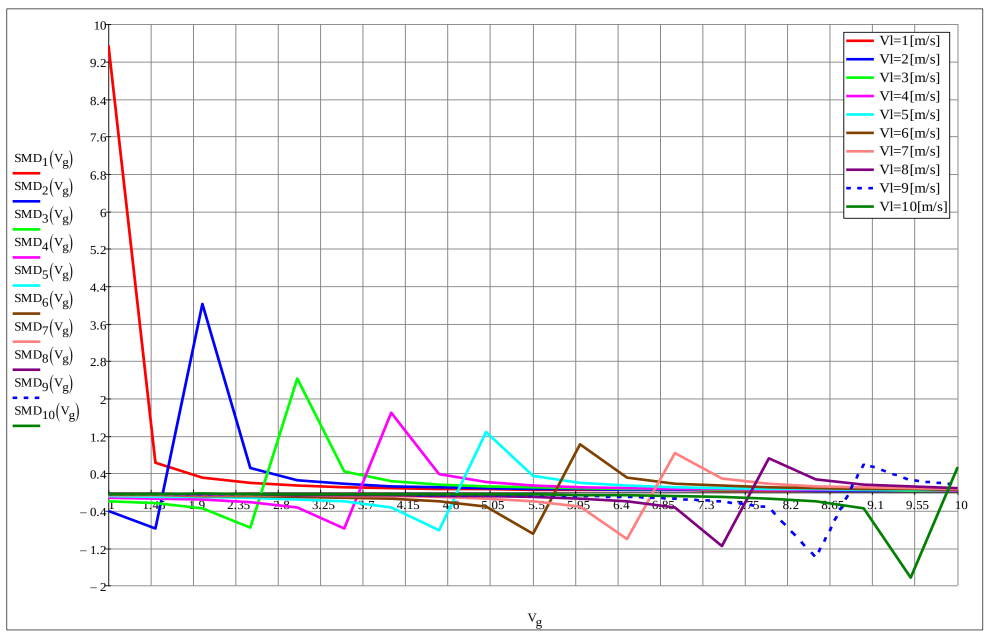

Fig. 4. Deformation of the drops injected liquid jet depending on the gas speed in the intake.

Deformation of liquid drops depending on the speed of atomized liquid

When determining the deformation curves of the liquid drops depending on the speed of the atomized fluid, it is proposed to use the equation (2) which has the following form:

$$SMD\left(V_L,V_g\right) \cong \frac{0,68\sqrt{\gamma\sigma}\left(\rho_l v_g\right)^{\frac{1}{4}}}{\rho_g^{\frac{3}{4}}\left[V_g\left(1+\sqrt{\frac{\rho_g}{\rho_l}}\right)-V_L\right]V_g^{\frac{1}{4}}} \tag{2}$$

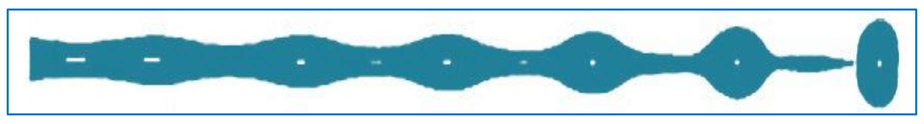

Fig. 5. Axial dismantling of the liquid jet and deformation of the drop.

V_L [m/s]	0, 0.5 ... 12
V_g [m/s]	1,2 … 10

Tab. 2. Speeds used in experimental calculation [4].

Within this chapter, the use of this range of values, V_l = 0 ÷ 12 [m/s] [4], ie up to 12 [m/s] and not up to 10 [m/s] as it is in the previous chapter, it aims to make the beginning of the atomized liquid jet visible, that is, the formation of the first drops of atomized fuel.
The segment of values of the fuel drops speed used in this work, is very close to that of [1] where V_l = 1.8 ÷ 8.8 [m/s], with which we will make procedural comparisons to obtain the experimental data.

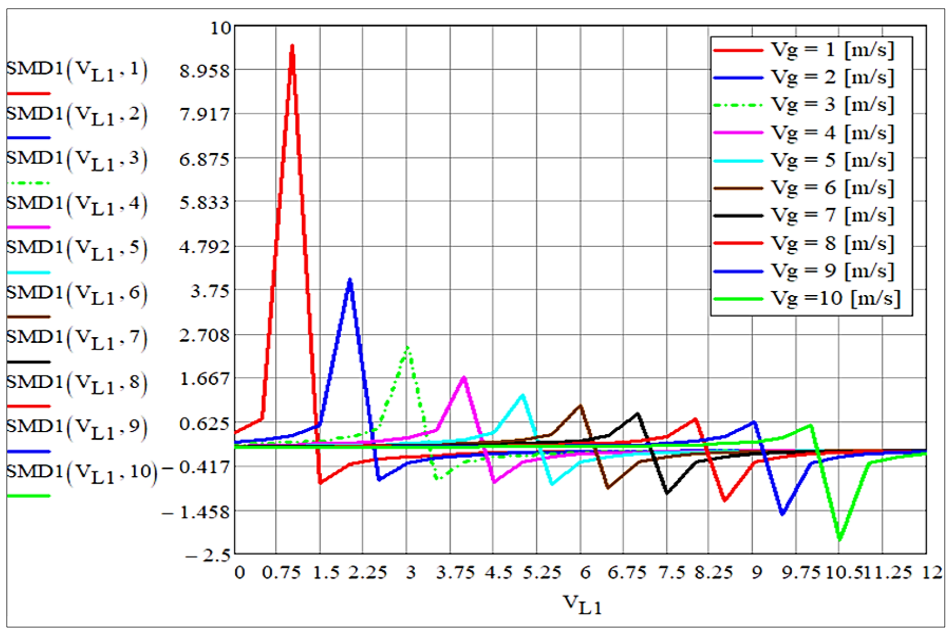

Fig. 6. SMD values depending on the speed of atomized liquid.

Conclusion

This study is discussed about the atomization of the liquid fuel in the internal combustion engines in four strokes equipped with multipoint aspirated injection system (without overload system). This explains the values of the gas speeds and liquid injected into the engine, much lower compared to [1] where the gas speed inserted into the engine is in the segment 13 ÷ 83 [m/s].
Following the previously made determinations, deformations of the drops depending on the air speed and the liquid injected on the segment 0 ÷ 12 [m/s], from which the SMD values according to the curves of the figures 4. and 6. comparative Souter Mean Diameter (SMD).
The calculation model of the modification of the Souter Mean Diameter (SMD) for the drops of atomized liquid fuel, depending on the speed of the gas, is influenced by the speed of the liquid ligaments, which changes on the segment 0÷12 [m/s]. By researching the results obtained in [1], we notice that at a significant increase in the speed of the liquid, a decrease in the Souter Mean Diameter (SMD) appears. This can be explained due to the rapid disturbance of the waves but also the convective heat transfer.
At the aspirated engines we notice that with the increase of the V_g speed, the values of the Souter Mean Diameter (SMD) converge to the low dimensions. So the more the speed, the speed surrounds the drop tire, the smaller the value of the diameter that translates by increasing the quality of the fuel atomization.
It is concluded that in order to obtain a homogeneous mixture in the combustion chamber of the internal combustion engine in four strokes equipped with multipoint injection system, higher pressures of the injected fuel will be used, which leads to an increase in fuel drop speed and implicitly decreased Souter Mean Diameter (SMD) during the formation of the mixture in the combustion chamber.

References

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