ANALYSIS ATOMIZED GASOLINE JETS WITH DIFFERENT PRESSURE ON DIFFERENT TIMES INJECTION

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Abstract: *The article presents analysis using two jet atomized gasoline injectors, one showing high wear and the other operating in normal parameters. The two atomization devices are removed from the internal combustion engine with four-stroke type MAS equipped with multi-point injection system. This system operates at pressures of injection injector tried by the manufacturer, 3 bars, ie 294 kPa, and the value that simulates a faulty pressure of 0.4 bar was established as the equivalent of 39.2 kPa. The inlet temperature of the fuel injector must be stabilized at a value of 20 ± 1.6°C, and the temperature must be the injector body of the enclosure (22 ± 3°C). Standardize the testing conditions requires the adoption of testing equipment with a degree of precision measuring equipment-registration [3], specifying the environmental conditions, the quality of fuel used, the characteristics measured under static and dynamic conditions, the parameters of sustainability and endurance, etc. Leakage of gas through the nozzles of the injectors are generating deposits accumulated in this area and lead to loss of pressure in the high pressure pipes (due to loss of tightness between the needle and seat), which leads to the formation of plugs vapor that prevent or hinder the warm start. Rains may flood runoff intake manifold, the effect is exaggerated enrichment of the mixture before starting. Since gasoline is a mixture of over thirty hydrocarbons, whose proportion varies according to primary source of extraction of crude oil, the conditions for refining the laws of the sulfur and MET (lead adds), etc., properties they may differ radically, particularly in terms of volatility, viscosity and density.*

Keywords: *Atomizing, jet fuel, number of drops, the injection pulse width.*

1. Introduction

The injectors used for research in this paper are eight in number, namely two sets of four pieces taken from two different vehicles, presenting different ages. They are produced by plants Bosch [2].

The first four injectors have been removed from a four-cylinder engine type MAS team a car which had a turnover of 132010 km, with a length of six years, at which the engine will use the normal parameters.

These injectors are presented in the paper as numbered from 1 (one) to 4 (four), bearing the name of *injectors normal operation with low wear*.

The next four injectors have been removed from a car equipped with an engine type MAS also that this operation inconsistent. This vehicle had a length of nine years and six months and present to the board a turnover of 257040 km.

These injectors are presented in the paper as *normal injectors with high wear*.

These two groups of injectors were randomly selected one injector, which were made research.

For the analysis of gasoline atomized jet will use a script and Matlab software [5].

This will provide flow based on the obtained image, a plurality of gas flow parameters [1], [5], as follows:

- The number of drops N_p;
- The average diameter droplet D_{medp};
- The maximum diameter droplet D_{maxp};
- Souter mean diameter SMD;
- Number of voids N_g;
- The average voids diameter D_{medg};
- The maximum diameter of voids D_{maxg};
- Atomized jet area of gasoline Aj;

It will capture images of the stream of gas for injection time values set by the electronic control module that simulates a vehicle computer.

With this device we have been predetermined three values of period ***T***, parameters corresponding to engine speed and three values for adjusting pulse width ***Li***, which corresponds to the variation amount of combulstibil released while the injector is open.

T period*, defined as the time that elapses between the start of injection and start of the next injection.*

Experiment three values were established, setting them as possible potentiometer R_1, called the position of minimum, medium and maximum, noted:

T_1 = 120 *ms;*
T_2 = 380 *ms;*
T_3 = 640 *ms.*

Li pulse width *defined as the time dedicated injector actuation command.*

Experiment three values were established, setting them as possible potentiometer R2, called the position of minimum, medium and maximum, noted:

Li_1 = 1.5 *ms;*
Li_2 = 7.2 *ms;*
Li_3 =13.0 *ms.*

2. Matlab image analysis obtained atomization jets

The figure below shows the program interface used to obtain the values that make this analysis study.

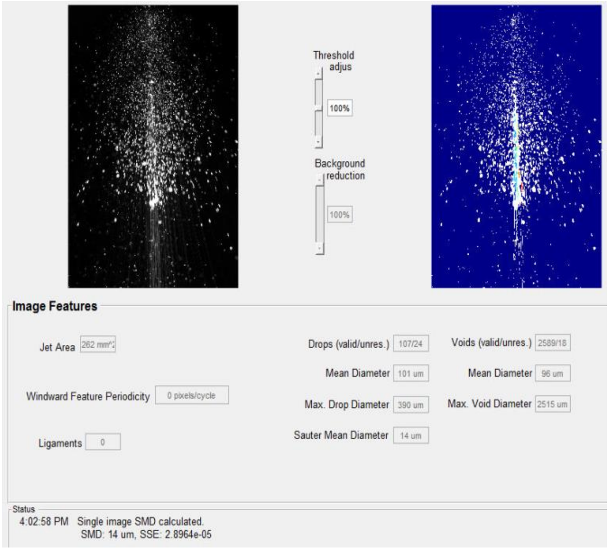

Figure 1: *Picture transposed into Mathlab atomized jet fuel [5].*

2.1. Injectors normal operation case with low wear test at low pressure

The study of the process of atomization injector with low wear with the malfunction was carried out at a low pressure, P = 39.2 *kPa* may coincide with the wear on the pump power, loss of fuel from the plant or other defects involving loss of fuel pressure.

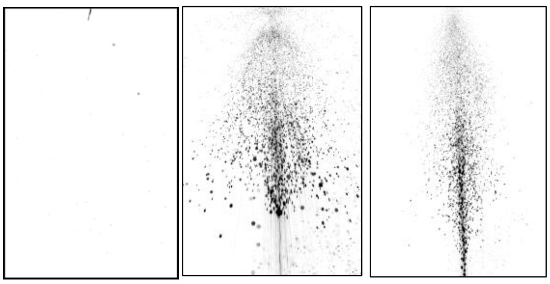

Figure 2: *Photos settings T_1Li_{123} on pressure P=39.2 kPa*

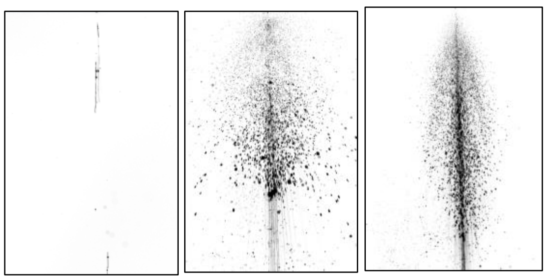

Figure 3*: Photos settings T_2Li_{123} on pressure P=39.2 kPa*

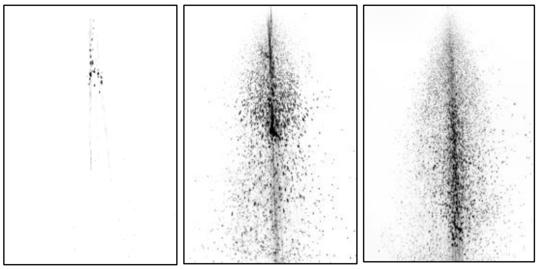

Figure 4: *Photos settings T_3Li_{123}*
On pressure P=39.2 kPa

2.2. Injectors normal operation case with low wear test at nominal pressure

The study injector atomization process with low wear with normal operation was carried out at a working pressure of 294 kPa.

This parameter is rated pump pressure supply gasoline equipping a wide range of systems multipoint injection type, on internal combustion engines.

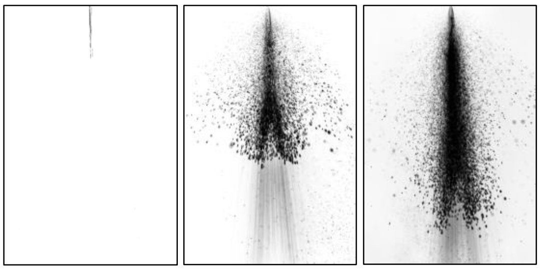

Figure 5: *Photos settings T_1Li_{123}*
on pressure P=294 kPa

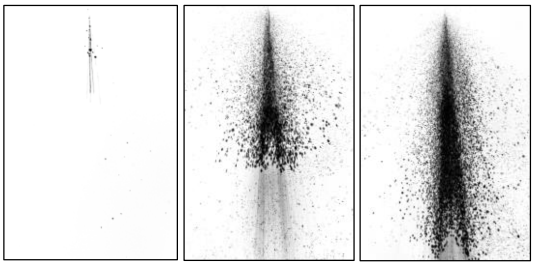

Figure 6: *Photos settings T_2Li_{123}*
on pressure P=294 kPa

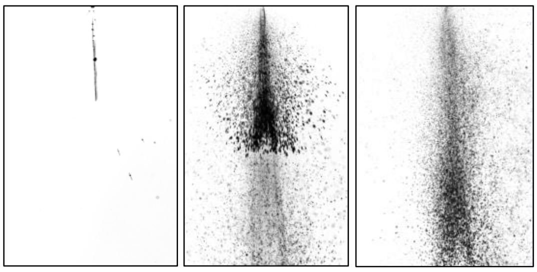

Figure 7: *Photos settings T_3Li_{123}*
on pressure P=294 kPa

2.3. Injectors normal operation case with high wear test at low pressure

The study injector atomization process with low wear malfunctioning was done at a low pressure, P = 39.2 *kPa* which may coincide with some flaws, as mentioned before.

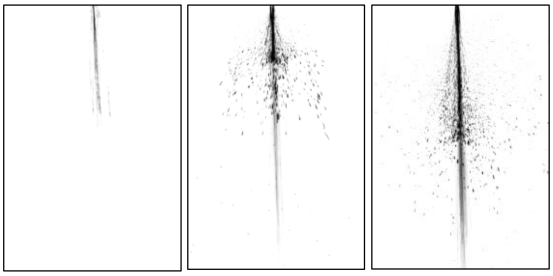

Figure 8: *Photos settings T_1Li_{123}*
on pressure P=39.2 kPa

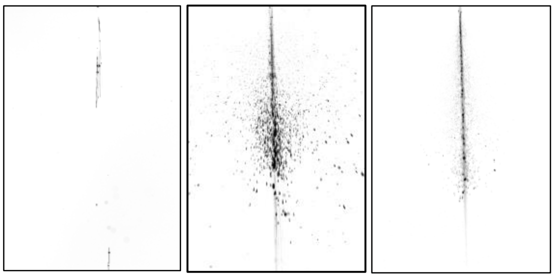

Figure 9: *Photos settings T_2Li_{123}*
on pressure P=39.2 kPa

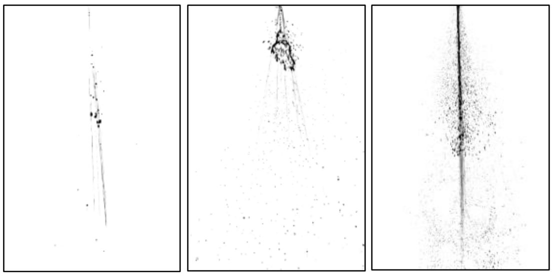

Figure 10: *Photos settings T_3Li_{123}*
on pressure P=39.2 kPa

2.4. Injectors normal operation case with high wear test at nominal pressure

Analysis injector atomization process with high wear with normal operation was carried out at a working pressure of 294 kPa.

As previously, this parameter is rated pump pressure supply gasoline engines on internal combustion.

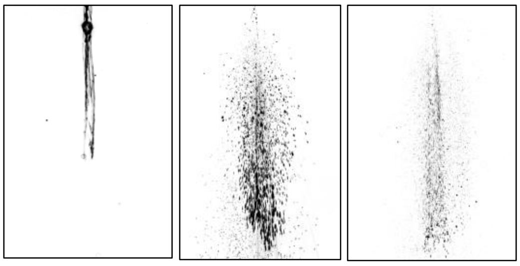

Figure 11: *Photos settings T_1Li_{123} on P=294 kPa*

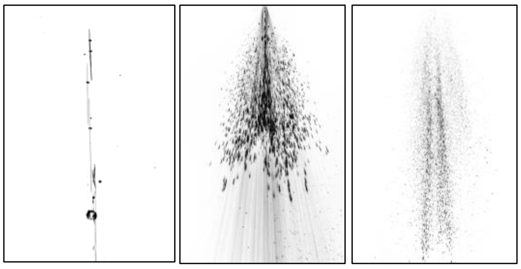

Figure 12: *Photos settings T_2Li_{123} on P=294 kPa*

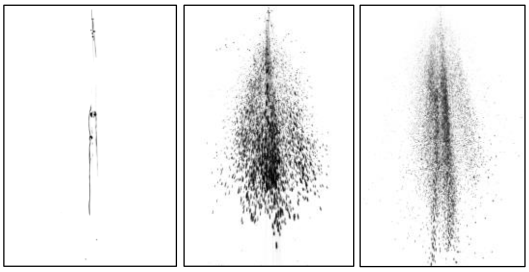

Figure 13: *Photos settings T_3Li_{123} on P=294 kPa*

3. Graphical representations of parameters analyzed injectors

This chapter quantified parameters provided by the software Matlab during analysis atomized jet fuel.

3.1. Injectors normal operation case with low wear

The following tables are cumulative injector parameters showing wear low data that is provided by the software Matlab [5] and Mathcad [4].

Tab. 1. Injectors with low wear with P=39.2 kPa.

Set	N_p	D_{medp} [µm]	D_{maxp} [µm]	SMD [µm]	N_g	D_{medg} [µm]	D_{maxg} [µm]	A_j [mm²]
T_1Li_1	5	39	57	4	19	53	133	12
T_1Li_2	46	105	397	5	2440	95	2267	265
T_1Li_3	88	123	479	17	3860	92	628	793
T_2Li_1	10	47	105	3	15	58	125	15
T_2Li_2	107	101	390	14	2589	96	2515	262
T_2Li_3	289	91	555	16	3274	97	753	613
T_3Li_1	38	54	180	5	60	150	1079	32
T_3Li_2	160	86	271	17	1971	112	3252	251
T_3Li_3	347	108	561	26	4914	87	718	605

Tab. 2. Injectors with low wear with P=294 kPa.

Set	N_p	D_{medp} [µm]	D_{maxp} [µm]	SMD [µm]	N_g	D_{medg} [µm]	D_{maxg} [µm]	A_j [mm²]
T_1Li_1	11	76	120	8	16	79	125	21
T_1Li_2	247	85	276	17	1659	167	5624	341
T_1Li_3	349	112	497	22	1879	243	9585	506
T_2Li_1	37	58	114	8	27	184	857	18
T_2Li_2	246	95	571	16	2535	144	5819	363
T_2Li_3	563	168	3118	18	3337	109	785	528
T_3Li_1	38	58	182	7	48	114	587	26
T_3Li_2	216	80	372	14	3021	128	4960	267
T_3Li_3	813	135	1867	35	6173	95	1705	574

Curves of comparison between the number of drops and number of spaces available at jet atomized gasoline injector with low wear are presented in the following two charts.

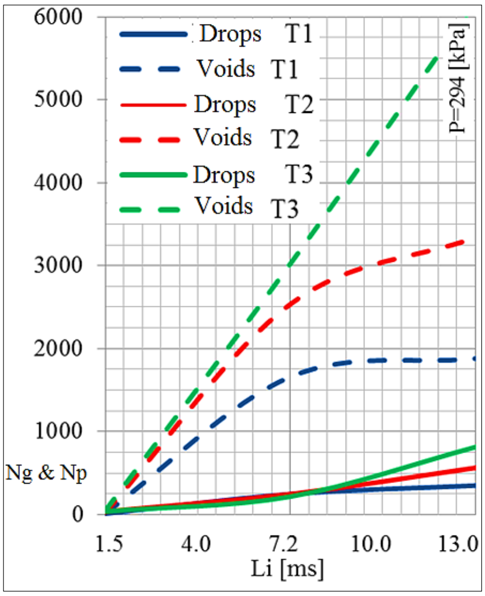

Figure 14: *N_p and N_g depending on the pulse width Li.*

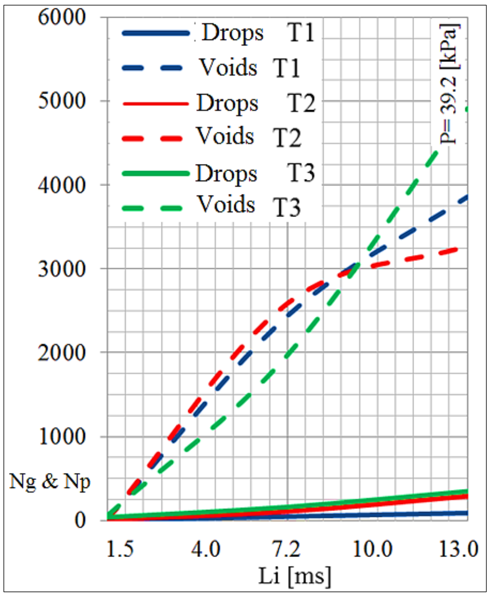

Figure 15: *N_p and N_g depending on the pulse width Li.*

3.2. Injectors normal operation case with high low wear

In the tables below are cumulative injector parameters showing high wear for both work pressures, values that are provided by the software Matlab.

Tab. 3. Injectors with high wear with P=39.2 kPa.

Set	N_p	D_{medp} [µm]	D_{maxp} [µm]	SMD [µm]	N_g	D_{medg} [µm]	D_{maxg} [µm]	A_j [mm²]
T_1Li_1	19	59	150	4	5	47	81	50
T_1Li_2	64	66	243	7	425	72	230	123
T_1Li_3	88	79	296	12	832	73	434	180
T_2Li_1	20	66	161	5	8	39	72	56
T_2Li_2	66	83	402	10	730	73	451	118
T_2Li_3	105	69	241	11	1229	86	449	385
T_3Li_1	18	69	253	3	42	287	1763	101
T_3Li_2	68	96	263	11	575	73	270	182
T_3Li_3	116	85	344	11	2201	73	431	336

Tab. 4. Injectors with high wear with P=294 kPa.

Set	N_p	D_{medp} [µm]	D_{maxp} [µm]	SMD [µm]	N_g	D_{medg} [µm]	D_{maxg} [µm]	A_j [mm²]
T_1Li_1	13	61	140	4	32	38	101	22
T_1Li_2	67	107	349	10	1066	103	2426	120
T_1Li_3	300	138	997	19	3667	99	4198	378
T_2Li_1	13	97	218	7	55	69	312	29
T_2Li_2	111	85	319	12	464	161	2660	85
T_2Li_3	516	102	1022	22	4713	110	5045	502
T_3Li_1	18	67	206	3	50	174	1064	54
T_3Li_2	203	83	281	14	912	146	3211	129
T_3Li_3	722	106	645	29	3786	128	5923	486

In the figure below are graphical representations of the number of drops compared to the number of voids (blanks), injector with high wear.

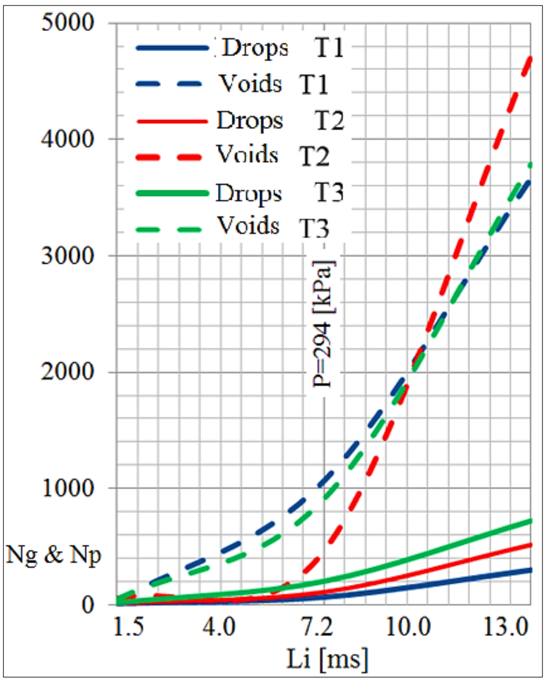

Figure 16: *N_p and N_g depending on the pulse width Li.*

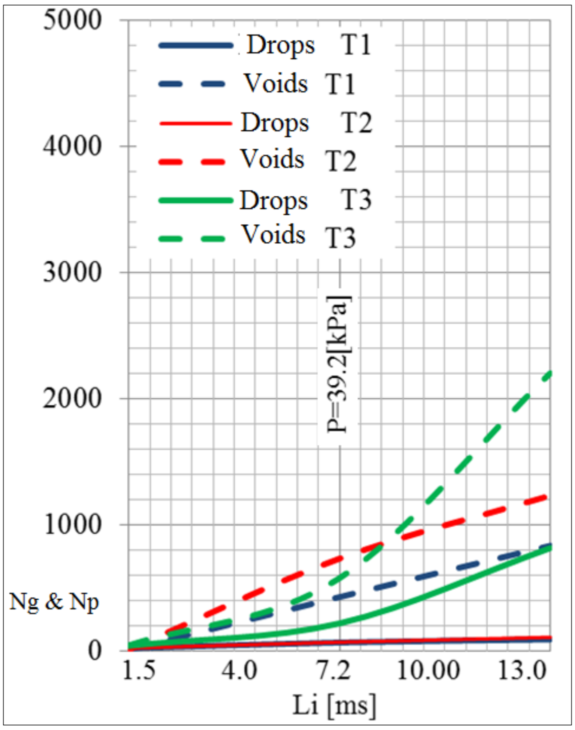

Figure 17: *N_p and N_g depending on the pulse width Li.*

The following figures are represented curves Souter mean diameter (SMD) to the injectors surveyed in each of the two working pressures.

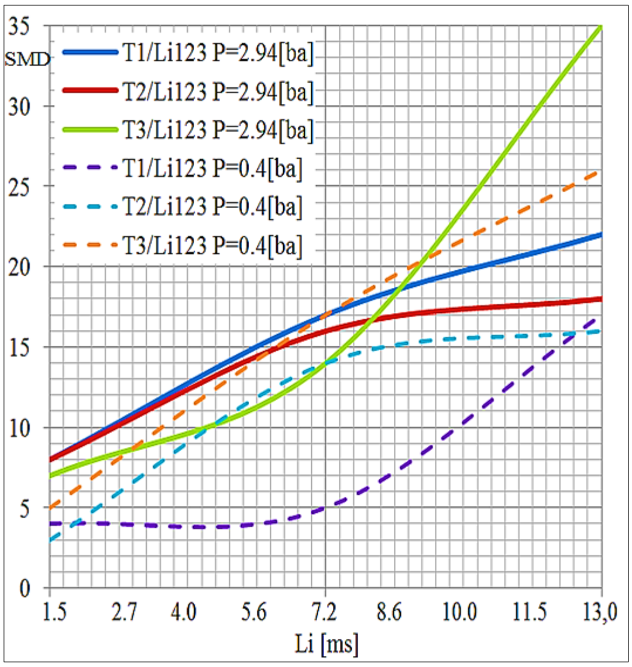

Figura 18: *Graphical representation of values SMD injector with low wear on the three values of pulse width Li.*

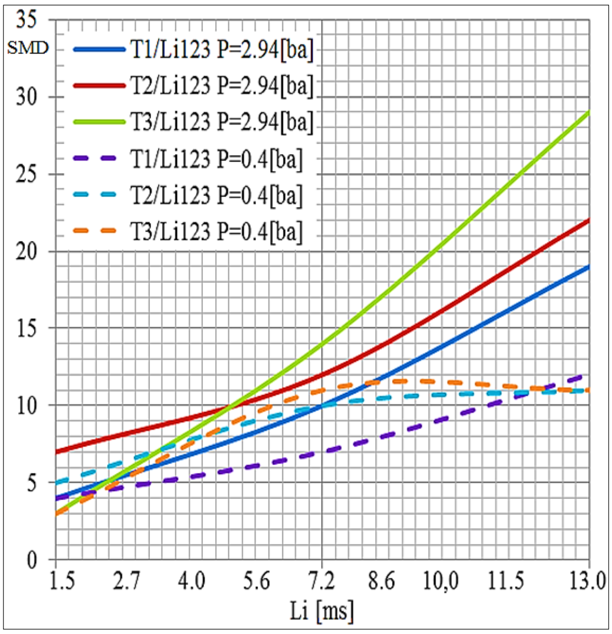

Figura 19: *Graphical representation of values SMD injector with high wear on the three values of pulse width Li.*

4. Conclusions

Use of the electronic control assembly, which were made settings to perform this work, has the primary purpose of changing the size of the operating values during the test injector. Operating similar to the type of internal combustion engine with multipoint injection, on the market.

These changes translate into variations in the quantity of fuel injected per unit time and time start and end of injection, to those provided by the construction of the engine by the manufacturer.

According to data obtained injector with high wear in Figure 16 where the rated working pressure using P = 294 *kPa*, the difference between the number of drops N_p and N_g number of voids is highlighted visible towards the end of pulse length Li.

This observation can observe and study injector wear low tested in both operating pressures P = 294 *kPa* and P = 39.2 *kPa*, specifying that this injector curve is shaped decreasing, while injector with high wear curves have a shape ascending from the beginning of the pulse length Li.

This observation translates into a larger segment of impulse length Li that we have a superior form of gas atomized jet (atomization almost complete).

Figure 20 is highlighted area previously explained, both pressures.

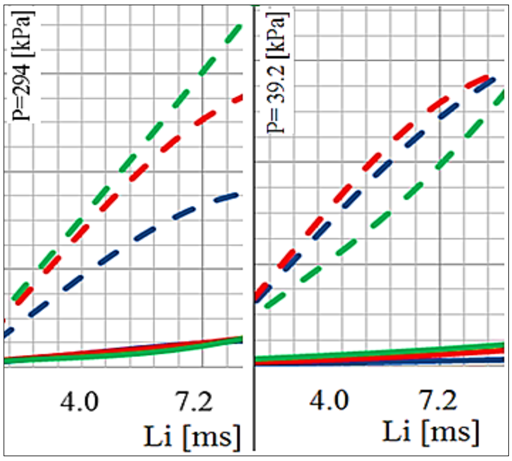

Figure 19: *Li segment of the quality atomization*

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[3] www.flir.com (vizualizat septembrie 2016).

[4] Mathcad 14, *Licensed to: Stefan cel Mare University, Partially Product Code JE140709XX2311-XXD9-7VXX*.

[5] Matlab Simulink 2008b, *Licensed to: Stefan cel Mare University, License No. 564227*.