LOGIC
Journal of Engineering Design and Technology
Vol. 20 No.2 July 2020; p. 113 - 117

p-ISSN : 1412-114X
e-ISSN : 2580-5649
http://ojs.pnb.ac.id/index.php/LOGIC

CHARACTERISTICS TEST OF DIESEL FUEL PROTECTION ON NOZEL MAINTENANCE, ISUZU PANTHER MACHINE EARLY GENERATION

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Abstract. Even though it is old / old, the existence and existence of Isuzu Panther cars in the 90s are still widely used, this is because in addition to the well-known / tested engine stubborn but also fuel efficient. To maintain the condition of the engine to stay fit, vehicle owners must pay attention to the maintenance of their cars regularly. One engine component that is vital and must receive special care is the Nozzle. The treatment of the nozzle is physical condition checking, cleaning and proper testing. This test is done by giving pressurized fuel to the nozzle, then we observe and analyze how the character of the spray. Testing pressure variations of 90 bar, 100 bar, 110 bar, 120 bar, and 130 bar (range of nozzle working pressure from the factory) using diesel, The characteristics of the fuel spray tested are the length of the spray penetration tip (L), speed spray (v or Uin), spray angle (Ѳ), and large distribution of granules formed at each pressure variation. From the test it is known, at 110 bar testing pressure has the best characteristics, both in terms of spray and the number of grains.

Keywords : Pressure nozzle, the length of the spray, spray time, spray angle, the distribution of grain.

1. INTRODUCTION

The treatment of the nozzle is physical condition checking, cleaning and proper testing. This test is done by giving pressurized fuel to the nozzle, then we observe and analyze how the character of the spray. Test pressure variations of 90 bar, 100 bar, 110 bar, 120 bar, and 130 bar (range of the nozzle working pressure from the factory [1]) using diesel, The characteristics of the fuel spray tested are the length of the spray penetration tip (L), speed spray (v or Uin), spray angle (Ѳ), and large distribution of granules formed at each pressure variation.

The test aims to determine the pressure that has the best characteristics, both from the angle of the spray and the number of grains.

In testing data from video camera observations in the form of: Spray penetration tip length (L), Penetration tip speed (Uin), Spray angle (Ѳ), Spray area area (A), and diameter size distribution of the grain / droplet (D) that occur on fuel spray. To be able to find the values of the spray characters mentioned above, the raw data is then changed in the format (jpg).

2. METHODS

In conducting the test, the test equipment is made similar to the original diesel engine spray system. The series of simulation tools can be seen in Figure 1 below:

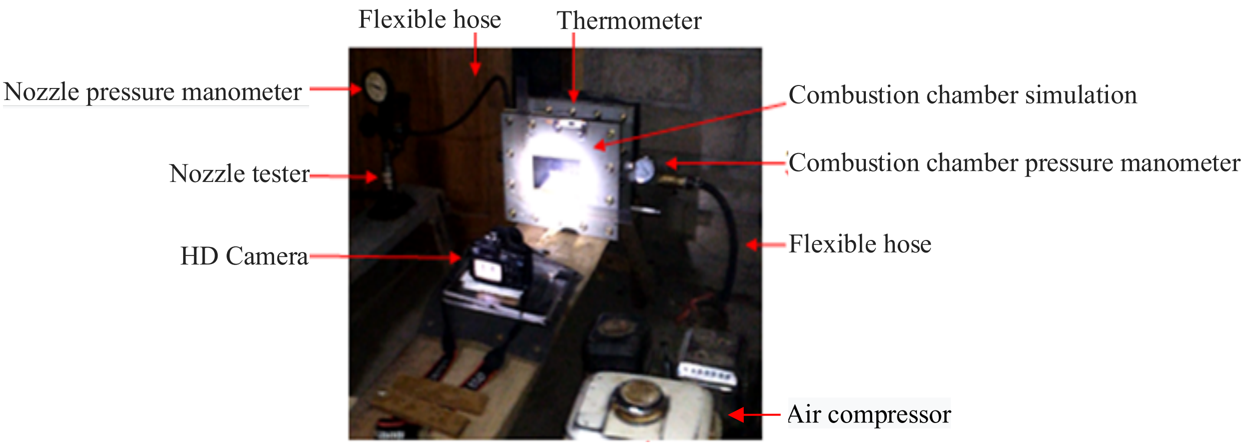

Figure 1. Photograph of the spray tool used in the test

To get the right spray, an injection tester / nozzle is used as a source of pressure, the injector or nozzle as a fogger and a beam-shaped test chamber that has conditions similar to the actual combustion chamber, then the fuel that enters the combustion chamber simulation is recorded with high divination (HD) the camera to get the image of the spray angle, grain size, and length of the spray [2].

3. RESULTS AND DISCUSSION

3.1. Research data

Research data obtained from video camera observations are as follows, Spray penetration tip length (L), penetration tip speed (Uin), spray angle (Θ), and diameter size distribution of the droplet / D (grain) that occurs in the oil spray material burn it. To be able to find the value of the spray character mentioned above, the raw data is then changed in the format (jpg). Figure 2 shows a spray of test results that has been converted to an image format (jpg).

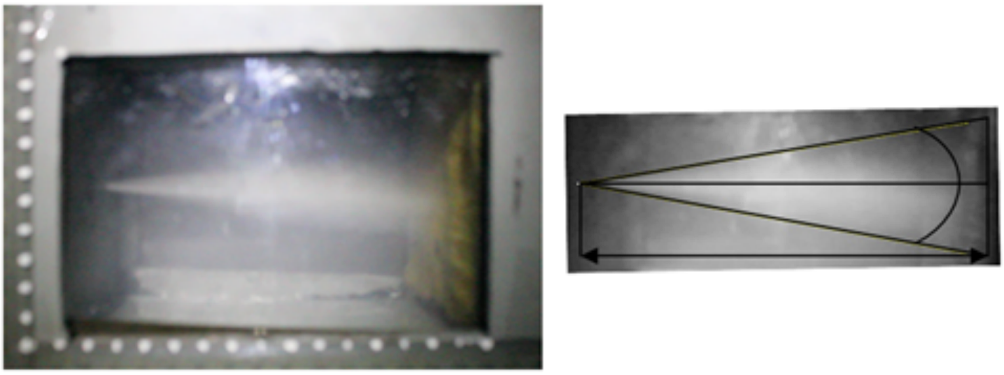

Figure 2. Initial spray data processing with Image J program

3.2. Data processing

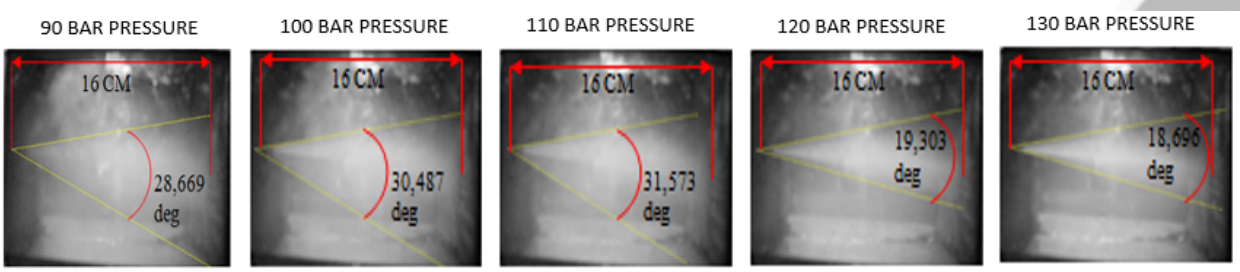

Figure 3. Measurement of angle and length of each test variation

The length of the spray penetration tip (L) formed in each of the tests mentioned above shows a length of 160 mm (the spray reaches the test chamber wall) and has a varying speed for its formation, different penetration for each test [3]. The following is a complete table of the spray results that occur in each test.

Table 1. Angle data, spray velocity and length for each variation of the nozzle pressure

No	Pressure P (Bar)	Angle Θ (Deg)	Distance L (10^{-3}m)	Time T (10^{-3}s)	Speed V (m/s)
1	90	28,67	160	54,95	2,91
2	100	30,49	160	47,95	3,34
3	110	31,57	160	44,95	3,56
4	120	19,3	160	41,95	3,81
5	130	18,7	160	37,95	4,22

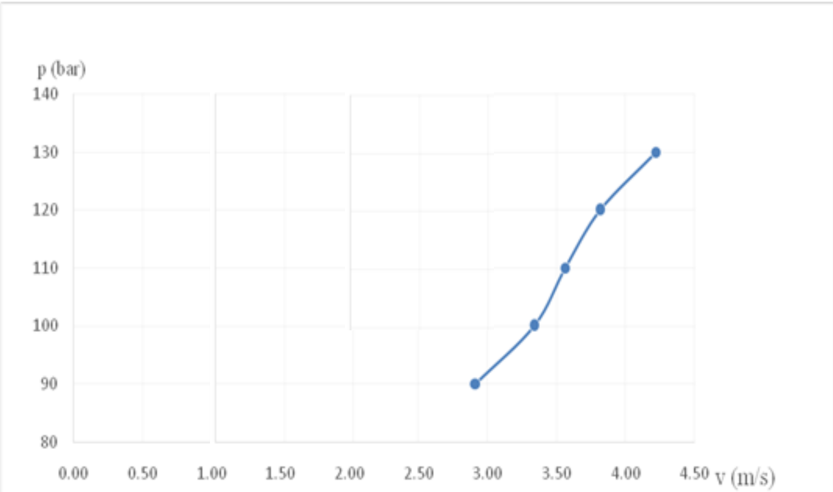

Figure 4. Graph of influence of nozzle pressure variation on the nozzle spray speed

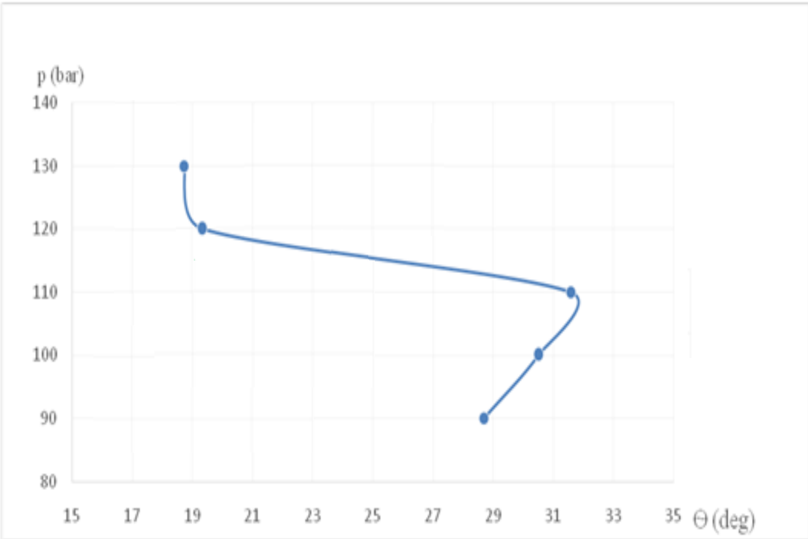

Figure 5. Graphic Effect of nozzle pressure variations on the nozzle spray angle

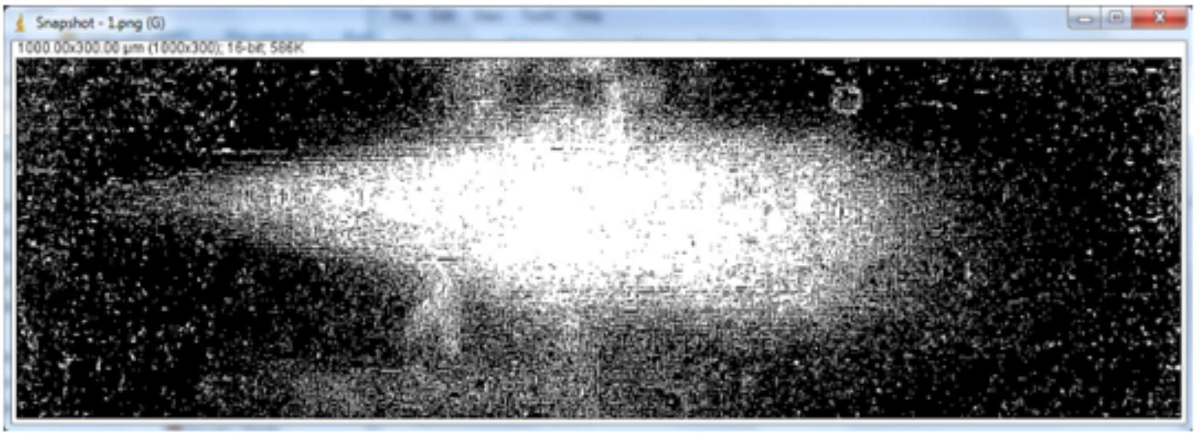

Figure 6. Results of data processing using the Image J program

Table 2. Total data distribution of granules for each test oil.

No	Nozzle Pressure (Bar)	Number of grains (n)	D Min (μm)	D Min %	D Max (μm)	D Max %	Total Area (μm^2)
1	90	3968	2,31	46,40	20,24	0,03	15.463,58
2	100	4285	2,31	44,43	23,29	0,02	17.089,23
3	110	4651	2,31	48,72	26,50	0,02	19.041,12
4	120	3830	2,31	48,77	36,10	0,03	16.365,67
5	130	3657	2,31	53,57	25,27	0,03	13.525,47

It can be seen from the table that the greater the pressure on the nozzle will have an impact on increasing the tip tip speed, the lowest tip tip speed is found at the 90 bar nozzle pressure where the tip tip penetration value is only about 2.91 m / s far smaller than the speed value at 130 bar nozzle pressure.

Theoretically the length of this penetration tip can also be estimated using equation 1 [4], and the results obtained as the table below:

$$\frac{L}{L_b} = 0.0349\left(\frac{\rho_a}{\rho_l}\right)^{\frac{1}{2}}\left(\frac{t}{do}\right)\left(\frac{\Delta p}{\rho_l}\right)^{1/2} \quad \ldots\ldots 1$$

$$L = 83,61 \; x \; 0,0349 \left(\frac{1,2}{840}\right)^{\frac{1}{2}}\left(\frac{54,95}{0,2}\right)\left(\frac{0,9 \; x \; 10^6}{840}\right)^{\frac{1}{2}}$$

L = 307 mm

Table 3. Difference in the length of tip penetration test results with the results of theoretical calculations

No	Pressure (Bar)	Actual distance (mm)	Time (ms)	Time (s)	Theoretical distance (mm)
1	90	160	54,95	0,05495	306,76
2	100	160	47,95	0,04795	297,43
3	110	160	44,95	0,04495	306,70
4	120	160	41,95	0,04195	312,25
5	130	160	37,95	0,03795	306,02

The penetration tip length obtained through calculations has a difference with the length of the penetration tip obtained by testing, this can be due to limitations in this study both in terms of testing tools, software, and the level of accuracy of the scale in the testing data processing which is done manually.

For the theoretical spray angle, you can use equation 2 [4], as follows:

$$\theta = 0.05 \left(\frac{\Delta p d_0^2}{\rho_a v_a^2}\right)^{1/4} \quad \text{......2}$$

$$\theta = 0.05 \left(\frac{0{,}9x10^7 .\, 0.002^2}{840x5{,}724x10^{-6}}\right)^{\frac{1}{4}}$$

θ = 16,35^{O}

While the velocity (v or Uin) of the spray can be estimated theoretically using equation 3 [3] :

$$U_{in} = C_d \sqrt{\frac{2\Delta P_{inj}}{\rho_L}};\ \rho_a = \frac{\rho_a}{\rho_L} \quad \text{......3}$$

$$Uin = 0{,}08 \sqrt{\frac{2\,x\,0{,}9\,x\,10^6}{840}}$$

Uin= 3,70 m/s

While the average diameter value of this spray can be calculated using the Sauter Mean Diameter (SMD) equation 4 [5] :

$$SMD = 10^{-3} \left[\frac{\sqrt{(\sigma \rho_L)}}{\rho_a v_a}\right] \left(1 + \frac{1}{AFR}\right)^{0{,}5} + 6\,x\,10^{-5} \left[\frac{\mu_L^Z}{\sigma \rho_a}\right]^{0.425} \left(1 + \frac{1}{AFR}\right)^{0{,}5} \quad \text{......4}$$

$$SMD = 10^{-3} \left[\frac{\sqrt{(0.068x940)}}{1.2x103.55}\right] \left(1 + \frac{1}{10}\right)^{0.5} + 6\,x\,10^{-5} \left[\frac{(5{,}724x10^{-6})^2}{0.068x1.2}\right]^{0.425} \left(1 + \frac{1}{10}\right)^{0.5}$$

SMD = 67.48 µm

4. CONCLUSION

From the tests that have been done, it can be concluded that at a pressure of 110 bar has the best characteristics, both from the angle of the spray and the number of grains.

5. ACKNOWLEDGEMENT

Finally, I would like to thank everybody who was important to the successful realization of this paper. This paper is far from perfect, but it is expected that it will be useful not only for the researcher, but also for the readers. For this reason, constructive thoughtfull suggestion and critics are welcomed.

6. REFERENCES

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