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Comparative Result Analysis on Test Line Matching of Common Rail Injector Relocation

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ABSTRACT

In this paper there are comparisons of different-different measurements like armature lift, residual air gap etc. between accepting plant and releasing plant. This measurement of comparisons between two plants are very much essential in such way that, to reduce deviation of products and set the setting parameters for each and every station of assembly and test line. The obtained results from measurements are then compare with releasing plant results if these measurements are within acceptable limit or specified tolerance then there is no deviation in the product. All this long process is called as assembly line and test line matching process. This is low volume investigation which saves time and cost of product. Aim behind this relocation is cost saving, manufacturing and labor cost is high compare to accepting plant so it is cost reduction and beneficial to organization

Keywords— line matching, CRI, Relocation

1. INTRODUCTION

Common rail injector is part of diesel fuel injection system. The common rail system consists of following component group: The Low-pressure system comprising the components fuel supply system like Fuel tank, fuel filter, water separator, heater etc. The high-pressure system comprising of the high-pressure pump, common rail, injectors, and electronic diesel control (EDC). The main advantage of common rail system is its ability to vary its injection pressure and timing over a broad scale. This was achieved by separating pressure generation (in the high-pressure pump) from the fuel injection system (injectors). The rail acts as a pressure accumulator.

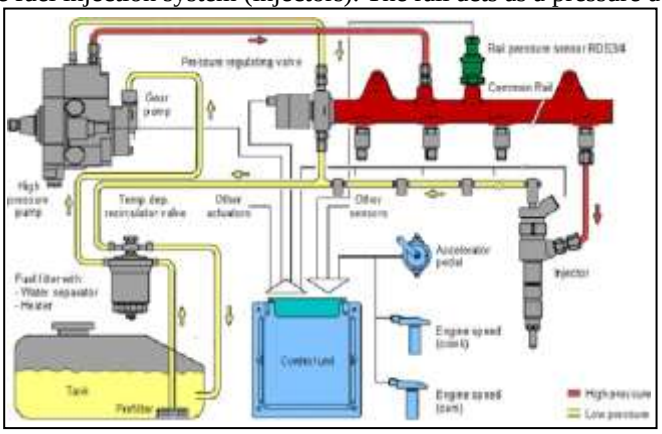


Figure 1. Common rail fuel injection system

2. TEST LINE MATCHING

A. Test Line

Basically Target of the test line matching process is to ensure that the differences between the test lines of the two plants are within the tolerances of the control system. Test line is start with high pressure leak test and with packing. All static measurement is done at test line. There are three stations to measure injected quantity (mm^3/stroke) of injector and all these three station are same. Injectors are tested at full load 1600 bar 800 µs . After full load injectors are tested at pilot 1200 bar 230 µs, emission 600 bar 630 µs, pilot 600 bar 275 µs and at low idel 300 bar 640 µs, full load back flow 1600 bar 800 µs.All these cycles are repeated for 50 numbers of times to ensure that whether these injectors are inject same quantity as per data sheet. All injectors are tested for high voltage resistance test at station no.13. Back flow connector clip is assembled on injector at station no.14. Test oil inside injector is suck and magnet group, nozzle retaining nut torque is check at station P_1. At station no.P_2 'O' ring and copper washer is inserted inside injector body, visual inspections are done on next station. Sorting and final packing injector are done at last station.

Steps followed for test line matching are as shown in Figure 2.

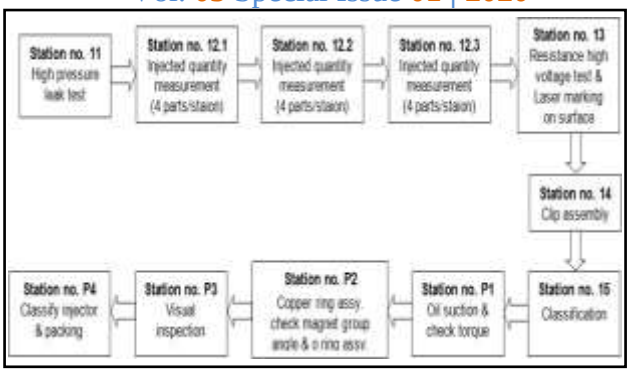


Figure 2. Test Line

B. *Test Line Matching Procedure*

$$x_{up3} = \bar{x} + 3s = 61.54$$
$$x_{lo3} = \bar{x} - 3s = 55.59$$

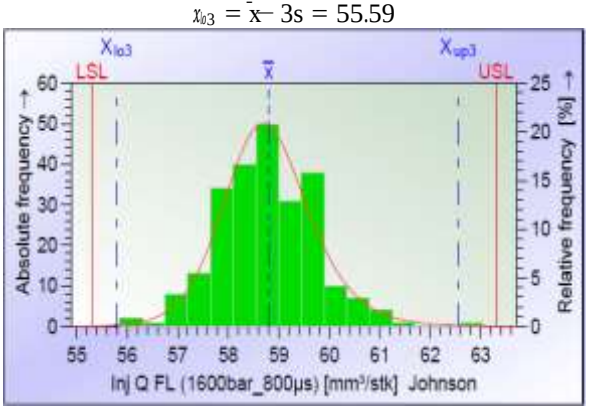


Figure 5. Test line matching Result Plant B

Plant B Pilot 2

$$\bar{x} = 58.81 \text{ mm}^3\text{/stroke}$$
$$S = 0.99$$
$$x_{up3} = \bar{x} + 3s = 62.57$$
$$x_{lo3} = \bar{x} - 3s = 55.88$$

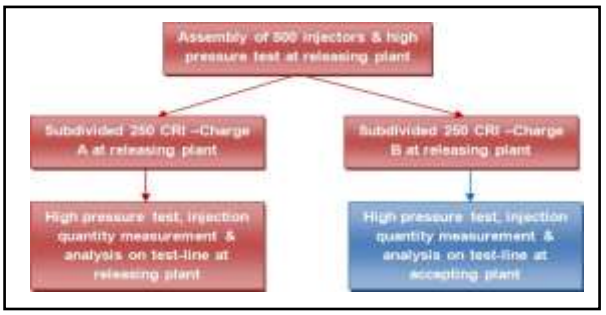


Figure 3. Test line matching procedure

500 injectors are manufactured at releasing plant and sub divided in to two sets of 250-250 injectors by zipper method. Charge 'A' of 250 injectors is tested at releasing plant and charge 'B' at accepting plant. Both charges are tested at high pressure test and injection quantity measurement for all cycles.

3. TEST LINE MATCHING RESULTS

The test data sheet consists of multiple injection point and injection quantity with tolerance. The cycle divided into main three phase's pre-injection (pilot injection), main injection and post injection.

A. Full Load 1600bar_800 µs for Plant A & Plant B

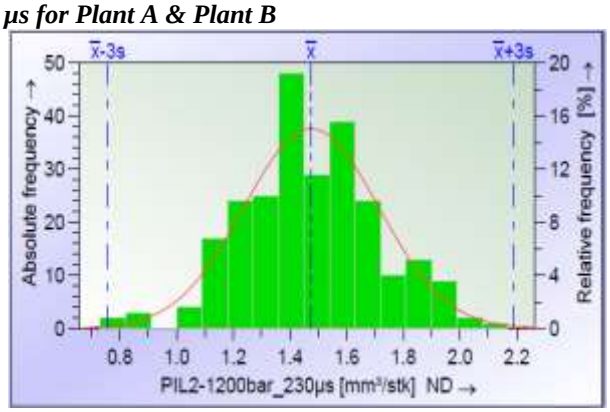


Figure 6. Test line matching Result Plant A

Plant A pilot 2

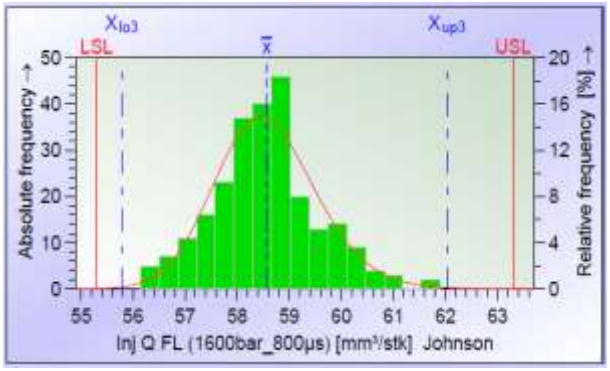


Figure 4. Test line matching Result Plant A

Plant A Pilot 2

$\bar{x}$ = 1.47 mm³/stroke

S = 0.24

x_{up3} = x̄+ 3s = 2.19

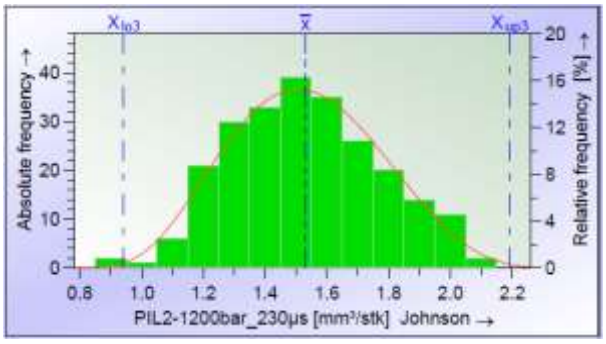


Figure 7. Test line matching Result Plant B

x_{lo3} = x̄− 3s = 0.75

$\bar{x}$ = 58.56 mm³/stroke

S = 0.99

Plant B pilot 2

$\bar{x}$ = 1.53 mm³/stroke

S = 0.2

x_{up3} = x̄+ 3s = 2.13

x_{lo3} = x̄− 3s = 0.93

D. Pilot cycle measurement at 600 bar and275 µs for Plant A & Plant B

C. Emission cycle measurement at 600 bar and 630 µs for Plant A & Plant B

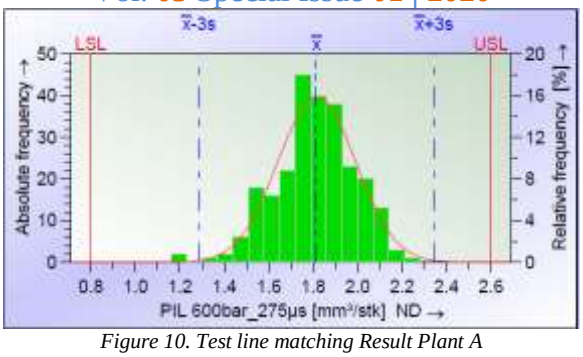


Figure 10. Test line matching Result Plant A

Plant A Pilot

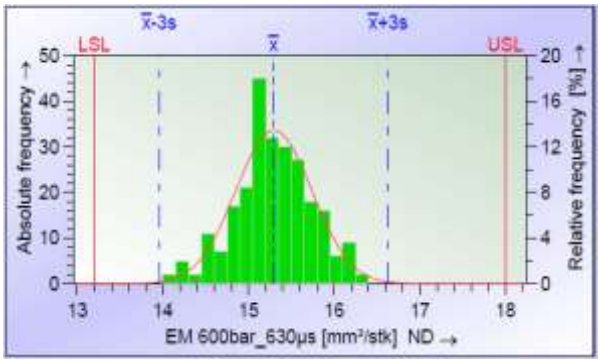


Figure 8. Test line matching Result Plant A

$\bar{x}$ = 1.81 mm³/stroke
USL = 2.60 mm³/stroke
LSL = 0.80 mm³/stroke
S = 0.18
x_{up3} = x̄+ 3s = 2.33

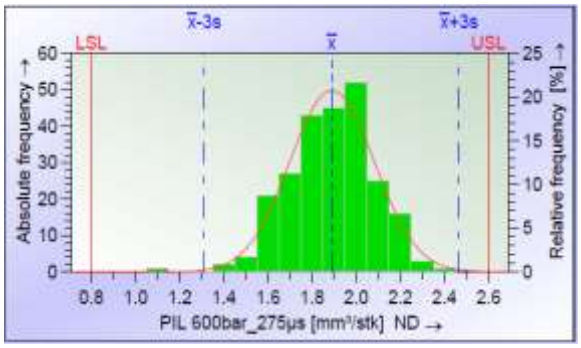


Figure 11. Test line matching Result Plant B

x_{lo3} = x̄− 3s = 1.28

Plant A Emission

$\bar{x}$ = 15.29 mm³/stroke
USL = 18 mm³/stroke
LSL = 13.2 mm³/stroke
S = 0.44
x_{up3} = x̄+ 3s = 16.625
x_{lo3} = x̄− 3s = 13.955

Plant B Pilot

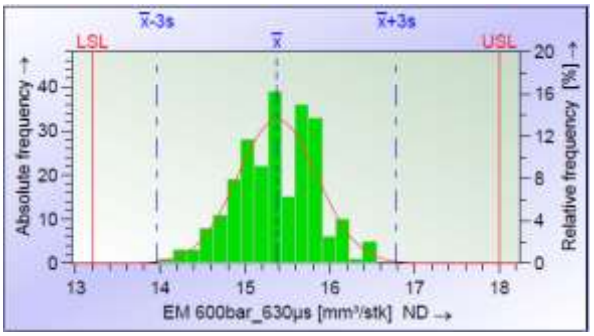
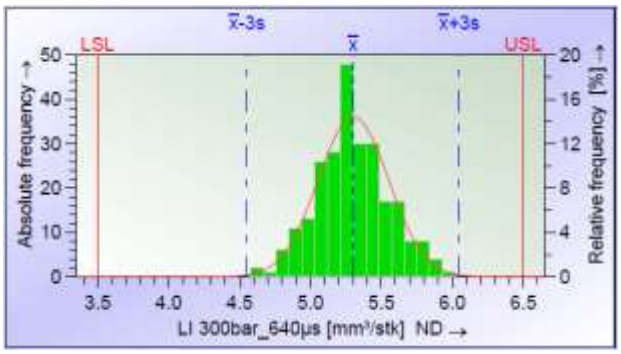


Figure 9. Test line matching Result Plant B

Plant B Emission

$\bar{x} = 1.89\,mm^3/stroke$
$USL = 2.60\,mm^3/stroke$
$LSL = 0.80\,mm^3/stroke$
$S = 0.195$
$x_{up3} = \bar{x} + 3s = 2.475$
$x_{lo3} = \bar{x} - 3s = 1.305$

E. Low idle at 300 bar pressure and 640 µs for Plant A & Plant B



$\bar{x} = 15.38\ mm^3/stroke$
$USL = 18\ mm^3/stroke$
$LSL = 13.2\ mm^3/stroke$ S = 0.47
$x_{up3} = \bar{x} + 3s = 16.79$
$x_{lo3} = \bar{x} - 3s = 13.97$

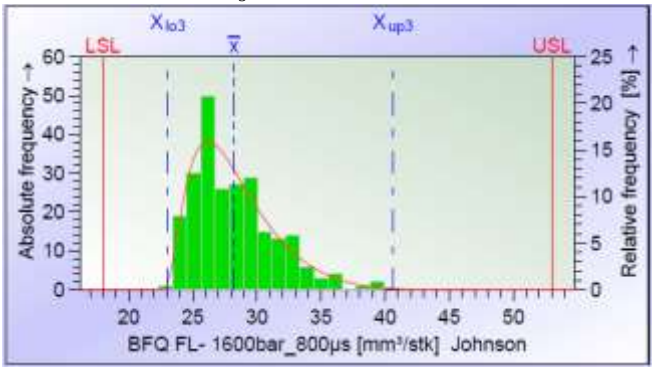


Figure 12. Test line matching Result Plant A

Plant A Low Idle

$\bar{x} = 5.30\ mm^3/stroke$
$USL = 6.5\,mm^3/stroke$
$LSL = 3.5\,mm^3/stroke$
$S = 0.25$
$x_{up3} = \bar{x} + 3s = 6.047$
$x_{lo3} = \bar{x} - 3s = 4.553$

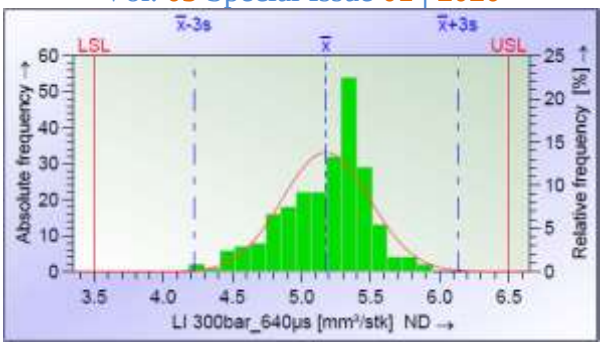


Figure 13. Test line matching Result Plant B

Plant B low Idle

$\bar{x}$ = 5.18 mm³/stroke

USL = 6.5 mm³/stroke

LSL = 3.5 mm³/stroke

S = 0.32

x_{up3} = x̄ + 3s = 6.14

x_{lo3} = x̄ – 3s = 4.22

F. Back 1000 flow quantity at 1600 bar pressure and 800 µs for Plant A & Plant B

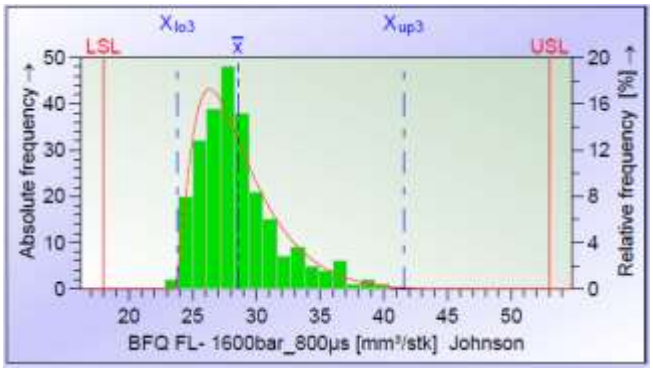


Figure 14. Test line matching Result Plant A

Plant A Back Flow

$\bar{x}$ = 28.53 mm³/stroke

$Max.$ = 53.0 mm³/stroke

x_{up3} = x̄ + 3s = 41.6

x_{lo3} = x̄ – 3s = 23.9

Plant B Back Flow

$\bar{x}$ = 28.25 mm³/stroke

$Max.$ = 53.0 mm³/stroke

x_{up3} = x̄ + 3s = 40.7

x_{lo3} = x̄ – 3s = 23

4. RESULT & DISCUSSION

Graph represents testing cycle's verses injection quantities (mm^3/stroke) of injector. Values shown in graph are the average values of 250 injectors. All injection quantities of injectors are match with each other; there is no deviation between both plants. Injection quantity is maximum at full load and minimum at pilot cycle, intermediate at other cycle.

Figure 16. Shows the overall comparison of plant A and plant B for different working conditions.

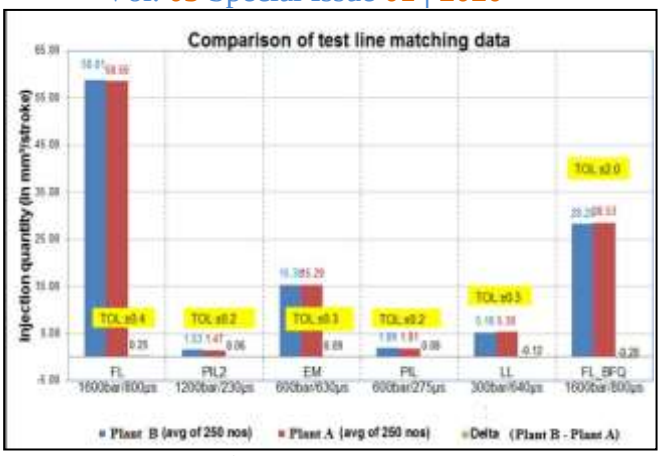


Figure 16. Over all comparison of test line matching between both plant A & Plant B

5. CONCLUSION

Comparing all reading of release plant of test line like full load, pilot cycle, emission cycle, low idle, backflow reading of 250 injectors with accepting plant are lies within acceptable limit so the product were releases on test line matching after assembly line matching results.

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