

ANALYSIS STUDY OF DUST SEAL GAP DEFECT OF A FRONT FORK

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ABSTRACT

The component on which we are working is called as front fork. It is used as a suspension system in vehicles. The process on which we have studying is the process of front fork production process in companies. So once the front fork assembly process is completed, some parts are rejected. The reasons for rejection vary. One of the prominent reason is the presence of Dust Seal Gap between the outer-limb and the Dust Seal component. The rejected parts are then sent for rework. This paper summarizes the study of the defect and its analysis part.

Keywords– Front Fork, Suspension System, Rejected, Dust Seal Gap, Rework.

I. INTRODUCTION

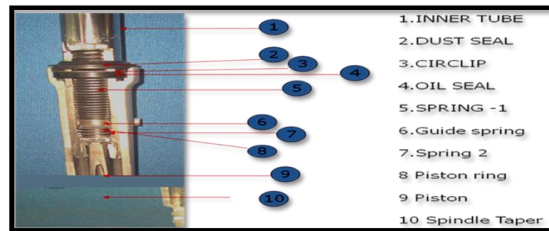
Our main aim for the project is to find solutions to reduce the number of rejectionss due to Dust Seal Gap Present Between. The outer limb and the Dust Seal component. The analysis helps any of the companies for their yield production. It would help to reduce the rework cost and increase the customer satisfaction for the product. The scope of the project is to study the process of the assembly line and study the various parameters that might affect the dust seal gap defect. After this, we shall focus on the main parameters and try to see if modifying the parameter/part of the process can bring in the reduction in the defects.

II. USE OF A FRONT FORK

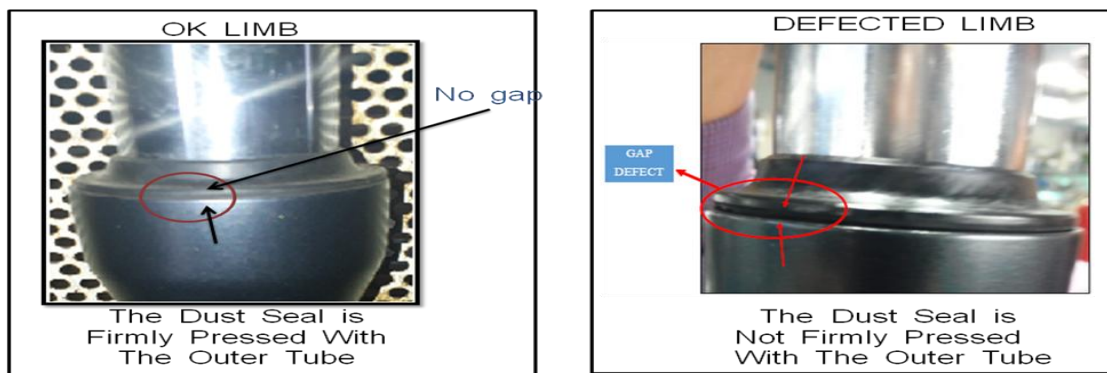
A front fork is one of the most important parameter in drive technology. It is used as a suspension system in vehicles for absorbing shocks during running vehicle. This suspension system helps other parts of vehicles from heavy damage and also gives comfort riding to vehicle driver. It is fitted in front side of vehicle in chassis. All front accessories are fitted in front fork. It is designed to handle shock impulses and dissipate kinetic energy. The sole purpose of a front fork is to damp spring oscillations. As the vehicle goes along the road irregularities the spring absorbs the road shocks, oil flows in the fork and thus the required damping of the shock is provided.

III. COMPONENTS OF A FRONT FORK

The following figure represent the components which are used during the production process of a front fork



IV. DEFECT DESCRIPTION



The dust seal gap defect is really undesirable as it affects the functionality of the front fork. It allows the seepage of dust inside and affects the retraction of the limb which is one of the core functionality of the limb in the motorcycle. The above figure shows two limbs. Out of which the first limb is OK limb as the dust seal is firmly pressed with the outer tube. Whereas the second limb is a DEFECTED limb as there exists a gap between the dust seal gap component and the outer tube. The gap may be uneven meaning only existing in some sides of the seal or in some extreme cases, the gap maybe present throughout the circumference of the seal. Most of the defects are of the former case as described above.

V. DEFECT COMPONENT



The component or part due to which the defect occurs is termed as DUST SEAL. Its main function is to protect the oil seal from dust contamination so it must be firmly pressed with the surface of the outer tube.

VI. MACHINE ON WHICH THE DEFECT OCCURS

6.1.Dust seal pressing machine

In producing a front fork in any of the company's material has to pass through many of the machines in the assembly line like spinning machine, m-10 torquing machine, DU bush pressing machine, leak testing machine bolt cap torquing machine, oil filling machine and many more. Out of this machine there is a machine called DUST SEAL PRESSING MACHINE. On this machine the Dust seal component is pressed on the surface of outer tube along with pressing of oil seal and insertion of circlip.

6.2.Sequence of operations of the machine

- 1 Pick up the limb from the limb stand and place on the bottom locator of the machine
- 2 Pick up the thimble and place it on the inner tube for oil seal insertion.
- 3 Pick up the oil seal from the greasing station by rotating it and check for grease on it also check the presence of getter spring on it insert through thimble in outer tube
- 4 Pick up next oil seal and place it on the greasing fixture
Remove the thimble and insert the oil seal pressing locator through inner tube Align the limb in the ball catch arrangement until it locks
- 5 Press both the buttons for pressing the oil seal. After oil seal pressing pull back the limb and remove the oil seal pressing locator.
- 6 Pick up the circlip and engage the same in groove of
- 7 The outer tube. Make sure it should be properly sit in groove.
- 8 Pick the dust seal from tray and insert the same in the limb.
- 9 Pick up the dust seal pressing locator and insert in the limb.
- 10 Align the limb in the ball catch arrangement until it locks. Press both the buttons for pressing the dust seal.
- 11 Pull back the limb and remove it from the bottom locator. Check the gap between dust seal and outer tube if there is no gap place it on stand for next operation. If not place it in rework bin.
- 12 Oil seal and dust seal storage should be in closed container box when not in use.
The pneumatic pressure of the machine is **3 – 6** bar.
Sequence of operation: Limb Assembly, Oil seal, Circlip, Dust seal.

VII. NEED OF REDUCING THE REJECTION QUANTITY

7.1. Problem in function:

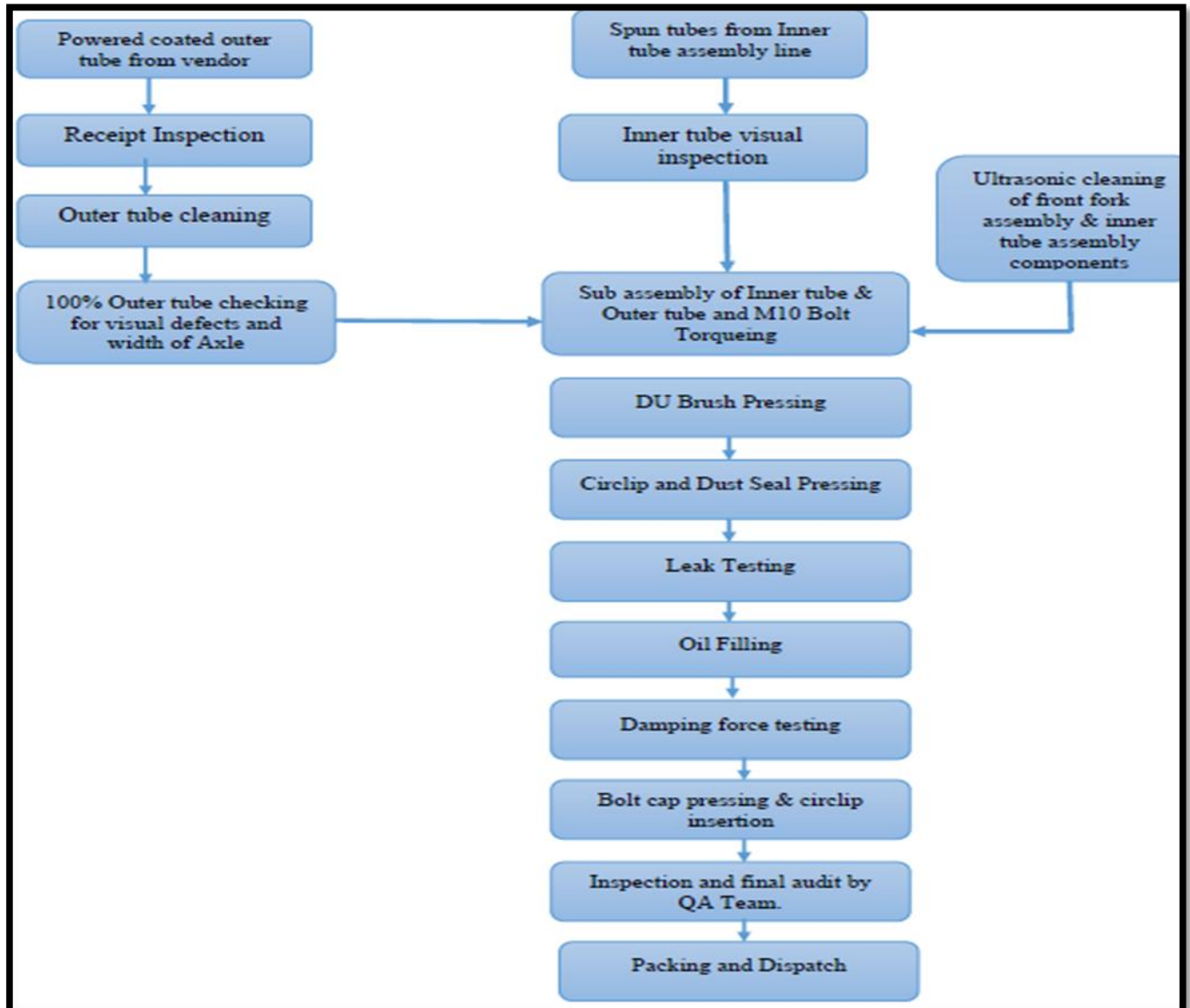
It allows the seepage of dust inside the limb, due to which the oil in the limb gets contaminated, and affects the retraction of the limb which is one of the core functionality of the limb in motorcycle.

7.2. Problem Faced By Company:

This defect increases the rework cost of the company required for production, it affects the production rate of company, it affects the reputation of the company if such products are dispatched in the market.

So it is necessary to reduce the reduction rate.

VIII. PROCESS FLOW CHART FOR PRODUCING A FRONT FORK



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graph LR; M1[MACHINE] --- L1[Low Pressure]; M1 --- L2[Improper application of pressure through nylon locator.]; M1 --- L3[Pressure in Leak testing process]; M1 --- L4[Groove Tool]; M2[METHOD] --- L5[Duration for which pressure is applied on dust seal is less.]; M3[MAN] --- L6[Operator forget to insert circlip.]; M4[MATERIAL] --- L7[Deformation of metal ring inside dust seal on application of pressure.]; M4 --- L8[Width of circular grooves of outer tube.]; M4 --- L9[Material specification of Dust Seal as supplier changed.]; M4 --- L10[Flatness of circlip]; L1 --- L11[DUST SEAL GAP]; L2 --- L11; L3 --- L11; L4 --- L11; L5 --- L11; L6 --- L11; L7 --- L11; L8 --- L11; L9 --- L11; L10 --- L11;
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The fishbone diagram illustrates the causes of a Dust Seal Gap, categorized into four main areas: MACHINE, METHOD, MAN, and MATERIAL. The central spine points to the effect, DUST SEAL GAP.

- MACHINE**
 - Low Pressure
 - Improper application of pressure through nylon locator.
 - Pressure in Leak testing process
 - Groove Tool
- METHOD**
 - Duration for which pressure is applied on dust seal is less.
- MAN**
 - Operator forget to insert circlip.
- MATERIAL**
 - Deformation of metal ring inside dust seal on application of pressure.
 - Width of circular grooves of outer tube.
 - Material specification of Dust Seal as supplier changed.
 - Flatness of circlip

IMPACT	HIGH	1)Material specification of dust seal as supplier changed	1)Improper application of pressure through nylon locator 2)Duration for which pressure is applied on dust seal is less
	LOW	1)Deformation of metal ring inside dust seal on application of pressure 2)Flatness of circlip	1)Low Pressure 2)Width of circular grooves of outer tube
		LOW	HIGH
IN OUR CONTROL			

X.CONTROL – IMPACT MATRIX CHART

CAUSE – VALIDATION PLAN

Based on the fish bone diagram and the above prioritized matrix, we had identified certain action points to initiate and find out the subsequent results. Based on the discussions, we started with the cause validation plan so that appropriate analysis can be done with the respective actions from our side.

S.No	Causes	Plan for validation
1	Low pressure	GEMBA
2	Improper application of pressure through nylon locator	Regression Analysis
3	Duration for which pressure is applied on dust seal is less	Graphical Analysis
4	Deformation of metal ring inside dust seal on application of pressure	GEMBA
5	Width of circular grooves of outer tube	GEMBA
6	Material specification of dust seal as supplier changed	GEMBA
7	Flatness of circlip	GEMBA

For few of the causes, which were in our control and had high impact, we collected the data and used the statistical analysis and for rest of the causes which we had less control, we followed the Gemba process to brainstorm with the respective department.

The details of validation of all causes in the cause and effect diagram are summarized below:

S.No	Causes	Actions taken	Output
1	Low pressure	Increased pressure from 4 Bar to 6 Bar	No significant change in defects
2	Improper application of pressure through nylon locator	Design modification of nylon locator	Significant reduction in defects
3	Duration for which pressure is applied on dust seal is less	Increased timings from 2 sec to 4 sec	Significant reduction in defects
4	Deformation of metal ring inside dust seal on application of pressure	Contact Supplier	Organization to take forward due to delay in response from Vendor
5	Width of circular grooves of outer tube	Change in the width and depth of the grooves	No significant change in defects
6	Material specification of dust seal as supplier changed	Contact Supplier	Organization to take forward due to delay in response from Vendor
7	Flatness of circlip	Contact Supplier	Organization to take forward due to delay in response from Vendor

SUMMARY OF VALIDATION OF PLAN

XI ANALYSIS OF THE ACTION TAKEN

A: ANALYSIS 1: LOW PRESSURE.

We had found that during the set of operations where the dust seal is pressed, there was input of pressure. To rule out this as one of the cause, we had the pressure increased from the existing four bar to six bar which is the maximum pressure. We found that this had no significant change in the reduction of defects.

B: ANALYSIS 2: HYPOTHESIS TESTING (CHANGE IN DURATION OF TIME)

Regression test is used here to establish a mathematical relationship between two variables (problem and its cause) and can be used for comparative analysis to determine how much variation is caused in the dependent variable (problem) in proportionate to the variation caused in the independent variables (causes) and hence determine the major cause of the problem using R – square value.

The existing timing that is used by the operator to press the dust seal in the outer limb is 2 seconds. We increased the timings for a period of 15 days (from Day -11) in the month of January, 2017 s shown below.

Pressure applied for 2 Seconds					Pressure applied for 3 and 4 Seconds				
Day	Total Production	Total DS Rejection	% DS	Time					
1	510	54	10.59	2	11	800	73	9.13	3
2	920	161	17.50	2	12	700	59	8.43	3
3	1176	205	17.43	2	13	800	75	9.38	3
4	854	169	19.79	2	14	400	30	7.50	3
6	830	93	11.20	2	15	400	30	7.50	3
7	1225	136	11.10	2	16	1100	56	5.09	4
8	800	136	17.00	2	17	1500	51	3.40	4
9	1510	252	16.69	2	18	1000	90	9.00	4
10	950	145	15.26	2	19	820	47	5.73	4
					20	800	46	5.75	4
					21	800	39	4.88	4
					22	1500	43	2.87	4
					23	800	12	1.50	4
					24	1400	16	1.14	4
					25	1225	23	1.88	4

% Rejection Quantity More

% Rejection Quantity Less

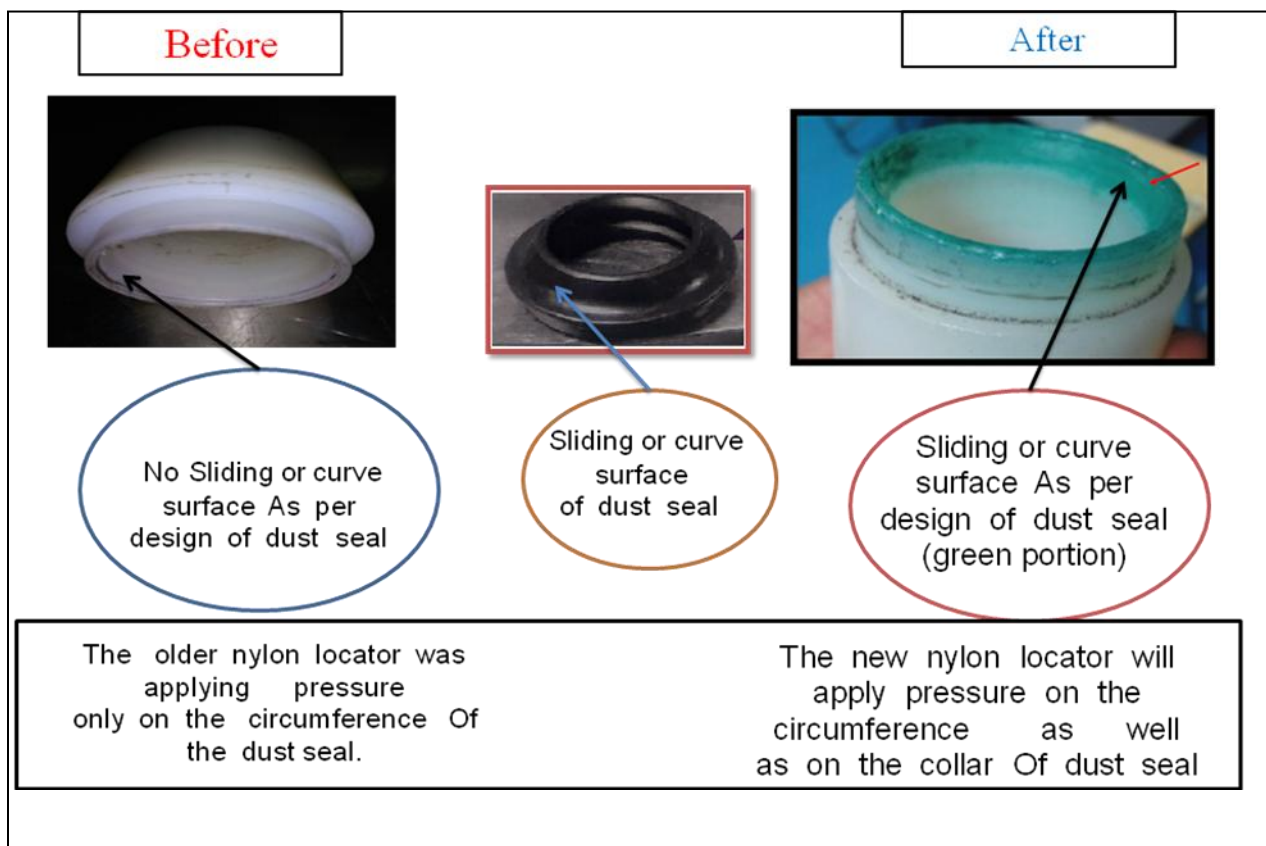
This charts show that when the pressure is applied for 2 seconds the rejection quantity of the defect was more, and when the pressure is applied for 3 to 4 seconds decrease in rejection quantity is observed. Thus this study shows that

there exists a relationship between the pressure and the duration for which the pressure is applied. Thus we saw a fall in the rejection quantity.

C: ANALYSIS 3: CHANGE IN DESIGN OF NYLON LOCATOR.

The moment of truth for the crucial operation concerning our project is when the nylon locator touches the dust seal component and in-direct the pressure is applied upon the points of contact. We observed that the existing nylon locator was only applying pressure on the circumference and not on the collar of the dust seal. This feedback was taken by the quality department and then they came up with a modified nylon locator as shown below :

CHANGE IN DESIGN OF NYLON LOCATOR



The above figure shows the design modification of the nylon locator. In the old nylon locator the pressure was applied only on the circumference of the dust seal during the dust seal pressing operation due to which the dust seal would buldge out and there would be seen a gap. So a new nylon locator is designed as per the design of the dust seal, a sliding or curve surface is provided on the new nylon locator. The green colour as seen in the new modified nylon locator shows a indication of sliding or curve surface so produced in the new design of nylon locator. The result was seen that the pressure was applied on the circumference as well as on the collar of dust seal during the dust seal pressing operation process on the machine.

Thus the proposed had desirable change in rejection quantity.

C: PROBLEMS RELATED TO SUPPLIER OR VENDOR INFORMATION.

S.No	Causes	Actions taken(Pending on Organization-Vendor) & Other suggestions
1	Deformation of metal ring inside dust seal on application of pressure	Told organization about the possibility of metal ring which might get deformed due to application of pressure. This may not be for all the defects observed. Only vendor can help in the further probe in this regard.
2	Material specification of dust seal due to change of vendor	Change in Vendor before the drastic increase in the Dust Seal Gap. We suspect through inspection of characteristics like Hardness of rubber etc. which might play a factor in the gap. Only vendor can help us in the further probe of this matter.
3	Flatness of circlip	1) We saw a few circlip components not being flat and told the organization to take a thorough inspection. Vendor will help in investigating if there has been any changes considering that this is one of the inputs. 2) We had also advised the workers to make sure that they take appropriate care in keeping the circlip inside the outer tube.

XII CONCLUSION

This case study project was carried out by us in GABRIEL INDIA LIMITED, NASHIK. The implementation of the solutions helped the company to reduce the rejection rate from 89% (ppm) to 21% (ppm). Solution implementation of the nylon locator modification, time and pressure study has proved to be successfully established and proved. Thus the aim of the study project was to help any company increase their productivity by solving the problems. This study project would surely help to solve the problems in any of the companies. At last we succeeded in falling down the rejection quantity and help company to solve its problem.

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