Reduce Rubber Short and Crack Problem in Injection Molding

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Abstract

To reduce rubber short and crack problem of Bellow Rack and bellow spin for car model in injection molding machine. This problem definition was studied over a six – month period and included an analysis of production yield and manufacturing costs.

Rejection PPM of Molding shop is 34,634 PPM for the year 14~15 (June-14 to Mar-15) against budgeted target of 15,000 PPM. This Manufacturing unit is involved in processing of different parte i.e. Bellow and spin, Air Cleaners, Mufflers and other type of rubber products. As per rejection trend bellow and spin was on top.

It consists of different types of defects like rubber short, crack, air bubble, cut mark and shrinkage etc. It was noticed that Rubber short and crack having 80% of the overall rejection facing on the production line and major pain area for selection of the problem.

Keywords— *Six Sigma, Quality, Yield, Injection Molding*

I. INTRODUCTION

Competitive market pressures and economic scarcity of raw material will force many automotive products companies to continually improve the quality of manufactured products. Such market pressures, combined with economic scarcity of injection molding, will also force automotive products companies to reassess inefficient and wasteful manufacturing practices. The quality movement, which arose in Japan in the 1960s and forced the U.S. automotive industry to reassess its quality philosophies in the 1980s, is being adopted again by the Indian automotive industry at the start of the 21st century. U.S. companies in general have attempted to implement many quality and business improvement philosophies during the past quarter of a century, e.g., Continuous Improvement, Total Quality Management, Reengineering and Six-Sigma Quality (Deming 1986, 1993, Harry and Schroeder 2000, Juran 1992). Some companies have been successful in improving business profitability through improved quality while many have been unsuccessful (Grant et al. 1994, Harry and Schroeder 2000, Young et al. 2000). Even though there has been a panacea of quality improvement philosophies, many businesses have struggled to quantitatively define any business improvement after implementing a quality improvement initiative (Hayes et al. 1988). Many scholars feel the distinguishing factor between a successful and unsuccessful quality improvement strategy is that successful strategies have an underlying foundation in statistical methods (Breyfogle 1999, Ishikawa 1987, Juran and Gryna 1993).

II. SELECTION OF PROBLEM

Rejection PPM of Molding shop is 34,634 PPM for the year 14~15 (June-14 to Mar-15) against budgeted target of 15,000 PPM. This Manufacturing unit is involved in processing of different parte i.e. Bellow and spin, Air Cleaners, Mufflers and other type of rubber products. As per rejection trend bellow and spin was on top. It consists of different types of defects like rubber short, crack, air bubble, cut mark and shrinkage etc. It was noticed that Rubber short and crack having 80% of the overall rejection facing on the production line and major pain area for selection of the problem.

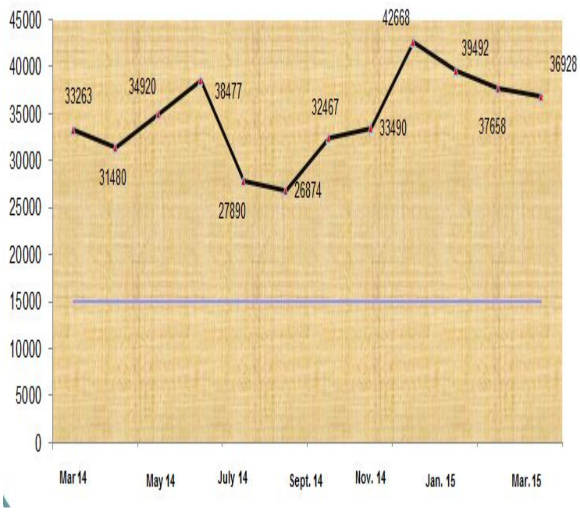


Figure 1 Run Chart For Rejection PPM (Mar 14 To Mar 15)

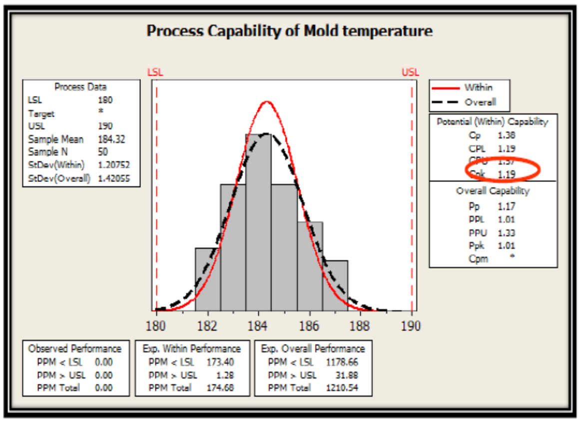
III. PRODUCT DETAIL

Bellow and boot is the rubber product which is used in the suspension system of the car.

After selecting the problem area, we collect the data for the last six month and plot there trend chart. From there, we found that the problem is consistent outside the criteria having high PPM. We plot the trend chart for both the parts i.e., Rubber short and Crack shown in the figure below.

A. Process Capability for Mold Temperature

Process capability for the Mold temperature process is not good. The Cp value is 1.38 and Cpk is 1.19 for the mold temperature process. We have to improve the capability of this process to produce the good parts, and lowers the PPM level.



Inference : Process capability is <1.67, process is not centric.

Figure 3.1 Process Capability For Mold Temperature

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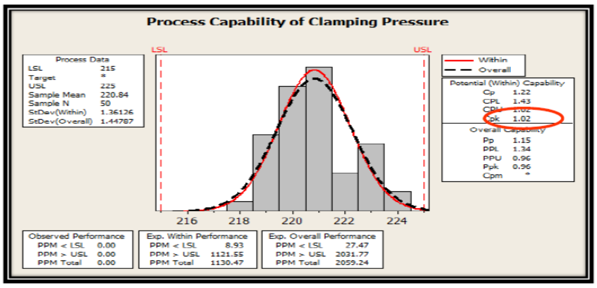
B. Process Capability for Clamping Pressure

Process capability for the clamping pressure is less. The Cp value is 1.22 and Cpk is 1.02 for the clamping pressure process. We have to improve the capability of this process to produce the good parts, and lowers the PPM level.



Inference : Due to lack of control , process is unable to perform.

Figure 3.2 Process Capability For Clamping Pressure.

The trend shows the total rejection PPM of molding shop is 34634 PPM against the budgeted target of 15000 PPM. Molding shop is involved in manufacturing of four different parts namely bellow and boot, air cleaner, muffler and other parts. From the figure shown below it was concluded that high rejection in the bellow and boot part in injection molding. It also concluded from the pareto chart that top defect is bellow and boot. So, it was selection for further study through the defect wise pareto chart.

IV. CAUSES AND EFFECT DIAGRAM

Cause and effect diagram for the Rubber Short and Crack problem is shown in the figures below. It is conducted by the operators following brainstorming and nominal group technique. The causes which are highlighted by the red circles are the probable causes for the process. These are further verified by conducting the experiment for the particular cause and its effect. They need to be validated by the process experts.

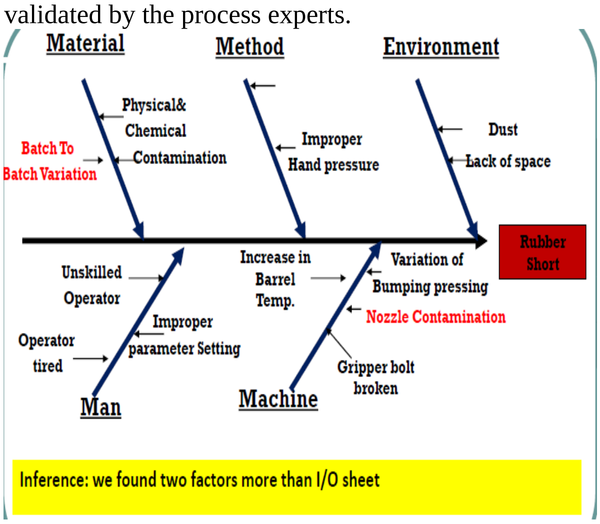


Figure 4.1 (A) Cause And Effect Diagram For Rubber Short.

V. DATA COLLECTION PLAN

Sample size = 5 continuous shots after every 30 min. Min. 5 defective should be covered in total data set, as historical rejection is 3.5 % so as per np ≥ 5 min. 150 shots data to be collected.

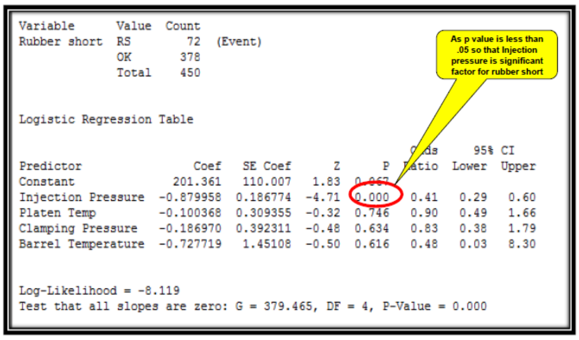
1.Sample size = 5 continuous shots after every 30 minutes.

2.Min. 5 defective should be covered in total data set, as min. historical rejection is 3.5 % so as per np>=5 min. 150 shots data to be collected.

S. no.	Date	Shift	Operator Name	Platen Temp	Barrel Temperature	Injection Pressure	Injection Speed	Packing Position	Weight	Catching in Mold	Clamping Pressure	Rubber short
1	29/9	A	Anuj	182	55	135	65	108	86.2	NO	140	OK
2	29/9	A	Anuj	185	55	140	65	108.2	86.78	NO	140	OK
3	29/9	A	Anuj	185	55	138	65	108	86	NO	139	OK
4	29/9	A	Anuj	185	55	135	65	108.1	86.25	NO	140	OK
5	29/9	A	Anuj	185	55	136	65	108.2	86.35	NO	138	OK
6	29/9	A	Anuj	186	55	135	65	108.1	87	NO	140	OK
7	29/9	A	Anuj	185	55	140	65	109	87	NO	138	OK
8	29/9	A	Anuj	185	57	135	65	108.2	86.75	NO	140	OK
9	29/9	A	Anuj	184	57	135	65	109.1	86.75	NO	138	OK
10	29/9	A	Anuj	185	56	140	65	109	86.75	NO	140	OK
11	29/9	A	Anuj	184	55	136	65	108.2	86.1	NO	140	OK
12	29/9	A	Anuj	185	55	136	65	108.1	86.17	NO	140	OK
13	29/9	A	Anuj	184	55	140	65	108.2	86.2	NO	140	OK
14	29/9	A	Anuj	185	54	140	65	108.2	86.25	NO	140	OK
15	29/9	A	Anuj	185	56	140	65	109	86.35	NO	140	OK
16	29/9	A	Anuj	187	55	142	65	109.1	86.1	NO	139	OK
17	29/9	A	Anuj	189	55	140	65	109	85.9	YES	140	OK
18	29/9	A	Anuj	185	55	144	65	108.7	83.1	NO	140	OK
19	29/9	A	Anuj	189	55	142	65	108.8	86.2	NO	142	OK
20	29/9	A	Anuj	188	55	140	65	109	86.15	NO	140	OK
21	29/9	A	Anuj	187	55	140	65	108.9	86.37	NO	140	OK
22	29/9	A	Anuj	185	54	142	65	108	86.05	YES	139	OK
23	29/9	A	Anuj	187	55	140	65	108.5	85.81	NO	139	OK

Table 5.1 Data Collection Sheet.

A. *Binary Logistic Regression for Rubber Short Problem*



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Variable      Value  Count
Rubber short  RS        72  (Event)
              OK       378
              Total    450


Logistic Regression Table


                                                         Odds    95% CI
Predictor              Coef   SE Coef      Z      P     Ratio  Lower  Upper
Constant            201.361   110.007   1.83  0.067
Injection Pressure  -0.879958  0.186774  -4.71  0.000   0.41   0.29   0.60
Platen Temp         -0.100368  0.309355  -0.32  0.746   0.90   0.49   1.66
Clamping Pressure   -0.186970  0.392311  -0.48  0.634   0.83   0.38   1.79
Barrel Temperature  -0.727719   1.45108  -0.50  0.616   0.48   0.03   8.30


Log-Likelihood = -8.119
Test that all slopes are zero: G = 379.465, DF = 4, P-Value = 0.000
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Figure 5.2 Binary Logistic Regression Output for Rubber Short Problem.

VI. RESULT

After implementing the solution the results of the process are shown in the below graphs. The first graph is the rejection trend for Rubber short and Crack and the second graph is overall rejection PPM. Both the charts shows that after implementing the solution the PPM trend is decreasing day by day. This is approximate to the target which is taken in the define phase.

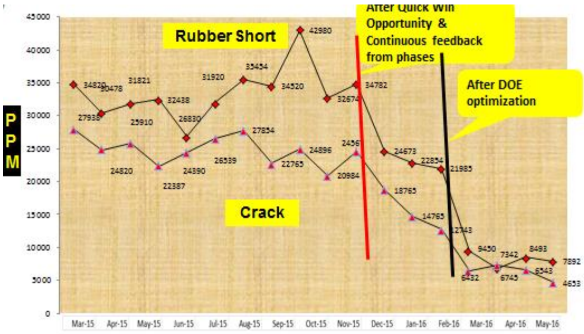

Figure 5.1 Rejection PPM Trend for Rubber Short and Crack.

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