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A Study on Process Capability on Crank Case in Assembly Line

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***Abstract* - In this project the machined parts of crank case from the machine shop belongs to the value stream of Compressor and Braking system-1 are taken for Millipore test to calculate the amount of dust particles present in the machined part. The Millipore values of the machined parts are taken to the process capability analysis through which Cpk value is produced from the process capability chart which plays a very important role in the organisation to improve the cleanliness of the component by increasing the Cpk value. The data of the amount of dust particles are collected for the machined part which gives the Cpk value less than the standard specific limit .To increase the Cpk value the washing machines of the machined parts are audited and the defects are rectified. Again the machined parts are taken for Millipore test in which it results as Cpk value is increased than before.**

Keywords: Machined Crank case, Process Capability, Millipore Test.

1. INTRODUCTION

This topic Study on Process Capability On Crank Case In Assembly Line belongs to the braking system of an automobile vehicle, In which Crank case is the component taken from the compressor and Braking System-1 to detect the amount of dust particles present in the crank case in order to reduce the leakage of the braking system and to avoid the road accidents of the automobile. The crank cases of 16 parts are taken from machine shop and assembly line for Millipore test to detect the amount of dust particles present in the components. The Millipore values of 16 parts of crank case is taken and placed in the process capability through which Cpk value is obtained from the process capability chart. The Cpk value which is obtained from the values is less which is not equal to the specific standard limit. So, In order to improve the Cpk value, the Washing machines are introduced which are used for washing the crank cases in which audit is done on the washing process and the abnormalities are identified and rectified. The crank cases are taken for washing machines to avoid the dust particles in the crank cases and again the parts are taken for test in which the Millipore values are placed in the process capability and the Cpk value is improved compared to the previous test. Thus the quality of the product will be increased by continuous improvement in the process through which it satisfies and meets the customer requirements.

2. LITERATURE REVIEW

A pragmatic view on process capability studies in recent years an increasing number of organizations use process capability studies on a regular basis. Contemporaneous with the increasing number of organizations using process capability studies, warnings have been launched that imprudent use of numerical measures of capability, the so-called process capability indices, might lead the user to make erroneous decisions. As a result, many practitioners of today are left with a somewhat ambivalent attitude towards process capability studies.

Mats Deleryd [1] states that Process capability studies are used for monitoring the capability of a process. This implies that it has to be based on some sort of collection of data from the process. In order to get a fair picture of the capability of the process, it has to be stable when the data is collected. After the collection of data from a stable process, the data may be assessed in several ways. One way to do the assessment is to use process capability indices, which provide numerical measures of the capability. Based on the assessment, improvement efforts can be initiated. The fact that, theoretically, there is no limit of how capable a process can become, implies that there is no end to the improvement initiatives aimed at achieving more and more capable processes.

3. METHODOLOGY

Method to conduct Millipore test, process capability, washing machines abnormalities and its improvements are discussed and better comprehension of the problem is presented.

Washing machines are used to remove dust particles from the part. The washing machines were audited as per operation standard sheet and Quality control process chart. A sample operation standard sheet and Quality control process chart are given in Table 1 and Table II the parameters to be controlled are air pressure, temperature, water pressure, time set, cleaning media, and cleaning media level.

Table I. Operation Standard Sheet

Parameter	*Specification*	*Check method*	*Check frequency*
Air pressure	5-7 bar	Visual pressure gauge	Once at the start of shift
Temparature	45-50	Visual Temparature indicator	Once at the start of shift
Cleaning media	Level	Visual level indicator	Once at the start of shift

Intolerance process parameters ± 10% variation allowed

Table II. Quality control process chart

MACHINE	***PARAMETER***	***SPECIFICATION***
Crank shaft	Washing oil	Solution water cleaning
	Nozzle	Nozzle cleaning
	Washing time	1 minute
	Water pressure	5-7 bar
	Temparature	45-50
	Cleaning media	Washing level

The Quality characteristics are washing effectiveness and cleanliness. Table III. provides a sample Quality characteristics and its specifications of crank shaft.

Table III. Quality Control Characteristics

Control item	***Specification***	***Gauge no***	***Checking frequency***
Washing effectiveness	Free from oil and other foreign particles	Visual	100%
Cleanliness	<10 mg	Millipore tester	1/shift

The washing effectiveness is evaluated visually for all the parts free from oil and other foreign particles. The frequency of checking parameters is once at the start of the shift .The second quality characteristics, Cleanliness is evaluated by a Millipore tester once in a shift.

Experimental:

Millipore apparatus is identified as the experimental set up for testing the Crank case in the organisation.

Procedure:

Before beginning the Millipore test the tray in which machined part is placed has to be cleaned with cotton cloth so that the dust particles present in the tray does not affect the machined part. open the lid of pressure pot and fill the pressure pot with the isopropyl alcohol through which the hand gun is connected to pressure pot. The machined part is placed in the tray after cleaning from washing machine. Press the hand gun manually so that the isopropyl alcohol is sprayed on the machine part at the pressure of 2bar and after 10 minutes release the hand gun by removing fingers on the hand gun .So the flow of alcohol from hand gun is stopped and the machined part is removed from the tray. After removing the machined part some alcohol is present in the tray with some oil and dust particles. Remove the vaccum funnel cup and place the weighed Millipore paper without dust particles on the top of vaccum funnel and close the vaccum funnel with cup. Later the alcohol present in the tray is poured into the vaccum funnel by lifting the tray manually and at the same time put on the vaccum pump so that alcohol present on the top of funnel is flown into the funnel and the dust particles are remained on the Millipore paper which is placed on the top of funnel. Switch of the vaccum pump after filtration of dust particles from alcohol and remove the vaccum cup and remove the Millipore paper on the vaccum cup. Place the Millipore paper in the hot oven, close the door and switch on the hot oven and temperature indicator to dry the Millipore paper from wet particles on the Millipore paper and also fan is present in the hot oven to dry the Millipore paper. Switch off the hot oven after 10 minutes and open the door and remove the Millipore paper from the hot oven. Take the Millipore paper to the analytical weighing machine to weight the amount of dust particles present in the Millipore paper in milligrams. Calculate the weight of the paper before test and after test so that weights of dust particles are calculated of the particular machined part. Therefore same process is repeated for 16 similar parts and the values are tabulated. Later they obtained Millipore values of 16 similar parts are taken to Minitab by using stat from which quality tools by which process capability chart is generated from capability analysis. In which Millipore values are taken for comparing Cpk value that is produced from process capability before and after improvement of washing machines. And the run chart is also produced from process capability. Later to improve the Cpk value of the machined parts the cleaning machines of machined parts are audited based on operation standard sheet and Quality control process chart. Abnormalities in washing machines are detected visually by auditing the washing machines and the abnormalities are rectified and implemented.

After the improvement of washing machine again 16 similar machined parts from the machine shop which belongs to five assembly lines are taken for Millipore test and the values are taken to process capability in which Cpk value is obtained. The Cpk value of machined part is increased after rectification of abnormalities found in the washing machines. The Cpk value obtained before and after rectification of abnormalities of washing machines is compared. In which operation standard sheet consists of

process parameters, Quality characteristics, tool change frequency, process work content, Incoming quality check, outgoing quality material.

4. CRANK CASE WASHING MACHINES ABNORMALITIES AND IMPROVEMENTS

Abnormalities found in the washing machines during auditing and its remedial actions are

Table IV. Abnormalities and Improvements of washing machine.

SNO	*Part Name*	*Washing Machine Abnormalities*	*Action Plan*	*Suggestions*
1.	Crank case	The air gun is broken	New air gun is placed	Air gun has to be checked once per shift.
		Crank case storage trolley contains lot of dust particles	Later trolley is cleaned.	Trolley has to be cleaned 1/shift
		Air gun station contains lot of dust particles	Air gun station is cleaned.	Air gun station has to be cleaned once per shift
		Air gun station contains lot of dust particles	Air gun station is cleaned.	Air gun station has to be cleaned once per shift
		The fixture is broken	The fixture is replaced.	Fixture has to be checked
		The work piece locator contains dust particles present in it.	Work piece locator is cleaned.	Work piece locator is cleaned 1/shift.

Process Control

In the existing procedure 16 parts are collected in a batch. Each part is cleaned separately in washing machine. The amount of dust particles collected through the Millipore test is recorded. The data collected for all the 16 parts are statistically analyzed. The data are fit into the established control charts to check the process in control. If the process is out of control, an analysis is made on 4M (i.e. men, method, machine ,material continuously) to check whether the men is working properly or not and whether the correct method is followed by men , whether the machine is working properly or not, and material used for part is checked properly or not. Corrective actions are taken to bring the process under control.

Using the statistical tool, the mean, the standard deviation ‘s’, Cp , CpKu , CpkL and CpK which are process capability indices are calculated . Cp is calculated by formula

(USL - LSL) / 6s where USL is upper specific limit and LSL is lower specific limit.

CpKu upper specification limit is calculated by formula

(USL - X-Bar) / 3s

CpKl lower specification limit is calculated by formula

(X-Bar - LSL) / 3s

Cpk value is taken as Min. of (CpKu, Cpkl) or Distance between mean of the process and the closest specific limit. In this project Cpk value plays an very important role in improvement in the washing machine process of the machined part. In the existing process the Cpk value is used for process improvement in the washing machine. If the Cpk Value is not within the standard specification limit i.e. 1.33 the process should be improved by continuous improvement in the washing machine.

5. RESULTS AND DISCUSSION

Process capability analysis solves the basic statistical problem in process quality controls, which is establishing a state of control over the manufacturing process, i.e. eliminating special causes of variation and then maintaining that state of control through time. Process capability analysis gives process capability chart and run chart. Process capability chart is produced by taking the Millipore values of machined parts which gives the comparision of natural tolerance limits with specification limits and the natural tolerance range with the specification range.

The normal distribution is used for the capability analysis. The graph represents capability statistics associated with within variation (Cp, Cpl, Cpu, Cpk) and with overall variation (Pp, Ppl, Ppu, Ppk). Whereas Cp, Cpl, Cpu, Cpk represents the potential capability of the process which estimates σ within considering the variation within the process and Pp, Ppl, Ppu, Ppk represents the overall capability of the process which estimates σ overall considering the variation for the whole process. Overall capability explains how the process is actually performing relative to the specification limits. Within capability explains how the process could perform relative to the specification limits. A substantial difference between overall and within variation may indicate that the process is out of control. A run chart, known as a run-sequence plot is a graph that displays observed data in a time sequence. In this project run chart is produced by Millipore a value which explains about the sequential flow of Millipore values that displays the data of the machined parts in a time sequence.

Process Capability and Run Chart Before and After Improvements in Crank Case

The Cpk values of crank case of sixteen parts are taken from process capability chart and run chart before and after the process improvement. The weight of dust particles of each crank case of 16 parts found out from the Millipore test is tabulated in the Table V and process capability chart and run chart is produced. The Cpk value is obtained by process capability chart. Table. V gives Cpk value before the process improvement.

Table V. Amount of Dust Particles Present in Crank Case before Washing Machine Improvement

USL=3.0 LSL=0.0

Part No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Amount of dust particles in mg	7.5	2.3	3.2	4.9	3	3.4	4.4	3	1.3	1.4	1.9	1.9	1	1.4	1.5	1.5

From Table V the actual Minimum value and Maximum value obtained in Millipore test are 1 and 7.5 respectively. It is found 4 components are out of range. Using these data process capability chart and Run chart were drawn as shown in Figure 1. and Figure 2.

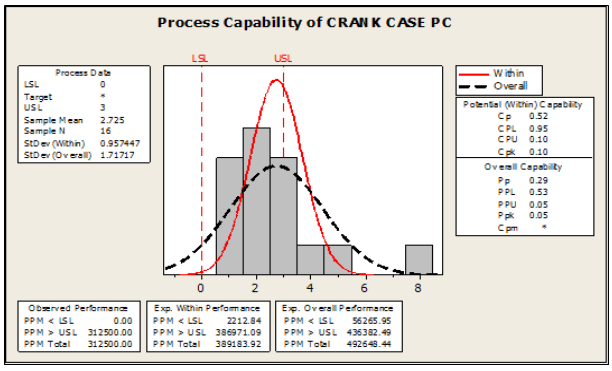

Fig. 1. Process Capability of Crank Case Before Improvement in Washing Machines

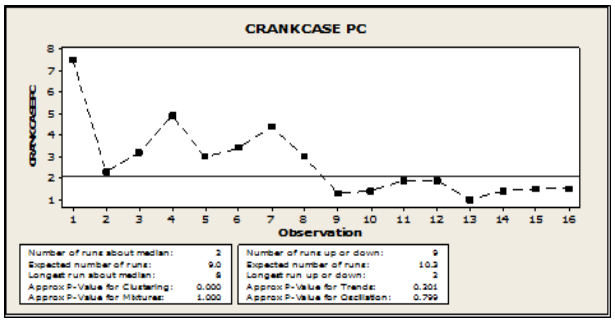

Fig. 2. Run Chart of Crank Case Before Improvement in Washing Machines

From the analysis it is found that Cpk value is 0.10 which is less than 1.33 given by the customer. And the 4 components are out of the range in which corrective action is taken place to improve the process by reducing the variability and centring the process on the target. And the run chart represents the observed Millipore a value of 16 parts of crank case in sequence which is tabulated in Table V is shown in Figure 2.

Process Capability After The Process Improvement in Crank Case

The washing machines of the machined parts are audited for the improvement in the washing machines to detect the defects in the washing machines and improve the washing machine process. So some of the abnormalities are found from the washing machines of crank case and the abnormalities got rectified. Thus the weight of the dust particles of crank case are taken after the improvement in the washing machines. The weight of the dust particles of the machined parts each of 16 components are tabulated in the following table VI through which the process capability chart and run chart are produced. The Cpk value generated by the process capability is improved after the washing machine defects are detected and rectified. The weight of dust particles of each crank case of 16 parts found out from the Millipore test is tabulated in Table VI through which the process capability chart and run chart is produced. The Cpk value is obtained by process capability chart. Table.VI gives Cpk value of crank case after the process improvement.

Table VI. Amount of Dust Particles Present in Crank Case after Washing Machine Improvement

USL=3.0 LSL=0.0

Part No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Amount of dust particles in mg	0.2	0.4	0.8	0.7	1	1.7	2.2	1.8	0.4	1.1	0.8	1.3	1.2	1.8	1.2	0.8

From Table VI the actual Minimum value and Maximum value obtained in Millipore test are 0.2 and 2.2 respectively. It is found that the values are within the range. Using these data process capability chart and Run chart were drawn as shown in Figure 3 and Figure 4.The Cpk value obtained by the process capability chart of crank case after the improvement is 1 which is more than the Cpk value of the crank case before improvement .And the Cpk value after the improvement in washing machines is 1 in which it does not meet the customer requirement i.e. 1.33 .In order to increase the Cpk value the continuous improvement in the washing machine has to be done. And the run chart represents the observed Millipore values of 16 parts of crank case in sequence which is tabulated in Table VI is shown in Figure 4 Using these data process capability chart and Run chart were drawn as shown in Figure 3 and Figure 4.

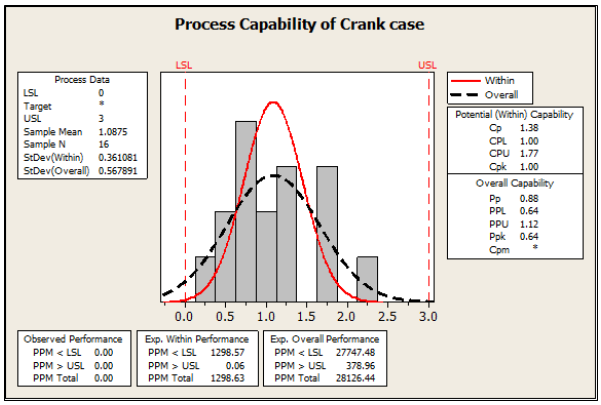

Fig. 3. Process Capability of Crank Case After Improvement in Washing Machines

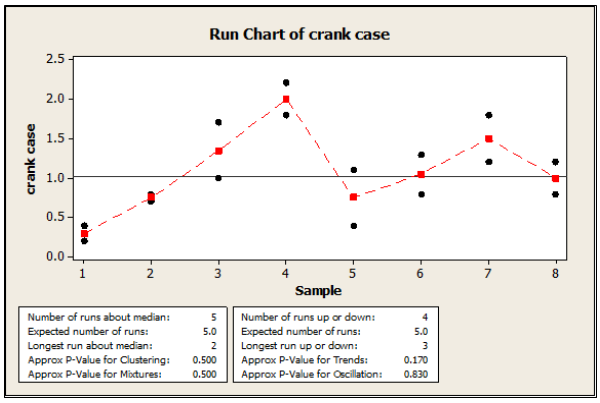

Fig. 4. Run Chart of Crank Case After Improvement in Washing Machines

Comparision Of Values Before and After the Improvement in the Washing Machines

The amount of dust particles of the machined part before and after the improvement in the washing machines are tabulated above and the comparision of minimum values ,maximum values, range, Cpk values are given below in figures.

Minimum values

The minimum weight of dust particles of the crank case machined parts represents the values before and after the improvement in the washing machine process. The minimum values are randomly obtained as shown in the Figure 5.

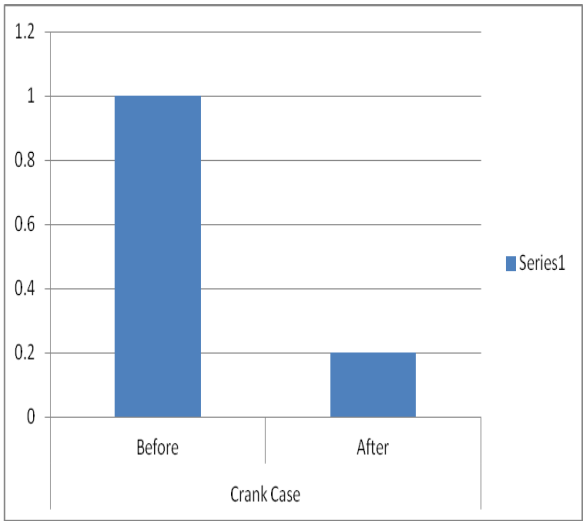

Fig. 5 .Minimum Values Of Crank Case Before and After Improvement in Washing Machines

Maximum values

The maximum weight of dust particles of crank case machined parts represents the values before and after the improvement in the washing machine process. The maximum values are randomly obtained as shown in the Figure 6.

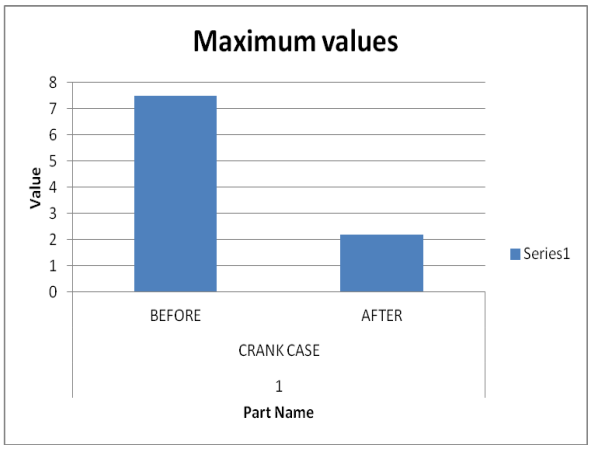

Fig. 6. Maximum Values Obtained Before and After Improvement in Washing Machine

Range Values

The weight of dust particles of crank case machined parts represents the range values before and after the improvement in the washing machine process. The range values are randomly obtained as shown in the Figure 7.

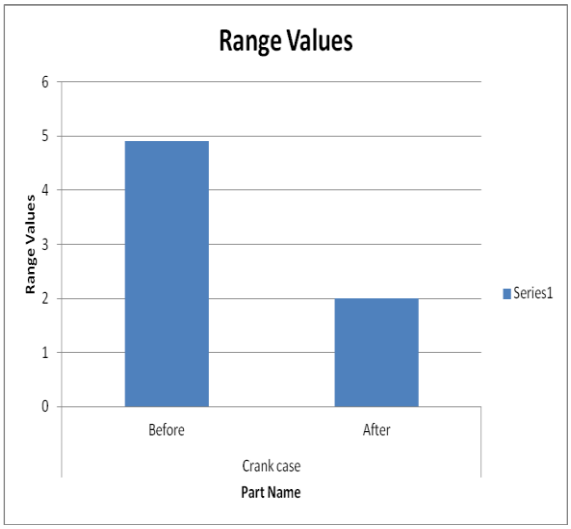

Fig. 7 .Range Values Of Crank Case Before and After Improvement in Washing Machines

Cpk values

The weight of dust particles of the crank case machined parts represents the Cpk values before and after the improvement in the washing machine process. The Cpk values are randomly obtained as shown in the Figure 8.

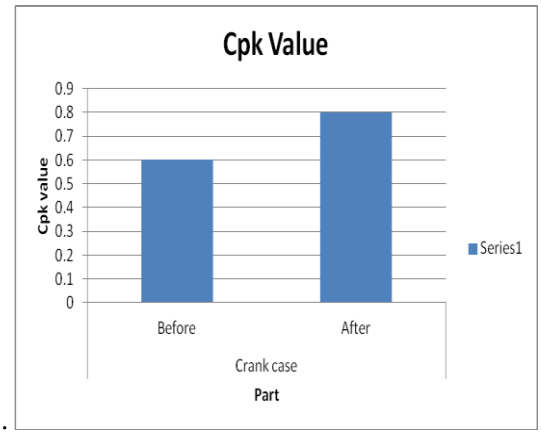

Fig. 8 .CpK Values Of Crank Case Before and After Improvement in Washing Machines

6. DISCUSSIONS

At present Millipore test is done only for one part per shift because of this the amount of dust particles are present in the machined parts as the other parts are not tested which leads to the leakage in the assembly part. In order to avoid the large amount of dust particles in the machined part the Millipore test has to be conducted thoroughly. And a standardized process is followed to reduce the amount of dust particles in the machined part by cleaning the machined part as shown in the Figure 9.In the standardized process the Millipore test is conducted thoroughly for different machined parts of 16 parts and the amount of dust particles are tabulated which gives the process capability chart and run chart in which Cpk is obtained. The obtained Cpk value is less to increase the Cpk value the washing machines are audited to detect abnormalities and get rectified. Later again the machined parts are taken for Millipore test in which Cpk value is increased than before. Thus the continuous improvement of washing machines are necessary to improve the washing machine performance and to increase the Cpk value up to the 1.33 to satisfy the customer.

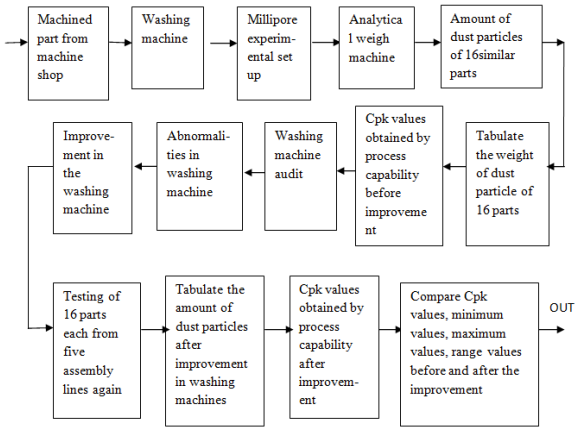

Fig. 9. Flow Chart of Standardized Process of Cleaning the Machined Part

7. CONCLUSION

The crank case of 16 parts belongs to Compressor and Braking System-1assembly line from the machine shop is taken for Millipore test to calculate the amount of dust particles present in the machined part per shift . In which only one part each from machine shop is taken for Millipore test and the other parts are not taken for testing which leads to the leakage in the assembly part and the rejection of part from the customer. So in order to reduce the amount of dust particles in the machined part the standardized process is followed in such a way that the machined parts of machine shop each of 16 parts belongs to assembly line are taken for Millipore test and the values obtained by Millipore test is given in the Minitab in which the process capability chart and run chart is generated and the Cpk value which is given by process capability chart plays a very important role to improve the cleanliness of the component. The Cpk value is taken before and after the improvement in the washing machines by testing the machined parts and the Cpk value is increased after the improvement in the washing machines the cleanliness of the component is improved. Thus the amount of dust particles in the machined part is reduced by this the rejection components are reduced to from 2% to 0.5% which satisfies customer requirement

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