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Improve Productivity Of Connecting Rod By Doe Method

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Abstract

This paper focuses on Reduce rejection Rate of Connecting rod by Design of Experiments. Connecting rod's major problem behind the rejection is connecting rod's cap and rod assembly bolts tight. Bolt cannot rotate freely in the cap and rod assembly bolt hole. So Connecting rod goes in rejection. Research work goal is reduce rejection rate of connecting rod. Tool use for this research is DESIGN OF EXPERIMENTS. In this Research use full factorial design approach by the help of MINITAB statistically analysis software. For control of rejection rate consider four type of control parameters namely, 1 central distance between two assembly hole of rod and cap, 2 Face Symmetricity of rod and cap, 3 Assembly hole diameter of rod and cap, 4 Cutting fluid viscosity to select for the optimize condition and reduce rejection rate of connecting rod Design of Experiment technique's result indicate that the Central distance between two assembly hole of rod and cap and Face Symmetricity of rod and cap are significant parameters which are affect the connecting rod quality level.

1. Introduction

Experiments are performed today in many manufacturing organization to increase our understanding and knowledge of various manufacturing process. Experiments in manufacturing companies are often conducted in a series of trials or tests which produce quantifiable outcomes. For continuous improvement in product or service quality, it is fundamental to understand the process behavior, the amount of variability and its impact on processes. In engineering environment, experiment is often conducted to explore, Estimate or confirm. Exploration refers to understanding the data from the process. Estimation refers to determining the effect of process variables or factor on the output performance characteristic. Confirmation implies verifying the predicted results obtained from the experiments. In manufacturing process, it is often of primary interest to explore the relationship between the key input process variable (or factors) and the output performance characteristic (or quality characteristic). For example in a metal cutting operation, cutting speed, feed rate, type of coolant, depth of cut etc. can be treated as input variables and surface finish of the finish part can be considered as an output performance characteristic.[10]

2. Problem statement

Amul automobile industries at Rajkot produce connecting rod for heavy automobile vehicle. The major reason behind the rejection of connecting rod is Cap and Rod assembly bolt tight. According to above figure connecting rod assembly has two main parts. Top part of this assembly called cap and bottom part is called rod. Problem is when these two parts are assembled at that time cap and rod assembly bolt are happen tight. And bolt can no rotate freely in the cap and rod assembly bolt hole. So Connecting rod goes in rejection. And Hino Company is the customer of this connecting rod. Customer requirement is freely rotate bolt in the cap and rod assembly bolt hole with best quality. So this type of bolt tight problem is main reason for rejection.

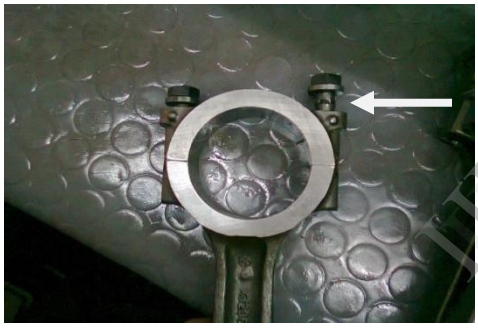


Figure 1 Connecting rod bolts tight problem

3. Considerable parameters [10]

1. Central distance between two assembly hole of rod and cap

2. Face Symmetricity of rod and cap

3. Assembly holes diameter of rod and cap

4. Cutting fluid viscosity

3.1 Parameter range for parameters and their levels [12-10]

First considerable parameter is Central distance between two assembly hole of rod and cap its low level value is **80.04 mm and high level value is 80.36 mm**. Second considerable parameter is face Symmetricity of rod and cap it's **high and low levels values are 19.10 mm and 19.50 mm** respectively. Third considerable parameter is assembly holes diameter of rod and cap it's **high and low levels values are 12.20 mm and 12.21 mm** respectively. Fourth considerable parameter is cutting fluid viscosity its **high and low levels values are 0.05 pas and 0.08 pas** respectively.

4. In full factorial design our Experiment performed total 16 experiments and it's Result Ok pieces indicate below table.[12]

Run Order	OK PIECES OUT OF 50
1	48
2	40
3	40
4	38
5	48
6	**49**
7	38
8	40
9	42
10	38
11	40
12	48
13	40
14	42
15	40
16	48

Table 1 Run order versus ok pieces

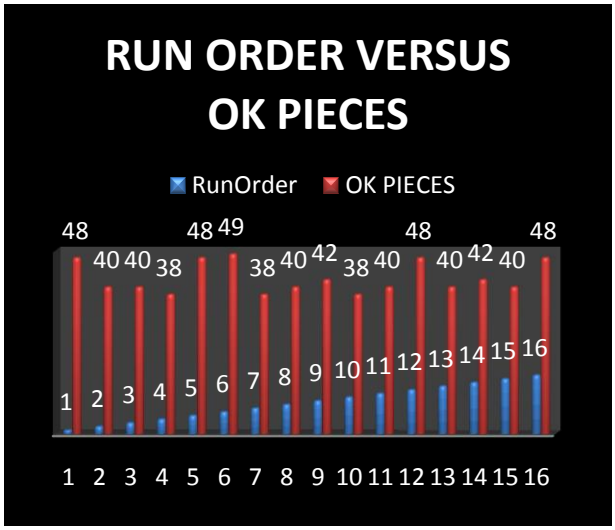


Figure 2 Run order versus Ok pieces

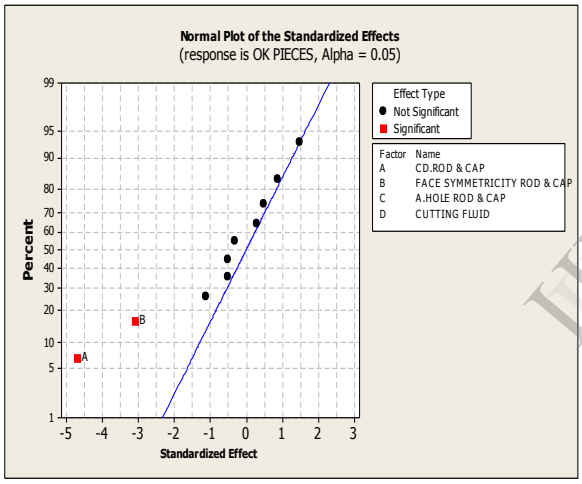
5. DESIGN OF EXPERIMENT RESULTS BY MINITAB SOFTWARE

In these Experiments our **alpha value** (Confidence level) is **0.05**.From session window of Minitab software, we can conclude that P-values of CD rod & cap and Face Symmetricity of rod & cap are 0.005 and 0.027 respectively which are less than the value of alpha-0.05.So CD rod & cap and Face Symmetricity of rod & cap are very significant parameters which are affect the connecting rod quality level and responsible behind the rejection rate .Other parameters and it's combination are insignificant.

6. DESIGN OF EXP.RESULT GRAPHICALLY [10-12]

Figure 3 Normal plot of standardize effect

From the Normal plot of the standardize Effects figure indicate below , we can easily conclude the Result by observing the inclined line, Here points near the line does not significant. But points situated



away from line give significant and affect the connecting rod quality and responsible behind rejection rate. Here point A and B are such points which indicate CD rod & cap and Face Symmetricity of rod & cap are two most dominant parameters which badly affect the connecting rod quality.

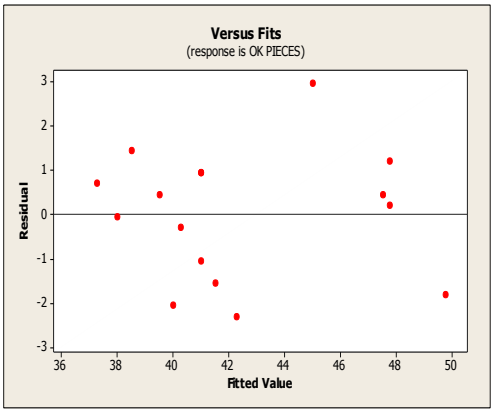


Figure-4 Residual versus Fits plot

Above plot should show a random pattern of residuals on both sides of 0. If a point lies far from the majority of points, it may be an outlier. Above figure suggest the spread of residual values tend to increase as the fitted values increase, and then this may violate the constant variance assumption. Above plot indicate here residual value is not linear. Residuals are the difference between the observed

values and predicted or fitted values

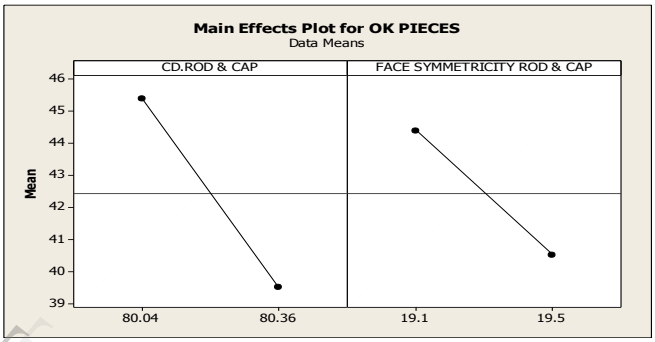


Figure 5 Main effect plots

Use in conjunction with an analysis of variance and design of experiments to examine differences among level means for one or more factors. A main effect is present when different levels of a factor affect the response differently. A main effects plot graphs the response mean for each factor level connected by a line. Here plot suggest that on x-axis level of parameters and on y-axis indicate mean of response. Above fig suggest that CD rod and cap parameter value at low level when mean at high level. And Face Symmetricity rod and cap parameter value at low level when mean of response at high level.

7. Implement in Parameters design values base on Design of experiments results.

1. CD rod & cap = 80.04 mm
2. Face Symmetricity = 19.1 mm
3. Hole of rod cap = 12.20 mm
4. Cutting fluid viscosity = 0.08 pas

Above figure 2 clear indicate that on **6th number of** run order gets **maximum output**. So we should **select that parameter values and apply on our operation** so we can reduce rejection rate. And Design of experiment result suggests same parameter values for getting maximum output.

8. RESULT AND CONCLUSION

As there are numbers of Parameters which are affect the connecting rod quality and responsible behind rejection. According to present work conditions and necessary Experiment set up being situated in an industry design and control parameters being chosen for experiments. Mainly four design and control parameters namely 1.Central distance between two assembly hole of rod and cap, 2. Face Symmetricity of rod and cap, 3. Assembly holes diameter of rod and cap, 4. Cutting fluid viscosity to select for the optimize condition and Reduce rejection rate of Hino connecting rod using DOE with help of Minitab software Package.

Design of Experiment technique's results indicate that the Central distance between two assembly hole of rod and cap and Face Symmetricity of rod and cap are significant parameters which are affect the connecting rod quality level and responsible behind rejection. After research work parameters values set for CD rod and cap at low level an Face Symmetricity for rod and cap is also low levels base on experimental result and reduces 3 % of rejection rate.

Reduce rejection rate = 3 %

Improve productivity = 3 %

Total cost reduction = 15 Rs per pieces

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