IMPLEMENTATION OF TAGUCHI METHODOLOGY OF THE DEFECT REDUCTION IN MANUFACTURING INDUSTRY

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ABSTRACT

Quality improvement method, in particular the Taguchi methodology, is used to design experiments to explore the impacts of distinct parameters on mean and variance of process performance characteristics(Surange, 2015). The Taguchi methodology is used in this paper to control the rejection of flexible hose assembly in the automotive industry. An attempt is created to correlate the effects of the process parameters on the final product. Experiments are carried out to validate the results obtained by implementing the Taguchi methodology in the automotive process industry and the most important parameters affecting product life are identified. A symmetrical cluster, the sign to commotion (S/N) proportion, and examination of change (ANOVA) are utilized to investigate the impact of chosen process parameters and their levels. The outcomes demonstrate that the chose procedure parameters fundamentally influence the deformities of adaptable hose gathering(Thomas & Kumaran, 1995). The enhanced procedure parameters for example lower creasing profundity of 0.35 mm and top internal distance across (oversize) of 16 mm is acquired and which lead to limit the pleating spillage surrenders.

Keywords: Taguchi methodology, Cause and effect diagram, ANOVA, S/N Ratio, Manufacturing and Assembling Process.

INTRODUCTION

The primary advantage of the Taguchi methodology(Rao, Kumar, Prakasham, & Hobbs, 2008) is the elimination of subjectivity in decision-making by establishing a scheme in which everyone in the organization collects, analyzes and shows information in a coherent way. For manufacturing companies, the direct benefit of the Taguchi methodology is the result of a reduction in the number of defects due to improved manufacturing processes. In the Taguchi method, the results of the experiments are analyzed in order to achieve the objectives:

(i) To establish the best or optimum conditions for the product or process;

(ii) To determine the contribution of the individual factors; and

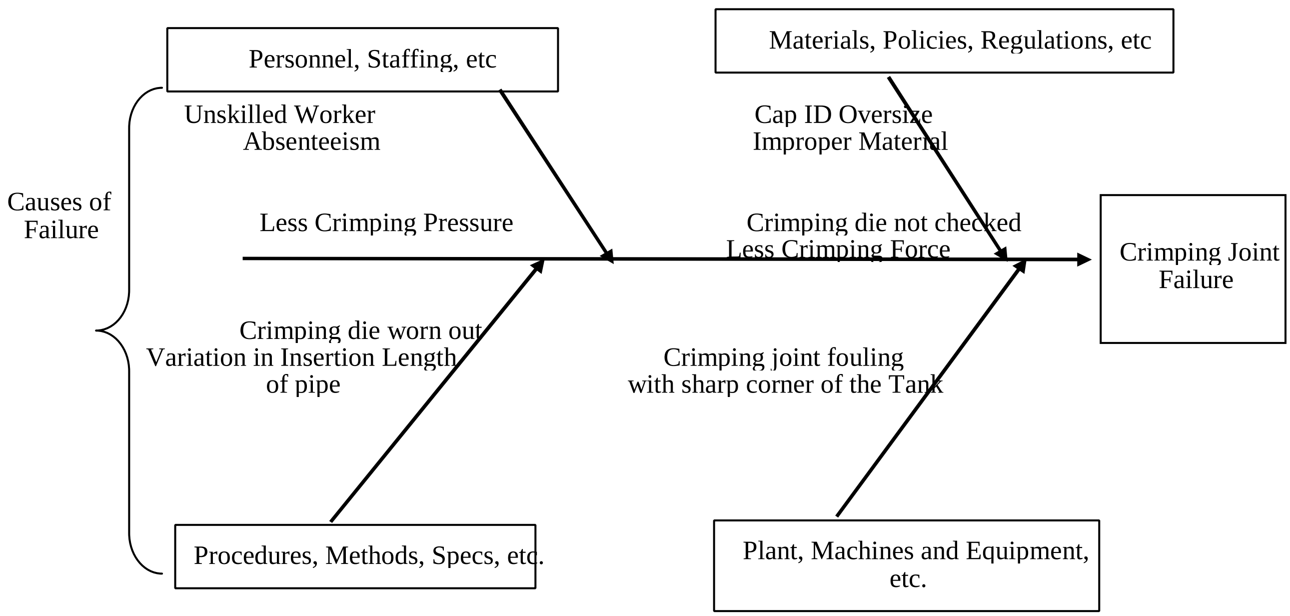
(iii) To estimate the response under optimum conditions.

Taguchi procedure expresses that even the best accessible assembling innovation without anyone else isn't an affirmation that the last item will really work in the hands of its clients as wanted thus emphatically upheld for the built items with hearty execution(Kavade, 2012). Taguchi portrayed whole idea in two fundamental thoughts, to be specific, quality ought to be estimated by the deviation from an extraordinary objective worth as opposed to by conformance to preset resilience cutoff points and quality can't be guaranteed through the review and revamp, however should be inherent, through the fitting structure of the procedure and item. There are two different methodologies for carrying out the complete orthogonal analysis ANOVA and S/N ratio(Myers, Khuri, & Vining, 1992)

METHODOLOGY

It is the pioneer industry in the manufacturing of automobile tubes in India and was established in 1969. It supplies its products to New Holland, Suzuki, DCM Toyota, Nissan, and Mahindra. It also manufactures automotive hoses and tubes. It joined a joint endeavor with TRI (Tokai Rubber Industries of Japan) in 2005. It is ISO-9000 and ISO-14001certified since 2003. It supplies Pipe Assemblies, Hose Assemblies, Tubing's, Multi-Layer Hoses, Stainer Assemblies, Molded Components, and Pipes and so forth for a wide range of overall automotives items. Adaptable hose gathering channels are utilized in auto thought process vehicles for fuel and air supply.

Cause and effect diagram of crimping joint failure



The Taguchi methodology is used to discover an ideal solution to the causes of dismissal. Three primary faults: Less Crimping Depth, Hose Length Variation and Cap Inner Diameter (Oversize) are regarded for the Crimping Leaking of the Hose Pipe Assembly.

Sample Calculations for Signal to Noise Ratios

The crimping leakage defects are "Lower the Better" type of quality characteristics. Lower the better S/N ratios are computed for each of the 8 trials and sample calculations are also given as under.

Lower is better: S/N_{LB} ratio = -10 log [(Σy^2i)/n]

For the case of minimizing the performance characteristic, the following values of the S/N ratio are calculated as:

$$SN_i = -10\log\left(\sum_{u=1}^{N_i}\frac{y_u^2}{N_i}\right)$$

For the case of maximizing the performance characteristic, the S/N ratio is calculated as:

$$SN_i = -10 \log \left[\frac{1}{N_i} \sum_{u=1}^{N_i} \frac{1}{y_u^2} \right]$$

Where, n is the number of observation and y_i are the different experimental values for various trials.

OTHER CALCULATION

Correction Factor (C.F.)

Correction Factor (C.F.) = (Sum Total) ^{2}/ No. of Observations

The total sum of squares

SS_{tot} = Y^2 - C.F.

Calculation of Sum of Squares for different factors

$$SS_A = \frac{(\text{Sum total in level 1})^2 + (\text{Sum total in level 2})^2}{\text{No. of Observations}} - \text{C.F.}$$

ANOVA TABLE for crimping defects in flexible hose assembly

ANOVA for crimping defects

Source	Sum of Square (SS)	Degree of Freedom	Variance	F ratio	Results	Percentage Contribution
A	36.3	1	36.3	18.4498	Significant	52.58
B	1.5	1	1.5	0.76239		0.021
A*B	0.77	1	0.77	0.39136		0.011
C	12.08	1	12.08	6.13977	Significant	17.49
A*C	0.28	1	0.28	0.14231		0.004
B*C	2.03	1	2.03	1.03177		0.029
A*B*C	0.33	1	0.33	0.16773		0.004
Error (e)	15.74	8	1.9675			
Total	69.03	15				

The ANOVA table shows that the Less Crimping Depth (mm) and the Cap Inner Diameter (Oversize) have a major impact on the Flexible Hose Assembly. The optimum concentrations for these variables can be achieved by examining the mean concentrations of the variables

The test statistic for testing H_0: $\mu_1 = \mu_2 = ... = \mu_k$ is:

$$F = \frac{\Sigma n_j(\bar{X}_j - \bar{X})^2/(k-1)}{\Sigma\Sigma(X-\bar{X}_j)^2/(N-k)}$$

and the critical value is found in a table of probability values for the F distribution with (degrees of freedom) $df_1 = k-1$, $df_2=N-k$. The table can be found in "Other Resources" on the left side of the pages.

In the test statistic, n_j = the sample size in the j^{th} group (e.g., j =1, 2, 3, and 4 when there are 4 comparison groups), $\bar{X}_j$ is the sample mean in the j^{th} group, and $\bar{X}$ is the overall mean. k represents the number of independent groups (in this example, k=4), and N represents the total number of observations in the analysis. Note that N does not refer to a population size, but instead to the total sample size in the analysis (the sum of the sample sizes in the comparison groups, e.g., $N=n_1+n_2+n_3+n_4$). The test statistic is complicated because it incorporates all of the sample data. While it is not easy to see the extension, the F statistic shown above is a generalization of the test statistic used for testing the equality of exactly two means.

CONCLUSION

The commitment of individual quality impacting components is the choosing key of the control to be authorized on the item structure. A generally connected factual treatment(Dellino, Kleijnen, & Meloni, 2012) - The Analysis of Variance (ANOVA) is utilized to examine the consequences of the Orthogonal Array (OA) analyze in item structure and to decide how much variety every quality-affecting element has contributed. By examining the primary impacts of every single one of the variables, the general patterns of the affecting elements towards the item or procedure can be described. Prior to the use of Taguchi's technique, the parameters of the pleating spillage procedure were progressively discretionary and hard to control and, obviously, the item quality has unsteadiness issues. (Hong, Holmes, & Heaton, 2003)Taguchi's technique yielded streamlined control factors, bringing about unrivaled item quality and soundness. From the investigation, it is discovered that the improvement in the quality at the most reduced conceivable expense can be accomplished by Taguchi's technique for parameter structure. It is additionally conceivable to recognize the ideal degrees of sign elements at which the clamor factor's impact on the reaction parameter is limited

$$F = \frac{\Sigma n_j(\bar{X}_j - \bar{X})^2/(k-1)}{\Sigma\Sigma(X-\bar{X}_j)^2/(N-k)}$$

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