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Quality analysis of stacking fingers used in hydro generator by using ultrasonic technique

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Abstract:- Stacking finger plays a important role in hydro generator. Stacking finger used to take a load and voltage fluctuation during the production electricity. If any stacking fingers is found to be defective than the working of hydro generator is affected. To reduce failure of hydro generator, it is important to use a good quality stacking finger. In Present work quality improvement of stacking finger is done with the help of ultrasonic testing technique at the time of inspection after production of stacking finger. In this work for quality measurement of stacking fingers C-chart and pareto chart is used.

Key terms- Stacking finger, Ultrasonic testing, C-chart, Pareto chart

I. INTRODUCTION

Hydro generator is an important part of any hydro power station. It converts mechanical energy which produces by hydraulic turbine in to electrical energy. Without hydro generator electricity is not produced. It comprises of varies elements such as laminated sheets, pressing plates, stacking fingers stators, rotors. In it stacking finger is very important component. Stacking fingers will be optimally designed, correct tolerance and al mechanical dimension will be correct. It takes loads and voltages fluctuation during the working of hydro generator. If any defect is found in it then the voltage fluctuation is not purely dissipated. And they damage the all assembly of hydro generator. If stacking finger is not doing there intend function then electricity production is minimized. Cost of Hydro Generator is 1 cror approximately so replacement is big loss and time for break down maintenance is also longer. From literature it is seen that there are numerous method available for knowing the internal defect. Ultrasonic testing is very effective method for knowing the internal defect.

Ultrasonic Testing (UT) uses high frequency sound waves (typically in the range between 0.5 and 15 MHz) to conduct examinations and make measurements. It can use to measure internal defect such as flaw detection/evaluation, dimensional measurements, material characterization, etc. [7]

A typical pulse-echo UT inspection system consists of several functional units, such as the pulser/receiver, transducer, and a display device. A pulser/receiver is an electronic device that can produce high voltage electrical pulses. Driven by the pulser, the transducer generates high frequency ultrasonic energy. The sound energy is introduced and propagates through the materials in the form of waves. When there is a discontinuity (such as a crack) in the wave path, part of the energy will be reflected back from the flaw surface. The reflected wave signal is transformed into an electrical signal by the transducer and is displayed on a screen. [7]

For the quality assurance C-chart is applied on a sample. The c-chart differs from the p-chart in that it accounts for the possibility of more than one defect per inspection unit, and that it requires a fixed sample size. C chart treats all defects alike. On C- chart if any point fall outside the control limit than the component should be rejected.

Pareto chart has been proposed for analysis of experimental data. The purpose of the Pareto chart is to highlight the most important among a (typically large) set of factors. A Pareto chart can be used to quickly identify what major issues need attention. [11]

II. EXPERIMENTAL WORK

In this section, there will be brief description of equipment used to carry out ultrasonic testing for determining the internal defect.

2.1 Test Specimen

Stainless steel 304 L (Medium carbon austenitic stainless steel, for high temperature application) Type 304L is an extra low-carbon variation of Type 304 with a 0.03% maximum carbon content that eliminates carbide precipitation due to welding. Velocity is set based on the specimen. For stainless steel 304L is 5660 m/s.

Table-1 Composition

Elements	Max.%
C	0.03
M	2
Si	0.75
P	0.045
S	0.030
Ch	18-20
Ni	8-12

Table-2 Material properties of test specimen

S.N.	Property	Value	Unit
1	Tensile strength	564	Mpa
2	Minimum yield strength	210	Mpa
3	Min elongation fracture	58	%
4	Hardness	158	Vickers Hardness
5	Elasticity	193	Gpa
6	Poisson ratio	0.3	
7	Density	8000	Kg/m^3

Fig -1 Sample

2.2 Experimental Setup

Epoch XT ultrasonic defector is used for detecting the internal defect. It is connected to the Probe (contact). The probe is placed upon the specimen and a couplant (water) is introduced at the interface. When the testing is done then the gain, range etc must be set.

Fig-2 Ultrasonic defect detector

Table-3 Data collected by ultrasonic testing

Samples	No of defect
1	3
2	2
3	2
4	0
5	3
6	2
7	4
8	1
9	5
10	3

Fig-3
Ultrasonic CRT screen for defect
Location 1

Fig-4
Ultrasonic CRT screen for defect
location 2

During ultrasonic testing the CRT graph which is collected is shows the location of defect. Sometimes defect is found at half of the thickness of test specimen and sometimes the defect is found well below the half thickness of test specimen. These defects occur in a specimen due to cracks, porosity or inclusion. Sometimes same defect occurs in 2 or 3 times.

2.3 Analysis Of Experimental Data

C Chart has been created with the help of minitab software. In minitab by using control toots (c chart) graph has been created. Evaluate the graph to see whether the process is in control or out-of-control. The graph is out-of-control if any point fall outside the control limit. If any point fall outside the control limit than the specimen should be rejected.

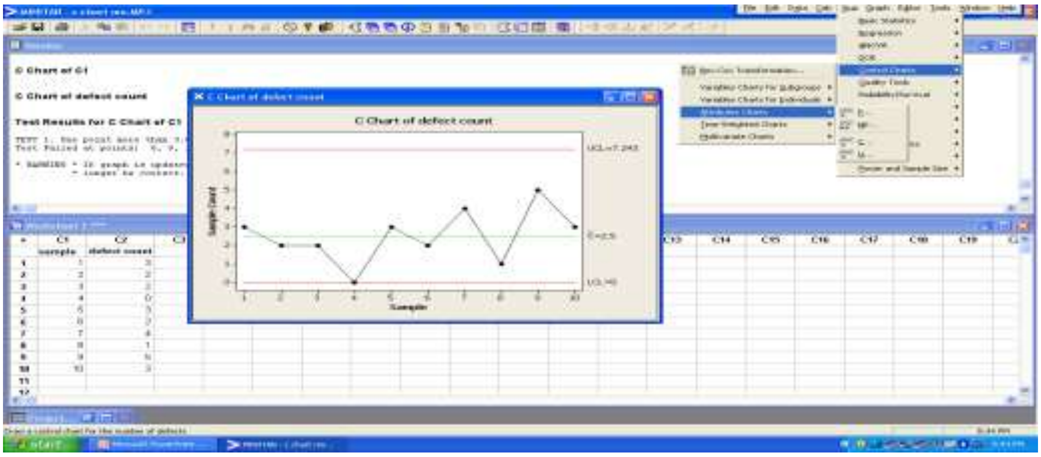

Fig-5 MINI TAB for C-chart

Here maintenance action is carried out due to, to avoid the production disruption, to not add production cost, to maintain high quality.

Pareto chart has been proposed for analysis of experimental data. The purpose of the Pareto chart is to highlight the most important among a (typically large) set of factors. A Pareto chart can be used to quickly identify what major issues need attention. Pareto charts can help to focus improvement efforts on areas where the largest gains can be made. In quality control it often represents the most common sources of defects, the highest occurring type of defect & resolves the majority of problem [11]. Pareto chart is a type of chart that contains both bars and a line graph where individual values are represented in descending order by bars, and the cumulative total is represented by the line.

Minitab software is used for analysis of experimental data. On minitab software quality tools are used. In quality tools pareto analysis /pareto chart has been used. Choose Chart defects table. In Labels in, enter Defects. In Frequencies in, enter Counts. Then click ok. Pareto chart has been created.

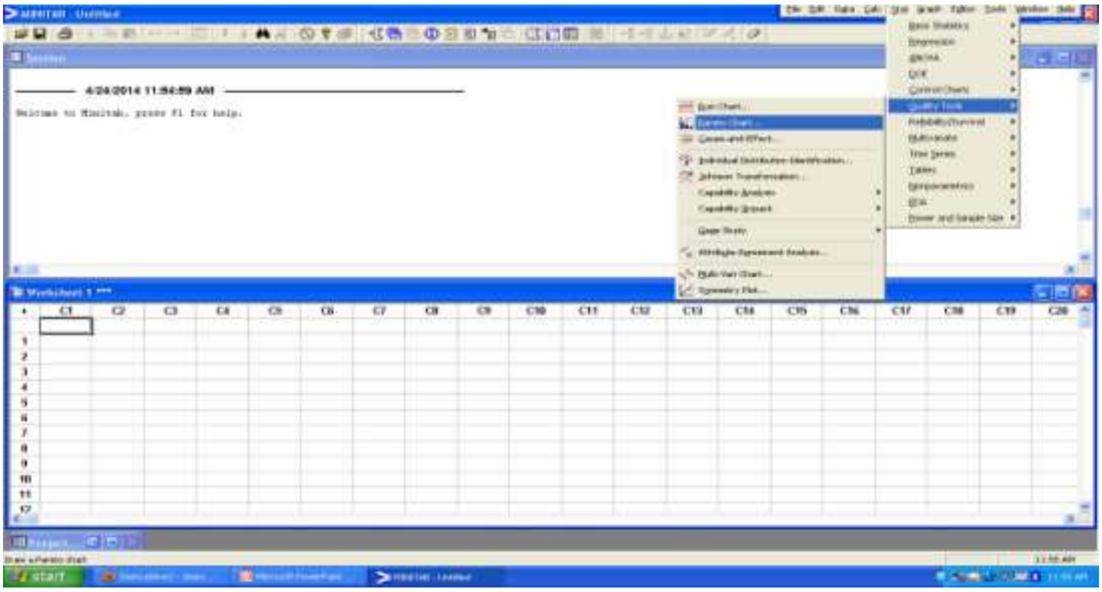

Fig-6 MINITAB for Pareto chart

From pareto chart it is clear that cracks occurs in most numbers of times. Thus it will enable to identify the defects beforehand and thereby reduce maintenance by knowing the problems earlier .So the focus has to be done on improvement to cracks because 52% of damage occurs due to this defect.

During the analysis it is seen that in total 25 defect the arrival of cracks is 13 times. So by probability in total 10 samples 5 samples are defective.

When this probability is applied on large lot, suppose 100 samples then 50 samples are found to be defective.

By this prediction of large lot, improvement in quality of samples is done by improving the manufacturing process or some heat treatment process.

III. RESULT AND DISCUSSION

Quality control technique shows that how many defect occur is a sample and whether sample is accepted or rejected. With the help of C-chart and pareto analysis it is clear that internal defect may leads to failure of stacking fingers.

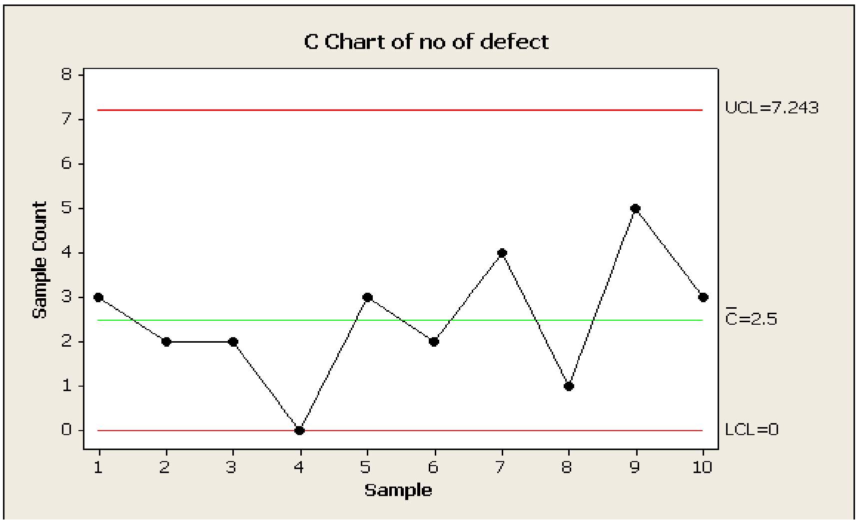

Fig. 6 C chart

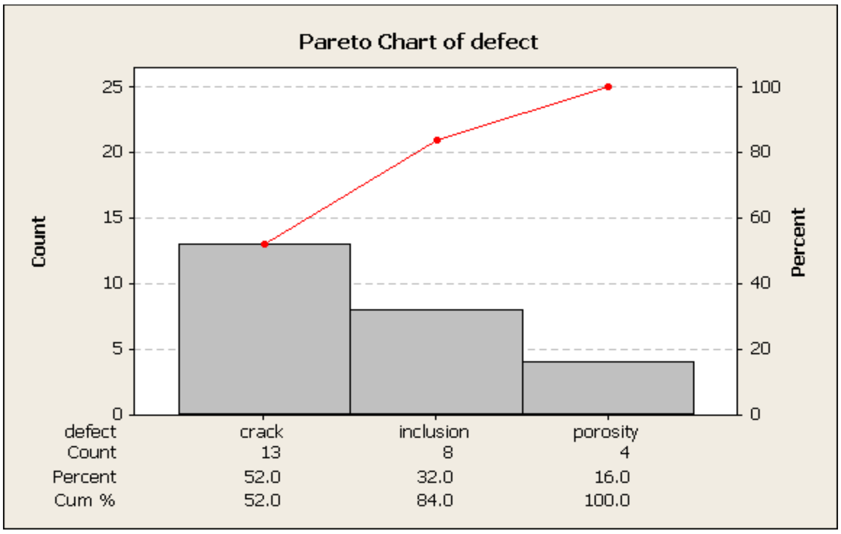

Fig. 7 Pareto analysis chart

From pareto analysis it is seen that cracks occurs in most numbers of times. Thus it will enable to identify the defects beforehand. So the focus has to be done on improvement to cracks because 52% of damage occurs due to this defect.

So by inspection of stacking finger in manufacturing stage with the help of ultrasonic testing, may increase the availability of stacking fingers during production of electricity. Simultaneously reduction in breakdown is happened during the operation and decrement in maintenance cost is done. Because during breakdown two major losses happened 1^{st} from when production is stopped during the operation period and 2^{nd} excess maintenance hours are required so maintenance cost is increased.

IV. CONCLUSION

Ultrasonic testing is found to be very effective for determining the internal defect. By these internal defect (cracks, inclusion, porosity) sudden failure of stacking finger is arrived. So by the knowing the problem earlier in manufacturing stage, the future failure of stacking fingers is minimized. So operation period of stacking finger is increased.

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