Reliability improvement of hook assembly life through process capability study & verification by ALT.

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Abstract – *Hook assembly is the part of the lift which operates while lift doors opening & closing time. The existing assembly fails within the period of 1.5 – 2 years of running. The failure is due to the excess play of the hook stud with spacer. The stud was manufactured from Centerless grinding machine & spacer from cnc turning machine. This paper gives a proposed methodology for to increase the quality of a product manufactured in a Centerless grinding machine, using the various quality improvement tools like Cause and Effect diagram & Process capability study to increase the life. The quality improvement is accompanied by the changes in machining parameters of a grinding machine & by maximizing process capability index (Cpk) of the Hook fixing stud. The improved life can be verified by accelerated testing.*

***Key Words*: Centerless grinding, process capability index (Cpk), Process capability study, Hook stud, Spacer, Hook assembly.**

1. INTRODUCTION

Hook assembly is the part of the lift which operates while lift doors opening & closing time. In other words it is called as "locks". During the lift running time the hook assembly must be kept in locked condition. (i.e) doors were closed.

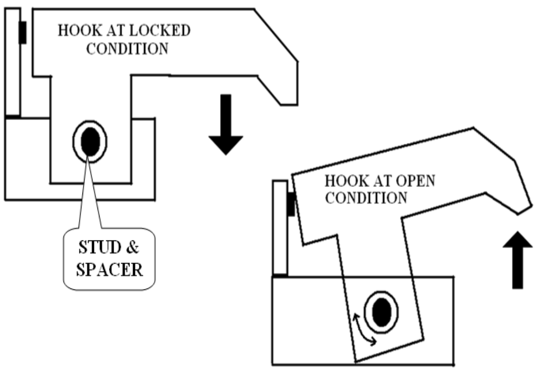

Fig -1: Hook assembly at operating condition.

The gap between the stud & spacer will determines the play in terms of the assembly life. So the initial play to be minimized to improve the life of the assembly. This can be achieved by the process capability study to improve the process capability index (Cpk) of the stud in grinding process.

1.1 Centerless grinding

Centerless grinding is a process for continuously grinding cylindrical surfaces in which the work piece is supported not by centers or chucks but by a rest blade. The work piece is ground between two wheels. The larger grinding wheel does grinding, while the smaller regulating wheel, which is tilted at an angle some angle, regulates the velocity of the axial movement of the work piece. Centerless grinding can also be external or internal, traverse feed or plunge grinding. The most common type of Centerless grinding is the external traverse feed grinding.

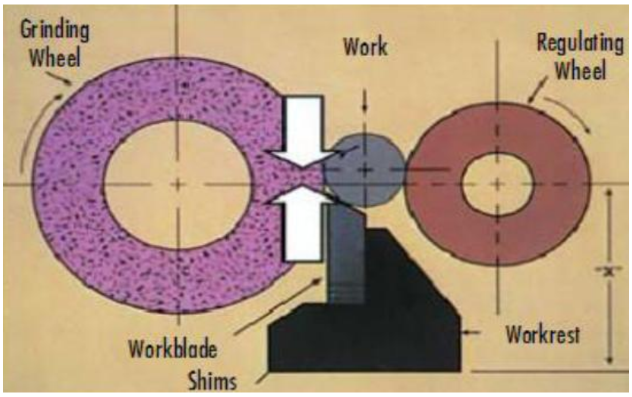

Fig -2: Centerless grinding operation.

1.2 Process capability index (Cpk)

Process Capability index value (Cpk) calculation is done with the use of Upper Specification. Limit (USL), Lower Specification Limit (LSL) of a product, given from the customer side. By using these specification limits, USL and LSL, the Cpu and Cpl are calculated. The formula for calculating,

Cpu = □ USL □ X □ 3 *Sigma

Cpl = □ X □ LSL□ 3 *Sigma

From the calculated Cpu and Cpl values, one can determine the Cpk value from the formula, shown below:

Cpk = Minimum (Cpu, Cpl)

The minimum value is taken for the Cpk calculation because it indicates whether or not the process being analyzed is capable of producing little or no defects. So, the quality level can be achieved in a grinding operation only when the variations on the grinding process are eliminated.

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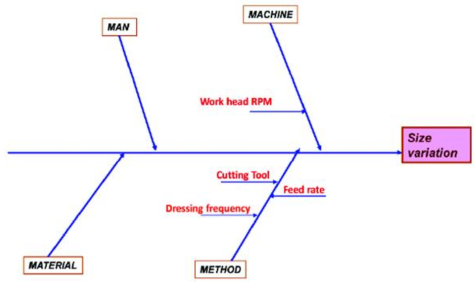
2. CAUSE & EFFECT DIAGRAM:

Cause and Effect Diagram Showing the Significant Causes for the Size Variation



Dressing frequency, Cutting tool, may eliminate the variations occur on the product during grinding operations". The analyzed results needed to be optimized for the continuous improvement in a grinding machine, if not; the outcome products will have defects and leads to rejection. To prove this statement a detailed analysis should be made on a grinding machine.

3. PROCESS CHANGE MADE:

Usually the regulating wheel will be set based on the work dia distance plus the min. tolerance limit. So the dressing frequency will be lesser. But in our case we have fixed the regulating wheel at the distance of work dia plus half of the tolerance limit. By maintaining the half of the tolerance, we can achieve better CPK value. At present we have 0.8CPK & 0.8mm hook play observed. We have to increase the CPK & reduce the play in the hook assembly.

4. RESULTS OF ACCLERATED TESTING:

"Accelerated Cycle test of Hook Assembly ~ Findings"

sl no	Specimen tested	Initial play	Cpk	1 year span				2 years span			3 years span			4 years span		5 years span		Beyond 5 years	
				10 L	15 L	25 L	35 L	50 L	60 L	70 L	75 L	100 L	105L	125L	140L	150L	175L	180L	200L
1	Hook assly	0.8mm	0.8	0.8	0.8	0.8	1.2	1.7	1.9	2.05	2.16	2.48	2.55	-	-	-	-	-	-
2	Hook assly	0.7mm	0.9	0.7	0.7	0.7	1	1.3	1.5	1.8	1.95	2.25	2.38	2.57	-	-	-	-	-
3	Hook assly	0.5mm	1.05	0.5	0.5	0.5	0.85	0.98	1.13	1.25	1.36	1.75	1.92	2.35	2.52	-	-	-	-
4	Hook assly	0.3mm	1.08	0.3	0.3	0.3	0.63	0.79	0.91	1.13	1.32	1.71	1.85	2.28	2.41	2.53	-	-	-
5	Hook assly	0.21mm	1.12	0.21	0.21	0.21	0.52	0.68	0.76	0.92	1.01	1.45	1.63	1.92	2.16	2.39	2.51	-	-
6	Hook assly	0.18mm	1.2	0.18	0.18	0.18	0.48	0.61	0.70	0.86	0.99	1.33	1.41	1.72	1.91	2.20	2.46	2.52	-
7	Hook assly	0.15mm	1.27	0.15	0.15	0.15	0.41	0.53	0.59	0.72	0.81	1.21	1.30	1.63	1.85	2.13	2.39	2.518	-

Table-1: accelerated test results.

5. PRODUCT LIFE

Based the above results we can say that the hook play was reduced by increasing the CPK of the stud. Consequently the life prediction function can be expressed as number of usage cycles to failure divided by the yearly usage cycle. Product life in years can then be expressed as:

$$\text{Product life in years} = \frac{\text{No. of cycles to failure}}{\text{Usage cycle*365}}$$

So based on the above expression we can derive the below data for the test conducted. They are as follows:

sl no	Specimen tested	Initial play	Cpk	No. of cycles to failure	Product life (in years)
1	Hook assly	0.8mm	0.8	10300000	2.9
2	Hook assly	0.7mm	0.9	12000000	3.4
3	Hook assly	0.5mm	1.05	13700000	3.9
4	Hook assly	0.3mm	1.08	14800000	4.2
5	Hook assly	0.21mm	1.12	16500000	4.7
6	Hook assly	0.18mm	1.2	17600000	5.0
7	Hook assly	0.15mm	1.27	17850000	5.1
Note: usage cycle = 9600/day					

Table-2 Product life comparison

6. CONCLUSIONS

- ❖ The process was changed to maintain the half of the tolerance limit while setting work during Centerless grinding process from Min tolerance limit.
- ❖ The CPK of the hook stud was achieved 1.27 from 0.8 by setting the work at half tolerance limit
- ❖ By reducing the initial play in the hook assembly leads to the life was increased by 5.1 years from 2.9 years (i.e) **57% increase in life.**

Thus the life of the hook assembly was increased using the process capability study as a tool.

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