iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** V **Month of publication:** May 2017

DOI:

www.ijraset.com

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Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

To improve c_p and c_{pk} of keystone angle and Axial height in piston ring on Katoka ks grinder

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Abstract: In present generation, agile manufacturing machine and their automation becoming more complex. The manufacturing company changes their production system over year. Competition has increase dramatically. Customer focus product quality, cost and delivery of the product. So industry should maintain quality control system to maintain the quality and improve the performance level of manufacturing and increase the satisfaction, loyalty of the customer and their requirement. C_p and C_{pk} plays important role to improve the quality of product and continuous production in industry, which are prime grandness to customer. Paper objective minimizing the defects and increase performance, quality rate of machines and improve process capability. Initially current and back year study of process capability have been analysed which helped to find bottleneck of machine. The Cp and Cpk was found less than 1 which very poor process capability. Further, a team was form to systematic approach study to improve process capability. Through the study and analysis the piston ring manufacturing increase the performance and process capability. On the basis of result a database has been prepared which can be further used.

The result obtained from study process capability and process capability improved from greater than 1 which show desirable for industry.

I. WHAT IS PROCESS CAPABILITY AND HOW IT MEASURE?

Process capability is the long-term performance level of the process after it has been brought under statistical control. In other words, process capability is the range over which the natural variation of the process occurs as determined by the system of common causes.

A. Measure of process capability

1) Cp, Cpl, Cpu, and Cpk are the four most common and timed tested measures of process capability. Process capability indices can be used effectively to summarize process capability information in a convenient unit less system.
2) Cp and Cpk are quantitative expressions that personify the variability of your process (its natural limits) relative to its specification limits (customer requirements).

B. The C_{pk}, P_{pk} Quandary

1) In 1991, ASQ / AIAG task force published the "Statistical Process Control" reference manual, which presented the calculations for capability indices (Cp, Cpk) as well as process performance indices (Pp, Ppk).
2) The difference between the two indices is the way the process standard deviation (s) is calculated.
3) Cpk uses s which is estimated using (R-Bar / d2) or (S-Bar / C2) .
4) Ppk uses the calculated standard deviation from individual data where s is calculated by formula:

$$\sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$$

NOTE: The readers should note that Ppk and Cpk indices would likely be similar when the process is in a state of statistical control.

C. Natural Variability versus Specifications for Process Capability

There are three components of process capability:

1) Design specification or customer expectation (Upper Specification Limit, Lower Specification Limit)
2) The centring of the natural process variation (X Bar)
3) Spread of the process variation (s)

Case 1: Cpk> 1.33 (A Highly Capable Process)
Case 2: Cpk = 1 to 1.33 (A Barely Capable Process)
Case 3: Cpk< 1 (The Process is not Capable)

D. Assumptions, Conditions and Precautions

Following are some of the precautions the readers should exercise while calculating andinterpreting process capability:

1) The indices for process capability discussed are based on the assumption that the underlying process distribution is approximately bell shaded or normal. Yet in some situations the underlying process distribution may not be normal. For example, flatness, pull strength, waiting time, etc. might naturally follow a skewed distribution. Forthese cases, calculating Cpk the usual way might be misleading. Many researchers have contributed to this problem. Readers are requested to refer to John Clements article titled" Process Capability Calculations for Non-Normal Distributions" for details.
2) The process parameter in question must be in statistical control. It is this author's experience that there is tendency to want to know the capability of the process before statistical control is established. The presence of special causes of variation make the prediction of process capability difficult and the meaning of Cpk unclear.
3) The data chosen for process capability study should attempt to encompass all natural variations. For example, one supplier might report a very good process capability value using only ten samples produced on one day, while another supplier of the same commodity might report a somewhat lesser process capability number using data from longer period of time that more closely represent the process. If one were to compare these process index numbers when choosing a supplier, the best supplier might not be chosen.

E. Concluding Thoughts:

In the real world, very few processes completely satisfy all the conditions and assumptions required for estimating Cpk. Also, statistical debates in research communities are still raging on the strengths and weaknesses of various capability and performance indices. Many new complicated capability indices have also been invented and cited in literature. However, the key to effectual use of process capability measures continues to be the level of user understanding of what these measures really represent. Finally, in order to achieve continuous improvement, one must always attempt to refine the "Voice of the Process" to match and then to surpass the "Expectations of the Customer".[1][2][3][4][5][6]

F. Root Cause Analysis

Sir Miles C. Miller Research Directorate September 1992 state the primary purpose of a Root Cause Analysis is to identify the real source (i.e., root causes) of a problem. It is someone else's job to solve the problem. A formal, systematic process is followed which identifies the root causes as well as documenting the basis for these results. There are many different techniques in use to achieve this end sometimes referred to as Failure Analyses, Problem Investigations, etc. A particular Root Cause Analysis Methodology which is employed throughout will be presented in this report.

The Root Cause Analysis includes a sequential series of steps which will both determine the root causes as well as document the basis for this determination. Some flexibility is possible, where the technique can be adapted to fit various technical situations, time, funding, etc.[7]

G. Handling the Finish Lapping Operation

Next, for tackling the other critical process, namely the Finish lapping operation, first an Ishikawa diagram (Montgomery, 1991, pp. 121–124) (see Figure 1.1) was prepared showing the various causes which might be affecting the axial thickness variation in the finish lapping operation. The Ishikawa diagram threw new light on the number of possible deficiencies in the machine, method and material that might be responsible for axial thickness variation in the finish lapping operation. The Ishikawa diagram narrowed down the machine-related causes to six factors. These were grinding wheel rotating speed, grinding time, grinding pressure, holding plate, holes (fixtures) within the holding plate and positions within a ring. Similarly, according to the Ishikawa diagram, two other important factors affecting axial thickness were coolant and dressing frequency of the grinding wheel. Thus, after studying the

Volume 5 Issue V, May 2017
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Ishikawa diagram it appeared that dimensional accuracy and the quality of surface finish, which could be achieved in a finish lapping operation, mainly depended on the following eight factors:

1) Grinding wheel rotating speed
2) Grinding time
3) Grinding pressure
4) Holding plate
5) Holes (fixtures) within the holding plate
6) Position within a ring
7) Coolant

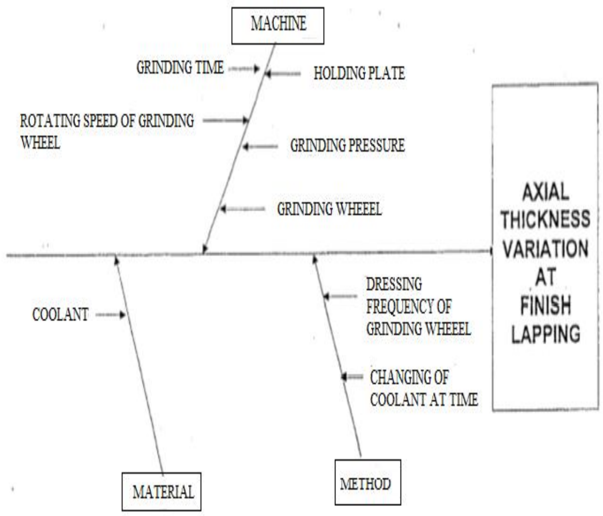

Fig-1.1 Ishikawa Diagram

Dressing of the wheel means removal of abrasive material from the cutting face and the sides of the wheel, so that it runs properly with respect to the axis of rotation. Dressing involves removing the worn out grains and loaded materials from the surface of the wheel, restoring the original geometric shape and preparing the wheel for the next grinding. Dressing of the wheel is accomplished by a single-point dressing diamond. During grinding, the surface of the rings in contact with the grinding wheel can experience considerable heat. Because of the material properties involved in the process, most of the heat generated at the contact is transferred to the rings, with only a little conducted to the grinding wheel. Hence a coolant system is used to cool the rings and flush the wheel. Thus, although coolant and dressing might affect the axial thickness, their effect is of an indirect nature. Moreover, since the effect of coolant and dressing of the wheels might only deteriorate over time, initially for the experiment with the other six factors, data were collected immediately after the wheels were dressed and the coolant was changed. However, to study the effect of these two factors, the experiment was again repeated under the optimal settings after a sufficiently long production run, details of which are provided later. For the remaining six factors, since no a priori engineering information was available about how they might be affecting the axial thickness during the finish lapping operation, it was reasoned that the only way to understand these effects would be to conduct a controlled and well-designed experiment. The design of this experiment is described in detail in the following subsection. [8][9][10]

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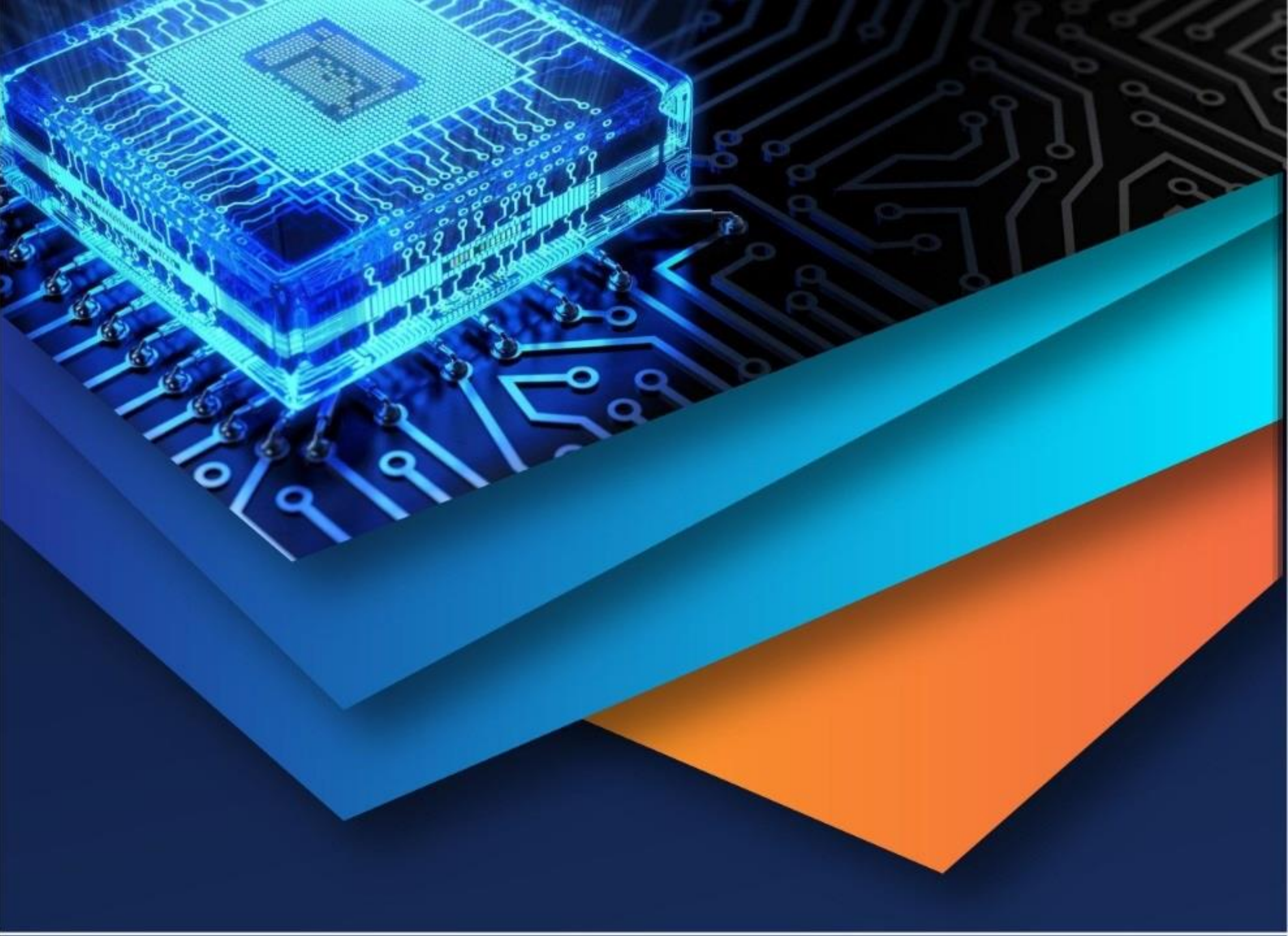

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