Review on Minimization of gear dent & damage by using Kaizens

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Abstract -This paper discussed of literature review of different author who have implemented Kaizens for reducing various gear qualities issues like gear dent, pitting, noise, damage etc. For improving the gear quality, the main focus was on the minimization of dent and damage by using Kaizens in the gear shop.After the implementations of Kaizens, the results were outstanding with a decrease in dent ppmin just one month.It was found that the reduction in gear dent & damage has been successfully carried out and has a satisfactory effect and be a promising factor to improve future quality issues.

***Key Words*:**Kaizens, pitting, ppm.

1.INTRODUCTION

Kaizen is a Japanese word which means change for better. The word refers to any improvement, one time or continuous, large or small, in the same sense as the English word "improvement". Kaizen is an approach to creating continuous improvement based on the idea that small, ongoing positive changes can reap major improvements. In gear industry, KAIZEN plays an important role as to achieve the desired quality as well as to reduce the rejection. In gear industry many issues have occurred and still do occur during the manufacturing process of gears, especially in the areas of hobbing, shaving, heat treatment processes etc. and attempts have been made to address them. Modern gearboxes are characterized by high torque, low torque, low running noise and compact design. By the use of various quality control tools, Statistical approaches etc. we can achieve the desired targets. Accordingly, we are working on the Quality control strategy for minimizing the dent and damage problem of the gears.

2. LITERATURE REVIEW

Literature review on Kaizens

Sokovic et al. (2006) presented a Six Sigma project, undertaken within company for production of automotive parts, which deal with identification and reduction of production cost by using DMAIC six sigma methodology. Achieved results, such as reduction of tools expenses, cost of poor quality, labour expenses and improvements through reduced production time, control time, material and internal scrap. With the help of six sigma, organization made annual benefit of $ 72 000.

Cheng (2017)proposed that Kaizen generated small improvements as a result of coordinated continuous efforts by all employees. Kaizen events brought together a group of process owners to map out an existing process and identify improvements that was within the scope of the participants. Kaizen could be effective which applied continuous improvement utilizing the rigor and discipline of DMAIC. Kaizen event and DMAIC together became elements of the larger quest for improvement. The purpose of this paper was to explore Kaizen events implementation under DMAIC mechanism. The goal was to explore how Kaizen event this evolution and the relative weight of factors as the methodology developed.

More et al. (2017) presented that DMAIC was a Data-driven quality strategy used to improve processes. They deal with application of six sigma for gearbox system for dent minimization purpose. The various problems which lead to Gear box rejections such as Noise, Leakage, Damages, Assembly jam were studied in details for period of 2013-2016.All the parameter of DMAIC technology such as Define, Measure, Analyze, improve & Control were applied to above stated problem. The given study found that the Dent Minimization had been successfully carried out and had a satisfactory effect and can be a promising factor to improve future quality issues.

Raghuwanshi and Baghel (2018) presented that Increasing productivity and profitability was main objectives of any organization. Many tools and techniques were used to reduce rejections and defects of product. Most of the rejections and defects were occurred due to improper control of quality of product. So use of 7 Quality control tools was the best way to reduce rejections and defects of product after analyzing of manufacturing process. Very few service companies had been able to reap full benefits of TQM. One major reason for its inadequate success was that of trying to implement in service companies techniques that had been successful in manufacturing. In manufacturing, emphasis of TQM was on "zero defects". Control charts and sampling were the major tools of quality control. However, in services, emphasis was on "zero defections". Focus was on customer satisfaction and team approach. TQM can boost profits and improved customer satisfaction by reducing defects.

Wicaksono et al. (2020) proposed that Kaizen was considered as the main concern and prerequisite for competitiveness in manufacturing. One form of continuous improvement was in the field of product quality. The continuous quality improvement was the key to long -term success and high performance of the organization. A case study was conducted in a manufacturing company. In the year 2019, company had not yet reached the target in particular on cylinder head part. One of the defects that still occurred was the dent. Research carried out using Toyota Business Practices [TBP] approach. Toyota Business Practices was a method for applying kaizen in daily work.

Literature review on Gear dent reduction

Mahto et al. (2008)adopted a root cause identification methodology to eliminate the dimensional defects in cutting operation in CNC oxy flame cutting machine and a rejection had been reduced from 11.87% to 1.92% on an average. A detailed experimental study had illustrated the effectiveness of proposed methodology.

Klocke et al. (2011)presented thatan important property of manufacturing processes was the process reliability. That refers to the macrogeometry and to the achievable surface quality. In dry gear hobbing as the most productive and common manufacturing technology for the soft machining of cylindrical gears sometimes surface defects were noticed. Those defects like welded-on chips and smeared areas on the flank was not acceptable. The mechanisms leading to surface defects was not known and understood in total. For the understanding, first the appearance and exact occurrence had to be investigated. Parallel, metallografic investigations was carried out for the characterization of the defects. Further on, the appearing of surface defects and characteristic values generated by a manufacturing simulation for gear hobbing was compared to find influences of the tool and process design on the tendency of dry hobbed gears towards surface defects.

Yadav (2012) – proposed about different types of failure detection and analyzing techniques, which was used to reduce failures from gears. The basic reasons of gear failure misalignment of gear, spalling, pitting etc, followed the reason of gear failure. The intention of this paper was focused on the different types of methodology that was used by the various researcher in the past recent year to find out causes of failure in gear and what is final result of that to reduce the failure in gear.

Sahu and Silarpuriya (2013) carried out Lean manufacturing concepts to the continuous production process sector with a focus on **Gear** manufacturing company. The basic idea behind the system was eliminating the waste. Waste was defined as anything that does not add value to the product from the customer's perspective. The primary objective of lean manufacturing was to assist manufacturers who have a desire to improve their company's operations and became more competitive through the implementation of different lean manufacturing tools and techniques.

Patel et al. (2015)proposed about the recent development in the field of gear failure analysis. The basic reasons of gear failure misalignment of gear, spalling, pitting etc. follow the reason of gear failure. Gears generally failed when the working stress exceeds the maximum permissible stress. The gears generally failed when tooth stress exceed the safe limit. In this study the technology of gears was presented along with the various types of failure that gears had. The causes of those failures was studied.

Panwar et al. (2015)presented that Gears was amongst the frequently encountered components to be found in rotating machinery used in various applications. Even though inexpensive, its failure can disturb the complete production in a plant resulting in unscheduled downtime and production losses. Also, the detection of gear failure at correct time was of utmost importance otherwise the system may sustain bigger loss. They deal with study of different gears failures of machines used in industries and the vibration based techniques used to detect these failures.

Sharma and Parey (2016)said that plentiful work had been done for condition monitoring [CI] and fault diagnosis of fixed-axis gearboxes. It was found that articles citing condition indicators for fault diagnosis of gearboxes was less in quantity, in academic journals, conference proceedings and technical reports. The specialty of condition indicators was to provide accurate information regarding the condition of various components at different levels of damage [initial, heavy or growing]. Here, these indicators was addressed domain-wise and their characteristics were stated. The objective of this paper was to review and encapsulate this literature to provide a wide and good reference for researchers to be utilized. The structure of a fixed-axis gearbox was briefly introduced. The unique behaviors and fault characteristics of fixed-axis gearbox was recognized and studied. Investigations on the basis of statistical indicators was also summarized based on the adopted methodologies. Lastly, open problems was stated and further research prospects pointed out.

Maczak and Jasinski (2017)carried out a methodology for developing model-based method of gear fault diagnostics. First, the simulation model of the helical gearbox was discussed allowing analysis of the phenomena-taking place during teeth mating in the presence of manufacturing and assembly errors. It included observation of influence of errors on the generated signals. The model was initially used to analyze the teeth contact in the presence of pitch errors and later to verify the sensitiveness of proposed diagnostic methods and their availability to detect the fatigue damages of teeth. The common feature of

discussed approach was the direct use of time signal processing algorithms, and in contrary to the methods based on spectral analysis it allows precise localization of gear defects like pitting and tooth fracture associating them to the particular pinion or gear teeth. Their advantage was the simplicity and speed of action that was of great significance for the implementation in the autonomous transmission diagnostic systems and diagnostic systems working online. Presented methods of signal processing were first tested on a simulation model of the gear assembly and later verified during the experiments on a back-to-back test stand.

Qin and Wang (2020)proposed that to accurately and quantitatively detect the gear pitting of different levels on the actual site, a new vision measurement approach was based on a tunable vision detection platform and the mask region-based convolutional neural network [Mask R-CNN]. The shooting angle could be properly set according to the specification of the target gear. With the obtained sample set of 1500 gear pitting images, an optimized deep Mask R-CNN was designed for the quantitative measurement of gear pitting. The effective tooth surface and pitting was firstly and simultaneously recognized, then they were segmented to calculate the pitting area ratio. Considering three situations of multi-level pitting, multi-illumination, and multi-angle, several indexes were used to evaluate detection and segmentation results of deep Mask R-CNN. Experimental results showed that the proposed method had higher measurement accuracy than the traditional method based on image processing, thus it had significant practical potential.

Thamba et al. (2020)carried out a research on the vibration analysis on worm gears at various conditions of oil using the experimental set up. An experimental rig was developed to facilitate the collection of the vibration signals which consisted of a worm gear box coupled to an AC motor. The four faults were induced in the gear box and the vibration data were collected under full, half and quarter oil conditions. An accelerometer was used to collect the signals and for further analysis of the vibration signals, MATLAB software was used to process the data. Symlet wavelet transform was applied to the raw FFT to compare the features of the data. ANN was implemented to classify various faults and the accuracy was 93.3%.

Karpuschewski et al. (2020)presented thatGears were highly loaded components in many different application areas such as automotive, aircraft turbines, ships or wind energy systems. The demand on gears could be summarized by ever rising load capacity on the one hand side and significant noise reduction on the other hand. Both demands can only be fulfilled by adapted gear finishing processes generating the best possible macro- and micro geometry as well as the desired surface integrity state. The paper presented research work on analyzing the thermal load on gears during gear hobbing, surface integrity states by different hard gear finishing operations and possibilities to avoid thermal damage in gear manufacturing by adapted process monitoring and fast non-destructive analyzing techniques.

Chandrasekaran and Nandakumar (2020)presented thatGear drives was one of the most essential mechanism of power transmission systems in numerous industrial applications such as automobiles, aerospace and wind turbines, etc. As the speed of gear transmission increases, the study of the dynamic behavior of the gears was more important in the gear design. Gear mesh stiffness played an eminent role in gear dynamics and it varies in the existence of gear fault such as pitting, spalling and crack. The dynamic performance of the gears was affected by module, contact ratio, pressure angle and transmission error, etc. In order to understand the dynamic properties of spur gear system, it was necessary to calculate the mesh stiffness of the gear tooth pair effectively. In this paper, a comparative study had been carried out using FEM between healthy gear and fault gear by considering pitting defect. Gear mesh stiffness of healthy and fault gear had been compared under dynamic load distribution in gear tooth contacts.

3. CONCLUSION

After reviewing above papers we can say that, no attention is given towards the gear dent, most of the research work in the field of gear manufacturing is carried out on improving the production by applications of Kaizens, Six Sigma and lean manufacturing. Dent problem is the most common problem that occurred during the manufacturing of the gears and gear shafts. There is a huge competition in the market and now everyone is more concerned about the quality rather thenquantiy. For improving the quality of the gears, the dents should be eliminated. The main objective of this research is to improve the gear quality by reducing the gear dents. Various 7 QC tools are implemented to find out the root cause of the dent & damage problem. Kaizens are implemented to decrease the dent ppm and increase the overall quality of gears.

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