Gear Bunk Service Life Improvement in Oil Quenching Process

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Abstract— By the most important supply of issue for heat treaters is distortion of component once heat treatment. Distortion causes excessive noise within the gear drive train, and potentially early failure due to high residual stresses. It also contributes to high grinding costs. However, the supply of distortion and residual stresses are not limited to either the Martensite Start Temperature, the oil used, or the alloy content. There are variety sources of residual stresses, and not all of them are heat-treating related. Gear bunk used for planetary gear hot oil quenching process is failing prior to the expected life after nearly 100 working cycles. As we know that oil quenching is an important procedure performed in gear manufacturing. It is necessary to maintain the exact dimensions or gears even after the quenching process. Size and dimensions of gear bunk is crucial in the process. This project is limited to Improve or enhance the life of gear bunk used in oil quenching process in gear manufacturing. The study of existing quenching process is included in the project. The project will involve building the CAD models of existing design, performing FEA analysis for stress development in gear bunk, modifying the design of gear bunk using CAD and FEA techniques and improving quenching process cycle. The main motive of this project is to improve or enhance life of gear bunk under repeated oil quenching with high stresses process.

Keywords: Heat Treatment, Oil Quenching, Gear Bunk

I. INTRODUCTION

Heat treating and quenching are arguably the most important operations in the manufacture of gears. It is these processes that provide a gear with the correct mechanical and wear properties to face up to high contact stresses and have high longevity. Unfortunately, heat treating and quenching are typically to understood within the manufacturing stream. Parts once heat treatment is usually distorted or stained. It is often the "blackhole" that all the ills of the manufacturing method are blamed.

By the most important supply of issue for heat treaters is distortion of component once heat treatment. Distortion causes excessive noise within the gear drive train, and potentially early failure due to high residual stresses. It also contributes to high grinding costs. However, the supply of distortion and residual stresses are not limited to either the Martensite Start Temperature, the oil used, or the alloy content. There are variety sources of residual stresses, and not all of them are heat-treating related.

Parts containing residual stresses before to heat treatment can relieve those stresses during heat treatment. The relaxation of those stresses can cause distortion because the half finds a stress-free equilibrium. Heat-up rates in the furnace may also cause distortion, as thermal gradients are formed and the thinner sections reach temperature quicker. There will be differential thermal expansion, which can cause sizable thermal strains to be developed within the part. If these thermal strains are large enough, then plastic deformation and distortion can occur.

The use of a preheat stage, to allow thicker sections to "catchup" to the thinner section will reduce distortion. The same thing can occur if the furnace has non-uniform temperature within the work-zone.

It is the purpose of this study to examine the causes of distortion during the heat treatment and quenching of gears, and provide some insight into proper corrective action to correct distortion and high residual stresses during quenching.

II. AIM & OBJECTIVES

The objective of this dissertation is to Improve or enhance the life of gear bunk used in oil quenching process in gear manufacturing industries. The objectives are:-

- To improve the service life of gear bunk by improving the process cycle.
- To study the factors affecting life of gear bunk.
- To analyze the behavior of gear bunk in quenching process.

III. LITERATURE REVIEW

K. DYBOWSKI, J. SAWICKI, P. KULA, B. JANUSZEWICZ, R. ATRASZKIEWICZ, S. LIPA [1] This paper presents a comparison of the deformations and residual stresses in gear wheels after vacuum carburizing process with quenching in high-pressure nitrogen and oil. The comparison was made on a medium-sized gear wheels, made of AMS6265 (AISI 9310) steel. This steel is applied in the aerospace industry for gears. Compared to oil quenching, high-pressure gas quenching following vacuum carburizing resulted in more uniform and smaller deformations.

Kiyoshi Funatani [2] In this paper, ideas for a cooling process design will be introduced and several successful examples of distortion control measures are given also for the HPGQ processes. Various trials and challenges are underway to increase the cooling power of High Pressure Gas quenching. However, the most important issue is distortion control via the optimization of the cooling process fit for products and should be discussed. Whichever quench media such as molten salt, cold or hot oils and gases, which have quite different cooling characteristics, is selected, the design of the cooling process should be optimized to minimize distortion. Various quench oils have been developed to reduce distortion problems with joint efforts of suppliers and users. Periodical analysis and control of quench oil characteristics and accumulated improvement of quench oil characteristics (Hvalue, L.P., viscosity and etc.) enabled the production of quality works. Not only the selection of quench oil types, temperature, agitation and dipping time, but also typical characteristics of cooling processes should be optimized to reduce distortion.

Adhwaydh Ajay, Adithya Ramesh, Amal V H, Govind R Menon [3] The Aim Of The Work Is To Study The Effect Of Different Quenching Medium On Hardness Of Tool Steel. In Conventional Heat Treatment Either Vegetable Oil Or Engine Oil Is Used. Here We Use Both The Combination

Of Engine Oil And Vegetable Oil In Different Proportion As Quenchant. The Process Involves Heating The Samples Above Austenitic Temperature And Quenching Them In Different Quenching Mediums. Heat Treatment Process Generally Involves The Controlled Heating And Cooling Of Engineering Materials In Order To Achieve Desired Physical And Mechanical Properties Without Changing The Product Shape. Nowadays Petroleum Based Quenchants Are Widely Preferred Over Water As The Main Quenching Medium Under Low Cooling Rates Due To Their Better Distortion Control And Crack Prevention Properties. The Major Drawback Of This Petroleum Based Quenchants Are Their Poor Biodegradability, Toxicity, Flammability And Non-Renewability. In An Attempt To Find A Suitable Alternative And To Provide Best Possible Results Gingelly Oil And Mineral Oil Are Used As Quenching Medium In The Heat Treatment Of D3 Steel. The Heat Treatment Helps In The Evaluation Of Change In Mechanical Properties Of The Material. In This Experiment, We Used 5 Samples Of High Carbon Steel (D3) Specimens Of 2% To 2.14% Carbon Content. The Main Processes Carried Out In This Experiment Are Annealing, Soaking And Quenching. The Material Is Austenised Above Its Critical Temperature I.E. About (1050 Celsius), Then It Is Soaked About 30 Minutes And Quenched In Specified Quenchant. Then The Specimen Is Highly Polished And The Microstructure Analysis Is Done By Using The Metallurgical Image Analysis Software (Mias). Hardness Of The Specimen Is Determined By Using Rockwell Hardness Testing Machine. The Main Scope Of This Study Is To Analyse The Proportions Of Quenchant And Temperatures Selected For The Quenching Process On The Specimens And As A Result Of This Its Effect In Microstructure And It Hardness..

D. Scott MacKenzie [4] It is the purpose of this article to examine the causes of distortion during the heat treatment and quenching of gears, and provide some insight into proper corrective action to correct distortion and high residual stresses during quenching. An effort was made to explain the three phases of quenching, and the effect that the quench path has on the development of distortion and residual stresses. The formation of residual stresses from non-heat-treating sources were examined and discussed. The variables affecting the distortion of gears during heat treatment and quenching were illustrated. Finally methods of characterizing the distortion and residual stresses using computer modeling were described. The limitations of different types of modeling (CFD and FEA) were examined.

Jotram Patel, Gopal Sahu, Prakash Kumar Sen [5] To objective of this paper to present the recent development in the field of gear failure analysis. By the help of this paper we can know about different types of failure detection and analyzing technique which is used to reduce these failures from gears. The basic reasons of gear failure misalignment of gear, spalling, pitting etc, follow the reason of gear failure. Gears generally fail when the working stress exceeds the maximum permissible stress. Advances in engineering technology in recent years have brought demands for gear teeth, which can operate at ever increasing load capacities and speeds. The gears generally fail when tooth stress exceed the safe limit. In this study the technology of gears is presented along with the various types of failure that gears have. The causes of these failures are studied. The type of stress related failure due to (fatigue failure) of gear tooth because of stress concentration is detailed in this paper.

V. Rajaprabakaran [6] Gears are commonly used for transmitting power. They develop high stress concentration at the root and the point of contact. The repeated stressing on the fillets causes the fatigue failure of gear tooth. The main objective of this study is to add different shaped holes to reduce stress concentration. A finite element model of Spur gear with a segment of three teeth is considered for analysis and stress concentration reducing holes of various sizes are introduced on gear teeth at various locations. Analysis revealed that aero-fin shaped hole introduced along the stress flow direction yielded better results.

P. H. Darji, P. R. Langaliya [7] Spur gears have wide range of applications in all over the world. It is obvious that improvement in fatigue life of spur gears can be beneficial. Corrected gears are one of the advanced concept used to solve variety of problems occur in gears. This paper represents theoretical design of spur gears by means of corrected gears to improve fatigue life. Problem states that a gear component mating with a pinion component for speed reduction purpose. Focus is mainly on improvement of fatigue life of spur gears by keeping centre distance and gear ratio exact, by involvement of corrected gears. Lundberg-Palmgren theory is used to define fatigue life of spur gears as well as corrected gears. In the end of paper, comparison is made for fatigue life between spur gears and corrected spur gears.

IV. PROBLEM FORMULATION

Gear bunk used for planetary gear hot oil quenching process is failing prior to the expected life after nearly 100 working cycles. This project is based on the requirement of oil quenching industry. Design improvement of gear bunk is consulted by At infinity engineering consultant providing service to the gear manufacturing industries. As we know that oil quenching is an important procedure performed in gear manufacturing. It is necessary to maintain the exact dimensions or gears even after the quenching process. Size and dimensions of gear bunk is crucial in the process

V. PLAN OF WORK

1) Data accumulation.
2) Literature survey.
3) Study of existing process and influencing parameters
4) CAD modeling of the design
5) Analysis of design using FEA analysis.
6) Improving the process cycle and influencing parameters
7) Result discussion.
8) Finalization of the design.

VI. RESEARCH METHODOLOGY

In this work all the essential data will be accumulated, CAD model of the existing design will be generated using CAD software then Analysis of the existing design will be performed using FEA for behavior of gear bunk. For design improvement modification of the design will be performed using CAD software / improvement in influencing parameters, after generating CAD model analysis for

modified design will be performed. After that results will be discussed and design will be finalized.

VII. CONCLUSION

The project involves the Life enhancement of gear bunk in oil quenching process. The detailed study of existing process from the sources has assisted us to gain deeper knowledge. By performing the Life enhancement of gear Bunk Company will be directly benefited as the work will help them to improve life of gear bunk thus increasing the downtime due to gear bunk failure.

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