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Different types Failure in gears-A Review

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Abstract- The 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 techniques 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. which is identified from this paper .the intention of this paper is not to provide detailed description of the causes of gear failure but it focused on the different types methodology, that is 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.

Keywords: gear failure, misalignment, and spalling, pitting, researcher.

1. INTRODUCTION

Gear is most essential element of power transmission prefer for short distance. It is very economical and very effective way of power transmission .it is used almost all engineering purpose for power transmission. A gear is a machine element designed to transmit force and motion from one mechanical unit to another. The design and function of gears are usually closely associated, since gears are designed for a specific function. Various types of gears have been developed to perform different functions, the most common of these being spur gears, helical gears, straight and spiral bevel gears, and hypoid gears.

The characteristics of these various gear types are discussed in most mechanical design texts Like all mechanical components, gears can and do fail in service for a variety of reasons. In most cases, except for an increase in noise level and vibration, total gear failure is often the first and only indication of a problem. Many modes of gear failure have been identified, for example fatigue, impact, wear or plastic deformation. Of these, one of the most common causes of gear failure is tooth bending fatigue. Fatigue is the most common failure in gearing. Tooth bending fatigue and surface contact fatigue are two of the most common modes of fatigue failure in gears. Several causes of fatigue failure have been identified. These include poor design of the gear set, incorrect assembly or misalignment of the gears, overloads, inadvertent stress raisers or subsurface defects in critical areas, and the use of incorrect materials and heat treatments [1]. A special emphasis is given gear failure due to misalignment of gear teeth while meshing with each other while other techniques also covered this paper consists of different overview by the different researcher by using various methodologies to calculate various aspects of gear failure and its conclusion to reduce the gear failure to some aspect. Gear failure can occur in various modes. In this chapter details of failure are given. If care is taken during the design stage it to prevent each of these failures a sound gear design can be evolved. The gear failure is explained by means of flow diagram in Fig. 1.

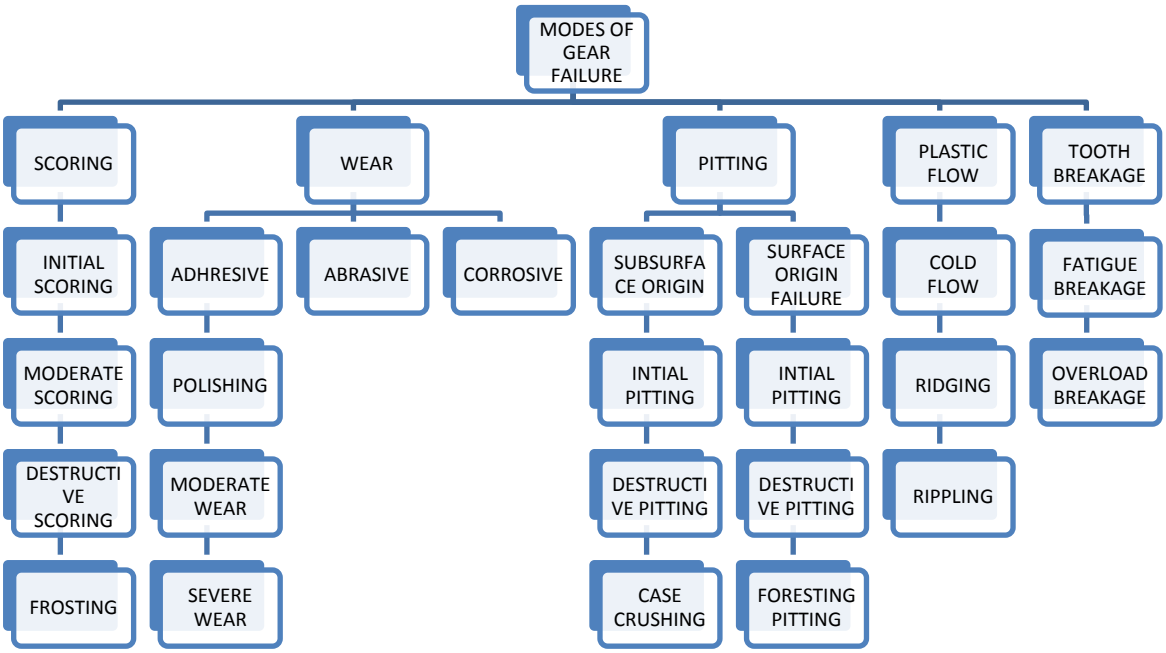

Fig. 1 Different modes of failure

2. PAST / RECENT WORK ON GEAR FAILURE

Osman Asi[2] has done his work on "fatigue failure of a helical gear in a gear box" in this work An evaluation of failed helical gear was taken to assess its integrity that includes a visual examination photo documentation, chemical analysis, micro hardness measurement and metallographic examination. The failure zones were examined with help of scanning electron Microscope equipped with EDX facility.

And the result of this study indicate that the teeth of helical gear failed by fatigue with a fatigue crack initiation from destructive pitting and spalling region at one end of tooth in the vicinity of the pitch line because of misalignment.

V.Morthy, B.A.Show[3] has done his research work on "contact fatigue performance of helical gears with surface coating" in this paper The evaluate the performance of helical gear with applied surface coatings either with or without inorganic fullerene like material nano particles. The contact fatigue performance of case carburized and tempered 5153

steel helical gear cooled with balinit C 1000 balinit C. CT IFLM, C6+1FLM and Nb-6 coating were tested using a 91.5 mm centre distance back to back test ring. The contact torque, Constant speed, Constant fatigue test were carried out for up to 50 million cycles to evaluate the performance of different coatings in compression with the uncoated, as ground condition. The endurance contact fatigue test were conducted at two different contact stress level with the performance assessed against the unsent of micro pitting damage and the associated any gear tooth profile deviation.

And it has found by the result of this study that gear canted with balinit C should the lowest micro pitting damage followed by these with C6+1FLM and Nb-S coatings. The NB-s coated gear showed the lowest gear profile decimation followed by these coated with balmit C. Other Coating tested in large gear tooth profile deviation below the Pitch diameter, from the result of gear testing. It is concluded the Nb-S coated gear showed the best overall contact fatigue performance followed by Balnit C coated gear that gave minimum Micro pitting damage and low levels of gear with profile deviation.

Nauman A. Siddiqui, M. Zubair Khan, Azhar Munir, MN Deen,M.Aftab Amir [4]has presented in his investigation paper on "failure investigation of wheel gear hub assembly of an air craft" in his failure investigation an aircraft rear wheel gear hub at hood position was conducted to find the causes of fracture. The stereographs represented river pattern at crack initiation site originating from the Preexisting cracks at the inner surface of hood. The metallurgical study showed the over aging of wheel hub material stress analysis by finite element analysis identified the stress concentration regions nearly at the same position of wheel hub from where it was failed in reality.

The result of this study shows that the overloading was a cause of find failure with visible features of chevron marks pointing back in the direction of crack originating site.

Ales Belack, Juriji Prezefi [5] has presented a article on "visualization and analysis of noise source of gear unit" in this study of gear noise source. they adopted A new visualization method of complex noise sources using an acoustic camera in this respect a new algorithm is used enabling visualization of all types of difference complex noise source of monopole dipole or quadmaste noise source can be observed simultaneously. A moving noise sources can be tracked by new or an acoustic camera. In addition to that various transient a coustrical phenomena can be noted.

And the result of this study shows that Advance determination of the condition of mechanical system by means of noise is possible.

I.Cedergrer,N.J.Surensem,S.Melia[6]presented his work on "numerical investigation of power compaction of gear wheels " in this study used the methodology To judge the porosity distribution within complex powder contacted 3D structures using a dynamic 3D dilatants finite strain finite element program is presented. The method is demonstrated for a gear wheel, using a FKM Gurson model with parameter calibrated from experiments to model a ferrous powder.

J. Mranberger,M. Sraml,J. Patre,J. Flasker[7] has done his work on "Numerical calculation of bending fatigue like of thin-ring spur gears" in this the methodology and procedure of analyzing of thin rim spur gear fatigue life has been performed using finite element method and boundary element method. The Continuum mechanics based approach is used for the prediction of the fatigue process initiation phase where the basic fatigue parameters of the materials are taken into account. The remaining life of gear with an initial crack is evaluated using the linear elastic fracture mechanics.

And result of this study indicates that the numerical analysis to investigate the effect of rim thickness on gear to the crack propagation path and remaining life has bee performed. The result obtained shows the importance of rim thickness on the kind of expected fatigue mode.

Xiao-Leixu,Zhi-Weiyu,Yuming Gao,Tie-non Wong[8] has investigated "the crack failure of gear used in generating electricity equipment wind paper " in this work A failure investigation had been conducted on the two failed helical gear which were used in generating electricity by wind power fractrography investigation on the cracked teeth

indicated that the crack origins are about 3mm from the groove and exhibits point like features. The cracking nature of two gears attributes to the once instantaneous cracking metallurgical analysis indicates that cracking of teeth occurred during the carburization quenching process.
And the result of this study shows that the presence of the number of inclusion cluster consisting of Al_2O_2 Complex inclusion in the crack origins zones is mainly responsible for cracking of the gears.

Marco Sonardi,FAbrizion, Errico Chiarce, Tagliabue[9] presented a case study on " Influence of Carburizing and Nit riding on failure of gear" To this aim particular case of failure analysis of a pinion gear is considered. It was built in 18 Ni Ci case carburized quench hardened and tempered steel. BY very few working cycles the transmission gear permanently failed. In any case, the failure involved only upper part of pinion teeth. A detailed investigation was needed to clarify the reason of such premature rapture. The root of failure was determined to be external overloading and initial stage of the damage was closed related to complex surface contact fatigue mechanism.

Result of this investigation the effort of carburizing was studied in relation to the mechanism of failure and an alternative nit riding treatment was considered to solve this problem.

Tezeon Sekercioglu, Volkar Kovan[10]investigated "Pitting failure of truck spiral bevel gear" In this study the fracture of spiral bevel gear for truck differential produced from case hardening steel is investigated. In order to study the causes of the failure specimens prepared from the damaged spiral bevel gear were subjected to experiments such as visual, inspection, hardness chemical analysis, metallurgical test pitting occurrence on the gear surface was observed the effect of microstructure on the facture was considered

And result shows Low surface hardness value were found the calculated contact stress were higher than allowable contact stress which is emphasized in literature.

M. fonte, L. Reis,M. Frietas [11] done his analysis work on "failure of gear wheel of a marine azimuth thruster "in this analysis work A failure analysis of two helical gear wheel of a ducted a zenith thruster is presented. The research work consisted of a fracture examination the material in order to determine the damage root cause. The sample of the failure analysis was obtained from two broken teeth of two helical gear wheels. An analysis through SEM was carried out close to the crack initiation, it was found that the damage in the bevel gear were by fatigue fracture mode. The SEM analysis shows that the gear teeth were under serves contact stress during the operation.

And final evaluation of this study is a possible misalignment between the pinions and the gear wheel teeth could also contribute for the premature failure.

Abhay K. Jha,V. Diwakar[12] presented a "metallurgical analysis of failed gear" in this paper Recently fracture of gear teeth occurred when a gear was in use. The fractured gear teeth were subjected to detailed analysis using std. metallurgical techniques. The result revealed that corrosive wear at the root fillet caused pitting intense localized plastic strain and fold leading to crack formation

And the result of this analysis work is Advancement of the crack took place under the successive stress repetitions to which the gear was subjected causing the tooth to fail by fatigue.

Samroeng Netpu,Panya Srichandr[13] presented a paper on "failure analysis of helical gear" in this paper Standard investigation procedure was employed in the analysis, it was found that the gear failed by fatigue fracture sub surface damages in the form of spalling were also observed such observation indicated that the gear was under excessive contact stress during operation. Bench mark on the surface was clearly visible detail examination the surface of the gear revealed that extensive surface damage had occurred in the form of pitting. Stress analysis did in fact confirm such hypothesis.

And the result of this study concluded that the helical gear failed by fatigue fracture initiated by surface sub surface damages resulting from the excessive contact stress. The lesson learned from this case is that one must be carefully when replacing key component.

K Mao [14] has worked on "gear tooth contact and its application in the reduction of fatigue wear" this

paper will concentrate on gear fatigue wear reduction through micro geometry modification method an accurate non linear finite element method will be employed to provide a quantitative understanding of gear teeth contact behaviors shaft misalignment and assembly deflection affects on gear surface wear damage will be investigate as well to achieve high accuracy of the gear geometry the tooth profile will be mathematically generated through using python script interfacing with the finite element analysis software instead of importing other cad packages real rolling and sliding contact simulation has been achieved through latest non linear (FEA) techniques

And result indicate that The shaft misalignment, deflection and assembly deflection effect on gear surface contact behavior have been investigated the optimized micro geometry based on the analysis has been proposed to reduce surface contact fatigue the model has been successfully applied in gear surface fatigue wear reduction the highly accurate gear micro geometry modification method imported the gear surface fatigue wear significantly. This method can also be applied to transmission system noise analysis in terms of transmission errors reduction.

S. Cicero,R. Ciceror, Localleg, Diazd,Ferrono[15] done his work on "failure analysis of lift gear shaft" in this paper analysis the failure of lift gear shaft which happened when the lift was carrying three people fortunately the safety system worked and there were no serious injury but when an investigation into the causes of that accident the analysis was performed using the FITNET FFS fatigue module and improper working conditions have been identified the major causes of accident

and the final conclusion of this of this work The failure of lift shaft gear has been analyzed firstly a fatigue process has been identified as the original causes of the failure then a fatigue analysis has been performed following the FITNET FFS procedure it has been concluded that no fatigue problem should have occurred in failure section and also that this section should not have been the most stressed one the hypothesis that explain the fatigue process and fact that the failure section was most stressed is an improper operation of gear unit with unsecured bolts in the main support of the shaft that increases drastically the stress in critical section

Ales Belsak,Joze Flasker[16] has completed his analysis work on "Wavelet analysis for gear crack identification " Fault analysis presented in this article are based on gear units with real damage s or fault produced on the basis of real operating conditions a test plan has been used a possible damage can be identified by monitoring vibrations .the influences of the crack in a single stage gear unit on produced vibrations are presented. A fatigue crack in the tooth root causes significant changes in tooth stiffness where as in relation to other faults changes of other dynamic parameters are mare exposed different method are used to analyses signals acquired by experiments signal analysis has been carried out in relation to a non stationary signal using the family of time frequency analysis tools such as wavelet Analysis typical spectrogram and scalogram patterns resulting from reactions to faults or damage indicate the presence of a damages in a reduce way.

And the result of this study Vibrations analysis aimed at detecting faults in industrial gear units at presented. This method described can improved the safety of the operations and the reliability of monitoring operational capabilities on the basis of wavelet transform it is possible to in very short time identify changes and to determine the presence of damage at the level of an individual tooth.

Zlaivei Yu,Xiaolei Xu[17] has analyzed of " failure of an idler gear of diesel engine gearbox " The micro fracture surface show brittle cracking characteristics and micro fracture exhibits interangular cracking features the delayed brittle fracture is the dominant failure mechanism of the idle gear the detailed metallurgical examinations on the carburized layer and the core zone were conducted the failure causes were assessed.

final result of this study indicate that The material of the failed gear is 20crmnti with corresponds to the specified material no obvious metallurgical inclusion and forging defects can be observed in the crack origin zone two fracture formed on the failed gear whose macro factography exhibits brittle fracture characteristics and micro factography intergrangular fracture features.

G.Dalpiaz,A.Ribola, R. Rubini[18] has presented his work on "Gear fault monitoring comparison of vibration analysis techniques" This paper deals with gear conditions monitoring based vibrations analysis

techniques the detection and diagnostic capability of some of most effective techniques are discussed compared on basis of experimental result concerning a gear pair affected by a gear pair affected by a fatigue crack. In particular the result of new approaches based on time frequency and clostationary analysis are compared against those obtained by means of well accepted cestrum analysis and amplitude phase demodulation of meshing harmonics moreover the sensitivity to fault servity is assured by considering two different depth of crack the effect of choosing different transducer location and different processing options are also shown.

3. CONCLUSION

In this paper author have been presented a brief review of gear failure analysis different conventional and recent techniques were discussed for particularly helical and spiral bevel gear through fatigue failure in gear while operation at various region. And after the review of this paper following points were calculated.

(i) The misalignment in gear teeth while meshing is the one of main causes of gear teeth fatigue failure. Due to this crack is also initiated in the vicinity of gear teeth. A proper alignment in gear wheel and pinion is necessary to reduce this failure.

(ii) Crack failure in gear possibly due to the presence of the number of inclusion cluster consisting of Al_2O_2 Complex inclusion in the crack origins zones is mainly responsible for cracking of the gears. To reduce the thing a attention need give while carburizing quenching process where due presence inclusion cluster the crack generates.

(iii) The failure zones were examined with help of scanning electron Microscope equipped with EDX facility. For further investigation An analysis through SEM was carried out close to the crack initiation, it was found that the damage in the bevel gear were by fatigue fracture mode. The SEM analysis shows that the gear teeth were under serves contact stress during the operation.

(iv)A fatigue analysis has been performed following the FITNET FFS procedure it has been concluded that no fatigue problem should have occurred in failure section and also that this section should not have been the most stressed one the hypothesis.

The conclusion inspired to further research to reduce the fatigue failure in gears to incorporate other parameters and symptoms with fatigue features develop more robust expert systems for fatigue failure in gears.

4. ACKNOWLEDGEMENT

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