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Experimental Investigations on Application of Cuprous oxide Coating on Gear Teeth for Delaying Pitting Formation

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Abstract: By the reference of different Literatures, they reported various types of failure of gear teeth from Strength considerations, Wear Considerations, Pitting Considerations etc. Vast data is reported in the literature to prevent such failures. Through enough research work was reported with regard to failures from strength and wear Considerations, failure against pitting is not considered in detail. The surface durability of gear tooth is closely related to its ability to resist pitting. A few methods including suitable additives in the gear box lubrication oil were reported in literature. These methods have worked well to some extent on pitting delay, but till date a comprehensive method to avoid or delay pitting initiation is not arrived at by researchers. Discrete references were reported in Literature on application coatings on gear teeth for protecting the teeth from pitting. However an in-depth study in this direction is yet to be taken up by researchers. An attempt is made in this paper to investigate the effect of applying cuprous oxide coating on gear teeth for delaying pitting initiation. A Comparison is drawn on pitting initiation without coating and with coating. It has been observed that, there is a slight delay to the extent of 5% in pitting initiation when cuprous oxide nano particle powder is mixed in suitable bonding agents are applied on the gear teeth. The major contribution of present work is to investigate the effect of cuprous oxide coating on gear teeth in delaying pitting initiation. The experimental results have indicated that ,there is nearly 5% delay in pitting initiation, When cuprous oxide coating mixed in suitable bonding agent were applied on gear teeth.

Keywords: Gear teeth, Wear, Pitting, Failure, and Nano particles of Cuprous Oxide.

I. INTRODUCTION

It has been noticed that the micro structural. Features of the ground gear flank tend to initiate micro pitting [1]. During the grinding process certain pits or depressions are formed. The latest research in pitting focuses on applying coating on the gear teeth, which penetrate and fill up the surface micro gaps [2]. These treatments are given keeping in mind to retain the basic profile of the gear teeth. The surface treated low carbon steel gears were tested for pitting failure. It has been observed that the Performance of gear teeth with coatings proved to be better compared to non coated teeth [3]. Since the surface hardness of gear teeth and their pitting resisting ability are interrelated surface treatments given to gear teeth appear to improve the pitting resistance [4]. Various researches have undertaken studies to improve the performance of gear teeth [5]. A study of the metallurgical microstructure of the pitting zone will indicate the pitting initiations [6]. This paper concentrates on applying cuprous oxide coatings mixed in suitable bonding agent on gear teeth and study its effect on pitting delay.

II LITERATURE REVIEW

Moorthy etal [1], did extensive work on effect of C and Nb-S coatings on contact fatigue damage in gear teeth. They concluded that above coatings resulted in enhanced contact fatigue performance. They observed that diamond like carbon coatings enhanced the durability of materials under high sliding conditions.

Krishna Moorthy etal [2], worked on effect of surface treatment on low and medium carbon grade steel gears. They have established the contact stress- pitting life curve. They concluded that the wear properties have considerably improved.

Oliver etal [3], worked on micro pit formation studies on elastic hydrodynamic contact, and listed their conclusions with regard to delay in pitting formation, durability, wear resistance etc.

Zhang etal [4], did pioneering work on surface hardness treatment methods including shot preening. They applied their research for pitting failure of gear teeth and concluded that surface treatment of gear teeth reduces the pitting formation tendency.

Blazer etal [5], made a review study on boosting the performance and reliability of precision components. Their review studies were oriented towards gears used in precision work.

Jiang etal [6], did extensive experimental work on different coatings applied on gear teeth with special reference to W-DLC coated spur gears. They concluded that the metal oxide coatings delay the initiation of pitting on gear teeth.

III SCOPE AND OBJECTIVE OF PRESENT WORK

The scope of the present work is to study the effect of metal oxide coatings given on gear teeth in delaying pitting initiation with an objective of fixing the correct parameters of coatings, namely the nano size of the metal oxide, suitable bonding agent, temperature of application of coating etc.

IV ISSUES AND CHALLENGES RELATED TO PRESENT WORK

- The major challenge facing the present work is to choose correct metal powder oxide for desirable results.
- Normally the metal powder cuprous oxide is in the 70 to 400 nano range. It is desirable to choose the same in 10 to 100 nano size.
- A scientifically designed criterion must be chosen for initiation as well as propagation of pitting.

V FORMULATION OF PROBLEM

The success of any power transmission mechanism lies in proper performance of the Gear box in the transmission system. Often pitting of gear teeth leads to failure of the gear box. Hence the current problem is formulated to investigate the effect of metal powder oxide coatings on gear teeth for delayed pitting initiation.

VI PRESENT WORK

The present work is split in to the following modules.

A) Choosing the gear transmission system, its parameters like input speed, output speed, power transmission, quality of the lubricating oil etc.,
B) Choosing the metal oxide powder along with suitable mixing agent.
C) Loading the gear box without coatings at defined operating conditions and study the pitting initiations and progress along with the surface microstructure.
D) Repeating above step after application of coating on the gear teeth keeping the same operating condition of above step and studying the pitting initiation and progress along with surface microstructure.
E) Estimating the weight of the gears after load test in case C and also estimation of the weight of gears after removal of coating in case D. Simultaneously the initial weight of the gear is noted at the beginning itself.
F) The loss of weight in each case is a measure of pitting and is estimated and the results are tabulated and discussed.

Model Calculation:

- Let Wi be the weight of gear pair in N before start both for step C and step D.
- Let W be the weight of gear pair for step c(without metal oxide).
- Amount of pitting for case c= Wi-W.
- Let for step d, the weight of gear pair be Wo.
- Amount of pitting for case d= Wi-Wo.
- For the current experiments

Wi = 0.5410 N
W = 0.5370 N
And Wo = 0.5372 N

Table 1 Average results for 3 sets of experiments are considered for Wi, W and Wo

S.No	W_i in N	W in N	W_o in N
1.	0.5410	0.538	0.5373
2.	0.5410	0.537	0.5372
3.	0.5410	0.536	0.53712

- Amount of pitting in step c (Without oxide coating) = Wi – W = 0.004 N
  Amount of pitting in step d (With metal oxide coating) = Wi –Wo= 0.0038 N
  Percent reduction in initiation time of pitting can be assumed to be proportional to Loss in weight. Hence percent delay in initiation of pitting is:

$$\frac{(Wi-W) - (Wi-Wo) \times 100}{(Wi-W)}$$

Method of applying cuprous oxide coating

200Nano cuprous oxide powder is thoroughly mixed with quich setting paint at 150^0 for about 10 minutes and the mix is coated on the gear teeth. Natural air cooling is provided for the coating to settle on the surface of teeth.

VII RESULTS AND DISCUSSIONS

- A defined literature on related work is presented under section literature review.
- Sets of readings are considered for each experiment and the average weight is obtained.
- Contribution of present work is to investigate the effect of metal oxide coatings on gear teeth in delaying pitting initiation. The experimental results have indicated that, there is nearly 5% delay in pitting initiation, When cuprous oxide coatings mixed in suitable bonding agent were applied on gear teeth.

VIII CONCLUSIONS

The major contribution of present work is to investigate the effect of metal oxide coatings on gear teeth in delaying pitting initiation. The experimental results have indicated that, there is nearly 5% delay in pitting initiation, when cuprous oxide coatings mixed in suitable bonding agent were applied on gear teeth.

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