Research Paper Engineering

Wear Debris Analysis of Case Carburized & Mild Steel Debris in Single Stage Spur Gear Box

* Vijay Kumar Karma ** Akshay Panchity

* Assistant Professor, I.E.T., DAVV, INDORE

** PG Student, I.E.T., DAVV, INDORE

ABSTRACT

In this paper, various experiments were conducted to predict the behavior and effects of wear debris being dragged into the single stage spur gear mesh. For performing these experiments an experimental setup was fabricated using maruti 800 gear box. Debris of different weights of hard and soft materials, namely Case Carburized Steel and Mild Steel were taken. These are then introduced in the gear mesh at different speeds. To establish a relationship between mass of the wear debris introduced and the torque, the wear debris were then introduced into the gear mesh at different conditions. Torque loss value for a constant speed for a fixed mass of wear debris was then calculated by recording output torque value.

Keywords: Debris, Wear Debris Analysis, spur gear

INTRODUCTION

In some transmission systems operating at high speed and at high load there is some possibility that debris get entrapped in the gear mesh. Due to closely packed nature of some mechanisms in the presence of lubrication, chips that are released due to gear deformation or from the defected bearing can then introduced to other gear meshes with the system. It is desirable to know the consequences of these entrapped debris in the gear mesh. One purpose was to establish a relationship between mass of the debris and the loss in torque output.

LITERATURE SURVEY

S.Eersbach and Z.Peng [1] had investigated the condition and faults of a spur gearbox using vibration and wear debris analysis techniques . The aim of their work is mainly to investigate the effectiveness of combining both vibration analysis and wear debris analysis in an integrated machine condition monitoring maintenance program. To this end a series of studies was conducted on a spur gear box test rig. They have conducted a test under normal condition to obtain basic condition of the test rig, then a no of different machine defect conditions were introduced under controlled operating condition at constant overload and cyclic loads. The data obtained from wear debris analysis is then compared with that of vibration analysis data in order to quantify the effectiveness of both the techniques in predicting diagnosing machine failures. The results have shown a evidence for decreasing wear rate as is typical for the running in to normal operating condition. The reduction in laminar particles, and the presence of limited quantity of fatigue particles found by wear debris analysis demonstrate good correlation with those of vibration analysis.

Qurban A Memon and Mohammad S. Laghari [2] had focused on microscopic application which is one of the important areas on the field of automation for online/offline visual inspection systems. They have obtained system process information through an image processing system with evolving knowledge database to improve the accuracy and predictability of the wear debris analysis. Their objective is to automate intelligently the analysis process of wear particle using classification via self organizing maps .this is achieved using relationship measurements among corresponding attributes of various measurements for wear debris. Finally visualization technique is proposed that helps viewer in understanding and utilizing the relationships that enable accurate diagnostics. In the end they have built up a library of normal and abnormal relationships of system parameters of wear particles. These type of multi-variant relationships is helpful in diagnosing machine life

O. Lundvall, N. Str .omberg and A. Klarbring [3] proposed a large rotational approach for dynamic contact problems with friction for modeling a spur gear pair. They have obtained a model by superposing small displacement elasticity on rigid-body motions, and postulating Signorini's contact law and Coulomb's law of friction on the gear flanks. To model the elastic properties of the gear pair they had used FEM. Shafts and bearings are represented by linear springs. The approach was used by avoiding mainly the difficulties of impacting mass nodes. By use of the augmented Lagrangian approach governing equations of the model are numerically treated, which is helpful in representing the geometry of the gear flanks in numerical simulations. They studied accurately the consequences of different types of profile modifications as well as flank errors, they also studied the dynamic transmission error. They had emphasized the effect of friction and concluded that it has an effect even on the motion in the rotational direction. Also by calculating the dynamic transmission error for a large number of mesh frequencies they noticed that it is less than the static one at high mesh frequencies that are far from natural frequencies . By studying different amounts of profile modification they have concluded that optimal values for the profile modification are not the same depending on whether frictional effects are included or not, also concluded that the possibility to decrease the dynamic transmission error by applying profile modifications is reduced in the case of friction.

N. Feki , G. Clerc , Ph. Velex [4] presented that an original integrated electromechanical model aimed at testing the possibility and the interest of tooth fault detection based on electric measurements on the motor stator. They used a lumped parameter model accounting for mechanical transmission and simulated motor using Kron's transformation. They obtained a unique non-linear parametrically excited differential system, which provides direct access to both the electrical and mechanical variables. They concluded that the presence of tooth defects has a limited influence on the current time-variations in the motor.

Robert F. Handschuh and Timothy L. Krantz [5] had investigated engaged metal wear debris into a gear mesh. Their idea was that in some space mechanisms the loading can be so high that there is a possibility that a gear chip might be liberated while in operation of that mechanism. Also due to closely packed nature of some space mechanisms and the fact that a space grease is used for lubrication chips that are released can be introduced to other gear meshes with in the mechanism. The main aim of their study was to determine the relationship of the chip size to the torque required to rotate the gear set through the mesh cycle. Another purpose was to determine the condition of the gear chip material after engagement with the meshing gear, primarily to determine if the chip would break in to pieces and to observe the motion of the chip as the engagement was complete. For this they have worked a number of experiments on a Glen Research Center spur gear fatigue test rig having two identical spur gears. From this experiment the chip size required to jam the mechanism can also be determined. The metal debris that was used for engagement into a pair of meshing gears are, shim stock , drill bit shanks and chips of gears liberated from a test gear . It was found that the peak torque required to rotate the gears with the object engaged was proportional to the size of the engaged object. In another way the engaging object of higher hardness required a significantly greater torque value relative to that of lower hardness comparatively. On the other hand the largest chip tested undergo sufficient deformation to the gear teeth to prevent smooth motions of the gear when the damaged tooth is engaged. During the experimentation no tooth fracture occurred. Finally they have concluded that the torque required to drive the gear chip through the gear mesh is system dependent.

METHODOLOGY

Debris of soft and a hard material and gear chips were selected. The debris were cut to length wider than the face of the gear. Then these debris were placed in the gear mesh between the teeth for testing. The material used was of mild steel and hard material is of case carburized steel. No lubrication was used when the debris of soft and hard materials were dragged in the gear mesh. During the testing the driving shaft is rotated by the input supply source i.e. a DC motor torque value without debris were recorded, then the samples of the debris were dragged in the gear mesh and braking torque value is calculated with the help of dynamometer. Torque values for each sample was recorded and a relationship between the mass of the debris and the torque loss were made.

Figure 1- Spur Gearbox

TEST RESULT

The resulting relationship of torque loss to mass of the sample at specified parameters were shown in the table no.1, table no.2 and were plotted in the form of the graph.

Table no. 1– Torque Loss of Soft Material

S. no.	**Mass of Debris (SoftMaterial)** In gms	**Speed** In rpm	**Torque Loss** In Ncm
1	5	400	146
2	10	400	230
3	15	400	324
4	20	400	366

Table no. 2–Torque Loss of Hard Material

S. no.	**Mass of Debris (Hard Material)** In gms	**Speed** In rpm	**Torque Loss** In Ncm
1	5	400	201
2	10	400	316
3	15	400	366
4	20	400	396

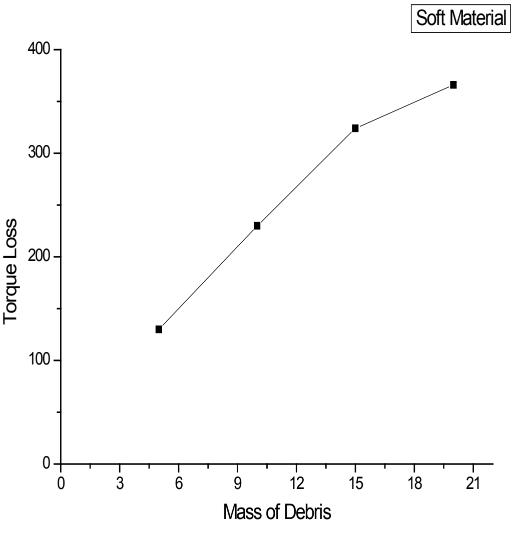

Figure 2- Graph of relationship between Torque Loss and Mass of Debris for Mild Steel

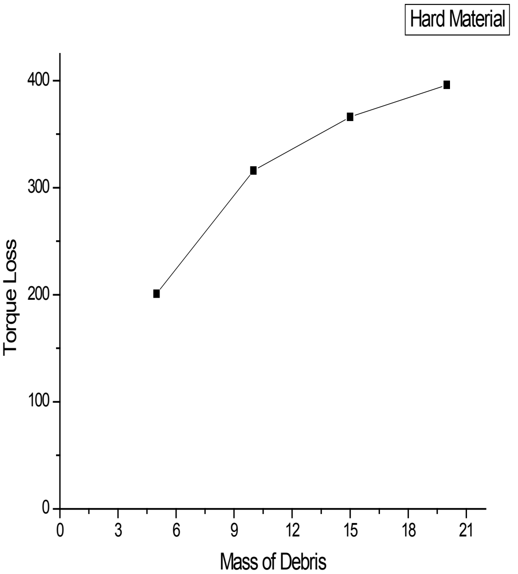

Figure 3- Graph of relationship between Torque Loss and Mass of Debris for Case Carburized Steel

CONCLUSION

No of experiments were conducted to understand the behavior of the debris dragged in the gear mesh. The metal debris were of Mild Steel, Case Carburized Steel and gear chips obtained from a test gear. The gears used were spur gears of Mild Steel. It was found that the torque loss increases on increasing the mass of the debris, also for the debris of material of higher hardness the value of torque loss is greater. In future by changing the gear material and debris testing can be done also single stage gear mesh can be converted to multi stage gear mesh and spur gear can be replaced by any other type of gear.

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