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Optimization of the Parameters Related to Bearing with the Help of Tagucchi Analysis

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***Abstract*— A specially designed test system involving boundary lubricated roller bearings was used to study wear at Low particle concentration levels. A separate oil system circulated the oil through the test bearings. The Effects of self-generated contaminants from the system were studied. Even at very low concentration low Levels, self-generated contaminants can cause significant wear. The concentration of self-generated small Particles were very high during the test period. It is therefore important that the filtration be taking Very efficient during this span. The experimental results show that filtration during run-in for 1 h with a 3 l micron filters can reduce both the mass loss and the number of self-generated particles by a factor of 10. This work aims to characterize behavior of viscosity of different fluids on Thrust bearings.**

Keywords*— Lubricant; Thrust bearing; Vibration; Viscosity; testing, Temperature

INTRODUCTION

Oil testing is a key component of successful condition monitoring programs. it can be used as predictive and proactive tool to identify the wear modes of rubbing parts and diagnose the faults in machinery It is a method of predicting the health of equipment in a non- intrusive way, by the study component and provides early warning and diagnosis. Oil condition monitoring can sense debris earlier than vibration technique. This technique holds good for both oil and grease samples. By analyzing the oil sample, the residual life of used oil is determined and a fault in the machine can be diagnosed before the machine has to be prematurely shut down. Sliding adhesive wear particles are found in most lubricating oils, they are an indication of normal wear. they are produced in large numbers when one metal surface moves across another. The particles are seen as thin asymmetrical flask of metal with highly polished surfaces.

OBJECTIVE OF THE WORK

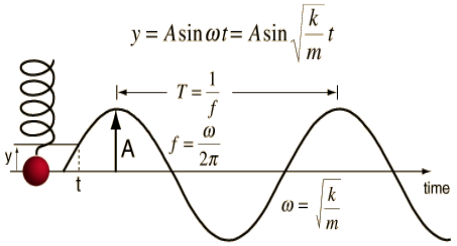
this information are used to analyze the condition of an engine i.e. where the rate wear is high or low, type of wear and also find out the component of the vehicle . The aim is to classify all these particulars according to their morphological attribute of size, shape, edge detail thickness ratio, color texture and by using this classification by predict wear failure mores in the engine and utilize this information to prevent the engine from possible future trouble. So in this way it is clear that the aim of this dissertation is to reduce maintenance work which in term also reduce all the expenditure which are used for a maintain a vehicles in a working able condition

VIBRATION

The physical movement or motion of a rotating machine is normally referred to as vibration, Since the vibration frequency and amplitude cannot be measured by sight or touch, a means must be employed to convert the vibration in to a usable product that can be measured and analyzed. Electronics, Machine, and chemical physics are closely related. Therefore, it would logically follow that the conversion of the Mechanical vibration into an electronic signal is the best solution

HARMONIC MOTION

All harmonic motion is periodic, machine it repeats at some point in time. In a linear system, imbalance in rotating equipment could generate harmonic motion. However, with many variables such as gear problem, looseness, bearing defects, misalignment, etc., such sinusoids are not often found. It is important to understand that a sine wave is simply a plot of a circle against time.



RANDOM MOTION

Random Motion occurs in an erratic manner and contains all frequencies in a particular frequency band .Random motion is any motion that is not repeatable. Popcorn in a popper, rain hitting a roof, and bowling pins being knocked over is

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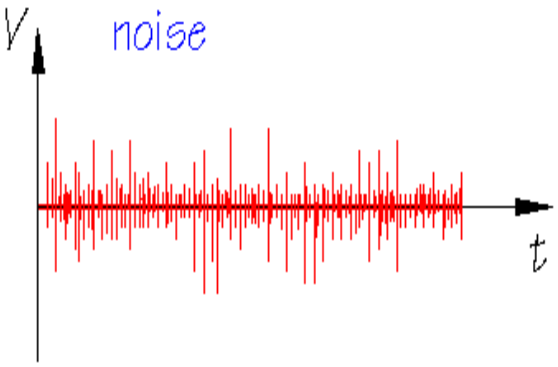
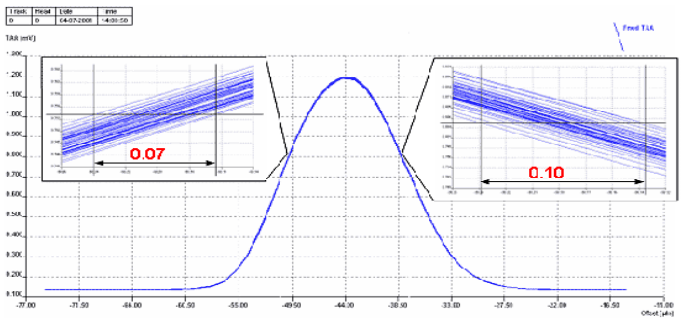
examples. Random motion is called When Random is noise generated by a machine, a recording of the noise played back ten times faster than it was recorded can sound like a TV set after the station has signed off the air.



AMPLITUDE MEASUREMENT

The four different way to express the vibration amplitude level are: peak-to-peak,zero-to-peak,RMS, and average ,peak-to-peak is the distance from the top of the positive peak to the bottom of the native peak. The peak-to-peak measurement of the vibration level is shown in Fig. 1-3(a). This type of measurement is most often used when referring to displacement amplitude.



For Example:

Duty Cycle= PW/PRF

Several forms of pseudo RMS are used in some equipment.

APPLICATION

Without an adequate flow of lubricant, bearings or other mechanical components can wear very quickly and result in severe mechanical damage. Especially after maintenance shutdowns, operators need to know if there are any lubricating flows not connected or very low. They need to know this immediately. Lubrication Monitoring provides this quick alert to dangerous situations, either through the sensate 6S displays in the machine control room or on field mounted panels in the Senso-160 monitoring stations.

FAULT INDENTIFICATION

The Bearing Test Rig comprises to introduce various machine Bearing fault,Outer race fault, Inner race fault ,Ball fault, Cage fault, Belt fault, Shaft fault

DETAIL OF LUBRICATING MACHINE

In many cases prototypes are built and stringent experimental testing is carried out. Increasingly engineers rely on modeling techniques to obtain knowledge the structure behavior in the operating environment. The machine indivisible parts are to be shown in fig. In many cases prototypes are built and stringent experimental testing is carried out. Increasingly engineers on modeling techniques to obtain knowledge the structure behavior in the operating environment

BEARING

The bearing assemblies can be set up rolling element simulation. The rolling bearing is coupled to the second shaft. Bearing housing allows adjust the bearing load. The bearing can be dismantled and different can be simulated. A Bearing is a device to permit constrained relative motion between two parts, typically rotation or liner movement. A rolling –element bearing is a bearing which carries a load by placing round elements between the two pieces.

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SHAFT

Simulator I have used three shaft of same diameter but having length, first and second shaft length is 600 mm and third shaft is 800 mm. material of this shaft is 600 mm and third shaft is 800 mm. material of this shaft is 45C8 steel being used .
Of all here I select 600 mm length and 28 mm diameter shaft on which Is mounted which is couple with an electric motor. This gear is meshed the pinion with is mounted on another shaft of same dimension, a in also mounted at the end of this shaft.

EXPERIMENTAL PROCEDURE

the optimization technique tagucchi analysis is used to optimize the value of taken parameters (wear rate and Temperature) by lower the better of tagucchi analysis .Our aim is to determined the condition at which we will get the minimum wear rate and minimum temperature on the bearing surface. Before applying the tagucchi analysis technique we conduct an experiment on the lubricant based wear rate machine in laboratory and collect the data of wear rate and temperature at different (loads, Speeds & Lubricants) because these are the essential factors those who can affect the wear rate and temperature on the bearing surface . After that we use the collected data from conducting experiment for getting the optimum value of wear rate and temperature with the help of tagucchi analysis. In the continuation of process first of all we have select a array which depends upon the factors so in our experiment

(Contains the value as per l9 orthogonal sequence)

	Column 1	Column 2	Column 3
S.No.	Load	Speed	Lubricant
1	30	800	SAE 5 W 30
2	30	1000	SAE 5 W 40
3	30	1200	SAE 15W30
4	40	800	SAE 5 W 40
5	40	1000	SAE 15W30
6	40	1200	SAE 5 W 30
7	50	800	SAE 15W30
8	50	1000	SAE 5 W 30
9	50	1200	SAE 5 W 40

For Larger the Better, normalized values of S/N ratios are calculated as-

$$Z_{ij} = \frac{y_{ij} - \min\left(y_{ij}, i = 1, 2, \ldots..n\right)}{\max\left(y_{ij}, i = 1, 2, \ldots..n\right) - \min\left(y_{ij}, i = 1, 2, \ldots..n\right)}$$

For Smaller the Better, normalized values of S/N ratios are calculated as-

$$Zij = \frac{\max\left(y_{ij}, i = 1, 2, \ldots..n\right) - y_{ij}}{\max\left(y_{ij}, i = 1, 2, \ldots..n\right) - \min\left(y_{ij}, i = 1, 2, \ldots..n\right)}$$

The grey relational coefficient is calculated as-

$$\gamma_{ij} = \frac{\Delta\min + \xi\Delta\max}{\Delta_{oj}(k) + \xi\Delta\max}$$

Control parameters	Level 1	Level 2	Level 3
Load (kg)	30	40	50
Speed (R.P.M)	800	1000	1200
Lubricant	SAE 5 W 30	SAE 5 W 40	SAE 15W30

S.No.	Normalized S/N ratio (Wear Rate)	Normalized S/N ratio (Heat Affected Zone)	Grey relational coefficients		Grey relational grades
			Wear Rate	Temperature C°	
1	1	0	1	0.333	0.665
2	0.906	0.125	0.843	0.363	.603
3	0.784	0.25	0.696	0.4	0.548
4	0.687	0.375	0.5714	0.444	.5077
5	0.562	0.5	0.470	0.5	.485
6	0.375	0.625	0.421	0.571	.496
7	0.218	0.75	0.390	0.66	.525
8	0.093	0.875	0.355	0.8	.5775
9	0	1	0.333	1	0.665

RESULT AND DISCUSSION

By conducting various experiments on the bearing with help of bearing wear rate measuring machine at considered condition. We get the optimum condition which `were measured after experimentation. The working data i.e. Wear Rate, temperature are the corresponding S/N ratios and their normalized values were generated

Determining Optimal Factor Level Combination

One of the objectives of this study is to find the optimal combinations of factors to improve the performance characteristics of the relative to need and expectations. Since there are two performance characteristics Width and Time, only Taguchi Method is not sufficient.

Factors	Level 1	Level 2	Level 3	Max. - Min.	Rank
Load	**.6053**	.4962	.5891	.109	1
Speed	.5625	.555	**0.569**	.014	3
Lubricant	**0.5795**	0.5627	0.519	.060	2

Predicting the Optimal Performance

As the optimal combination is determined which is A_1, B_1 and C_1, the expected optimal value of combined performance characteristic is required to be predicted. Equation 6.1 gives the formula for calculation

$\mu = A_1+B_3+C_1 -2(T_g)$

where, Tg is the gross average of all the averaged grey relational grades.

Or, $\mu = 1.7538 - 2\ (0.5598)$

$= 1.7538 - 1.119$

μ = 0.634

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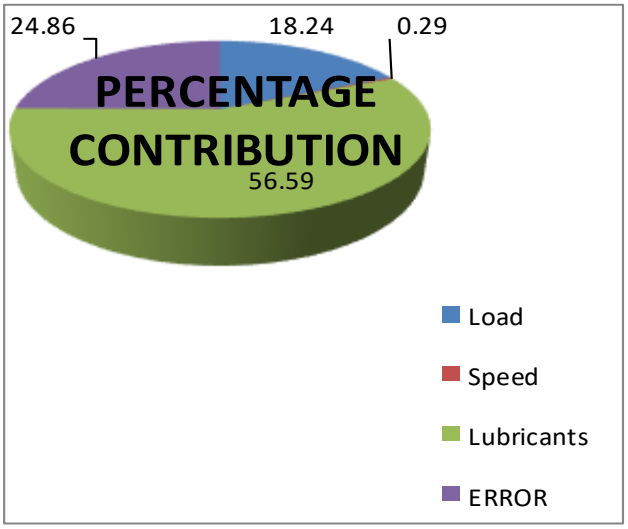
Results of ANOVA

Factors	DOF	S.S	M.S	Percentage Contribution
Load	2	0.0069	0.0034	18.24%
Speed	2	0.00011	0.00005	0.29%
Lubricant	2	0.0214	0.0107	56.59%
Error	2	0.0094	0.0047	24.86%
Total	8	0.03781	0.0189	



CONCLUSION AND FUTURE SCOPE

On the Grey based Taguchi method, an optimal combination of parameters for minimum Wear rate of bearing and minimum temperature was predicted. The grey relational method was conducted and the calculated value of combined performance characteristic was found to be **0.634**

Following conclusions can be drawn for the present study:

1)For a normal composition of any other substances like, paste is not much more effective to determine the wear rate and temperature material So, by considering the factors Load, Speed & Lubricants there are limited options of control parameters as well as on their levels as levels can be set at some particular discrete values only. Appropriate factors are required to optimizing the value of wear rate and temperature.

2)The test on Bearing surface is performed in lab. by using lubricant base wear rate machine.

3)At optimal settings the experimental values of performance characteristics are much higher and experimental grey relational grade**=0.634** was found close to that expected.

4)Lubricant was found to be the most significant factor with **56.59%** contribution, followed by Load with **24.86 %** and lastly Speed with **0.29 %.** Thus none of the factors was insignificant in this study.

Future Enhancements

This study was a preliminary attempt to understand the role of control factors on the performance characteristics. Grey based Taguchi method is most suitable for process having more than one performance characteristics. A limited number of control parameters were considered for the study. The study can be extended –

1) By considering other factors for predicting the optimum condition of wear rate, and temperature on bearing surface like vibration in wearing due to wear, heat effected zone on bearing surface, coated and uncoated surface and More performance characteristics such as, surface hardness, properties of bearing can be included depending upon the objective of the study.

2) The optimal performance of the bearing can be predicted under different combinations of control parameters so as to utilize in different bearing uses in different applications. Depending on the objective of the study other tools such as artificial neural network or regression method can be combined with Grey based Taguchi Methodology.

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