Study and Investigate Effect of Input Parameters on Temperature and Noise in Gearbox Using DOE

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***Abstract* - Before make gearbox we have to verify how it will work, performance, efficiency, which factors effecting gearbox performance. Which parameters like temperature and noise. we have to find out it's effect on gearbox design before making gearbox by using modeling and/or various methods, then optimize that parameters which effects temperature and noise before making gearbox, we can also optimize our cost factor to make gearbox, And predict design for good gearbox. Hi-tech drives Pvt. Ltd. is manufacturer of Gear and Gearboxes. In Gearboxes when they are tested at that time noise and temperature limits to be taken care. Here our attempt is to apply DOE techniques to achieve desired design of gearbox for control the temperature and noise levels in gearbox.**

***Index Terms* - Design and Analysis of Experiments (DOE), Gears, Gearbox, Regression Model**

I. INTRODUCTION

Before make gearbox we have to verified how it will work, performance, efficiency, which factors effecting gearbox temperature and noise we have to find out it before making gearbox by using modeling by various methods, then optimize temperature and noise before making gearbox, we can also optimize our cost factor to make gearbox, And predict design for good gearbox[19].

A gearbox is a mechanical device utilized to increase the output torque or change the speed(RPM) Of A motor. The motor's shaft is attached to one end of gearbox and through the internal configuration of gearbox, provides a given output torque and speed determined by the ratio.

The physical components of gearboxes very from one gearbox type to another, as well as differences between manufacturers. Most gearboxes are constructed from steel material such as iron, aluminum and brass. Unlike other gearbox types, spure gearboxes can also be made with plastics such as polycarbonate or nylon. Other then the raw materials used ,the orientation of the gear teeth play a major role in the overall efficiency, torque and speed of the system. Straight gear teeth gearboxes are typically use in low-speed applications. These gearboxes can be noise, and may have lower overall efficiency. Helical gearboxes are typically use din high-speed applications. The gearboxes are quieter in operation then straight(spur)gear teeth gearboxes, which may improve their overall efficiency.

DOE is a useful method in identifying the significant factors and in studying the possible effect of the factors during machining trials. The factors must be either quantitative or qualitative. The range of values for quantitative factors must be decided on how they are going to be measured and the level at which they will be controlled during the trials. Meanwhile, the qualitative factors are parameters that will be determined discretely. The term experiment is defined as the systematic procedure carried out under controlled condition in order to discover an unknown effect, to test or establish a hypothesis, or to illustrate a known effect. When analyzing a process, experiments are often used to evaluate which process inputs have a significant impact on the process output, and what the target level of those inputs should be to achieve a desired result (output). DOE is powerful tool to achieve manufacturing cost savings by minimizing process variation and reducing rework, scrap, and the need for inspection [5].

II. LITERATURE REVIEW

Title: SIMULATION AND ANALYSIS OF MACHINERY FAULT SIGNALS [7]
Author: M.F.white.

In this paper author discuss a bout how mechanical machinery monitoring and how analysis. And also say that, "A typical fault signal is assumed to be impulsive in nature because of the way In which. It is generated. In the case of journal bearings or gears, for example, surface defects will produce pressure fluctuations in the lubricant and the oil film between sliding surfaces may also momentarily break down causing impulsive contact to occur. With rolling element bearings the interaction defects will produce a pulse whenever the defects tricolor is struck due to the rotational motion of the system."

Title: DYNAMICANALYSISOF HIGH SPEED GEARS BY using LOADED STATICTRANSMISSIONERROR [8]
Authors: H. NEVZAT Ozguvent and D.R. Houser.

In this paper author discuss about dynamic modeling of gears so we can predicting the noise of gears when they run and we can design according to optimize noise. Authors discuss two method one is Experimental and computer simulation for modeling of gear design. An analysis and computer program(DYTE)has been developed for predicting the dynamic mesh forces, dynamic tooth

forces, dynamic factors based on stresses, and dynamic transmission errors in a gear pair. And also predicting noise when they will run. also come to know that backlesh effects noise of gearbox.

Title: MATHEMATICAL MODELS USED IN GEAR DYNAMICS-A REVIEW[9]
Authors: H. NEVZAT Ozguvent and D.R. Houser.

In this paper authors review 188 research papers on gear. And discuss various types of modeling of gear. There is a vast amount of literature on gear dynamics and dynamic modeling of gear systems. The objectives in dynamic modeling of a gear system vary from noise control to stability analysis. The ultimate goals in dynamic modeling of gears may be summarized as the study of the following: stresses(bending stresses, contact stresses); pitting and scoring; transmission efficiency; radiated noise; loads on the other machine elements of the system(especially on bearings);stability regions; natural frequencies of the system; vibratory motion of the system; whirling of rotors; reliability; life.

Title: Impact velocity modeling and signal processing of spur gear vibration for these timati on of defect size[10]
Authors: A. Parey, N. Tandon

In this paper author discuss below thing by this we can say that the design of gear is very important to archive long life of gear and it is done by regular maintenance and it will done by continuous condition monitoring and/orma the matically modeling(DOE method).Gears are mechanical link a get transmit power and motion between machine parts. In many industrial and automotive applications gears are one of the most critical components. Unexpected breakdown of gear, presents a major concern for maintenance personnel. If gear defect can be assessed, gearbox maintenance reschedule can be optimally planned. Machinery failures are not unpredictable; they often occur long after the condition of the machine begins to deteriorate in some for more other. Gears may fail in many different ways but an increase in noise and vibration levels are always associated with incipient defect. Some work has been carried out by many people to study the effect to varying defect size on overall vibration level but no relationship was established be two end effect size and vibration level. To establish the relationship between end effect size and vibration level, better understanding of the basic physic involved in the generation of the basic physics involved in the generation of the vibration signal at the presence of a gear defects necessary. This paper presents a rigid body dynamic model to describe the relationship between measurable vibration signal sand the surface defect size on one of the tooth faces.

Title: GEAR NOISE AND VIBRATION- A LITERATURE SURVEY[11]
Authors: Mats Åkerblom.

The transmission error is an important excitation mechanism for gear noise. The definition of transmission error is "The difference between the actual position of the output gear and the position it would occupy if the gear drive were perfectly conjugate". In addition to transmission error, friction and bending moment are other possible time varying noise excitation mechanisms that might be in the same order of magnitude as transmission error, at least in the case of low transmission error gears.

Title: Gearbox corrosion prediction via oil condition sensing and model fusion[15]
Authors: James Hopkins

In this paper he get idea for how to measure oil parameters. The author have proposed an approach that combines key diagnostic methods of in line oil quality monitoring and vibration analysis with advanced modeling techniques to provide characterization of corrosion-influence default sin lubricated aero space gearbox application. initial results of the author developed sos and gear vibration module technologies, as applied to scaled gearbox test rig, we are provided.

Title: GEAR BOX EXPERIMENT[16]
Author: University Tenaga Nasional, 2006 Mechanical Design and CAD Laboratory Experiment.

A gearbox consists of a means of transmitting mechanical torque between two shafts with structural support between them. Normally it is contained within a casing which would provide the structural support and also have containment and safety functions. Most gearboxes are designed for speed reduction though some may be suitable for speed increasing duties. Some types are not suitable for reverse driving and the system may require the prevention of 'over-running'.

III. PROBLEM DESCRIPTION& METHODOLOGY

Before make gearbox we have to verified which factors effecting gearbox temperature and noise. Because temperature and noise are most impotent parameters of gearbox, If temperature of gearbox is cross the threshold temperature limit of gearbox at that time performance of gearbox will not be satisfactory because of the oil viscosity is inversely proportionaltotemperatureso,thethinoilthickness(0.08micronminimum required)between two tooth cannot achieve and it will take place pitting(surface defectsproduce)ongearboxinternalscomponentsdegradationandalsoincrease noise and it will crests noise pollution. We have to find out it before making gearbox by using experimental. Then improve the design according to optimize temperature and noise before making gearbox. We can also optimize our cost of gearbox, And predict design for good gearbox.

IV. OBJECTIVES

- Gearbox assembly and service factors.[13][17].
- Can predict proper(good and noiseless)design of gearbox.
- Increase company product value.
- Improving the effect of temperature and noise on gearbox by Optimize input parameter of gearbox**[14].**

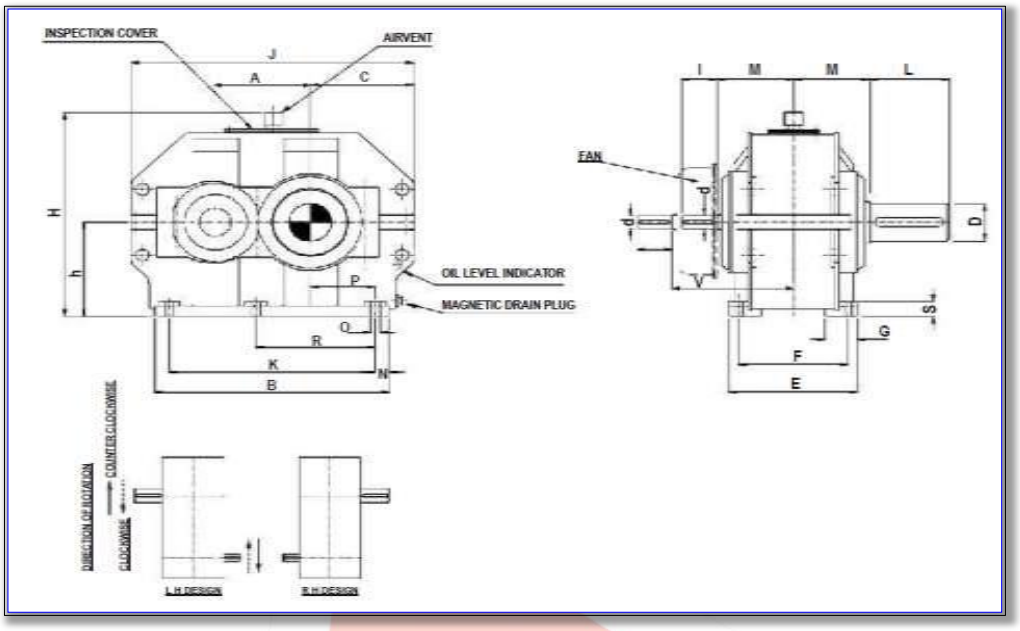

Figure3.10:our modelgearboxH1080[14]

PECIFICATION OF GEARBOX.[14]

Model	H-1080
Make	HI-TECH Drives Pvt. Ltd.
Type	Helical gearbox
Input shaft(for ratio in<3.15)	Diameter : 25 mm
Output shaft	Diameter : 32 mm Length : 80 mm
Average weight(kgs)	25 kg
Oil quantity	0.7 litter
Dimension of other parameter	
These are indicates dimensions of gearbox which indicated in above image.	A:80 mm, B:205 mm C:115 mm,E:140 mm H:110 mm,H:240 mm J:280 mm,K:175 mm M:90 mm,N:15 mm O:14 mm,P:60 mm S:20 mm 1880 X 475 mm

FACTORS AND LEVELS

Factors	Coded factors	Low level (-)	High level (+)
Input speed (rpm)	A	200	1440
Back lash in(mm)	B	0.01	0.15
Axial play of pinion and output shaft(mm)	C	0.00	0.02
Oil viscosity(mm2/sec)	D	VG-220	VG-320

Here 2^4 with two replication design are selected to perform the reliable experiments [5]. So according to 24 with two replication total 32 experiments will be performed as shown in table II. After performing experiments, measurements of noise will be carried out using dB meter or by using ultrasonic sensor. F1to F16 indicates the values of noise for respective treatment combinations.

Coded factors and experimental runs

Treatment Combination	Coded Factors				Responses					
					Oil temperature			Gear box noise		
	A	*B*	*C*	*D*	*Replicate 1*	*Replicate 2*	*Average*	*Replicate 1*	*Replicate 2*	*Average*
1	-	-	-	-	T1	T1	T1	N1	N1	N1
A	+	-	-	-	T2	T2	T2	N2	N2	N2
B	-	+	-	-	T3	T3	T3	N3	N3	N3
ab	+	+	-	-	T4	T4	T4	N4	N4	N4
c	-	-	+	-	T5	T5	T5	N5	N5	N5
ac	+	-	+	-	T6	T6	T6	N6	N6	N6
bc	-	+	+	-	T7	T7	T7	N7	N7	N7
abc	+	+	+	-	T8	T8	T8	N8	N8	N8
d	-	-	-	+	T9	T9	T9	N9	N9	N9
ad	+	-	-	+	T10	T10	T10	N10	N10	N10
bd	-	+	-	+	T11	T11	T11	N11	N11	N11
abd	+	+	-	+	T12	T12	T12	N12	N12	N12
cd	-	-	+	+	T13	T13	T13	N3	N3	N3
acd	+	-	+	+	T14	T14	T14	N14	N14	N14
bcd	-	+	+	+	T15	T15	T15	N15	N15	N15
abcd	+	+	+	+	T16	T16	T16	N16	N16	N16

V. REGRESSION MODEL

3^3 full factorial method for the detail analysis of this research and finally we get regression model for Temperature and Noise and we can predicate the noise and temperature from that regression model and which is as below.

Temp = 51.3704 - 4 A + 1.83333 B + 1.86111 C + 1.38889 A*A - 1 A*B + 0.138889B*B - 1.08333 B*C - 0.791667 C*A + 0.138889 C*C + 0.4375 A*B*C

Noise = 61.6481 + 0.805556 A - 1.41667 B - 1.22222 C – 0.277778A*A+7.25195e-015 A*B + 0.638889 B*B + 0.875 B*C +0.75 C*A + 0.222222C*C- 0.5625 A*B*C

VI. CONCLUSION& FUTURE SCOPE

From the literature it seems that the input speed, back leas, axial play of pinion and output shaft, oil viscosity are very crucial for the gearbox noise and temperature of oil. After performing experiments at different levels, all the factor effects and inter effects will be known. Also modeling will be developed to predict oil tempura and noise in context of above mention input parameter. By optimize input parameter, life of the gearbox will be increase.

VII. ACKNOWLEDGMENT

We would like to acknowledge the HI-TECH DRIVES PVT. LTD. Manufacturer of GEAR BOXES(443/A, GIDC, Vitthal Udhyognagar - 388 120, Anand, Gujarat, India.) for providing information and the infrastructure.

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