DESIGN AND DEVELOPMENT OF AUTOMATIC LUBRICATION SYSTEM FOR BEARINGS AND GEARBOX

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Abstract: Automatic lubrication system has marked appreciable progress in almost all mass production industries throughout the world. This study has been undertaken to provide automatic lubrication system to worm gearbox and sprag bearing of spool used to wind steel wire. This system was developed for TATA Steel Wire Division Boisar to reduce their downtime and boost the production activities. We have developed a low cost automatic centralized system for bearings and gear box. Low cost in the sense that a timer is used to re lubricate the system at specific time intervals. This system gives safety part to worker and minimizes manpower required for lubrication. This system also saves the lubrication, labor wages and keeps the system in proper working parameters as per the proposed design. The actual lubrication system was proposed to the plant with cost of entire system along with maintenance and operation cost. Further improvements in the system required is development of a software system which will effectively monitor the entire system and will ensure the leakage problems to ensure smooth operation. This proposed system will operate in closed loop and feedback from sensors will avoid sudden breakdown during operation. Although any problem in existing system will not cease the production of plant.

***Index Terms* – Sprag bearing, worm gearbox, timer**

I. Introduction

Oil Recirculation Systems are not only used to pump oil to bearings or gears to lubricate them but also to purge them of wear debris and, if necessary, to remove heat introduced into the oil by power losses due to friction. However, the majority of recirculation oil systems are nearly always custom designed to suit the application. Reservoir, pumps, filters, oil coolers, reservoir heating, pressure control and instrumentation are selected depending on the duty and the viscosity of the lubricant required to be pumped.

Too much lubrication can destroy bearing and too little lubrication is also harmful, so automatic lubrication system is a boon for highly automated industries. The motivation of this study came in our mind when we were intern in TATA STEEL and we were placed in the maintenance department to analyze the maintenance procedure of their industry and suggest the required changes to reduce downtime for machines used in wire drawing section. We observed that the machine would operate for 24x7 and would be shut for maintenance for nearly 8 hours in whole month. So, we realize that the downtime was increasing due to improper lubrication as it was done by the unskilled worker and it would lead to frequent shutdown as bearings and gearbox would get over heated. So, we decided to atomize the lubrication process and we were in search of that process that will have low initial cost and higher outcomes. So, we decided to develop an oil circulating system which would be low cost and easy to maintain as well as operate This paper covers the entire methodology to develop a cost-effective oil circulating system. This system is truly customized as per customer requirement and made to suitable for a range of oil viscosities from 100cst to 320cst. So that this system will be integrated with any other system and designed in such a way that if manufacturer wants to expand the current system t would be possible for him to do so. Different systems of lubrication system were studied, and we concluded to oil circulating system based on customer requirement and budget. The need for automatic lubrication system in machines that operate 24x7 was evaluated in this report and cost saving in the expensive system that is available in market today is done. The correct amount of lubricant required for bearings and gear box was evaluated so that saving in cost of lubrication can be done. Our aim is to reduce unnecessary loss of lubricant and provide metered quantity of lubricant. This reduces the cost of maintenance and downtime for each machine.

This is necessary for each industry which operates 24x7 and for the machine which is in constant load. This makes the industry to operate at ease and reduce overheating problems in gear box especially when worm gear box with higher reduction ratio is used.

This system was implemented in industry as the wear out contaminants present in gear box that would remain for at least period of 10 months needs to be filtered. So, to develop a cost-effective automatic lubrication system for the industry which will be able to operate in any environmental conditions to maintain suitable property of lubricant is the aim of our study.

1.1 Lubricant Selection

For this we referred we referred gearbox manual and based upon the heat generated in gearbox same lubricant was used even for sprag bearing. Thus, most suited lubricant SAE 320 in terms of viscosity and cooling requirements was selected.

1.2 Data and Sources of Data

For this study we collected data from PSG design data book and lubrication tribology book

Equations

Heat generated = (1- theoretical efficiency of gear box) (Power required for gearbox operation)

= (1-η_{th}) (P)

Heat Dissipated = (Temperature of sump – Surrounding Temperature) (Heat carried by oil)

II. RESEARCH METHODOLOGY

Modes of operation: This system is used in continuous production industries which increases its scopes. The G.I pipes were used to carry lubricant and avoid leak proof operation. The selection of G.I pipe was based on IS standards and theoretical calculations. The reservoir size was decided based on gearbox sump capacity of 20 liters and bearing lubricant volume. The internal gear pump was selected based on viscosity of oil and flow rate required in pipe. The miscellaneous components such as oil cooler to maintain viscosity, humidifier and dehumidifier to avoid moisture, oil breather to maintain atmospheric pressure, return line and pressure line filter to remove solid particles, pressure switch to avoid leakage have been selected from basic calculations and standard charts.The float switch was also used to maintain level of oil in reservoir.

2.1 Data and Sources of Data

$$D_{pipe} = 20\sqrt{flow\ rate\ in\ \frac{m^3}{sec}}$$

Volume of Reservoir = Fitment allowance + Running Capacity + System Capacity + Free Space
= Length (3w) x Breadth (w) x Height (1.3w)

Pump Pressure = (outlet pressure - reservoir pressure) + $\rho g h$

2.2 Theoretical Framework

For starting the design, we first calculate the heat generated and heat dissipated from gearbox and then appropriate lubricant was selected. However, lubricant was suggested on the gearbox along with volume of lubricant. Then G.I pipe was selected based on IS standards and then based on pressure requirement. The flow rate in inlet pipe was assumed as 3 to 5 m/sec and so the pressure in pipeline was calculated. Based on this internal gear pump was selected then other fitting were selected based on standard pressure and oil viscosity charts. The heat exchanger used was plate type heat exchanger and oil filter of 50 micron was also suggested. The entire outline was prepared on AutoCAD and piping length was calculated. The other fittings were selected based on pressure requirements and viscosity. The annual operation cost was calculated for system along with savings in labor and lubricant cost. The entire calculations were done based on actual oil requirement in running condition and cooler calculations were also made in order to maintain the viscosity to get required cooling and smooth operation of sprag bearing.

III. RESULTS AND DISCUSSION

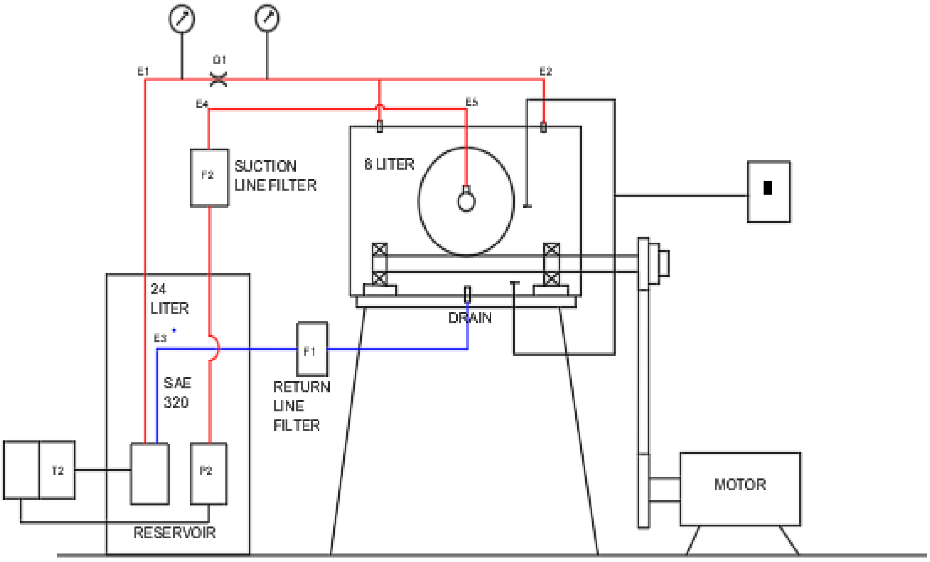
3.1 Results of Descriptive Statics of Study Variables

Table 3.1 Descriptive Statics

Number of lube points on machine	Number of times points lubricated	Average time to lube single point	Break down time a week	Labor cost for each technician including repair	Time taken a year for lube and repair	Annual labor cost for manual lubrication and repair	Annual cost for automatic lubrication system	Annual saving from automatic lubrication
4 points	3times/months	60 mins	6 hours	700rs/hrs.	216 hrs.	Rs 5,12,000	Rs1,50,0 00	Rs 3,62000

The Final system which we proposed for industry had enabled them to increase productivity of their plant. This system can be customized as per industry. The failure of any one lube point will not stop the production of wire and the fault can be repaired without stopping the production i.e. by isolation of the defective supply or delivery line. Further analysis of entire system along with flow of lubricant in pipes and thermal analysis of gearbox is to be done.

Figures



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