

Comparative Study of Manual Lubrication and Automatic Lubrication

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ABSTRACT

Lubrication is the process or technique employed to reduce the wear of one or both surface in close proximity. Most of the bear lubrication fail due to the too much or too less grease injected using manual lubrication. So, to replace the manual lubrication discrete wiring employed in lubrication system in heavy machines using PLC. The PLC's can be used to overcome the shortcomings PLC is mainly used to reduce the labor cost, power consumption, complication in circuits.

I. INTRODUCTION

Lubrication describes the phenomenon of reduction of wear occurs without human intervention (hydroplaning on a road). The science of friction, lubrication and wear is called tribology. Adequate lubrication allows smooth continuous operation of equipment, with only mild wear, and without excessive stresses or seizures at bearings. When lubrication breaks down, metal or other components can rub destructively over each other, causing destructive damage, heat, and failure. Automation is the use of various control systems for operating equipment such as machinery, steering of heavy machines. This involves the automation in lubrication system of a crawler system deployed in heavy excavator machine. The biggest benefit of the automation is that it saves labour. However, it is also used to save energy and materials and to improve quality, accuracy, precision. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronics in integration with computers. The automation of lubrication in excavator is carried out using a PLC. Excavators are heavy construction equipment consisting of a boom, stick, bucket and cab on a rotating platform (known as the "house").The house sits at top of an undercarriage with tracks or wheels. A cable-operated excavator uses winches and steel ropes to accomplish the movements. They are a natural progression from the steam shovels and often called power shovels. All movement and functions of a hydraulic excavator are accomplished through the use of hydraulic fluid, with hydraulic cylinders and hydraulic motors. A PLC is a digital computer used for automation of electromechanical process. PLC is designed for multiple I/O arrangement, immunity to electrical noise, extended temperature

ranges, resistance to vibration and impact, memory back-up.

II. Manual Lubrication

Earlier the only method to lubricate the bearings was manual and this lead to 54% failure of the lubrication due to presence of "too much or too less" lubricants. Later the discrete wiring came into existence but this wiring system lead to complications such as maintenance, power consumption. In the discrete wiring system, there are two modes of operation namely auto and continuous. When the crawler is ON, the delay timer is set. There is a separate wiring for the safety measures such as pump overload, the grease tank empty, pressure release. When there is a continuous current flow in the above mentioned wirings and the pressure in the dual lines increase the end switch is activated. The activated end switch triggers the changeover unit from position 1 to position 2 or vice versa. As the grease moves into the dual lines, the pressure gradually increases this is detected by the end switch. The end switch serves as the pressure sensor which detects the pressure in the dual lines. As the pressure increases, the pressure switch switches from one position to the other via the change over unit. Change over from the one position to another is done with the help of a motor.



Fig 1 Manual Lubrication

The disadvantages include sudden failure in the wiring systems; lose connections in the wires that lead to current leakage which is highly hazardous. Since there is no automation involved in the system there is high danger to the operators in the field.

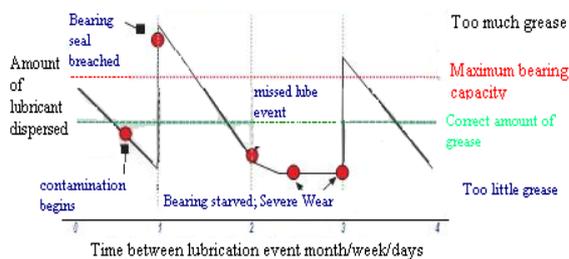


Fig 2 Response of manual lubrication

III. SURVEY ON AUTOMATIC LUBRICATION

In today's industrial environment, improper lubrication plays the major role. Improper lubrication scenarios include the contamination of the lubricant by replacements and repair, excess lubricant and labor for inefficient manual practice. Some of the indirect, but very real costs are downtime or lost production; product spoilage due to excess lubricant; environmental, safety or housekeeping issues; and excess energy consumption. While grease guns and manual lubrication seem to get the job done for many maintenance operations, their benefits often cannot compare to those provided by an automated lubrication system in terms of productivity, environmental issues and worker safety. An automated lubrication system helps to prevent bearing failure by providing the right amount of the right (fresh, clean) lubricant at the right time to the right place.

The main difference between automated and manual lubrication is that in the case of manually applied

lubricants, technicians tend to lubricate on schedule. It also prevents excess lubricant from finding its way onto the finished product, the plant floor or other work surfaces. This results in fewer rejections, clean up and disposal problems, as well as less waste of lubricant. And of course, all of this positively affects the company's bottom line.

H.G.Elrod on 18 October 2010 discussed the multiple scale double variable technique. Earlier work by others concerning the effects striated roughness and grooving upon the load carrying capacity of lubricating films is summarized substantiated and generalized. A multiple scale double variable technique is used on such lubrication problems for the first time. The present analysis applies to one face roughness having striation wavelengths sufficiently long for the applicability of Reynolds equation. Transient effects are included. The final differential equation for support pressure is simple in form. In addition to predicting the effects striated "Reynolds roughness", this equation can be directly used in grooved bearing design.

H.Christensen and Tonder on 18 October 2010 discussed a hydro dynamic lubrication technique. The paper describes a theoretical analysis of the effects of theoretical analysis of the effects of surface roughness in a finite width bearing. The analysis is based upon a stochastic theory of hydrodynamic lubrication developed previously. It is shown how the effect of surface roughness on the bearing characteristics is closely tied up with features of nominal geometry as well as with operational factors.

Bousu Sch of Electr. Eng. &Autom., Henan Polytech. Univ., Jiaozuo, China Li Wang discussed a special lubrication system is needed to ensure normal operation and prolong service life of the large machinery. In traditional centralized lubrication system, lubrication faults are easy to occur for many shortcomings such as poor generality, low measurement precision, inaccurate diagnosis of leakage and blockage. The practical systems cannot meet the requirements of a reasonable lubrication. This paper describes the structure planning of the lubrication system, technology of quantitative lubrication, online monitoring of pressure and temperature. A centralized lubrication system with distributed structure is put forward, which is composed of monitoring master, main control cabinet and lubricating terminals. The point-by-point lubrication and detection can be achieved in this system. The detection methods of oil pressure, flow and temperature are studied and reliable digital detection schemes were discussed. This system has been successfully applied in industrial field and the lubrication performance gets obvious improvement.

Zhao, Chunhua; Yan, Xinping; Gao, Huiliang on June 2004 discussed a offline sampling or on online measuring with a single sensor. Machine lubrication contains abundant information on the equipment operation. Nowadays, most measuring methods are based on offline sampling or on online measuring with a single sensor. An online oil monitoring system with multiple sensors was designed. The measurement data was processed with a fuzzy intelligence system. Information from integrated sensors in an oil online monitoring system was evaluated using fuzzy logic. The analyses show that the multiple sensors evaluation results are more reliable than online monitoring systems with single sensors.

Muskat, M., Gulf Research & Development Company, Pittsburgh, Pennsylvania and Evinger, H.H. has explained a Study in Lubrication. The effect of the pressure variation of viscosity on the lubrication of plane sliders. The Reynolds theory is applied to the calculation of the lubrication properties of plane sliders – thrust bearings – of infinite width provided with lubricants whose viscosities increase exponentially with the pressure. The friction coefficient, minimum film thickness and lubricant flow were calculated for fixed wedge angle and pivoted sliders. The effect of viscosity variation with pressure is determined by the magnitude of the dimensionless product of the viscosity pressure exponent and the bearing load per unit area. The analysis shows that for each choice of this product there will be a limiting position of the pivot line of the slider or of the equivalent sommerfeld variable at which the film pressure and friction forces will become infinite and beyond which it will be impossible to operate the slider. Moreover this product is shown to be limited by a maximum value equal 2 which means that the absolute maximum load per unit area which can be carried by such slider systems is equal to twice the reciprocal of the viscosity-pressure exponent. Specific calculations on the friction properties of bearings operating with lubricants of different viscosity pressure exponents give curves of friction coefficient vs. load or Sommerfeld variable quite similar to those observed in practical tests. At high loads or low values of the Sommerfeld variable the friction coefficient curves split and follow the behavior generally interpreted in terms of oiliness and boundary lubrication phenomena.

Bowden, F.P. Council for Scientific and Industrial Research, East Melbourne, Australia and Tabor, D on Mar 1947 discussed. The Lubrication by Thin Metallic Films and the Action of Bearing Metals. An investigation has been made of the role of thin metallic close proximity, reducing the friction and wear between metal surfaces. It shown that with metallic films possessing suitable mechanical and

surface properties the coefficient of friction is very low and may be similar to that observed on eyes. The friction and wear properties of some copper leads alloys have been studied and the results indicate the lead in the alloy is extruded during sliding and forms a thin lubricating film on the hard copper matrices.

IV. Automatic Lubrication

PLC is mainly used to reduce the power consumption due to discrete wiring system, cost effectiveness is achieved. The lubrication system consists of 6 crawlers divided into 3 sections containing 2 crawlers each. When 1 of the crawlers moves for 20 minutes the PLC checks for 25 bar pressure and activates the end switch grease tank empty, pressure release.

As the pressure increases the pressure switch switches from one position to another to the change over unit. The annunciation involves checking the critical situation that was not dealt in conventional systems. Later the the discrete wiring came into existence but this wiring system lead to complication such as maintenance, power consumption. In the discrete wiring system two modes of operation namely auto and continuous.

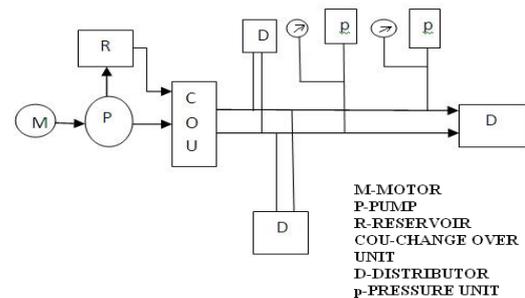


Fig 3 Basic block diagram for lubrication

when the crawler is ON the delay timer is set there is separate wiring for safety measures such as pump overload, the grease tank empty, pressure releases. When there is a continuous current flow in the above mentioned wirings and the pressure in the dual lines increase the end switch is activated. The activated end switch triggers the changeover unit from position 1 to position 2 or vice versa. As the grease moves into the dual lines, the pressure gradually increases and it is detected by the end switch. The end switches severs the pressure sensor which detect the pressure in dual line

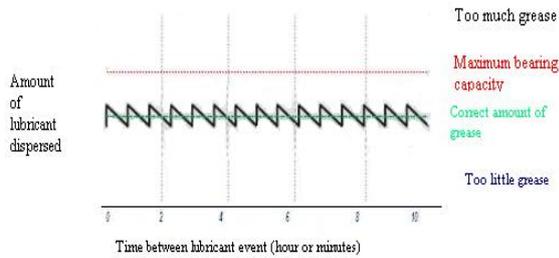


Fig 4 Response of Automatic lubrication

Another benefit of an automated lubrication system is worker safety. It becomes unnecessary for employees to engage in the potentially hazardous practice of manually applying lubricant while machinery is operating or in hazardous, difficult-to-reach locations.

V. Regimes of lubrication

As the load increases on the contacting surfaces three distinct situations can be observed with respect to the mode of lubrication, which are called regimes of lubrication.

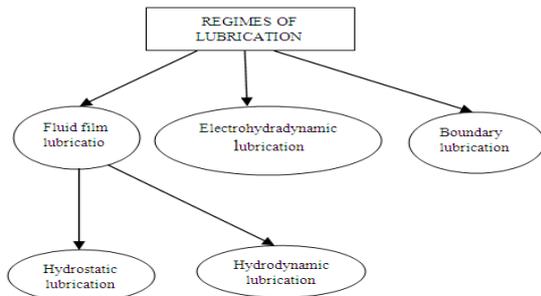


Fig 5 Regimes of lubrication

VI. DIFFERENT TYPES OF AUTOMATIC LUBRICATION SYSTEMS

There are several different types of automatic lubrication system including

1. Single line parallel system
2. Dual Line Parallel systems
3. Single Line Progressive systems (or Series Progressive)

A. SINGLE LINE PARALLEL

The first single-line parallel system for industry was introduced in 1937 by Lincoln Engineering (now known as Lincoln Industrial) in the U.S.A.

While simultaneously venting the second (vent) return line. Once the required pressure is reached, a predetermined amount of lubricant is dispensed by the metering devices to half of the lubrication points via feed lines.

A single line parallel system can service a single machine, different zones on a single machine or even several separate machines and is ideal when the volume of lubricant varies for each point. In this type of system, a central pump station automatically delivers lubricant through a single supply line to multiple branches of injectors. Each injector serves a single lubrication point, operates independently and may be individually adjusted to deliver the desired amount of lubricant.

Operation begins when the controller/timer sends a signal to the pump starting the lube cycle. The pump begins pumping the lubricant to build up pressure in the supply line connecting the pump to the injectors. Once the required pressure is reached, the lube injectors dispense a predetermined amount of lubricant to the lubrication points via feed lines.



Fig 6 Single line parallel

Once the entire system reaches the required pressure, a pressure switch sends a signal to the controller indicating the grease has cycled through to all the distribution points. The pump shuts off. Pressure is vented out of the system and grease in the lines is redirected back to the pump reservoir, until the normal system pressure level is restored.

B. DUAL LINE PARALLEL

A dual line parallel system is similar to the single line parallel system in that it uses hydraulic pressure to cycle adjustable valves to dispense measured shots of lubricant. It has 2 main supply lines which are alternatively used as pressure / vent lines. The advantage of a two-line system is that it can handle hundreds of lubrication points from a single pump station over several thousand feet using significantly smaller tubing or pipe.

Operation begins when the controller/timer sends a signal to the pump to start the lubrication cycle. The pump begins pumping lubricant to build up pressure in the first (the pressure) supply line.



Fig 7 Dual line parallel

Once the pressure switch monitoring main supply line pressure indicates a preset pressure in the lines has been reached, the system is hydraulically closed. The controller shuts off the pump and signals a changeover valve to redirect lubricant to the second main supply line.

The next time the controller activates the system, the second main line now becomes the pressure line while the first line becomes the vent line. The second line is pressurized and the entire process is repeated lubricating the remaining lube points.

C. SINGLE LINE PROGRESSIVE

A single line progressive system uses lubricant flow to cycle individual metering valves and valve assemblies. The valves consist of dispensing pistons moving back and forth in a specific bore. Each piston depends on flow from the previous piston to shift and displace lubricant. If one piston doesn't shift, none of the following pistons will shift. Valve output is not adjustable.



Fig 8 Single line progressive

Operation begins when the controller/timer sends a signal to the pump to start the lube event. The pump then feeds lubricant into the supply line which connects to the primary metering valve, for either a preprogrammed amount of time or number of times as monitored through a designated piston cycle switch.

Lubricant is fed to the multiple lubrication points one after another via secondary progressive metering valves sized for each series of lubrication points and then directly to each point through the feed lines.

VII. CONCLUSION AND DISCUSSION

The lubricant consumption will considerably reduced by control system optimization that is right quantity of lubricant at right part. Failure of bearings due to lack of lubrication is considerably reduced. Frequent lubrication run time is eliminated and pump motor energy consumption is considerably reduced by appropriate material of stator core material winding. Motor overloading is reduced by using thermal relay which has high sensitivity.

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