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Automatic Dual Line Lubrication System Using Programmable Logic Controller

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Abstract: **- Lubrication is a technique employed in most of the steel industries that delivers controlled amount of lubricant to multiple points of rollers in order to perform a smooth operation. The manual lubrication system requires more manpower that leads to more downtime in production and maintenance. Meanwhile, the discrete wiring system leads to complication in the wiring. The proposed automatic dual line lubrication system using PLC sends a command to initiate lubrication cycle that pumps the lubricant to the entire first supply line and then signals a changeover valve to the second supply line. The pressure in the supply line is vented out and lubricant in the line is returned to the pump reservoir through lubrication filter. Thus the lubrication is done alternatively in both the lines to the bearings of rollers with a time interval of every 45 minutes. If any fault occurs during the lubrication cycle, the system will generate a fault message in HMI and gives a signal to alarm. Hence it overcomes the constraints that are associated with the manual and discrete wiring lubrication systems.**

Keywords: **- Bearings, Changeover valve, Human-Machine Interface (HMI), Programmable Logic Controller (PLC).**

I. INTRODUCTION

Lubrication is the process of applying a lubricant such as oil or grease to the rollers or bearings so as to reduce the friction and allow smooth movement. Nowadays many industries maintenance areas are decreasing because of improper lubrication. But there are many numbers of production machines and lubrication places that require manual lubrication. By manual lubrication the many times the product is spoilage due to excess lubricant and large energy consumption. Due to this large amount of lubricants is wasted and lower the production. There benefit is not comparable to those provided by automated lubrication system in the terms of worker safety, production rate and etc.

Issues with Manual Lubrication

- Many machines are dangerous to lubricate while running
- Safety is an issue when lubricating hard-to-reach bearings
- Lock Out/Tag Out process are time-consuming and lost production takes place
- Over greasing can cause bearing seal damage, product spoilage and cleanup difficulty

Need for Automatic Lubrication

- Too much or too less grease injected using manual lubrication.
- A large amount of lubricants is wasted and lower the production.
- To reduce the labor cost
- Worker safety
- Power consumption
- Complication in circuits

Automation can be achieved by using different ways including mechanical, electrical, hydraulic, and pneumatic with the integration of controllers. Here the automation of lubrication is done using a PLC. PLC is designed to provide multiple I/O arrangement, immunity to electrical noise, resistance to vibration and impact, extended temperature ranges, memory backup. The automation function, application area and production required defining the appropriate automation hardware. SIMATIC S7-400 automation systems address advanced and demanding applications in the industrial environment. This is the reason that for many years plant operating companies and construction companies have been relying on these controllers and extensively use them in their plants and systems. A human-machine interface (HMI) is the user interface that links an operator to the controller for an industrial system. An HMI comprises electronic components for signalling and controlling automation systems. Some HMIs also convert data from industrial control systems into human-readable visual representations of the systems. Through the HMI, an operator can watch schematics of the systems and turn switches and pumps on or off. Automatic lubrication

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system protects the rolling failure by giving the proper amount of lubricant to the machine at a proper time. The biggest advantage of the automation is that it reduces the number of labor and provides safety to labor. It controls the excess amount of lubricant supplied to the rollers. It also offers to save the energy, material, increase quality and efficiency.

II. LITERATURE REVIEW

In the present steel industries, inappropriate lubrication is one of the major issues. Improper lubrication includes the impurities in the lubricant and manual practices involve excess lubricant and labor that leads to an inefficient system. As we know manual lubrication increases the downtime, housekeeping issues and excess energy consumption. The proposed automated lubrication system overcomes the manual lubrication method and helps to prevent bearing failure by providing the right amount of the clean lubricant at the right time interval to the right location.

The major difference between automatic and manual lubrication system is that, in the case of manually applied lubricants, labors tend to lubricate on time so it requires longtime and involves some safety issues. Whereas in automatic lubrication PLC monitors and controls the entire operation. Thus, prevents excess lubricant from finding the exact location of a finished product and other work surfaces. This results in fewer rejections, clean up and disposal problems, as well as less waste of lubricant. Hence, automatic lubrication leads to positive effects on the company's production line.

III. PROPOSED METHOD

Fig.1 shows automatic dual line lubrication system has two main supply lines i.e. Line A and Line B which are alternatively used as a pressure and return lines. The advantage of a dual line system is that it can handle 120 lubrication points from a pump station over 180 feet using significantly smaller pipes.

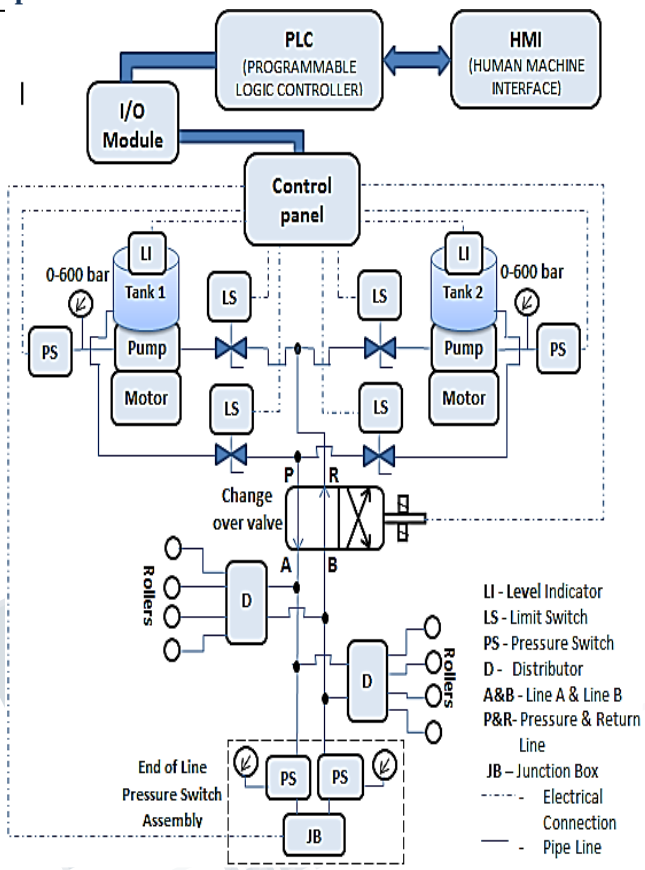

Fig.1- Proposed Automatic Dual Line Lubrication System

A. Line a Operation

The lubrication cycle begins when the controller sends a signal to the pump to start the lubrication process. The lubricant is pumped to build up a pressure in the first supply line (Line A) which connects a pump to the injectors through distributors. Once the entire lubrication line reaches the required pressure, an end of line pressure switch sends a signal to the controller indicating that grease has cycled through all the distribution points and then signals a changeover valve to redirect lubricant to the second main supply line (Line B). Pressure is vented out of the system and grease in the line is redirected back to the pump reservoir through lubrication filter, until the normal system pressure level is restored.

B. Line B Operation

Next time when the lubrication cycle starts, the second main line now becomes the pressure line while the first line becomes the vent or return line. The second line is pressurized and lubricates all the roller points. Once the whole system reaches the required pressure, an end of line pressure switch sends a signal to the controller indicating that grease has cycled through all the distribution points, the pump shuts off and the system

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waits for 45 minutes. After the timer reaches 45 minutes, the lubrication cycle repeats again.

C. Fault Operation

If the end of line pressure switch assembly unable to detect preset pressure, the pressure switch assembly waits for five minutes then gives a signal to alarm and display greasing system fault message in human-machine interface.

D. Algorithm

Fig.2 illustrates the proposed system components. The genetic algorithm provides the optimal solution based on lubrication function. This algorithm includes feeding the grease to the bearings of rollers.

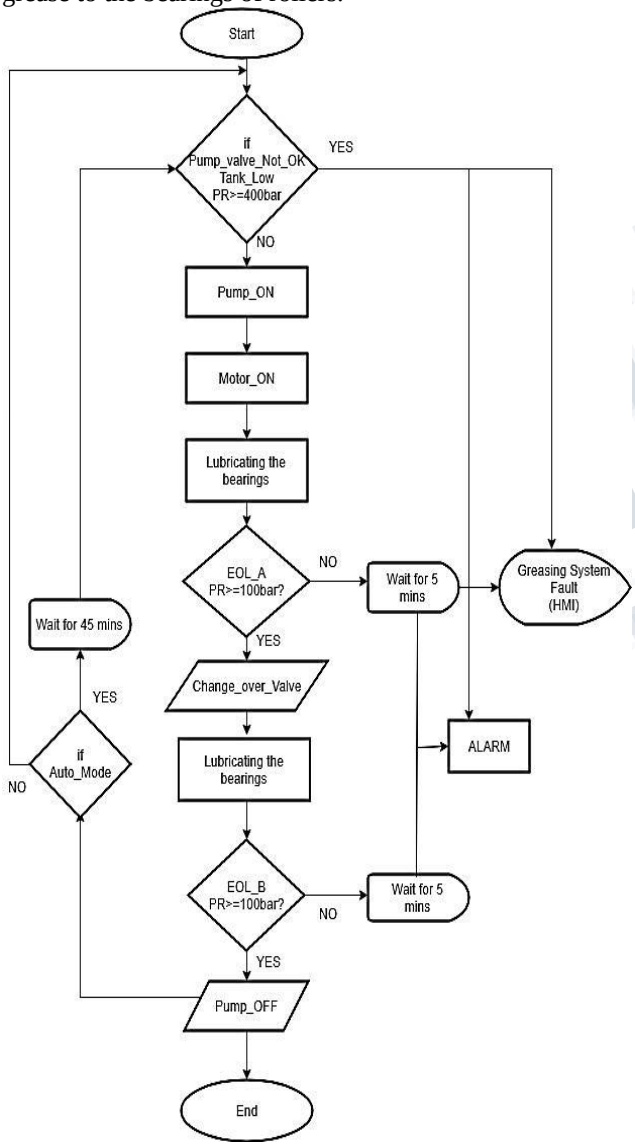

Fig.2- Proposed Genetic Algorithm Components

The first step is checking the conditions of a pump. Based on the output of these conditions; the pump and the motor will be ON. The next process is lubricating the bearings, that responsible to lubricate all the lubrication points. Once the required pressure is reached at the end of line pressure switch assembly and then signals a changeover valve.

Next, the second line lubricating the bearings and commands to shut down the pump. Finally, the system checks for the mode of operation. If the system is in auto mode then it waits for 45 minutes and the lubrication cycle starts again. If it is not in auto mode then the lubrication cycle repeats continuously.

If any fault occurs during the lubrication cycle, then the system will generate a fault message in human-machine interface and gives a signal to alarm.

IV. DESIGN AND IMPLEMENTATION

Fig.3 represents interfacing the input/output module to a programmable logic controller by using PROFIBUS for assigning the input/output addresses respectively. PROFIBUS DP for fast, cyclic data exchange with field devices.

Benefits of PROFIBUS

- PROFIBUS is a powerful, well-built and open bus system that ensures hassle-free communication.
- The system is completely standardized, which enables effortless connection of standardized components from different manufacturers.
- Configuration, commissioning, and troubleshooting can be carried out from a different location. This results in user-defined communication relationships that are very flexible, simple to implement, and easy to change.
- Continuous observing and checking of network components through a simple and powerful signalling concept.
- Existing networks can be extended without any adverse effects.

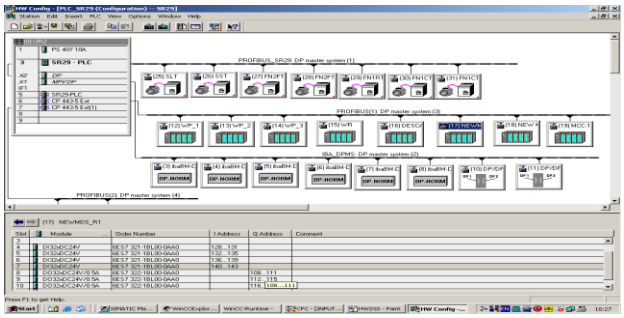

Fig.3- PLC Configuration

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Fig.4 shows programming for the proposed system using Continuous Function Chart (CFC) in Process Control System (PCS 7). PCS 7 supports configuration with numerous automatic functions so that it creates a project quickly and conveniently. The entire operation of a system is described by continuous processes. This is achieved by creating CFC charts in the CFC Editor of PCS 7. The CFC Editor is a graphic editor for programming objects in the CFC language. CFC allows techno-logical requirements to be transformed into executable automation programs with minimal cost.

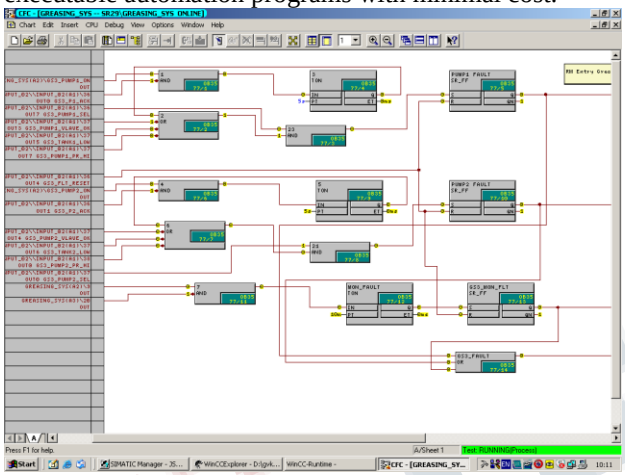

Fig.4- Input/Output Configuration

V. RESULTS

Fig.5 shows the Human-Machine Interface display of automatic dual line lubrication system working under normal condition. HMI is a graphical interface that allows humans and machines to interact. It also signifies various parameter values, data updates and continuous online monitoring for the remote engineers.

Fig.5- Working Output in Human Machine Interface

Fig.6 shows the fault output of automatic dual line lubrication system in HMI display which is generated when the initial conditions of the pump is not satisfied, the end of line pressure switch assembly unable to detect the required pressure.

Fig.6- Fault Output in Human Machine Interface

VI. CONCLUSION

The automatic dual line lubrication mechanism that will be developed is used as an alternative to manual lubrication. This would be a native mechanism to supply lubricant to the rollers to achieve smooth rotation. Failure of bearings due to lack of lubrication is considerably reduced. The overall performance of the rollers increases which in turn reduces downtime. Modification in the circuit according to the technology changes is difficult in the discrete wiring system used earlier and it can be easily carried out through HMI. Thus it will eliminate the dependency of manual lubrication where human interface is not possible.

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