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Machine Oiling Automation

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Abstract: *Manufacturing industry has always been well-known for the frequent use of heavy machineries. To facilitate easy functioning and to use the machines to its fullest potential, lubrication is performed which increases the precision of the final product. In today's world, lubricants may have many uses, but its primary function is to reduce friction between two mechanical parts. This decreases wear and tear, lowers operating temperatures, prevents metal surface corrosion, and ensures smooth operation. This frequently neglected important job by technicians, if automated using IoT, will ensure the timely care of machines for a longer lifespan. Scheduling the operation of machine oiling as and when required by using Raspberry Pi for the same will help us achieve this goal.*

Keywords: IoT, Automation, Raspberry Pi, Scheduling, etc.

I. INTRODUCTION

Mineral oil is used as the fluid component in the majority of greases today. In most industrial applications, these mineral oil-based greases deliver satisfactory results. A grease with a synthetic base oil will provide higher stability in temperature extremes (low or high). Lubricated equipment performs more efficiently, lowering maintenance expenses in the long run. Friction reduction is a critical component in optimising the efficiency and life-expectancy of any spinning equipment. Lubrication decreases friction, allowing moving machine parts to slip past one another smoothly. Machine oils are also used to lubricate machine parts and offer a layer of corrosion protection. Multipurpose oils assist reduce squeaks and other noises by preventing moving or threaded parts from adhering or binding with one another. An autonomous lubrication system delivers the right amount of lubricant to your equipment at the right time and in the right location. It frequently happens while the machine is running. It takes the place of the traditional lubricating system, resulting in longer equipment life, less wear, and lower maintenance costs. [4]

II. LITERATURE REVIEW

The reference to papers mentioned in the References section give a detailed overview on selection criteria and connection of sensors, buzzers and LEDs to Raspberry Pi. Enabling the control of these pins through GPIO programming and complete study for interfacing of these components was facilitated through the referenced documents from IEEE. [6] The client-server model exploration through Raspberry Pi is the main goal of the paper 'Exploring IOT Application Using Raspberry Pi' while giving an overview about connections for different sensors. [7] The demonstrated theft prevention system in 'IoT Security Solution to Avoid Theft' paper is successfully depicting how an alarm will alert as soon as the sensors sense any unusual activity. [8] In the referred paper 'IoT based Smart Waste Management System: India Prospective', a considerable factor shows management of system through website updates which considerably reduces manual interference with the help of IoT through other possible implementation operating systems like Arduino.

III. PROBLEM STATEMENT

Heavy machineries in the industry needs to be oiled periodically to function efficiently. Many a times this job is neglected by the subordinates. An efficient solution for this problem can be alerting the person in charge of the shopfloor/department once the oil level in the machine recedes a certain amount. Automation of this process after alerting will save manpower, machine breakdown, production loss, repair cost and time. Everyone is aware of the consequences of inadequate lubrication. Increased component wear, earlier failure, higher energy consumption, and higher operating and maintenance expenses are all prominent examples. Over-lubrication has the potential to waste lubricant, cause excessive heat build-up, put stress on lube points, and result in greater downtime.

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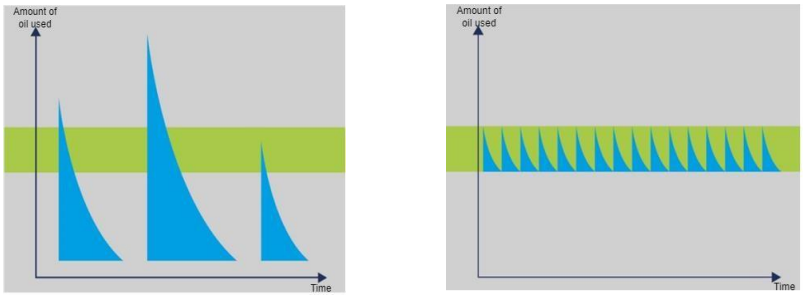
IV. SOLUTION

[5] The obvious solution for the problem mentioned above is optimal lubrication. Lubricating machines manually typically produces inconsistent lubrication. Uneven lubrication wastes oil and allows impurities to enter the bearing, causing premature wear and a considerable reduction in bearing life. Optimal lubrication prevents unplanned downtime. The comparison graph below shows the inconsistencies seen in the manual lubrication and how it can be avoided by the automation of the process. Using Raspberry Pi (here used, Raspberry Pi4 model B) will help in achieving the goal through reduced manual efforts and web alert (Tkinter) for person-in-charge of monitoring. The machines and sensors connected will work as devices connected to internet, thereby acting as an example of IoT. [6]



MANUAL LUBRICATION vs AUTOMATED LUBRICATION

Figure 1

The pie-chart below shows that the major cause of bearing failures is due to inadequate lubrication. While the bearing is in motion, little amounts of lubrication applied frequently will extend its life.

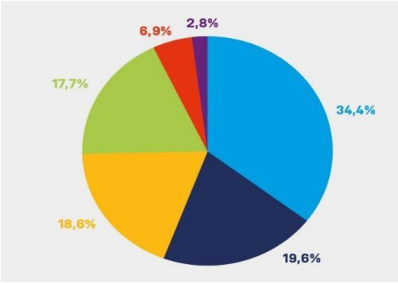


Figure 2

Causes of bearing failures :34.4% inadequate lubrication, 19.6% contamination, 18.6% other reasons, 17.7% installation errors, 6.9% bearing overload, 2.8% storage & handling errors.

V. IMPLEMENTATION

Every machine needs to be oiled after periodic intervals. Oiling the machines regularly with the right amount will increase machine's work efficiency and hence increase the production and its quality along with saved resources as no oil/lubricant is wasted. Scheduling of the oilers using Raspberry Pi, for automatic turning on and off at these times of the day helps achieving the purpose of periodic machine oiling automation.

Here, every 24 hours, machine will be oiled once for 15 minutes on its first start-up. This ensures that the functioning of machine throughout the day will be smooth as it will be well lubricated from the first use itself. Machine will be oiled on its start-up so that the workers can pay attention to lubrication control if needed through the small knob or solenoid valve manually. The automation also helps the workers work side by side and saves time. Oiling during the machine is still running helps the oil reach every nook and cranny of the joints which are to be oiled for smoother functioning rather than when the machine is shutdown.

The machine's start-up is linked to relay, when the machine starts it will in turn start the relay. As the relay is connected to the oilers' motor, it will start pumping the oil through the pipes once the relay starts. The LED connected above every machine is only an indication of the ongoing process. The LED will be turned on while the machine is being oiled and turned off as soon as the process terminates. This was the brief explanation of the first phase of automation process.

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The second phase includes maintaining the oil levels of the oilers and the reservoir. The oiling process starts every morning through scheduling and as a result in the end of the process, oil level of the oiler decreases. When oil level reaches the threshold, the oiler must be filled with oil. [8] The decrease in oil level below the margin is detected with the help of a sensor, the sensor in turn opens the solenoid valve (solenoid valve controlling the flow of oil towards the oiler). The opening of solenoid valves is linked to the sensor that detects the decrease of oil level in the oiler below the threshold. The main pump senses the opening of solenoid valve and pumps the oil of the reservoir into the pipes of the respective solenoid valves that are open. Once, the oiler is filled till a certain amount, program closes the solenoid valve and the main pump is turned off because of their connection. While oil is being filled in the oiler from the reservoir, LED on every solenoid valve will glow to indicate this process. Every solenoid valve and its connection to the main pump is independent of the other and hence, only the oilers that require oil will be filled depending on the open solenoid valves. To prevent any air traps, by default all the pipes will contain oil. Over a period of time, if any solenoid valve fails to do its function, any electrical component of the circuit trips, or pressure builds up due to unforeseen reasons there is a relief wall to store the excess oil and relieve the pipes of excess pressure to prevent any cases of pipe bursts or other hazards.
The last phase of our automation process addresses the oil level decrease of the main reservoir. The refilling of the main reservoir will be done through manual intervention. If oil level drops below 10 percent of the total oil, the LED will glow as the first indication and if the refilling job is still neglected, the until the oil level decreases below 5 percent then the buzzer will also be turned on till the job is completed.

VI. BLOCK DIAGRAM

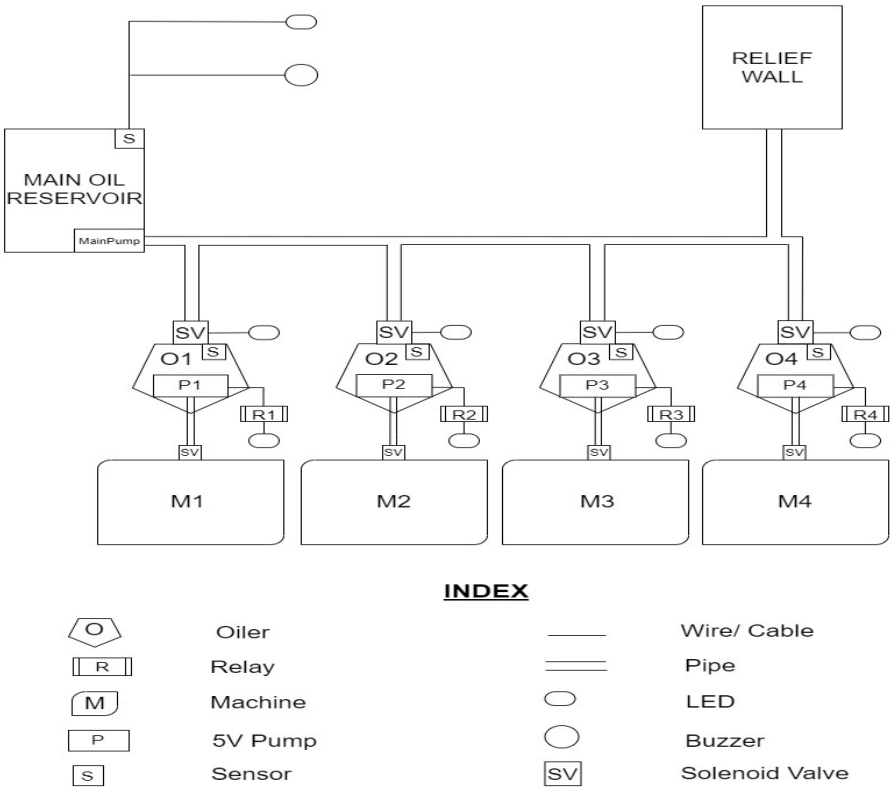

Figure 3

Note: All electrical components associated with scheduling are connected to RaspberryPi4 model B

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VII. SYSTEM FLOWCHART

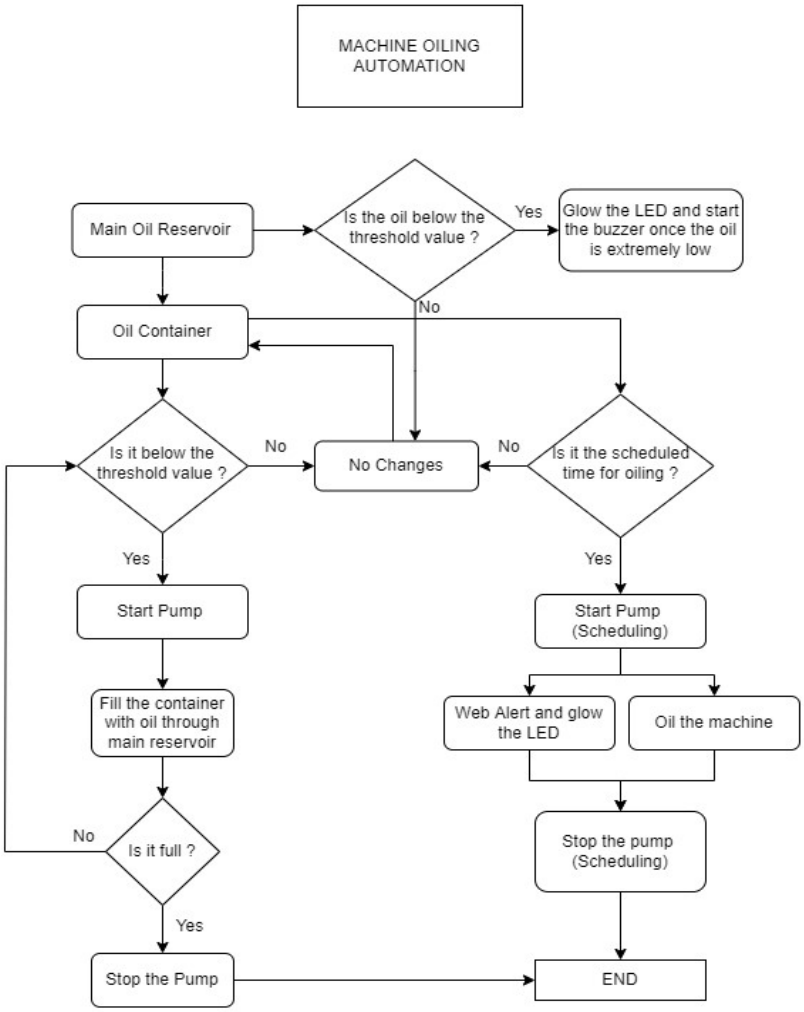

Figure 4

VIII. ADVANTAGES

[1] [3] Automation of oiling machines will help reduce or vanish the problems being faced right now due to manual lubrication through the following advantages-

1. Environmental Improvements: Since automatic systems will measure the exact amount of lubrication needed. Wastage will be reduced, less friction and less energy consumption.
2. Machine Downtime: will be reduced since machines need not be shut down in order to add more oil.
3. Extended Equipment Life: by providing machines with the right amount of lubrication at the right time automatic lubrication results in reduced wear and extended equipment life.
4. Chemical protection: Lubricants and their additives can coat machine components' surfaces, preventing them from corrosion such as rust.
5. Lower maintenance costs: Automatic lubrication extends the life of equipment by minimising wear, lowering the cost of spare components.

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IX. LIMITATIONS

[1] Every application has its own shortcomings and only after identifying them can the application become better.

1. Different types of machines have different oiling system so this prototype may not be applicable to all the machines.
2. Automated lubrication may not be cost effective for smaller systems.
3. Large systems may require complex piping/tubing runs. This might take up a lot of space and make the model bulky.

X. FUTURE SCOPE

[2] Every application created now always has a scope of improvement in the future. These applications are made such that updating the same will be easy in the future as and when needed. Some of the future scopes of the application are listed below:

1. Automatic lubrication system or centralized lubrication system is specially designed so they can be used to deliver lubricant to the various locations on the machine when the machine is functioning.
2. Their main function is to distribute correct amount of oil & grease into the lubricant at preset regular time interval. Oil based lubrication system and grease-based lubrication system are two of the common types of the lubrication systems.
3. Mostly automated lubrication system decreases the time intervals, provides worker protection and requires less maintenance.
4. With the increasing awareness about human and working rights on the end of technicians, risk-free jobs are always preferred. In manual lubricated environments, a machine technician needs to access some of the vital machine parts which might require climbing on the machine, sometimes when it is still running. An automatic lubrication system avoids these risks in addition to reduced human contact with lubricants preventing hazardous incidences such as slipping on the floors due to spilled oils.

XI. CONCLUSION

As the world moves towards helping mankind by saving labour and time through automation of different applications with the help of IoT. Using Raspberry Pi or Arduino, simple or small devices can be connected to internet, and this provides a helping hand for making IoT simpler and reachable as it ranges from simple to more complex uses. Better product quality with efficient use of resource helps us achieve required precision. This paper focuses on the advantages of automatic lubrication system and the benefits of using appropriate amount of oil during the process and also describes our idea for implementation of an automated system. [6]

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