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Automation in Die Lubrication Unit in the Hot Forging Process using PLC

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Abstract: ***Hot forging process is the most widely used method in the automobile production section. Due to the mass production many companies are moving towards automation. Automation reduces human interruption and production cost and increases degree of accuracy. Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) system are leading tools in automation. In the process of Hot Forging, there is need of frequent lubrication for die. This lubrication is in the form of graphite solution, but before spraying it on die it is required to be mixed with water in a specific ratio, depends on die material. This paper deals with automation using PLC, in the process of mixing graphite lubricant in water with specific proportion and preparing the solution ready to spray on die. This paper also includes the reasons of failure of lubrication and its solutions using automation.***

Keywords: Hot forging, water based graphite lubricants, automation, sensors.

I. INTRODUCTION

In the process of hot forging dilute water based lubricants are used to spray on hot surfaces of die to cool it down and for lubrication purpose. The dilution ratio is decided by considering the parameters such as, die temperature, type of material being forged, forging temperature, structure complexity of die. Lubricity and adhesion are also very important properties to be considered. If dilution is very less lubricant itself offers more frictional force and problem of less cooling takes place and if dilution is very high than expected then more water droplets may cause problem in adhesion property. So dilution plays an vital role in quality lubrication and quality forging. Manual process of dilution introduces more errors so it reduces standard of lubrication. Electronic components such as sensors, solenoid valves helps to increase accuracy with using automation tools.

II. DESIGN

To solve the problems with manual system the new design of system which will automatically mix the graphite with water is as shown in block diagram given bellow.

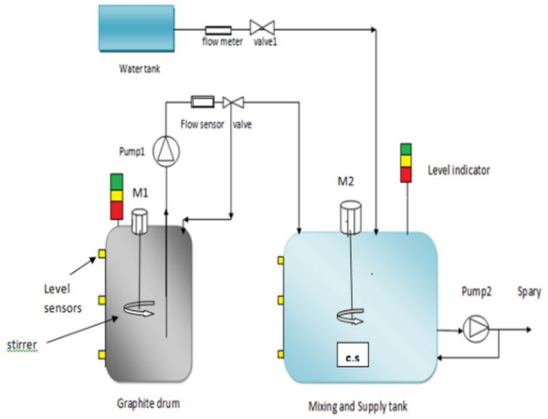

Fig. 1. Block diagram of mixing system

Level sensor of mixing tank will detect that the tank is empty. Then this signal will received by plc and to refill the tank valve1and valve2 will gets open. flow sensors are installed just before the valves to measure the flow. then comparing the flow sensors readings with entered input ratio plc will decide, when to turn off the valves. During this process conductivity sensors takes parallel action. It will measure conductivity of solution. According to this readings plc will decide the actuation of valves. Hence the lubricant solution with desired concentration is ready to spray on die.

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A. Components used

Following table shows the components used for this project

Table 1. list of components used and there quantity

Name of component	*Quantity*
Flow sensors	2
Conductivity sensor	1
Solenoid valve	2
Level sensors- float type	3
Level sensor- Microwave type	1
Motor	2
Pneumatic pump	2
Level indication lamp	2
Water tank	1
Mixing tank	1
Stirrer	2
PLC	1

B. Explanation

As shown in fig. 1. Graphite drum is a fixed concentration graphite lubrication supplied by the lubrication company. Here flow sensors, conductivity sensors and solenoid valve plays an important role. Once graphite lubrication drum is bring in system then system stars to work. Level sensors in mixing tank will detect the level of newly prepaid solution in mixing tank, if level is low then solenoid valve 1 and 2 gets open.

Pump 1 is continuously in on position to maintain a pressure in a system. Flow sensors will count the amount of water and graphite lubrication flowing towards mixing tank. Once the amount equals to PLC input ration the both valve will close. Then conductivity sensor will measure the conductivity of mixed solution. In programming conductivity is saved for different ratios. The conductivity sensor's reading is being compare with reference if it is not matching then again respective valve gets open till conductivity equates to set value.

The more the concentration of graphite more will be the conductivity. Once the mixing tank gets full valves remain close. Once the new batch of solution is ready in the mixing tank then it can be spray on die.

Motors are placed on both graphite drum and mixing tank and stirrers are connected to both motors with the help of shaft. Continuous stirring is important otherwise lubrication may transfer into solid form. Level sensors detects the level of lubrication and it will indicate by respective indication lamps.

C. Conductivity Concept used in Dilution

Graphite is conducting material. When more water is added in graphite then conductivity decreases. Hence we can comment as percentage of water in one unit of graphite increases conductivity decreases. This concept is used in dilution proses. For different combinations of water and graphite volume conductivity is measured and entered in PLC. For example For 10 unit of water in 1 unit of graphite gives 4 units of conductivity. Then when values 10:1 (water : graphite) is entered then conductivity sensor in mixing tank gives actual readings of solution in tank to compare with set conductivity reading 4unit.

III. AUTOMATION DETAILS

A. Automation tool

Here Programmable Logic Controller (PLC) is used as a automation tool. Programmable Logic Controller is a digitally operating electronic device which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic sequencing, timing, counting, and arithmetic to control, through digital or anlog input/output modules. A PLC is an example of a hard real time system since output results must be produced in response to input conditions within a limited time.

B. List of input and outputs

1) Inputs

a) Level sensors
b) Flow sensors
c) Conductivity sensor

2) Outputs

a) Solenoid valves
b) Level indication lamps
c) Pumps
d) Motors

C. Process Flow(logic)

If mixing tank is empty then level sensor in it gives that input to plc. Due to this input PLC does following operations,

1) Show this empty level by lowing respective indication lamp.
2) Turn off pump P2 and keep it in same condition using latch function
3) Turn on solenoid valve 1 and valve 2 on

Then flow sensor 1 will measure flow of water through valve 1 and flow sensor 2 will measure flow of graphite through valve 2. The when output of flow sensors matches to PLC set input value then valves turn off. For eg. If PLC set value is 15 unit of water in 1 unit of graphite then, when flow sensor 1 measures 15 units of water is passed through valve then it turns off valve 1. Simultaneously when flow sensor 2 shows 1 unit of graphite is passed then it will turn off valve 2.

Then if conductivity sensor reading doesn't matches with set value then again respective valve will turn on till conductivity matches to set .Now tank is filled with desired diluted lubricant hence turn on pump P2.

Water based graphite lubricant needs continuous stirring once it comes in contact with air otherwise it starts to convert into solid form. Hence keep motor 1 and 2 continuous in ON condition.

Keep pump P1 also continuous in ON condition to maintain pressure in system. Pump is provided with return valve. Show indications of levels of lubricant in graphite drum and in mixing tank.

IV. ADVANTAGES AND DISADVANTAGES

A. Advantages of Hot Forging

The high temperature during hot forging enables the highest possible level of material deformation and the access to complex 3D geometries.

Hot forged components possess increased ductility which makes them desirable for many configurations. Also, as a technique hot forging is more flexible than cold forging, since customized parts can be manufactured.

The excellent surface quality allows a wide range of finishing work as polishing, coating or painting, tailored to customers' specific need. Hot forging materials are available all over the world which has a positive impact on their final price.

B. Disadvantages of Hot Forging

The properties of hot forged metals are obtained by subsequent heat treatment, where the material has been quenched to 1000° C and then returned to 500 ° C. This requires additional cost, which can be avoided if using cold forging (except in some cases as softening, annealing or relaxation).

Less precise dimensional tolerance is another possible disadvantage of hot forged components compared to the cold forged ones. The cooling process should be also performed under special conditions; otherwise there is a risk of warping. Also, the grain structure of forged metals may vary and there is always a possibility of reactions between the atmosphere and the work piece.

V. CONCLUSION

From the images we have conclude that for different points on die, the temperatures are different and hence lubrication adhere to that different temperature points is also different.

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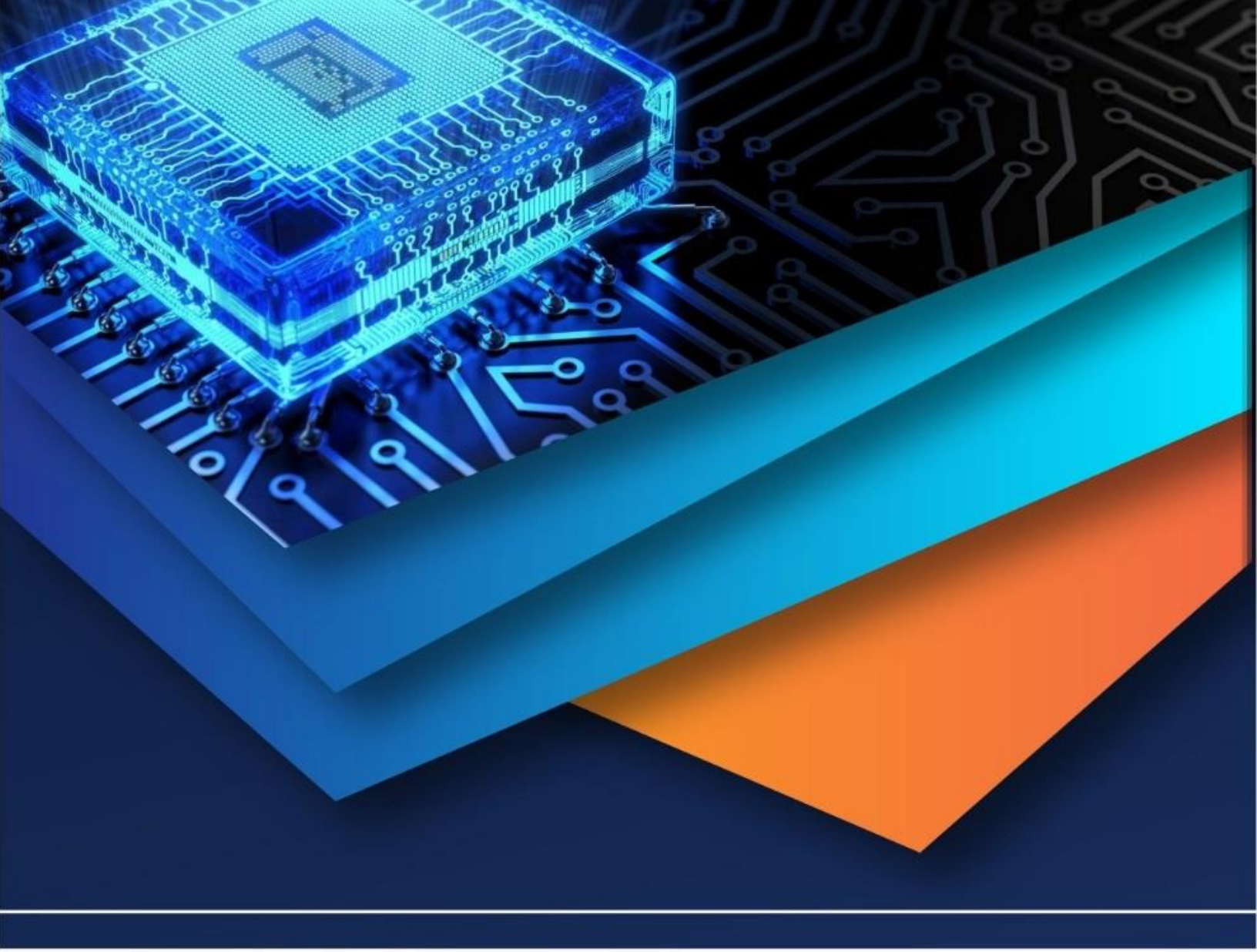

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