REDUCTION OF LEAD TIME AND LUBRICATING OIL CONSUMPTION IN CROWN WHEEL PRODUCTION LINE USING AUTOMATION SYSTEM

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ABSTRACT

The ultimate aim of this study is to minimize the lead time and reduce the consumption of lubricating oil in gear hobbing machine during the crown wheel machining process. During the machining process, more heat is generated due to the direct physical contact between the gear hobbing tool and work piece (crown wheel). In order to eliminate the gear hobber wear and improve the surface finish of the crown wheel, high viscosity lubricating oil (blaser cutting oil) is used. After the gear hobbing process, well finished crown wheel is allowed to hang in a hook for lubricating oil drying process. The separation of lubricating oil from the crown wheel surfaces takes much more time due to the open atmosphere drying. The manual oil separation from the crown wheel surface also leads to wastage of the lubrication oil due to the uneven drying and short drying time. In order to eliminate the above issues in a gear hobbing process for making crown wheel, an automation system has been introduced to reduce the lead time and lubrication oil consumption. The outcome of this automation system in gear hobbing process for making crown wheel production line is superior when compared with manual drying process. The outcomes of this automation system for lubrication oil drying process are compared with manual process.

Keywords: Lead time reduction, lubricating oil consumption, crown wheel production, automation system.

INTRODUCTION

The CNC gear hobbing machine is the main gear processing equipment and gear manufacturing industries need CNC hobbing machine for the accurate production which ultimately leads to manufacture large volumes and high efficiency production of spur gear and helical gear. Every manufacturing industry is aiming for its production to be high in qualitative and high in volume in a short span of time when they contribute something valuable to the world. Gear hobbing is one of the most versatile and widely used cutting process for creating spurs and gears. The process works through a special piece of equipment called the hobbing machine. The hobbing process works by using a hob to cut the grooves or teeth into a blank gear. Crown wheel hobbing process is done using CNC Gear hobbing and it takes a long time and for a developing and leading industries, it is a great loss. They consider the time is the most precious aspect that they can invest. Hobbing is a continuous gear generation process widely used in the industry for high or low volume production of external cylindrical gears [1]. Gear hobbing is one of the major manufacturing processes in the industry. Modern engineering practice is continually increasing its demands for more gearing of old and new types with a higher and higher degree of accuracy [2]. The traditional gear machining methods hobbing and shaping has limitations on manufacturer’s ability to efficiently manufacture gears in small and medium batches [3].

2. Observations and Problem Identification

During the gear hobbing process, more heat will be generated and this heat can damage the crown wheel in various aspects. So, to reduce this heat, Blaser Cutting Oil can be used as the viscosity for this oil is very high in complexion. When this process is done, the oil, in the crown wheel does not get dried up completely. So, generally a worker removes this left over oil manually, in the crown wheel when it is in the position of hanging. Obviously, it takes a lot of time for every single of this removal process. Sometimes, the oil in the wheel remains even after a manual drying up process. So, this is being wasted. It is estimated that the oil which is worth of Rs 4,500/- is being wasted every day. Also, the time to remove the oil while in hanging position is hugely wasted. In order to save these leading aspects, this automation process is highly advantageous to the industries with much marginal financial support.

3. Implementation of Automation System

In hobbing process, it is picked and once the process gets over, it comes out automatically. The consumption of time is very lesser. The automation process carries the steps as the crown wheel will be attached to the pallet conveyor, then the conveyor gets moved
and stopped once the process begins, the drying process begins. All these processes are done by an IR sensor. The servo motor and the solenoid valve are connected with the IR sensor with help of electronic control unit. Electronic control unit have two controllers one is time cut off controller, this controller time depend auto off the oil drying system, another one controller is control the motor speed. The functions of the IR sensor to sense the crown wheel, IR sensor send the feedback to electronic control unit; this unit makes the servomotor and solenoid valve work once it detects the crown wheel. Servo motor will rotate also solenoid valve supply 10 bar compressed air on crown wheel. At first, in hobbing process, the work piece is automatically picked up, and sent out once the process gets over. This complete oil drying process takes just 1.4 minute, and the crown wheel will be attached to the pallet conveyor. Through the IR detector sensor, the oil drying automation process is taken care of since the sensor is connected with the motor, air system and the rotation of crown wheel.

Figure 1 Observations in crown wheel production line for manual oil drying process

3.1 Single port Solenoid valve

A solenoid valve is an efficient method of converting electrical signals into pneumatic functions. Applying electricity to the solenoid quickly directs air through the valve and into the circuit. Quick response times and high flow rates make our pneumatic solenoid valves suitable for numerous applications.

3.2 Servo motor

Servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate and object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run through servo mechanism.

3.3 IR Sensor

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

3.4 Electronics Control Panel

Electronics Control panel is an electrical device control panel sensor signal used to control the stepper motor and solenoid valve. Two controller used in control panel. One is control the speed of motor other is control off timing of motor.

Figure 2 Components used in the proposed automation system (a) single port solenoid valve (b) servo motor (c) IR Sensor

Figure 3 Assembled view and components of the proposed automation system

Figure 4 Three dimensional views of the proposed automation system

4. Outcomes and discussions

The different outcomes from the successful implementation of an automation system for lubricating oil drying process in gear hobbing process for crown wheel machining process are shown in figure.5-9 respectively. Figure.5 shows the wastage of lubrication oil during the manual hanging and proposed automation in crown wheel production line. The comparison reveals that the proposed automation system is significantly
reduced the wastage of the lubricating oil during the drying process due to the continuous blowing of air on the lubricated crown wheel surface. Figure 6 shows the oil drying time for manual hanging and proposed automation process at crown wheel production line. The comparison shows that the remarkable reduction of oil drying time has been achieved in the proposed automation system. Figure 7 shows the cost for the wasted lubricating oil during the drying process in manual hanging and proposed automation process at crown wheel production line. The comparison shows that the outstanding reduction in lubrication oil wastage cost has been achieved in the proposed automation system. Figure 8 shows the total cost for the wasted lubricating oil during the drying process in manual hanging and proposed automation process at crown wheel production line. The comparison shows that the outstanding reduction of total lubrication oil wastage cost has been achieved in the proposed automation system. Figure 5 shows the effects of implementation of automation system in a crown wheel production line for lubricating oil drying process. The average time consumption for lubricating oil drying process is reduced from 4.84 seconds to 3 seconds due to the automation and faster response of the proposed system.

Figure 5 Comparison of lubricating oil wastage for manual hanging and automation process

Figure 6 Comparison of lubricating oil drying time for manual hanging and automation process

Figure 7 Comparison of wasted lubricating oil cost for manual hanging and automation process

Figure 8 Lubricating oil cost comparison for manual hanging and proposed automation method

Figure 9 Average time consumption for lubricating oil drying

CONCLUSION

The different outcomes of a proposed automation system implementation to reduce the lead time, lubricating oil wastage and lubricating oil drying time in crown wheel production line during the gear hobbing process have been analyzed experimentally and the outcomes are compared with the manual hanging method of lubricating oil drying process. The proposed automation system is notably reduced the lubrication oil wastage, lubrication oil drying time and cost of the wasted lubricating oil during the lubrication oil drying process than manual hanging process. The proposed automation system also saves the huge amount of lubricating oil wastage cost due to the reduction of crown wheels waiting time and oil drying time. In future different PLC based automation system will be implemented and the corresponding outcomes will be compared with normal automation methods.

REFERENCES


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