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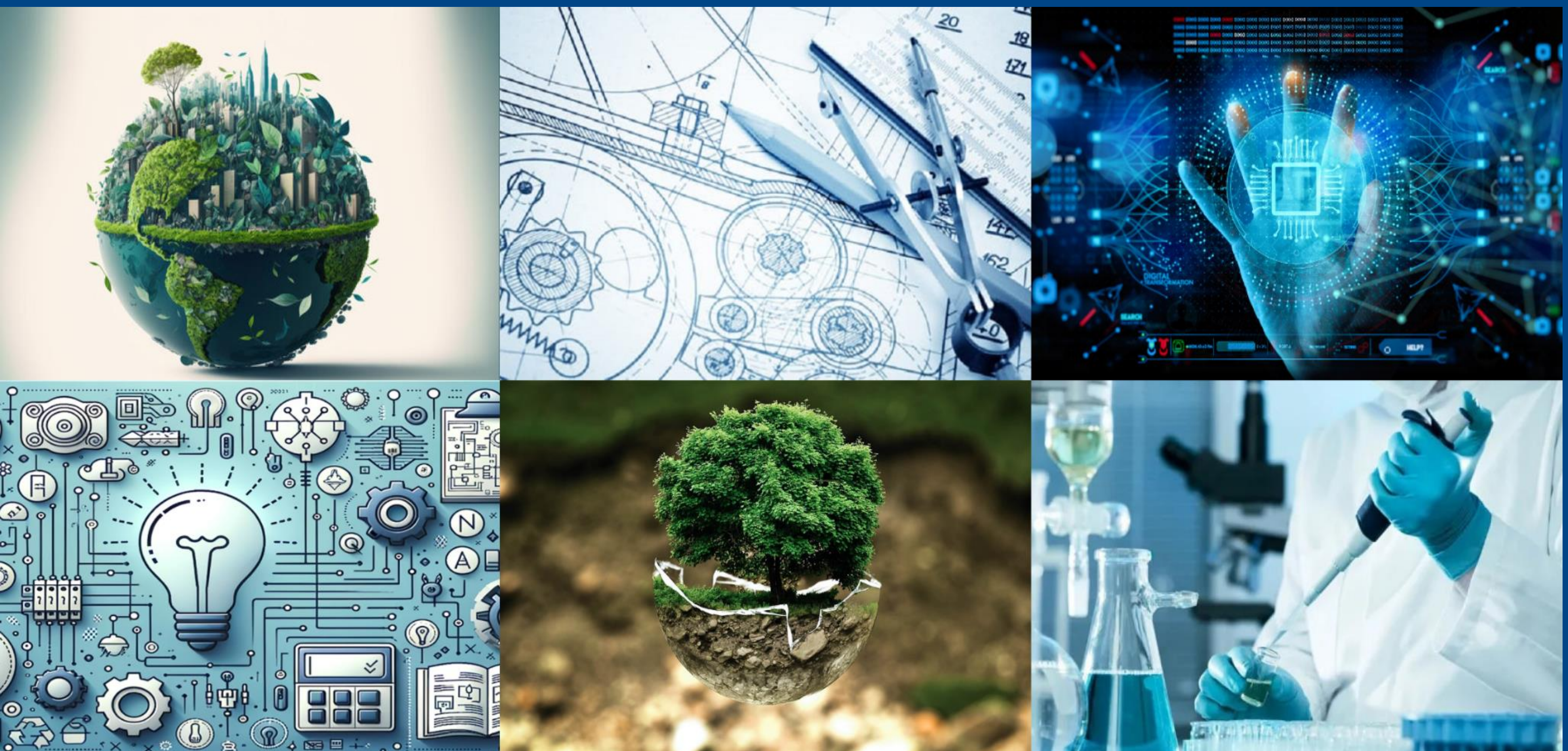

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Auto Coolant Filling System

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ABSTRACT: This paper presents a comprehensive overview of the auto coolant filling system. An auto coolant filling system for vertival machining centre (VMV) machines is designed to enhance operational efficiency reduces the down time, and maintain optimal coolant levels for precision machining. The system integrates sensors, relays, solenoid valve and quality in real time. By employing level sensor. The system ensures precise coolant ratios, mitigating issues such as overheating, tool wear and poor surface finish caused by inadequate coolant management. The setup includes a centralized reservoir, filtration units, and delivery pipelines to supply clean, properly mixed coolant to the VMCs coolant tank, eliminating manual refilling and minimizing human error. This system improves tool life, enhances machines accuracy, and reduces operational cost, making it idea for the high-volume manufacturing environment.

KEYWORDS :- Auto coolant system, VMC (vertical machining centre), Automated filling, tool life enhanced, precision machining.

I. INTRODUCTION

This paper presents design and the implementation of an automated coolant filling system in VMC machine. The system aims to enhance operational efficiency, reduce manual intervention, and insure consistent coolant level for optical machining performance, by automating the coolant refilling process, the proposed system contributes to improve tool l;ife, reduced downtime, and inhanced safety in VMC machine environments.

" maintaining optimal coolant levels in Vertical Machining Centers (VMCs) is critical to ensuring machining precision, tool longevity, and overall process reliability, the monitoring and refilling of coolant is performed manually, which is labor-intensive, prone to human error, and can lead to production downtime. This paper explores the development of an automated coolant filling system designed to integrate seamlessly with existing VMC infrastructure. The proposed system utilizes sensors, and a fluid delivery mechanism to detect low coolant levels and autonomously initiate refilling operations. By reducing dependence on manual checks and interventions, the system enhances operational efficiency, promotes consistent machining conditions"

Recent advancements in the field of VMC machining have focused on automation and smart systems to increase productivity, precision, and sustainability. the automation of coolant management in VMCs has gained significant attention. Researchers have various aspects of coolant systems, including automated monitoring, level detection using sensors.studies have explored the sensor-based systems to automate coolant refilling processes. These systems not only help in maintaining optimal coolant levels but also monitor coolant quality parameters such as pH level, temperature, and concentration. Further more, the use of machine learning algorithms to predict coolant usage. The smart coolant management systems are increasingly designed to be interconnected with central monitoring systems, enabling real-time data. Research also highlights the economic and environmental benefits of automated coolant systems, including reduced waste, lower labor costs, and minimized equipment wear.

II. LITERATURE REVIEW

The management of coolant in the Vertical Machining Centers (VMCs) plays a crucial role in enhancing tool life, surface finish, and overall productivity. Coolants aid in dissipating the heat generated during machining operations, reduce friction, and help for chip removal., coolant maintenance — especially filling and monitoring—remains a largely manual process in many machine. Manual coolant replenishment introduces several inefficiencies, including

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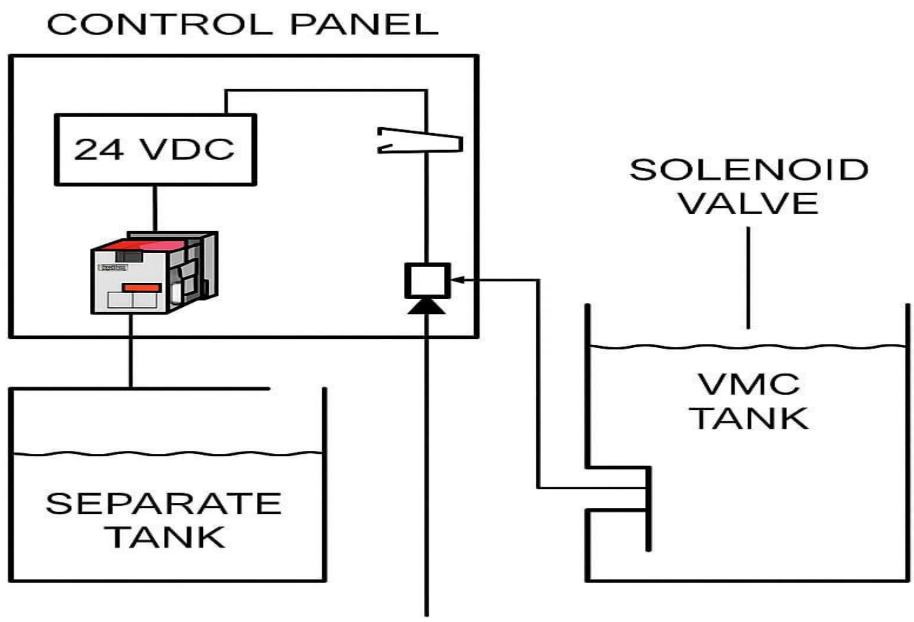
human error, irregular filling schedules, all of which can impact machining quality Several researchers have explored coolant-related technologies, primarily focusing on coolant delivery methods, filtration. However, automation in coolant level maintenance remains relatively underdeveloped in academic and industrial research. Studies such as those by Prasad et al. (2017) and Kumar and Singh (2019) have emphasized the need for automation in auxiliary systems of CNC machines, noting that unattended operations are only truly effective when every subsystem—including lubrication and coolant—is monitored and controlled automatically. advancements in fluid management have made automated systems more economical. proximity, capacitive, and float-type sensors have become widely adopted in industries for real-time liquid level monitoring due to their reliability. Researchers like Zhao et al. (2020) investigated sensor-based fluid monitoring in process automation and concluded that integrating sensors based control systems can significantly enhance process accuracy and reduce the maintenance costs.

Even through these developments, there remains a gap in literature addressing the specific integration of automated coolant filling system within a VMC environment. Most documented systems still require periodic manual intervention or lack smart feedback loops to dynamically adjust to varying operating conditions. This research aims to address that gap by developing an integrated solution that combines real-time sensing, intelligent control, and mechanical actuation to automate the coolant filling process, thereby contributing to the broader goal of achieving fully autonomous VMC machining systems.

GENERAL DESIGN OF AUTO COOLANT FILLING SYSTEM



AUTO COOLANT FILLING SYSTEM IN VMC

LEVEL SENSOR:- This level sensor commonly used in applications like automatic coolant filling systems in Vertical Machining Centers. In such a system, the sensor continuously monitors the coolant level inside the reservoir. It typically consists of a transparent tube where a float moves up and down with the liquid level. Sensors mounted externally, often inductive or capacitive, detect the float's position without making direct contact with the liquid.
When the coolant drops below a preset lower limit, the sensor sends a signal to the control unit, which then activates to refill the coolant automatically. Once the coolant reaches the upper limit, the sensor signals the system to stop filling. This automated process ensures consistent coolant levels, preventing dry running and maintaining optimal machining conditions without manual intervention. The sensor consists of a float inside a transparent vertical tube, with two

electronic level sensors like proximity or reed switch sensors which mounted on the outside — one near the top and one near the bottom. The float has a magnetic ring or magnet embedded in it. As the coolant level changes, the float rises or falls accordingly.
As the coolant refills and the level rises, the float moves upward. Once it reaches the upper sensor, the magnetic field is detected, and this triggers the system to stop the coolant filling process, preventing overflow. The system ensures reliable, hands-free maintenance of coolant levels, which is critical for cooling.

SOLENOID VALVE:- In an automatic coolant filling system in a Vertical Machining Center, the solenoid valve plays a crucial role in regulating the flow of coolant based on electrical signals. The valve is electrically actuated, meaning it opens or closes in response to an electrical signal from the control system of the VMC.When the control system detects that the coolant level in the tank is low or that it's time to refill the coolant, it sends an electrical signal (in this case, 24V DC) to the solenoid coil—the black box on top of the valve. The coil generates a magnetic field that lifts the actuator inside the valve, allowing coolant to flow through the pipe and into the coolant tank or system.Once the the filling process is complete, the control system cuts off the electrical signal. This de-energizes the solenoid coil, removing the magnetic field, which allows the plunger to return to its original position, stopping the flow of coolant.
The solenoid valve ensures precise control, quick response, and automation in the coolant filling process, minimizing manual intervention and improving the efficiency and reliability of the VMC operation.

RELAY:- The Omron MY2N-GS 24VDC general-purpose relay in an auto coolant filling system for a VMC operates as an electromechanical switch. When the control system sends a 24V DC signal to the coil of the relay, it generates a magnetic field. This magnetic field pulls the internal contacts together, allowing current to flow through a separate, higher-power circuit. In the auto coolant filling, this relay can be used to control the valve that fills the coolant tank. When the system detects low coolant level, it energizes the relay coil. This closes the contacts, turning on the opening a solenoid valve to allow coolant to flow. Once the level is sufficient, the control system cuts the 24V signal, deactivating the relay and stopping the filling. Essentially, the relay isolates the control circuit from the power circuit and allows a small control signal to operate larger loads safely.

POWER SUPPLY:- The 24V DC power supply manufactured by Shavison, model G41-60-24. It converts standard AC mains voltage (230V AC) into a stable 24V DC output at up to 2.5A. In an automatic coolant filling system used in a Vertical Machining Center, this power supply serves as the primary power source for low-voltage DC components.In this systems, the 24V DC output from the power supply is used to operate solenoid valves, sensors, and control relays that manage the filling of coolant into the VMC tank. The power supply ensures that the electronic control unit receives a steady voltage, which is essential for reliable operation of automation. The "DC OK" indicator confirms the health of the output voltage.

This power supply plays a crucial role in automating the coolant refilling process by powering control circuits that detect coolant levels and actuate the necessary components to stop the filling operation, thereby maintaining optimal coolant levels without manual intervention.

III. CONCLUSION

An automatic coolant filling system in a VMC plays a critical role in maintaining the efficiency, productivity, and longevity of the machine. As CNC machining processes continue to evolve, the demand for more self-sustaining auxiliary systems has grown. Among these, the coolant system is essential in regulating temperature, removing chips, and reducing tool wear during high-speed operations. Traditionally, coolant filling and monitoring have been manual processes, requiring frequent operator attention, which could lead to downtime, human error. With the integration of an automatic coolant filling system, these issues are significantly mitigated, offering numerous operational benefits. The core function of an automatic coolant filling system is to monitor the coolant level continuously and automatically replenish, ensuring optimal levels are maintained at all times without the need for manual intervention. This is typically achieved using sensors, level indicators, and a control system that activates valves when the coolant level drops below a predefined threshold. Some systems also incorporate concentration monitoring and adjustment capabilities, further enhancing their utility. These features not only contribute to process reliability but also improve workplace safety, as operators are less exposed to handling chemicals and fluids directly. In addition, the implementation of such systems can lead to improved machining performance. Consistent coolant levels help in maintaining thermal stability within the machining zone, preventing thermal distortion of both the tool and the workpiece. This results in improved accuracy

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and surface finish of the machined components, maintaining proper coolant concentration and flow ensures effective chip evacuation and tool lubrication, both of which are crucial for extending tool life and reducing wear.Another notable advantage is the reduction in machine downtime. With manual systems, the risk of running a machine with insufficient coolant is higher, which can lead to overheating, increased tool breakage, and in severe cases, damage to the spindle or other critical components. An automatic system eliminates such risks by ensuring the coolant is always present in the required quantity. reducing waste, minimizing delays, and enhancing overall process efficiency.From a maintenance, automatic systems are easier to monitor and diagnose. Alerts and system logs can provide valuable data for predictive maintenance, allowing operators and maintenance teams to address issues before they escalate, the system can be integrated with coolant management systems for facilities with multiple machines, leading to even more efficient resource usage and centralized control.In the conclusion, the adoption of an automatic coolant filling system in a VMC significantly improves operational efficiency, process reliability, and product quality while reducing manual labor and operational risks. It represents a forward step in the modernization of VMC machine shops and supports the goals of Industry by intelligent automation into essential auxiliary processes.

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