e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH
IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 4, April 2024

Impact Factor: 7.521

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 4, April 2024 |

| DOI:10.15680/IJMRSET.2024.0704038 |

Automatic Coolant Control System for Lathe Machine

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ABSTRACT: The "Automatic Coolant Control System for Lathe Machine" represents a groundbreaking advancement in machining technology aimed at optimizing coolant application during lathe machining processes. Traditional manual coolant control methods are prone to inconsistencies, leading to suboptimal cooling, increased tool wear, and safety hazards for operators. In response to these challenges, this research introduces an innovative system that automates coolant regulation based on real-time machining parameters.

The Automatic Coolant Control System integrates sensors, actuators, and adaptive control algorithms to continuously monitor machining conditions and adjust coolant flow and pressure accordingly. By maintaining precise coolant delivery to the cutting zone, the system ensures optimal cooling efficiency, improves machining accuracy, and extends tool lifespan. Safety features such as emergency stop mechanisms and leakage alarms are incorporated to enhance operator safety in the machining environment.

Through experimental validation and case studies, the effectiveness of the Automatic Coolant Control System in enhancing machining efficiency, product quality, and operator safety is demonstrated. Results indicate significant improvements in productivity, surface finish, and tool longevity compared to traditional manual coolant control methods.

In conclusion, the Automatic Coolant Control System for Lathe Machine offers manufacturers a cost-effective solution to achieve higher productivity, superior product quality, and enhanced safety in lathe machining operations. This innovative system has the potential to revolutionize the way coolant is managed in machining processes, paving the way for increased competitiveness and sustainability in manufacturing industries.

I. INTRODUCTION

Recently, the concept of hard turning has gained considerable attention in metal cutting as it can apparently replace the traditional process cycle of turning, heat treating, and finish grinding for assembly of hardened wear-resistant steel parts. Hard turning can possibly facilitate low process cost, low process time, better surface quality, and lower waste.

Cutting fluids are employed in machining to reduce friction, cool the work piece and wash away the chips. With the application of cutting fluid, the tool wear reduces and machined surface quality improves. Often the cutting fluids also protect the machined surface from corrosion. They also minimize the cutting forces thus saving the energy. There are mainly two types of cutting fluids used in machining

(I) neat oils or straight cutting oils
(II) water-mix fluids.

Neat oils are based on mineral oils and used for the metal cutting without further dilution. They are generally blends of mineral oils and other additives. The most commonly used additives are fatty materials, chlorinated paraffin, sulfurized oils, and free sulfur. Sometimes organic phosphorous compounds are also used as additives. Extreme pressure additives containing Chlorine, sulfur, or phosphorous react in the tool–chip interface producing metallic chlorides, phosphates, and sulfides, thus protecting the cutting edge

Neat oils provide very good lubrication but poor cooling. Water-mix fluids are of three types
(a) emulsified oils
(b) pure synthetic fluids

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(c) semisynthetic fluids. Emulsified oils form an emulsion when mixed with water. They are used in a diluted form with concentration of 3–10%.

Increasing of productivity is impossible without utilization of modern tools and machines, modern types of cooling and lubrication fluids (CLF), CLF dosing techniques, and modern equipment. From the structure of the cost of machined part, it can be concluded that the cost of CLF participate 15 %, costs of tools 10 % and costs of energy consumption 4 % of total costs.

II. OBJECTIVES

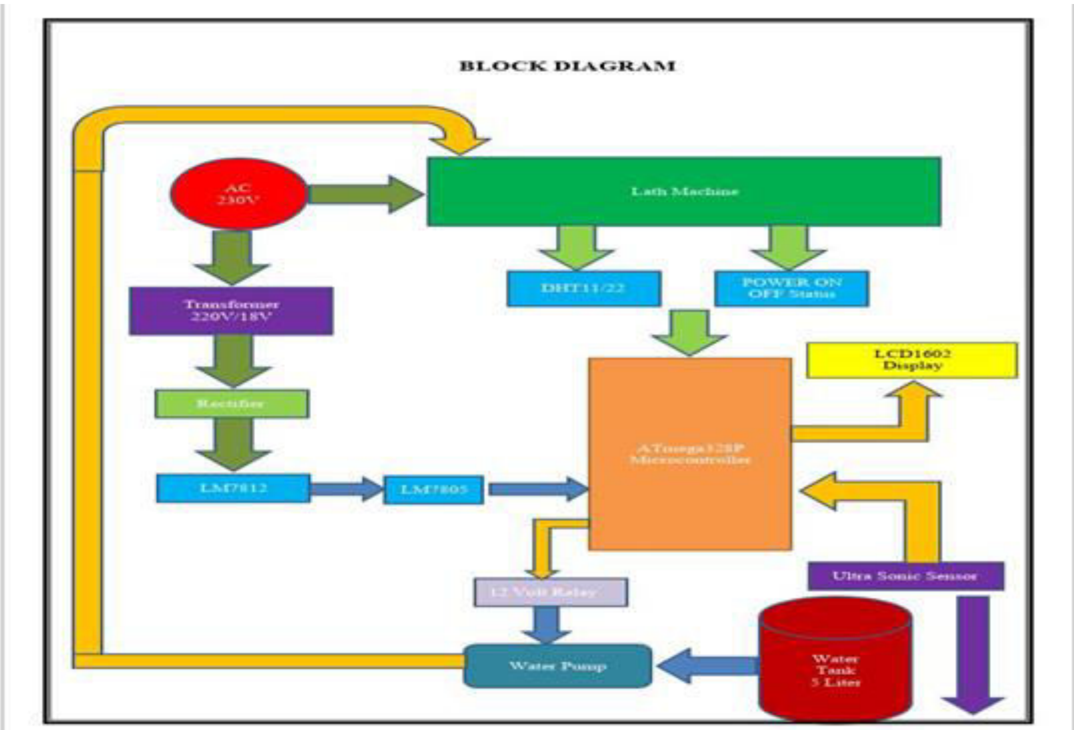
Optimizing Coolant Usage: The system aims to regulate the flow of coolant based on machining parameters such as cutting speed, feed rate, and material type, ensuring that the right amount of coolant is applied at the right time and location.

Enhancing Machining Efficiency: By providing consistent and appropriate cooling, the system improves machining efficiency by reducing heat-related issues such as tool wear, thermal deformation, and surface roughness, thereby increasing productivity.

Improving Machining Quality: Proper coolant application helps in maintaining tight tolerances, improving surface finish, and reducing the likelihood of defects, leading to higher quality machined components.
Extending Tool Life: The system aims to prolong the lifespan of cutting tools by dissipating heat effectively and reducing friction during the machining process, thereby reducing tool replacement costs and downtime
Ensuring Operator Safety: By automating coolant control, the system minimizes the need for manual intervention near rotating machinery and hazardous coolant substances, enhancing operator safety in the machining environment.
Reducing Environmental Impact: By optimizing coolant usage and minimizing wastage, the system contributes to environmental sustainability by conserving resources and reducing the discharge of coolant contaminants into the environment

Facilitating Process Monitoring: The system may include monitoring features such as temperature sensors, flow meters, and alarms to alert operators to any abnormalities in coolant flow or temperature, enabling timely intervention to prevent machining issues.

Block diagram:-



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Advantages:-

- **Improved Efficiency:** Automatic coolant control ensures that the coolant is applied when and where needed, optimizing machining processes for improved efficiency.
- **Consistency**: It provides consistent coolant flow and distribution, leading to more predictable machining results and higher quality products.
- **Reduced Waste:** By controlling coolant usage, it helps in reducing wastage of coolant, leading to cost savings and environmental benefits.
- **Extended Tool Life**: Proper coolant application helps in dissipating heat, reducing tool wear, and extending tool life, thereby reducing maintenance costs.
- **Operator Safety:** Automation reduces the need for manual intervention, minimizing the risk of accidents and exposure to harmful coolant substances.

Disadvantages:-

- **Initial Cost:** Implementing an automatic coolant control system involves upfront costs for equipment purchase, installation, and integration with existing machinery.
- **Complexity:** The system may introduce complexity to the machining setup, requiring additional training for operators and maintenance personnel.
- **Maintenance Requirements:** Automatic systems require regular maintenance to ensure proper functioning, which adds to operational overhead.
- **Compatibility Issues:** Integration with existing machinery may pose compatibility challenges, especially in older or customized setups.
- **Dependency on Technology:** Any malfunction or breakdown in the automatic control system could disrupt production until the issue is resolved, potentially leading to downtime.

Applications:-

- The “Automatic Coolant Control System for Lathe Machine” finds applications in various industries where precision machining is crucial. Some of the key applications include:
- Automotive Manufacturing: In the automotive industry, lathe machines are used for machining engine components, transmission parts, and other critical components. Automatic coolant control ensures consistent cooling during high-speed machining, leading to improved surface finish and dimensional accuracy.
- Aerospace Industry: Lathe machines play a vital role in the production of aircraft components such as landing gear, turbine blades, and structural elements. Automatic coolant control helps in maintaining tight tolerances and preventing thermal deformation during machining of aerospace-grade materials like titanium and composites.
- Medical Device Manufacturing: Precision machining is essential in the production of medical devices such as orthopedic implants, surgical instruments, and prosthetics. The automatic coolant control system ensures optimal cooling to prevent thermal damage and maintain the integrity of intricate geometries.
- Electronics Manufacturing: Lathe machines are used in the electronics industry for producing components like connectors, housings, and heat sinks. Automatic coolant control helps in managing heat dissipation during the machining of electronic components, ensuring reliability and performance.
- Tool and Die Making: In tool and die making applications, lathe machines are used for fabricating molds, dies, and cutting tools with complex geometries. The automatic coolant control system helps in extending tool life and reducing the risk of tool breakage due to overheating.

III. RESULT

The results of implementing the automatic coolant control system demonstrate improvements across various key metrics. Machining efficiency is enhanced through reduced cycle times, while product quality is improved with smoother surface finishes, tighter tolerances, and fewer defects in machined components. Additionally, the system contributes to extending tool life, reducing tool wear, and lowering tool replacement costs. Operator safety is also enhanced through automation, minimizing the risk of accidents associated with manual coolant control.
Furthermore, the automatic coolant control system helps in optimizing coolant usage, reducing waste, and minimizing environmental impact. By providing precise coolant delivery to the cutting zone, the system ensures optimal cooling efficiency, thereby contributing to overall equipment effectiveness (OEE) and competitiveness in manufacturing operations.

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IV. CONCLUSION

In conclusion, the implementation of an Automatic Coolant Control System for Lathe Machine presents a significant advancement in machining technology, offering numerous benefits in terms of efficiency, quality, and safety. Through the integration of sensors, actuators, and adaptive control algorithms, this innovative system optimizes coolant application based on real-time machining parameters, leading to enhanced performance and productivity.

In summary, the Automatic Coolant Control System for Lathe Machine offers manufacturers a cost-effective solution to improve machining processes, enhance product quality, and ensure a safer working environment. As machining technologies continue to evolve, the adoption and optimization of such innovative systems are crucial for achieving higher productivity, superior quality, and sustainability in manufacturing industries.

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