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Analysis of Filter System Study to Maintain Liquid Quality Cooler for Conventional Lathe Machines

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Abstract

This study aimed to improve the coolant filter system to maintain its quality and longevity in the machining process. It tested the cooling liquid's quality against the filter system and compared it with a mesh wire filter. The analysis method involved five phases: identifying and defining the problem, designing the experimental procedure, conducting the experiment, collecting data, analyzing experimental data, and proposing a solution. The study found a gap in value differences between viscosity, concentration, and weight of scroll fragments. The recommendation for future research is to apply the study to CNC machines and understand each analysis to ensure accurate data collection. The study aims to determine the need to replace the filter in the cooling liquid system to ensure its quality efficiency and long-term use as a cooling agent.

1. Introduction

In today's rapidly evolving technology, machining is a crucial aspect of component manufacture. Coolant is a crucial element in metal cutting processes, activating when it boosts output and prolongs the life of cutting tool tips. According to Kui, Sumaiya, Moola, Neamul and Vincent (2021) machining operations play an important role in the field of modern manufacturing industry. Maintaining the quality of coolant ensures its efficacy as a heat-reduction agent between colliding surfaces. This prevents unpleasant scents and reduces efficiency during the machining process.

Maintaining a good filtration system is crucial for maintaining coolant purity. Mechanical filtration removes trace iron levels from coolant mixtures, ensuring heat insulator properties during the fluid cycle. Various filter types are available, but selecting the appropriate one is essential to prevent interference with the coolant's ability to act as a heat insulator. An excellent filter prevents chips from entering the cooling liquid, increasing quality assurance. This filtering system is essential in industrial settings to ensure components are safe from metal particulates that could harm them.

1.1 Problem Statement

Coolant is the primary element used in the machining process to maintain the quality of a tool and it may keep the surface smooth in numerous procedures that need to be carried out. Zhen Yang, Pramanik, Basak, Dong, Prakash, Shankar, Dixit, Kumar, and Nikolai (2022) claim that coolant can also be utilized as a lubricant to lessen friction at the interface between the tool chip and the tool-workpiece while simultaneously lowering cutting force and temperature.

The system's flow must be in good shape to use coolant and preserve its long-term viability. This is because the current method only has one section of the filter on the machine and that there is a chance that various materials other than those used in the machining process may still be mixed with the coolant in the tank.

Implications from challenges or problems that arise: When material is mixed with cooling liquid, a material's properties and quality are lowered, and its lifespan is also shortened. Additionally, the coolant loses its efficiency as a coolant, which puts other equipment in danger. With that, the researcher will analyze the investigation on the machine conventional array's coolant filter system enhancement. This is because this component of the filter is also important in ensuring the coolant retains its effectiveness and purity.

1.2 Objective

The study that was done has two goals. The following are the objectives for improving the coolant filtration system for conventional lathes:

1. Checking the coolant's quality against the system for filtering coolant.
2. Establishes a comparison of the densities of liquid coolers with and without the addition of wire mesh filters to the current coolant filter systems.

2. Methodology

The methodology section describes all the necessary information that is required to obtain the results of the study. It consists of Research Design, Research Procedure and Research Instruments or other important information related to methodology.

2.1 Research Design

A research design is a plan of action that describes the specifics of a study's execution, guiding researchers in analyzing issues, collecting data, and drawing conclusions. It includes various techniques or models to ensure systematic and frequent research. The choice of methodologies is crucial to avoid deviating from the original objective and determine the usefulness of the collected data in resolving the issues raised. To ensure the analysis proceeds as planned, the researcher has chosen the analysis method, consisting of five phases:

i. Problem identification and determination.
ii. Experimental procedure design.
iii. Experiment and data collection.
iv. Analysis of experimental data.
v. Problem solution proposal.

By following these steps, researchers can conduct research more organized and analyze results that meet the study's objectives and long-term goals.

2.2 Research Procedure

1. **Phase Identifying and Defining the Problem**

   The researcher conducted observations to evaluate the comparison of an existing coolant system with wire mesh filters from a standard lathe. They identified a problem with the coolant quality, determining where it is. The problem was identified through presence, observation, and discussion in favor of a cooling fluid filtering system. The researcher then conducted analysis and research to determine if improvements are needed. The coolant system was poor quality due to various factors, including an odor and unclean cooling liquid. The cooling liquid's performance in reducing heat was also affected. The researcher identified similar issues in other studies by reading publications, websites, and other materials.

2. **Phases of Designing Experimental Procedures**

   The next phase is to do the design procedures for the study to be conducted. With the procedure then the researcher is clearer to analyze the problem determined.

3. **Phase of Conducting Experiments and Collecting Data**

   The next step is where the researcher needs to conduct an experiment to collect data on the cooling liquid during the machining process. In the analysis of study, the researchers conducted machining process according to the set time which is 5 hours according to the density of the coolant selected is 1:20 to 1:10. Density analysis involves two analyses: one focusing on the current filter system and the other adding a wire mesh filter. Coolant samples are taken every hour during the 5-hour procedure, resulting in 20 samples and 3 initial readings. The liquid is tested for viscosity, concentration, and weight of scroll parts mixed with cooling liquid to determine its quality. Data points are entered into a lab sheet for organized data collection, and coolant replacement is necessary after each step to improve data reading.

4. **Experimental Data Analysis Phase**

   Every piece of information that is obtained and gathered by researchers after an experiment is completed will be used by them during this phase of data analysis from the experiment. Using the average calculation method from the cooling liquid obtained throughout the commissioning procedure, the researcher conducts an analysis at this phase. This is due to the fact that the data collected can aid researchers in comparing wire mesh filters and current filters to determine whether the coolant filter system needs to be improved.

5. **Proposed Solution Phase**

   The drawing illustrates the location of a mesh wire filter to upgrade the coolant filter system on conventional lathes. The cost is evident, but the problem can be solved with new tools that are affordable and easy to obtain. The researcher experiments and observes the effectiveness of each new component to determine if it is necessary. This analysis helps identify areas for improvement, ensuring the quality of the coolant and its effectiveness as an agent.

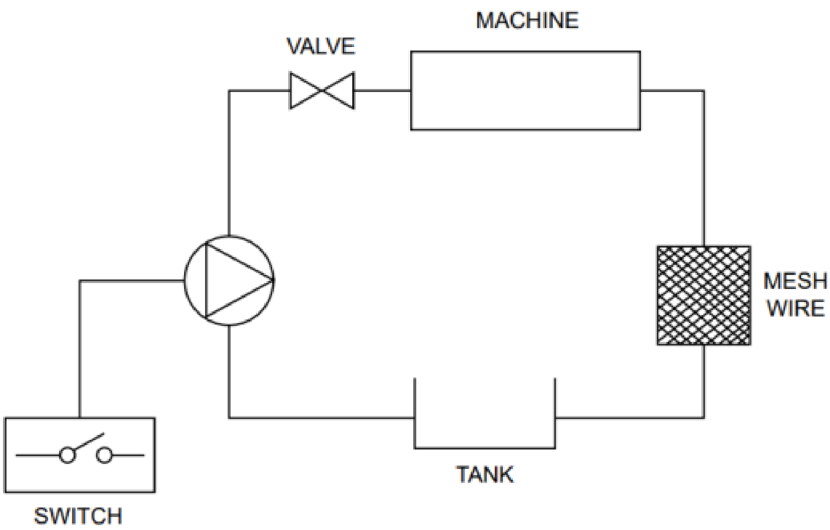

Figure 1: Schematic sketch of wire mesh addition

2.3 Research Instrument

A research instrument is a tool used by researchers to conduct research or analysis. It collects data to meet established objectives and involves various methods, including experimentation and observation, to conduct a good analysis.

1. Observational Instruments

The observation instrument is the first instrument used for conducting the analysis of this study. The use of this instrument is to analyze as well as looking for problems and evaluating every process that goes on in the study developed. Every comparison and discussion are from observation to conventional machining workshop at University Tun Hussein Onn Malaysia for ensure that improvements to the problem are correct and accurate. Each the production of research or product development requires observation as well research to identify the problem to be solved.

2. Experimentation Instrument

Three testing instruments will be used in the study: a portable viscometer to measure the viscosity of the cooling liquid, a refractometer to measure the concentration of the cutting oil mixture (cutting oil with water), and a digital scale lab weight to measure the weight of the scroll fragments gathered in the tank. Because it is the right size to filter and is able to clear the passage of cooling liquid for down to the tank, the addition of a filter made of mesh wire size 10 mesh was chosen for the kind of filter, which is normal filtration, on a regular lathe.

3. Results and Discussion

The study done on filter systems to maintain coolant quality during the machining process by taking liquid coolant samples is presented in this chapter. After mesh wire filters are added in line with the selected and established density, data is gathered using a portable viscometer, refractometer, and digital lab scales, and the results are compared to the specifications of the current filter system. The study's findings show that every piece of data collected to ensure the liquid's quality, including analyses of viscosity, concentration, and pollutants (Dust). For a longer coolant life, each of these examinations can guarantee the coolant's quality level and the suitable filter difference.

3.1 Viscosity Analysis

Table 1: Viscosity reading for density 1:20 for 1 hour.

Density 1:20	Sample (60 min)				
	1	2	3	4	5
Standard Filtrations					
Viscosity (50ml)	0.9	1.0	1.2	1.6	1.9
Mash Wire					
Viscosity (50ml)	2.5	2.3	1.8	2.5	3.6

According to Table 1, the machining procedure caused an increase in viscosity at 1:20 density values for both filter types. The final viscosity reading of 1.90 cP showed a decrease both before and after the procedure. Samples 1 and 2 saw an increase in the viscosity of the mesh wire filter, whereas samples 3 saw decreases. Samples 4 and 5 saw an increase in viscosity. Variable temperature during the milling operation is probably the reason for the inaccurate reading. Zhen Yang et al. (2022) who stated that it can influence aspect for the improvement of shape changes to the work material associated with stress factor, temperature, and material characteristics.

Table 2: Viscosity reading for density 1:10 for 1 hour.

Density 1:10	Sample (60 min)				
	1	2	3	4	5
Standard Filtrations					
Viscosity (500ml)	1.5	1.6	1.3	1.2	1.1
Mash Wire					
Viscosity (500ml)	2.2	1.5	1.4	1.3	1.2

(1)

The reading for the current filter standard at a density of 1:10 is quite low in comparison to the reading at a density of 1:20. In addition, there is a lot of variation in the measurement of viscosity, with sample 2 indicating an increase of 1.6 cP and sample 3 showing a decrease. One of the probable factors that could have an impact on the measurement results is the movement of the tool point during the machining operation. The component of heat temperature is another. Additionally, the cleanliness of the cooling system or the engine may be a factor. This is because combining an excessive amount of foreign material could lower the coolant's quality. The viscosity reduces during the machining process, and the initial value for the 1:10 density is 1.7 cP.

When compared to the starting viscosity of 1.7 cP, the first sample's viscosity on the wire mesh filter yields appropriate data. The consistency reduced but the viscosity was still falling until sample 5, which was 1.2 cP. According to the literature on wire mesh filters, a contributing factor may be the development of microscopic cracks throughout the course of the machining process. This is due to the possibility that tiny cracks could allow capillary action to cause the cooling liquid to seep through it.

3.2 Concentration Analysis

Table 3: Concentration reading for density 1:20 for 1 hour.

Density 1:20	Sample (60 min)				
	1	2	3	4	5
Standard Filtrations					
Concentration (Brix 20%)	60%	70%	75%	80%	80%
Mash Wire					
Concentration (Brix 20%)	50%	58%	60%	65%	68%

According to Table 3, the concentration readings for the current filters are quite high, with an average value of 73 percent as opposed to the initial value of 35 percent. This shows the elements of the machining process being performed and how long it takes for the machining process to complete increased viscosity. While the average value of the wire mesh filter is less than the filter currently in use (60.2 percent), the difference between the two types of filters is reduced by 12.8 percent. This is seen on the addition factor mesh wire filter, which keeps scroll debris out of the tank and reduces the concentration of the coolant by filtering it. Furthermore, the wire mesh filter can help to keep the quality of coolant maintained due to keeping the chips from coming into the tank and it is because the chips can help the bacteria grow inside the coolant. Benedicto, E. et al., (2017) stated that bacteria and fungi could grow in water-soluble coolants such as commons and pseudomonas testosterone and these organisms feed on corrosion inhibitors and contaminants from the system as well as causing the loss of functional characteristics of the fluid.

Table 4: Concentration reading for density 1:10 for 1 hour.

Density 1:10	Sample (60 min)				
	1	2	3	4	5
Standard Filtrations					
Concentration (Brix 20%)	63%	65%	70%	74%	75%
Mash Wire					
Concentration (Brix 20%)	55%	58%	62%	65%	69%

Data measurements on the current filter system reveal values at the end are 75%, indicating that the coolant is thickening due to the machining process that was done. As a result, the average for new filters is 61.8%, whereas the average for standard filters is 69.4% when wire mesh filters are added to the system coolant. In this case, the lack of iron scroll pieces and the temperature's impact on the cooling fluid during the process cause the concentration to decline once the filter is added. After the installation of a wire mesh filter, the range of difference versus the standard filter with a mesh wire filter is reduced by 7.6 percent.

3.3 Analysis of Chips

Table 5: Weight reading of chips of density 1:20 for 5 hours.

Density 1:20	Sample (5 Hours)
Standard Filtrations	
Dust/Chip (0.001 g)	13.707g
Mash Wire	
Dust/Chip (0.001 g)	3.178g

According to the data obtained, the existing filter standard was utilized with a scroll fragment with a relatively high range of values, or 13.707g. Readings in this high-value range may be produced by continuous machining operations, and an existing filter may contain some extra scroll accumulation from prior treatments. The reading range for wire mesh decreased by 76.81 percent to 3.178g. Readings from table 5 may be acquired because of data decrease factors such as the addition of wire filters mesh, the second filter in the coolant liquid system and located between the standard filter's outlet and the coolant liquid tank.

Table 6: Weight reading of chips of density 1:10 for 5 hours.

Density 1:10	Sample (5 Hours)
Standard Filtrations	
Dust/Chip (0.001 g)	8.730g
Mash Wire	
Dust/Chip (0.001 g)	1.132g

The weight of scroll pieces for filter standards is shown in reading table 6 at a value of 8.730g, which is less than the weight of the current filter. This is feasible due to the process's high amount of machining. The reading result for the mesh wire filter is 1.132g, but the reading for the filter installation wire mesh on the cooling liquid system revealed a reduction of 87 percent. A size 10 wire mesh filter is a factor that contributes to weight loss. The coolant channel, which passes through the machine before entering the tank, is filtered by the mesh.

4. Discussion

4.1 Coolant Quality Analysis

Heat during machining can cause differences in viscosity and concentration during a 5-hour procedure. Stress factors, temperature, and material properties affect form modifications, as high concentration values or viscosities can damage cooling fluid quality and shorten its lifespan. Using mesh wire filters can reduce excess scrolling, but the average weight of scroll fragments collected shows significant differences. The viscosity analysis at 1:20 density has an incorrect value, possibly due to the slow machining process causing temperature variations. To keep the temperature cutting at a safe operating level, Woon (2021) claimed that the cooling liquid can aid in limiting aggressive heat generation by eliminating heat from the cutting tool as well as the work material through conduction. The viscosity analysis shows a consistent reading for the first and last two hours of the reading value, while sample three's reading is inconsistent with other samples. This indicates that a liquid becomes more viscous as the temperature rises due to heat produced by friction between the workpiece and cutting point. Through the friction that develops between two surfaces when there is relative movement, heat can be produced (Zhen Yang et al., 2022).

4.2 Comparison Between Existing Filter Standard with Additions Wire Mesh Filters Against Coolant Density

The density of 1:20 filters was compared between the existing filter system before wire mesh filters and the viscosity analysis after the addition of wire mesh filters. From the analysis of quality, it can be seen the difference between both filters is due to the test. It is because to test the quality of the coolant, it can be seen from the characteristics of coolant quality through analysis of viscosity, viscosity (concentration), pH value (pH value), stability (stability), and color (Agu C. K. et al. 2019). The wire mesh filter was found to be superior to the existing filter system. The machining process took five hours, and temperature was the primary determinant of value change. The researcher found that higher values from both types of filters were obtained when wire mesh filters were added, while lower viscosities were better at maintaining coolant quality. The influence of temperature on the machining process can raise or lower the value taken. The analysis before data collection had flaws, as it did not select a fixed temperature for viscosity assessment but used a useful number.

For the analysis of concentration for both results sets can see where the analysis data on the addition of wire mesh is lower compared to the existing filter system. From the data taken, 2 factors are different where for the density of 1:20, the concentration for the mesh wire filter reduced by the factor of the addition of the filter can help reduce concentration in the coolant. While for 1:10 it is likely from the reduction of the scroll debris mixture on the coolant throughout the process machining takes place. The results of the comparison found that additional wire mesh can help reduce the impact on the coolant.

To reduce chips in the coolant tank, researchers use mesh wire filters to filter coolant without creating a reservoir and filter the chips from entering. Comparing weight analyses of chip fragments is crucial. Proper mesh wire filters prevent chips from entering the coolant, highlighting the importance of data collection.

Conclusion

The study aimed to analyze the need for improvements in standard lathe system filters to maintain coolant quality and reduce the cost of liquid coolers. Longer use of coolants leads to higher quality and prevents pollution. A wire mesh filter can help maintain coolant consistency as a heat sink on traditional lathes. The study's analysis identified the usefulness of conventional lathes' coolant filter systems and the need for modifications. The wire mesh filter can also help prevent the release of harmful pollutants, ensuring the longevity of the cooling fluid.

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