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Design and Analysis of Diverter Mechanism based on Noise Suppressor using MQL Method

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***Abstract*: Minimum quantity lubrication is a new concept in lubrication methods where in a metered quantity of lubricant is delivered by the MQL system to the machine / process under consideration. These systems normally employ piston pumps for application due to accuracy of the piston pump in delivering exact quantity of fluid. But noise generated from this pump is the main problem in industries. Pump noise can be categorized into two basic classes namely the audible noise that can be heard and needs to be controlled to maintain comfort level in the industry / workshop where this device is used and secondly the pump noise in form of pulsations of flow which is more significant because it one of the major cause of inaccuracies in the metered quantity of fluid. The proposed design is developed for R-11 pumping element to be used in one such MQL pumping unit.**

***Keywords*: MQL, Machining, Diverter Mechanism, Noise.**

1. Introduction

Minimum quantity lubrication is a new concept in lubrication methods where in a metered quantity of lubricant is delivered by the MQL system to the machine / process under consideration. These systems normally employ piston pumps for application due to accuracy of the piston pump in delivering exact quantity of fluid. Pump noise can be categorized into two basic classes namely the audible noise that can be heard and needs to be controlled to maintain comfort level in the industry / workshop where this device is used and secondly the pump noise in form of pulsations of flow which is more significant because it one of the major cause of inaccuracies in the metered quantity of fluid. The variable forces inside the pump mainly depend on variations of pressure within the pump. They change periodically with the change of the load at the displacement elements Thus considering that the heart of the MQL system is the dispensing unit i.e. the pump used to supply the fluid to the lubricant system, the pump element used in the system is as follows: The proposed design is developed for R-11 pumping element to be used in one such MQL pumping unit.

A. Problem identification

Paramount Industries, Pune one of the gear blank manufacturing company, they having found some problems frequently at the time of manufacturing the gear blank such as low production rates, lower surface finish and dimensional inaccuracies while machining components. Earlier method of lubrication uses the coolant pump to circulate cooling fluid using coolant pump this method proved costly and so also the machine environment conditions were affected namely floor becoming slippery etc.

B. Objectives

1. The ultimate aim of the proposed work is to overcome the problem of convectional lubrication system by providing alternative system i.e. minimum quantity lubrication system.
2. As per the problem defined, we are overcome the problem by implement the minimum quantity lubrication on the machine with the help of pumping unit.

C. Scope

Pump noise can be categorized into two basic classes namely the audible noise that can be heard and needs to be controlled to maintain comfort level in the industry / workshop where this device is used and secondly the pump noise in form of pulsations of flow which is more significant because it one of the major cause of inaccuracies in the metered quantity of fluid. The proposed design is developed for R-11 pumping element to be used in one such MQL pumping unit. The purpose of paper is to discuss the design and analysis of two critical components namely the neo-polymer membrane (eartlon-66) and the diverter that play a significant role in noise reduction.

2. Literature review

A. Review of Book, Journal & International Paper

There were many works performed on Design Analysis and Testing of Diverter mechanism based noise suppressor for single piston pump system for minimum quantity lubrication application by different investigators using various mechanisms or techniques. Present literature review gives the overview of some researchers work on Design Analysis and Testing of Diverter mechanism based noise suppressor for single piston pump system for minimum quantity lubrication application.

Pooja S. Patel [1] Minimum quantity lubrication is a new concept in lubrication methods where in a metered quantity of lubricant is delivered by the MQL system to the machine / process under consideration. These systems normally employ piston pumps for application due to accuracy of the piston pump in delivering exact quantity of fluid. But noise generated from this pump is the main problem in industries. The proposed design is developed for R-11 pumping element to be used in one such MQL pumping unit. The purpose of paper is to discuss the design and analysis of two critical components namely the neo-polymer membrane (Eartlon-66) and the diverter that play a significant role in noise reduction. The paper also discusses the effect of change in discharge from pump on the audible noise from the system.

The-Vinh Do [2] as a successful solution applied to hard machining, the minimum quantity lubricant (MQL) has already been established as an alternative to flood coolant processing. The optimization of MQL parameters and cutting parameters under MQL condition are essential and pressing. The study was divided into two parts. In the first part of this study, the Taguchi method was applied to find the optimal values of MQL condition in the hard milling of AISI H13 with consideration of reduced surface roughness.

The L9 orthogonal array, the signal-to-noise (S/N) ratio and analysis of variance (ANOVA) were employed to analyse the effect of the performance characteristics of MQL parameters (i.e., cutting fluid type, pressure, and fluid flow) on good surface finish.

Attanasio M [3] Industries and researchers are trying to reduce the use of coolant lubricant fluids in metal cutting to obtain safety, environmental and economic benefits. The aim of this research is to determine if the minimal quantity lubrication (MQL) technique in turning gives some advantages in terms of tool wear reduction. This paper reports the results obtained from turning tests and SEM analysis of tools, at two feed rates and two cutting lengths, using MQL on the rake and flank of the tool. The results obtained show that when MQL is applied to the tool rake, tool life is generally no different from dry conditions, but MQL applied to the tool flank can increase tool life.

A.S.S Balan [4] in this work the grinding of Titanium alloy Ti-6Al-4V with minimum quantity lubrication conditions were carried out. In order to maintain a good surface integrity and to improve the grind ability of Ti-6Al-4V experiments were conducted by varying different MQL parameters. The MQL parameters such as coolant concentration, coolant flow rate and air pressure were varied and its influence on the grinding forces, surface roughness, surface texture data were measured and analyzed.

3. Lubricant properties for MQL

- *Fatty alcohols:* are preferred for machining processes in which the separation effect rather than the lubricating effect is of prime importance (avoidance of built-up edges).
- *Smell:* The smell of the lubricant is not inconsequential. Spraying the lubricant can cause the smell to be intensified.
- *Spray ability:* The lubricant should spray easily and, especially with 1-channel systems, be able to produce a stabile aerosol (oil-air mixture).
- *Additives:* The additives should be adjusted to the processing requirements, particularly when processing non-ferrous metals and difficult-to-cut steels.
- *Residues on machine parts:* Despite minimum spray amounts and the use of extraction devices, lubricants may leave residues on work pieces and machine parts.
- *Corrosion protection:* A check should be made as to whether the thin MQL residual film on the work piece after machining offers corrosion protection that meets the requirements or whether additional corrosion protection is necessary.
- *Natural oils and greases:* Esters (rape seed oil, etc.) have the disadvantage that they are very prone to oxidation. They tend to gum up machine elements.

4. Model of Diverter Mechanism

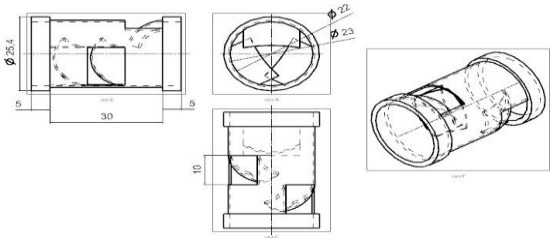

Fig. 1. CAD Drawing of Diverter Mechanism

Fig. 2. Geometry of diverter

A. Testing

Test and trial on the Diverter mechanism based noise suppressor for single piston pump system for minimum quantity lubrication application is as shown below:

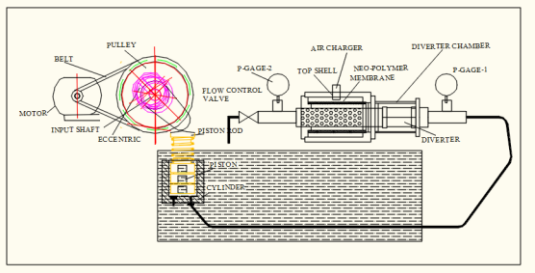

Fig. 3. Working of hydraulic noise suppressor

Noise of the system without noise suppressor with maximum discharge of 0.1 liter per minute is 108 dBA.

Fig. 4. DB Meter used for noise measurement

Figure 4 shows Digital sound level meter GM 135.1 is used for the measurement of process audible noise.

5. Results

Table 1
Result table

S. No.	Volume (ml)	Time (sec)	Flow rate LPM	Noise (dBA)	% Reduction in noise
01	20	30	0.04	84.1	22.12962963
02	20	25	0.048	88.1	18.42592593
03	20	19	0.063158	92.7	14.16666667
04	20	16	0.075	94.1	12.87037037
05	20	14	0.085714	97.2	10
06	20	12	0.1	98.3	8.981481481

6. Conclusion

- The analysis of the diverter element shows that the diverter is safe under maximum operating pressure and shows negligible deformation under the operating conditions.
- The analysis of the neo-polymer membrane shows that it is safe under maximum operating pressure and shows negligible deformation under the operating conditions.
- The Test and trial indicate that the noise increases with increase in flow rate with minimum noise of 84 dBA and maximum noise of 98.3 dBA. It is also clear that the noise reducer successfully reduces the noise level well below that without noise reducer.
- The Test and trial indicates that a maximum of 22% reduction in noise over conventional method is possible by us of modified diverter chamber noise reducer.

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