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Compressed Air and Cutting Fluid in Lathe Milling Drilling Machine for Cooling System

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***Abstract*: While cutting operation, high temperature is produced. that high temperature often leads to several problems like a high heat affected zone, temperature tool wear, change in hardness and micro-structure of the work piece, burning and its consequence and micro cracks. Application of cutting fluids in conventional method reduces the above problems to some extent through cooling and lubricating of the cutting zone. But in this process the cooling rate is low. For this reason, mist application technique has become the focus of attention of researchers and technicians in the field of machining as an alternative to traditional flood cooling. The minimization of the requirement of cutting fluids leads to economical benefits, and environmental friendly machining**

This paper deals with some studies of mist application that is compressed air with fluid for cutting operation on milling machine. For this, a mist generator set-up was developed. A series of machining operation have been conducted under various mist application condition for find out the effect on the performance of the mist applicator. The optimum quantity of cutting fluid required to maintain the cutting zone temperature beyond 35^0C at various cutting conditions is determined. The optimization of cutting fluid bring the most economical condition for cutting fluid usage.

***Keywords*: cutting fluid, mist application, machining operation, optimization.**

1. Introduction

Any metal cutting process produces enormous heat and chips. The heat is generated due to plastic deformation of metal, friction between tool and chips and tool and work piece. This heat, generated in the cutting process, has many disadvantages like tool wear, rough surface, residual stresses, etc. So it is essential to remove heat generated in metal cutting process. Cutting fluids is one of the important aids to improve production efficiency [1].

Cutting fluids play a significant role in machining operations and impact shop productivity, tool life and quality of work [2].

With time and use, fluids degrade in quality and eventually require disposal once their efficiency is lost. Waste management and disposal have become increasingly more complex and expensive. Environmental liability is also a major concern with waste disposal. Many companies are now paying for environmental cleanups or have been fined by regulatory agencies as the result of poor waste disposal practices [3].

For low speed machining operations, lubrication is a critical function of the cutting fluid. Cooling is not a major function of the cutting fluid as most of the heat generated in low speed machining can be removed by the chip [4].

For very high speed machining operations, cooling is the main function of the cutting fluid, as the chip does not have sufficient time to remove the generated heat. The lubrication effects of the cutting fluid in high speed machining operations are also limited. In high speed machining, there is insufficient time for the capillary flow of the fluid to reach the tool- cutting surface interface [5].

In a modern workshop practice or another industry using power, an enormous amount of power is lost either by the generation of heat or by friction between tool surface and work piece [6].

Heat in the cutting process is generated by plastic deformation and by chip or tool friction at the rake and flank faces. It has been seen that the amount of power lost due to generation of heat varies from 22-30 percent and hence to reduce it, the use of cutting fluids came into existence in the field of production technology.

Cutting fluids can be applied in the machining process in a number of different ways. The most common is flood application, where a large volume of fluid is pumped to the metal removal interface. The fluid is collected and then reused many times. Another method, Micro- lubrication, provides fluid to the cutting interface in the form of a mist, providing the lubrication effect. Because of the small volume used, the fluid is not collected for reuse [7].

The fluid is atomized, often with compressed air, and delivered to the cutting interface through a number of nozzles. Because the fluid is applied at such low rates, most or all of the fluid used is carried out with the part [8].

Also related to the method of fluid application are the

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concepts of dry (no metal removal fluid used), near-dry, and semi-dry machining. The last two methods are different applications of methods for reducing the volume of fluid used in the machining process [9].

This paper deals with some studies of mist application for machining operation on a milling machine to find out optimum quantity of cutting fluid required to maintain the cutting zone temperature reasonable. For this, a mist generator was developed.

2. Experimental Set-Up and Instrumentation

Mist application of cutting fluid refers to the use of cutting fluids of only a minute amount, typically a flow rate of 50 to 700 ml/hr which is about three to four orders of magnitude lower than the amount commonly used in flood cooling condition.

Mist application requires a high pressure and impinged at high speed through the nozzle at the cutting zone. The mist application system has six components, these are,

1) Compressor, 2) Cutting fluid container, 3) Nozzle, 4) Pressure gauge, 5) Pressure release valve, 6) Pressure control valve.

The compressor used in this system acts as air supply unit and the main purpose is to supply air at a pressure. The cutting fluid container has an inlet port and an outlet port at the top and the bottom respectively. It is used only to contain the cutting fluid. It is connected to the compressor by a flexible pipe through the inlet port to keep the fluid inside the container under the constant pressure. It is required to maintain the flow into the nozzle over a long period of time during machining operation. In the inlet section of nozzle there are two inlet ports through which air and fluid can enter. High- pressure air from the compressor enters into the nozzle mixes with the fluid, which come from the cutting fluid container with high pressure. Pressure gauge is used for measuring the air pressure at different section of the flexible pipe. For measuring pressure at different section of flexible pipe, two types of pressure gauges are mainly used. Such as digital pressure gauge and analog pressure gauge. Pressure control valve is used for varying air pressure at the inlet of cutting fluid container and the nozzle. Pressure control valve ensure the minimum cutting fluid flow and the maximum airflow in the mixing chamber of nozzle.

In mist application system a compressor is used to supply air at high pressure. The cutting fluid, which is to be used, is placed in the cutting fluid container, and there is a connection of high-pressure airline from the compressor with the help of flexible pipe at the top of the cutting fluid container. When the air at high pressure enters the cutting fluid container it pressurizes cutting fluid for going the cutting fluid in the nozzle mixing chamber and this cutting fluid coming out from the nozzle with the air coming in another flexible pipe line from the compressor as a jet, which is applied to the hot zone. In the cutting fluid container, there is a regulating valve by which the flow rate of the cutting fluid can be controlled. Two pressure gauges are used for mist application system. One is placed on the flexible pipe at the air inlet portion in the cutting fluid container and another is placed on the flexible pipe at the air inlet portion in the nozzle-mixing chamber. Two pressure control valves are used; both are placed before the two pressure gauges respectively. These are used for varying the air pressure. Schematic view of the experimental setup is shown in Fig. 1.

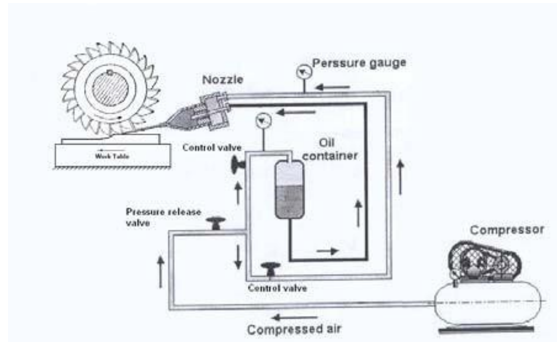

Fig. 1. Schematic view of the experimental setup

Experimental Cutting Conditions:

1. Machine: Lathe Milling Drilling Machine
2. Work-piece material Medium Carbon Steel
3. Cutting tool material: High Speed Steel (H.S.S
4. Cutting Fluid: LACTUCA LT 2
5. Cutting Conditions:

Milling cutter rpm 112rpm, 160rpm, 224rpm, 315rpm.
Depth of cut1mm
Feed rate 28mm/min

3. Experimental Investigation

The cutting is associated with high temperature, which is responsible for aggravating several problems like thermal damage of the ground surface, change in hardness, change in surface roughness etc. In present research work the benefits expected out of mist application over dry and wet environment are also based mainly in reduction in cutting zone temperature.

Table 1
Experimental data Sheet for temperature of work piece

P_a (m bar)	$T_{cutting\ Zone}$(^oC)	M_l %	M_a %
100	28.8	1.73	98.27
120	30.1	1.44	98.56
150	31.5	1.16	98.84
180	35.1	0.97	99.03
200	39.6	0.87	99.13
220	45	0.79	99.21

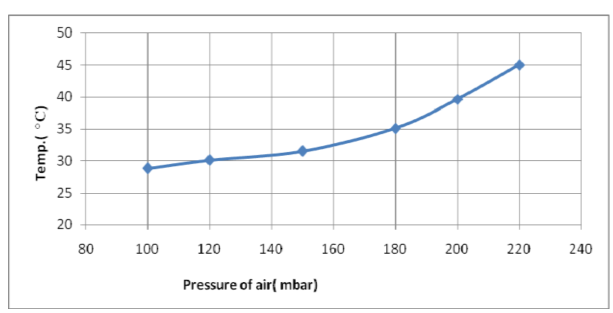

Fig. 2. Temperature vs. Air pressure

Table 2
Experimental data Sheet for temperature of work piece
Rpm: 112; Feed: 28mm/min; Depth of cut: 1 mm Dry cutting temperature: 78ºC, Mass flow rate of cutting fluid: 1.33×10-4 kg/s

P_a (m bar)	$T_{cutting\ Zone}$ (^oC)	M_l %	M_a %
130	24.3	2.67	97.37
150	25.2	2.29	97.71
180	26.6	1.91	98.09
250	31.5	1.38	98.62
340	33.7	0.99	99.01
350	37.4	0.93	99.07

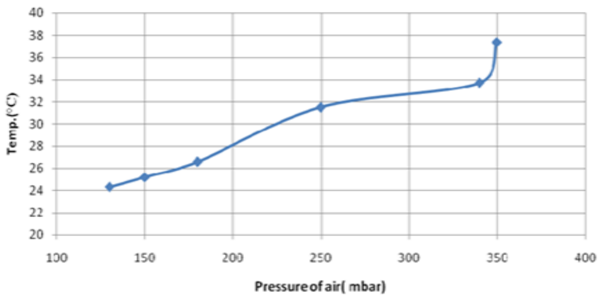

Fig. 3. Temperature vs. Air pressure

Table 3
Experimental data Sheet for temperature of work piece
Rpm: 160; Feed: 28mm/min; Depth of cut: 1 mm Dry cutting temperature: 85ºC, Mass flow rate of cutting fluid: 6.645×10^{-5} kg/s

P_a(mbar)	$T_{cutting\ Zone}$(^oC)	M_l %	M_a %
110	33.4	1.71	98.27
130	35.6	1.44	98.56
140	37	1.33	98.67
150	38	1.25	98.76

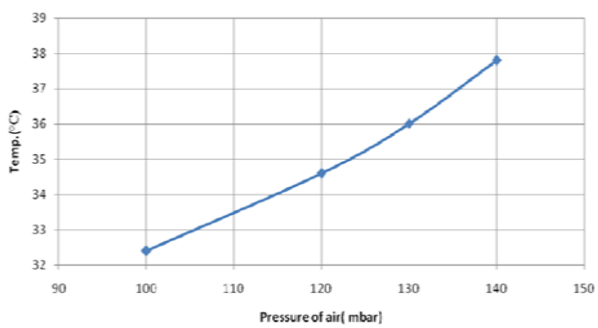

Fig. 4. Temperature vs. Air pressure

Table 4
Experimental data for temperature of work piece Rpm: 160; Feed: 28mm/min; Depth of cut: 1 mm, Dry cutting temperature: 85ºC
Mass flow rate of cutting fluid: 1.33×10-4 kg/s

P_a(mbar)	T Cutting $Zone(^oC)$	M_l %	M_a %
130	25.2	2.85	97.15
140	27	2.29	97.71
190	29.7	1.91	98.09
230	32.4	1.57	98.43
240	35.1	1.38	98.62
270	36.9	1.33	98.67
290	39.2	1.24	98.76

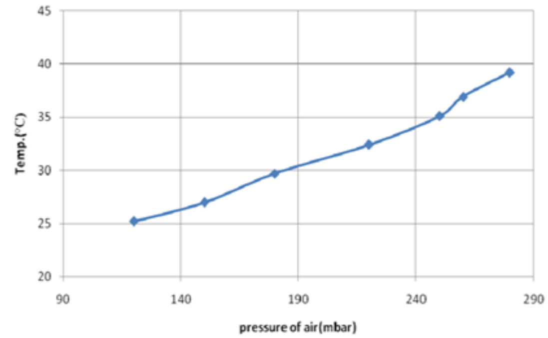

Fig. 5. Temperature vs. Air pressure

Table 5

RPM of millingcutter	The ratio of air and cutting fluidmixer m_a :m_l
112	99.1:0.9
160	98.6:1.4
224	97.1:2.9
315	96.0:4.0

4. Results and Discussion

To keep the cutting zone temperature at 35ºC at different rpm of milling cutter, the ratio of air and cutting fluid mixer which are obtained from the experiment are given bellow: From the fig. 2 to 5 it has shown that pressure of air increases and the pressure of temperature decreases the cutting zone temperature increases. The optimization of cutting fluid is done by increasing the pressure of air into the nozzle. To keep the cutting zone temperature in a reasonable condition such that at 35ºC (room temperature) at different rpm; the ratio of air and cutting fluid mixture varies. At high rpm to low rpm which are generally used, to get the best performance the ratio of air and cutting fluid mixture should be 96:4 to 99.1: 0.9 respectively.96:4 to 99.1: 0.9 respectively. As the pressure of the air through the pipe towards the nozzle increase, the percentage of cutting.

5. Conclusion

Based on it experiment carried out the study following inferences are written. The optimum quantity of cutting fluid used to make the cutting surface temperature not beyond 35ºC at different rpm which is generally used is find out. The air fluid ratio should be under 4:1 for best performance The optimization of the cutting brings the most economical condition for cutting usage. Mist application of cutting fluid ensures the high productivity of the machining with respect to continuous and discontinuous operation.

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