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Development of a Magnetization Device to Magnetize Cutting Fluids in the Flowing State During the Metal Cutting Process

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Abstract: In this paper, special magnetic treatment device to magnetize flowing lubricating cooling fluids during the metal cutting process is developed. Analysing results show that it is possible to create a special lubricating-cooling technological environment by magnetizing cutting fluids with a high magnetic field in their flowing state in machining. Developed device has an important impact on metal cutting process performances.

Keywords: Machining, metal cutting, cutting fluids, magnetization, magnetic field.

Introduction

In the process of metal cutting, the use of lubricating-cooling fluids and their contribution to the improvement of wear resistance of cutting tools make particular importance in creating a lubricating-cooling technological environment in the machining process. Experiments and studies have shown that the lubrication, cooling, and washing properties of magnetized cutting fluids differ from those of conventional cutting fluids, and this difference is even higher when cutting fluids are magnetized in the flowing state [1, 2].

Moreover, the magnetic field also changes the degree of its influence by changing the physicochemical properties of lubricating coolants in machining. It is also clear that the influence of the magnetic field on liquids depends on the state of their magnetization. The accumulated experience in creating a device for magnetizing magnetized lubricating cooling fluids, their properties, application in the cutting process, and flowing lubricating cooling technological medium shows that, along with specific advantages, it should be noted that the effect of magnetized cutting fluids with increased cooling capacity on the wear resistance of the cutting tool is low when drilling deep holes and processing at low cutting speeds. When magnetizing flowing lubricating cooling fluids, as well as when developing and creating a magnetizing device, it is necessary, first of all, to take into account the cutting process intended for their use. It is also necessary to pay attention to such factors as the main properties of lubricating cooling fluids that affect the cutting process, the method of delivery to the cutting medium, the flow rate, the elements of the cutting mode, and the design solutions of the magnetizing device.

The results give a conclusion that it is possible to create a special lubricating-cooling technological environment by magnetizing cutting fluids with a high magnetic field in their flowing state in metal cutting. This poses the new problem of solving the magnetization of cutting fluids in the flowing state during the metal cutting process. It can be said that changing the above-mentioned properties and managing their influence on the cutting process has great scientific and practical significance.

Methods

Magnetization scheme

In order to solve this problem, a scheme of direct magnetization in the current state of cutting fluids during the cutting process was developed (Fig. 1).

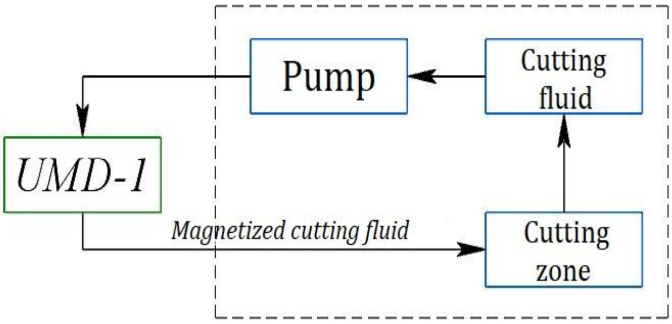

Fig. 1. Magnetization scheme of cutting fluids in flowing condition during machining

Magnetizing device

UMD-1 magnetizing device was developed to provide a permanent magnetic field for magnetizing flowing liquids, there are eight ceramic magnets with the size of 120 mm in length, 80 mm in width, and 16 mm in height. The construction of the magnetizing setup UMD-1 is given in Fig. 2.

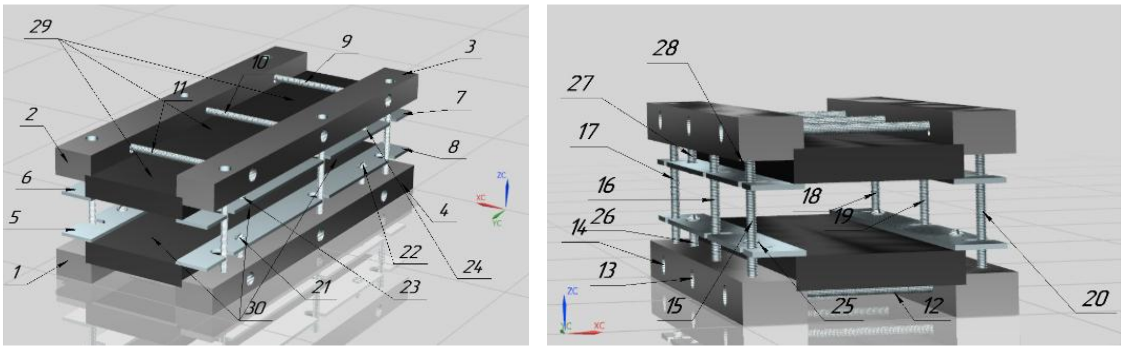

Fig. 2. *UMD-1 magnetizing setup details. 1, 2, 3, 4 - Supports, 5, 6, 7, 8 - holders, 9-20 – Vertical hexagon bolts, 21-28 – Screws, 29-30 – Static magnets*

It can be seen from the Fig. 2 that, ceramic magnets (29, 30) are stand on base (1, 4) and top (2, 3) supports by opposite poles. Paying attention to width of the ceramic magnets long horizontal hexagon bolts (9-14) are settled, and holders (5-8) are fixed to attach the ceramic magnets tough with the aid of screw (21-28). In the experiment, it is very important to adjust the length between ceramic magnets. To provide that adjustment, holders and supports are developed on the UMD-1 setup construction. Base and top supports have the equal shape and sizes, and the space among them can be modified without problems with the aid of vertical hexagon bolts (15-20). Converting the space among the base and top supports is designed to alternate the space among the ceramic magnets located on base and top supports. Because of this design, it is very easy to alternate the static magnetic field strength through adjusting the space among lower and higher magnets. Furthermore, the magnetizing setup design is developed to hold the magnets with different length, that is the space among the supports can be adjusted horizontally in line taking into account the length of the magnets.

Results and Discussions

The construction of the magnetizing tool is generic due to the fact it is feasible to hold magnets with various sizes. The tool is designed to fix the magnets that have size from 20x10x5 (mm) to 300x80x30 mm. The gap between the upper and lower magnets can be modified from zero to 50 mm and it is also related to the sizes of the magnets located on the supports. Moreover, the magnetizing tool could be very transportable and it is very feasible to exchange its function on metal cutting process.

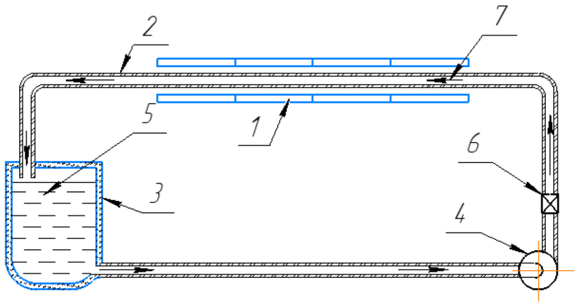

Fig. 3. *Magnetizing setup with static magnetic field (UMD-1), 2 – Polyvinyl chloride pipe, 3 – Storage, 4 – Pump, 5 – Cutting fluid, 6 – Speed controller, 7 – Fluid movement direction*

In the experiment, to provide the pulsating electromagnetic field to magnetize the sample cutting fluids, the special SMD-2 magnetizing laboratory setup tool designed and developed (Fig. 4).

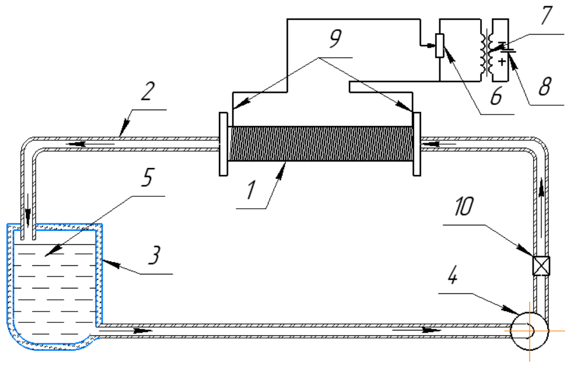

Fig. 4. *Magnetizing setup with electromagnetic field. 1-Solenoid (SMD-2), 2- Polyvinyl chloride pipe, 3- Storage, 4-Pump, 5-Cutting fluid, 6-Rheostat, 7-Transformer, 8-Electric power, 9-Pulsated signal, 10- Speed controller*

Cutting fluid (5) is stored in the container (3), diverse cutting fluid samples can be used in each experiment. Then, the cutting fluid in the storage can flow through polyvinyl chloride pipe from the storage, and the pump (4) is used to provide flowing cycle to the cutting fluids that is experimented. The cutting fluid flowing through the polyvinyl chloride tube is follows the course (shown in fig. 4) flows through the middle of solenoid (1) that has the diameter of 18.5 mm and is poured again into the storage. The cutting fluid flowing through the polyvinyl chloride passes from the middle of the solenoid, that is creating a pulsating electromagnetic field. After passing through the electromagnetic field, it becomes a magnetized cutting fluid and is poured again into the storage. The flowing speed of the cutting fluid is managed through speed controller (10) and the specified flowing speed of the experimented fluid can be obtained.

Providing the cycle for about one hours (it is calculated for experimented eight liters of fluid in the container) the cutting fluid within the storage will become a completely magnetized and the viscosity coefficient of the sample cutting fluid can be measured. The solenoid created for the experiment was made by way of wrapping an insulated copper wire on in a plasma coil with a radius of 25 mm, and the diameter of the wire is d=1.06 mm. The quantity of turns of wires on it was n=2100. The voltage (U=220 V) from the source (8) is passes through the transformer (7) and managed through a rheostat (6) that allows you to flip to a regulated pulsating voltage (9). The pulsating voltage from the diode bridge is transmitted to the solenoid and an electromagnetic field is generated. The volume of the electric power is managed the use of a rheostat and it can be settled to the favored voltage.

Conclusion

The impact of magnetic field on fluids remains one of the controversial topics in the world. The thorough recognition of the magnetic field impact on cutting fluids has a great advantage on production, manufacturing, science, biotechnology and other various fields [3-5]. Many researchers has worked on the problem of magnetic field effect on water, however, researches on this topic is not many in the world, specially, the magnetic field influence on various cutting fluids.

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