

Study the effect of metal cutting fluids in operating machines on operator health and the environment

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ABSTRACT

Due to their function in reducing friction, reducing temperature in the cutting area and preventing corrosion, cutting fluids is an important part of many different materials operating processes. The main function of the liquid cutting is to control the temperature by cooling and lubrication, improving the workpiece quality by continuously removing the metal sculptor and the resulting limitation of the tool.

Through this study, we will introduce method of automated coolant supply based on Arduino for CNC Machining, Coating the walls and ground of CNC workshop by making nano-coating to prevent the growth of harmful bacteria. In addition, we will give as well overviews and suggestions to address the risks related to the health of the operator that results from its exposure to inhaling the smell or fog generated from fluids and includes respiratory diseases (asthma, chronic bronchitis, and hypersensitivity pneumonia), cancer, skin diseases, and the eye in addition to environmental risks during disposal later as waste.

In addition, some of the techniques used to overcome and reduce the risks of the cutting fluids used will be reviewed.

Keywords: Metalworking fluids, metal processing, Cutting fluids, health and environmental study, Arduino

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1. Introduction

CNC machining process is a basic aspect of fluid cutting. Cutting fluid is a type of coolant and lubricant primarily for machining processes like rotary and rotational processes.

These fluids, however, have very severe negative environmental and health consequences. Shashidhara and Jayaram [1] reported that a lot of negative effects on the environment can arise from the regular use of oil-based oils. Cetin et al. [2] also reported that fluids are vaporized and dispersed into micro particles during processing. during processing. The operator could face severe problems and health problems from dermatological as well as inherent disorders, lung cancer, genetic conditions, and breathing infections. Debnath et al. [3] have said that fluid cutting cannot be excluded from the budget, but that the use of fluid cutting can be minimized and the costs can be indirectly reduced.

Diverse techniques for applying fluids in the CNC machine have been studied and developed in order to reduce or replace cutting liquid, including dry machining and minimal lubrication in amounts, because health issues, environmental concerns and economic issues were addressed by the producer (MQL). These cooling methods are developed by means of research on the surface roughness, wear of the instrument, temperature difference and the amount of coolant used.

Three types of fluids are available: mineral, half-synthetic and synthetic [4-6]. The semi-synthetic and synthetic cutting fluids seek to incorporate best oil and the best water output by holding emulsified oil in a water base. Cutting

fluid is used to remove sculptors, to reduce friction in the cutting area, and to increase the life of the cutting tool and prevent corrosion. The cutting fluid is chosen according to the required job and the associated cost.

Cutting fluids are basic oils in general. Cutter fluids today represent a special mixture of chemical additives and lubricants, which have been produced to satisfy the requirements for the performance of metal operations (such as turn, milling, skimming, punching, etc.), particularly with the intention of removing heat from processing. Metal operators' exposure to vapor inhalation problems include respiratory disorders (asthma, chronic bronchitis, hypersensitivity pneumonia), cancer, allergies and skin diseases, as well as heat produced from operating procedures. Health problems include respiratory conditions.

A mechanism for creating fog in metal operations in Metalworking Processes based on Mechanism of Mist Creation The following are the primary mechanisms by which cutting fluids are converted to vapor (fog) in the working environment:

- 1) Evaporating as a result of high cutting temperature.
- 2) Distraction due to the rotation of the Tool and the work piece (W.P.).
- 3) Spray the liquid as a spray under the pressure of the tool, the worker.

2. Health risks

Cutting fluids are a cause of worker disease, especially cardiovascular disease, asthma and skin diseases due to external contact (skin), including touching parts and tools; Be sprayed or sprayed with liquid; Or the presence of fog on the skin or the mouth and nose enters the normal respiratory tract of tissues of the respiratory system or gut (such as the mouth, throat, oesophagus, trachea or lungs) [5-7].

Chemical toxic mechanisms or physical irritants include:

- The liquid itself.
- Metal particles (from previous pieces) that are transported in the liquid.
- Bacterial or fungal groups that obviously have a tendency to grow in fluid over time.
- Biocides added.
- Corrosion inhibitors added to protect the device and tools.
- Interlocking lubricants from slip lubricants.

The majority of cutting fluids provide space for the growth of bacteria that could be harmful to the operator. Heavy metals can affect the lungs and stomach of humans in liquids. The emulsions of existing water formed from fluid concentrate cutting can also be simple for microbes under normal conditions of operation[6].

For environmental hazards, cutting fluid has an important role in manufacturing processes in terms of tool life and quality. After a period of cutting fluid use, it degrades, decreases its quality and eventually requires disposal as soon as its efficiency is lost. Dispose of cutting fluid contaminated by sculptor, material chips etc[7].

3. Approved methods of prevention

1. Dry cutting: in order to avoid environmental problems and health risks from being imposed by fluid cutting, the safest way of using the dry cutting process is to remove its use entirely.

2. Many different researchers have studied unconventional cutting liquids that minimize fog formation to solve the problem, as previously discussed. Solid lubricants

Given the weak crystal structure, general graphite is used as a strong lubricant. Often used was molybdenum disulfide. It is called a solid lubricant as well. As a dry lubricant, titanium aluminum nitride has been used.

3. Jet systems fluid.

4. Degradation, replacement and disposal

Due to contaminants entering the lubricant system, fluids are degraded over time. The formation of the basin oil, which is the undesirable oil mixed with the cutting fluid, is a common deterioration. It is a lubricating fluid that runs away from the lateral lines, washed into a mixture of coolants, a protective film in which a retailer of stainless steel uses a band to avoid leaking stocks or hydraulic oil outages. The surface of the coolant or the floating drops of the oil can be perceived in extreme cases as a membrane or skin [8-12].

For the separation of the tangle oil from the coolant, scrapers are used. These are typically rotating disks which spin partially immersed in the main tank under the coolant stage. When rotating the disk, the hobo oil sticks with two wipes on either side of the disk until the disc returns to the refrigerant. before the disk returns. The channel spaces are then redirected to a container, where displacement oil is collected for disposal. Floating scraper is often used in this situation where the water has excessive temperature or quantity of oil.

Within these systems, the effect of continuous separation more efficiently can control displacement oil after the introduction of CNC additives. The accumulation of homeless oil is isolated from the cooler on water or on oil and can be removed easily using a sorbent.

Chemically (with loss of benefit) as with used motor oil or any waste which could have minimized environmental impacts, the aged, used or rotting cutting fluid must be disposed of.

The disposal of liquids requires the use of polymer and ceramic films, which concentrate on the suspended oils and emulsions, to new technology, such as ultrafiltration.

The filing by sculptors and metals was also treated in such a way that many metalworking processes now employ engineering solutions for the entire period of the processing, isolation and recycling of refrigerant chips.

5. Automated coolant system

A CNC milling machine was part of this study. Installed with an efficient coolant system built (see Figure 1). A valve and the specially produced drums should transfer the coolant from the CNC machine to supply the initiation coolant to be in contact with ZigBee wireless module.

Arduino controller system is used to control the supply as shown in Figure 2.

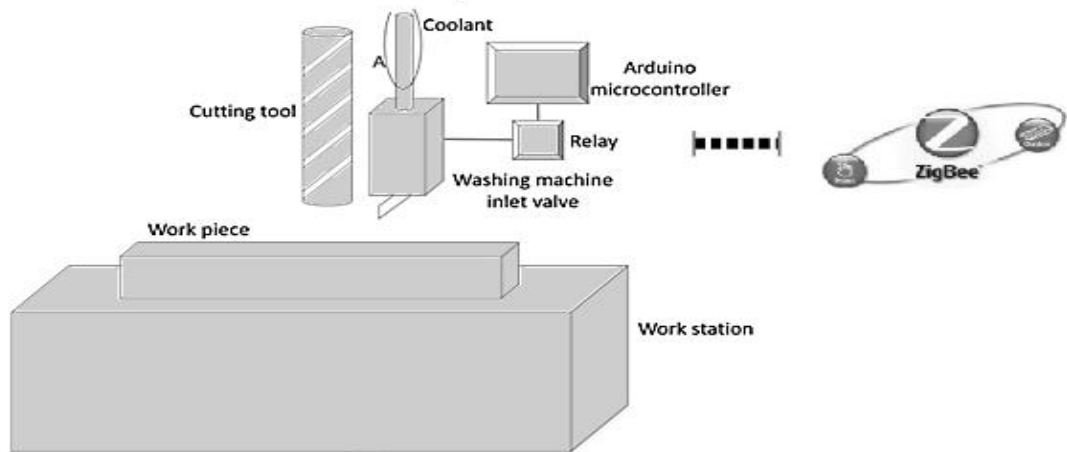


Figure 1. Complete coolant supply device designation with ZigBee wireless module

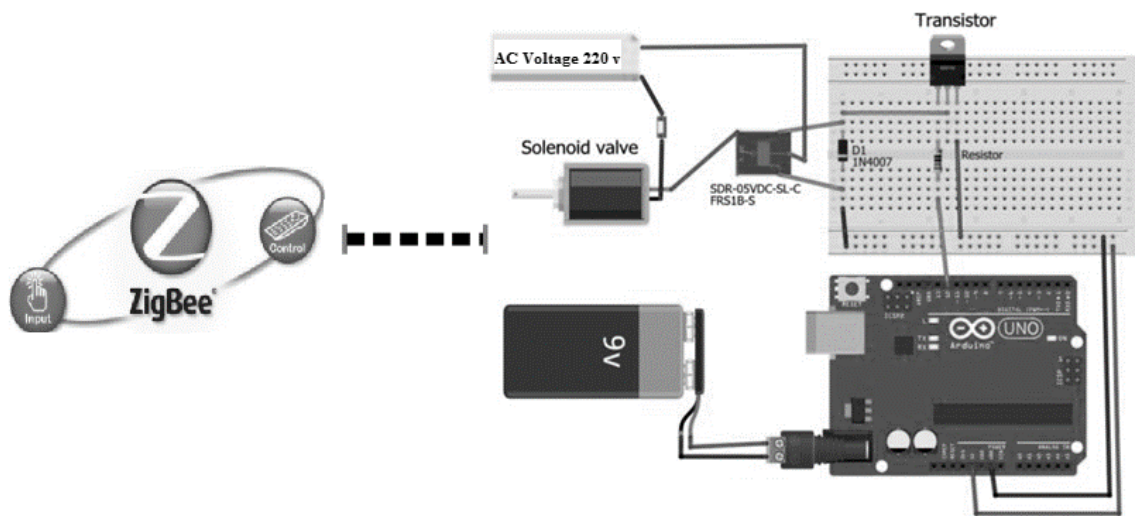


Figure 2. Circuit system based on Arduino controller and ZigBee module

If the switch is triggered, the coolant can be supplied by time from the tank to the cutting tool and workpiece. The Arduino microcontroller board had a direct 9V current inserted on the other side. The number 12 is connected to the relay (SDR-05VDC-SL-C) and the relay controls the solenoid valve circuit to be encoded and deactivated.

The Arduino environment for beginners without software or electronics experience has been designed to be easy to use. With Arduino, you can create objects to respond to light, sound, touch and movement or monitor them. On a computer, software programs are developed using the integrated development environment of Arduino (IDE). The IDE lets you modify and write code for Arduino hardware, translating it into instructions. The IDE also moves the Arduino board these instructions (a process called uploading) [13].



Figure 3. The window of IDE

The distribution of the coolant is conditioned by the time setting of the supply stop. If the set time is, for instance 5s, then 5s and ends for the coolant for 5s before delivery again. This loop is repeated until the process is done.

Table 1. Electrical specification of Arduino UNO

<i>Microcontroller</i>	<i>ATmega328P</i>
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Zigbee is an IEEE 802.15.4-based series of high-level communication protocols for building personal-area networks with small digital radios with low power for domestic automation, the processing of data from various devices and other low bandwidth requirements for smaller, wireless connectivity ventures. Zigbee is thus a powerless, low data rate and wireless ad hoc network nearby (i.e. personal area) [14]. Zigbee-defined technology tends to be easier and less costly than other wireless personal area (WPA) networks, such as Bluetooth or wireless networks more broadly, such as Wi-Fi. Applications include wireless, domestic, traffic, industrial and other consumer equipment which requires short distance, low-speed wireless data transmission.

Data can be transmitted via data passing through the mesh network of intermediate devices to more distant devices or control panels or whatever. Zigbee devices can transmit data over wide distances through a network of intermediate devices to reach the largest intermediate devices. Zigbee is usually used in low battery life and secure network applications (128 bit symmetric encryption keys are secured for Zigbee Networks). Zigbee has a fixed rate of 250 kbit/s and is ideally suited for intermittent data transmission from a sensor or input device.



Figure 4. 2.4GHz ZigBee module for sending CNC results wirelessly to remote control panel

For A 200mm wide, 120mm long and 30mm high, a workpiece was used to cut the 10mm high-speed stainless steel cutting tool. AI Soluble Extra is the added cutting flux for the workpiece to refresh. The test was carried out on a spindle speed of 1200 rpm, feed rate of 100 mm/min and cut depth of 0.4mm on a CNC milling machine.

The product instance of the process is shown in Figure 5. The aluminium block can be employed. Each time interval runs for one cut and is marked with a black marker. After all of the cutting processes, Figure 5 demonstrates the surface roughness of the cutting surface with a roughness tester.



Figure 5. The workpiece before and after cutting operation

Figure 6 shows obviously that the surface roughness value results decrease from 1s interval to 25s until they increase back to 60s. It can be concluded that, over a time interval of 25s, the best surface roughness is at $0.4975\mu\text{m}$, as shown in Table 1. On the basis of [15, 16], the forming of chips through coolant appears to emerge from the cutting region. The chips cannot be released from the cutting zone because the quantity of coolant is too

high when the coolant is supplied into the cutting area. Therefore, boiling with a commonly practiced external coolant might not be of good value for mechanization. The amount of coolant during the period of time (below 15s) in our proposed method is too low and the chips cannot escape from the cutting zone and have become obstructive. The surface roughness of the cutting area may be poor. If the period increases, the volume of coolant is reduced and the chips are more quickly removed from the cutting area and surface roughness improves.

The surface roughness value increases after the time interval 30s back up to the time interval 60s. The condition after 30s is maybe more fashionable for dry workmanship because the cutting process has taken nearly half or more of the time without a supply of coolants. And before 30s, the trend towards low-quality lubrication is more pronounced. MQL demonstrated on the basis of Sun et al.[5] the ability to boost the processing conditions for cooling and dry cutting of traditional floods. The coolant flow rate is limited and has a sufficient cooling effect.

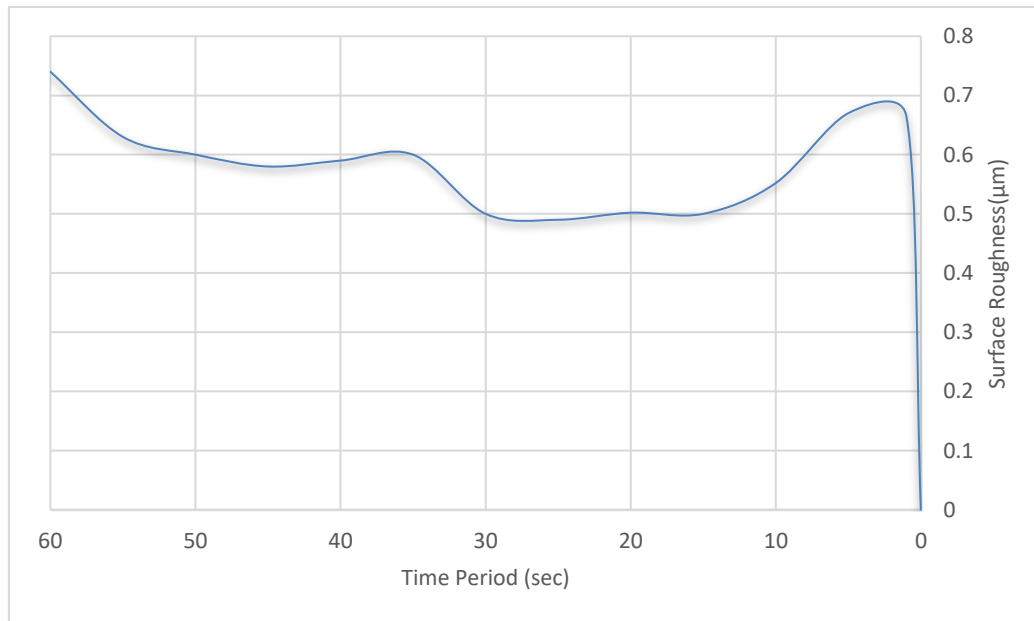


Figure 6. Graph plotted based on the obtained data

The automated coolant system can be enhanced by cloud computing technology to save the reported results periodically in the cloud for archiving purposes [17-18]. Internet of thing (IoT) can be as well adopted along with automated coolant system for alerting about any failure in the system automatically to workhouse director by any type of alerts via internet [19-20]. Finally, genetic algorithm (GA) and field-programmable gate array (FPGA) can be employed to optimize the outcomes of automated coolant system [21-23].

6. Nano-coating to prevent harmful bacteria

This work as well aims to create a healthy workhouse environment that reduces the risk of metal cutting fluids along with medical personnel contracting diseases caused by bacteria and viruses. By making nano-coating, it can prevent the growth of harmful bacteria that grows on workhouse environment floors and walls.

In laboratory experiments, Bioarmor-nano reduces to 99,9 percent harmful surface bacteria. Staphylococcus aureus and MRSA were specifically examined. Ethanol disperses the bioarmor-nano and cleanses the surface on touch. Ethanol evaporates and leaves a nano-thin layer containing our antibacterial nano-silver formula. The layer is tactile, ready to use and starts working in less than 5 minutes. For the next five hours, the coating begins to harden and then covers minimum normal surfaces for the next three months.

"Viruses are not invulnerable as chemical building blocks because they contain sulfur atoms. Sulfur atoms react on the chemical level with silver, and cause the viral building blocks to be irreversible destroyed. Viruses are still: they must first come into contact with silver when they are placed on a surface, such as a door handle. In this case, the nanotechnology provides its indispensable advantage; Silver can be used in smaller amounts in surfaces, such

as door pockets, handles, touch screens etc., finely isolated and active against viruses. Nanosilver has been shown to be effective against viruses in various scientific studies worldwide [24-26].

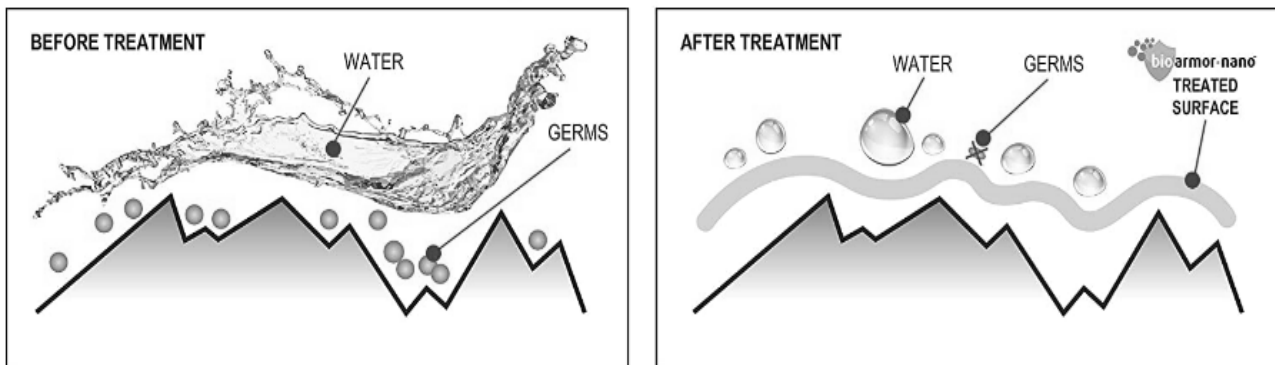


Figure 7. Bioarmor-nano before and after treatment

7. Conclusion and recommendation

- Extracting a large number of fluid parts is a major challenge, considering the rapid growth of bacteria and pathogenic substance, since it is unsafe for the environment.

Spray any of the cutting fluids that can cause severe health conditions such as cancer of the mouth, pancreas, rectum, prostate, and breathing difficulties.

Air conditioning for manufacturing activities and compressed air for cooling. Various studies have shown that the instrument has a longer service life because of the use of air cooling and also because of its many benefits, because it is considered environment friendly, a cheap alternative to cutting fluid cooling.

- The overall trend in fluid therapy use. Only the use of reduced waste technology, whereby the waste is filtered from the sculptor and re-used in the manufacturing process, will remove the negative effects of refrigerants.
- The need for sustainable and biodegradable cutting fluids is on the rise, due to the importance of the environment and the rising industry regulations related to pollution. Different vegetable oils have reduced the environmental challenges caused by mineral fluids substantially due to this essential fluid cut.
- The application of dry cutting methods (MQL). These techniques have decreased substantially the quantity of liquid used in metal cutting processes.
- Academic study should be conducted to achieve the highest possible material removal rate with the above suggested environmental methods.

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