

ENVIRONMENTALLY REDUCING OF COOLANTS IN METAL CUTTING

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Abstract: *Strained environment is a global problem. In metal industries the use of coolant has become more problematic in terms of both employee health and environmental pollution. It is said that the use of coolant forms approximately 8 - 16 % of the total production costs. The traditional methods that use coolants are now obviously becoming obsolete. Hence, it is clear that using a dry cutting system has great implications for resource preservation and waste reduction. For this purpose, a new cooling system is designed for dry cutting. This paper presents the new eco-friendly cooling innovation and the benefits gained by using this method. The new cooling system relies on a unit for ionising ejected air. In order to compare the performance of using this system, cutting experiments were carried out. A series of tests were performed on a horizontal turning machine and on a horizontal machining centre.*

Keywords: cutting fluids, environmental, eco-factory, eco-products

1. Environmental thinking - the next milestone for machine shops

There has been three major milestones in the history of industry. Between the 1700's and 1800's, steam power gave machines shops the necessary power to function. A hundred years later electric power brought new possibilities. Computer power and information technology, at the end of the 20th century was the third milestone.

Strained environment is a global problem. The experts in environmental matters believe that the importance and weight put on environmental issues will increase in the future. The greatest cause of industrial pollution is not caused by the mechanical industry. What can be done to prevent and control pollution, however, must be carefully researched and action towards the control of pollution must be taken.

Today companies are faced with increasing demands on managing environmental issues. The demands can come from the authorities, but also consumers, customers and workers in the companies set more and more of the demands. It is assumed that managing environmental issues and eco-friendly production methods will be the next milestone in production engineering.

The industry has quickly developed new materials and these are often hard-to-machine materials. Due to the difficulty in machining the new materials, new cutting methods and techniques are highly appreciated.

The metal industry has been among the first to implement quality management. In many cases, quality certificates are in fact, prerequisites for trade. Voluntary environmental standards, such as EMAS and ISO 14000, fulfil and complete companies' developing tools and they are comparable to quality management.

It is said that clean production methods are tomorrow's competitive advantage. The increasing environmental awareness and legislation question the current production methods. A new, ecological production is needed. Nowadays, piece meal actions on environmental issues are not sufficient. Companies must focus to a total clean manufacturing in all steps of production.

An eco-factory is a company, which considers the environment. Primarily less material, energy and goods are used. The company produces as little waste as possible and of this it tries to recycle as much as is possible.

Eco-products are the growth area in metal and machine shop industries. The method-, material-, and goods decisions prefer ecological alternatives, however, without impacting the company's productivity and competitiveness.

An eco-factory has implemented environmental issues management system. The current approach towards environmental issues has been mostly deferring against threats. The new approach must move from that to exploiting the possibilities and considering ecological production as a competitive advantage, which can bring new business opportunities and polish the image of the company. Being prepared for new demands, rather than waiting for them, has been proven a good strategy for companies.

When a company commences ecological production and awareness, first it has to consider the current state and make an environmental analysis. The analysis contains lists of materials and production processes to be used. Additionally, it includes a description of the waste the production process produces.

If rapidly implemented ecological procedures will turn out insufficient, a more extensive thinking is needed. In such case the following list of procedures is recommended as a model of thinking:

- Is it possible to reduce or minimize the current method of production process ?
- Is the current method of production process replaceable?
- Can the current method of production process be sufficiently improved?

2. Cutting fluids cause environmental problems

The environmental issues in machining industry concern mostly the cutting fluids. Coolants are widely used in machining processes to cool the tool and workpiece and to help remove chips from the cutting zone. Despite these benefits, the use of cutting fluids can present potential environmental problems. In addition to this, coolants also cause harmful effects - for the machine operator, as well as in disposal of hazardous waste. The costs of using coolants arise from handling equipment and disposal of used material. The cleanliness of machined parts is an important issue.

With modern tool materials, the traditional roles of fluid as coolant and lubricant may not be as important as they were. In metal industry, large amounts of cutting fluids are used for improving the efficiency of machining, for removing chips and for protecting the machine tool from corrosion. Nowadays we have cutting systems with

- flood cooling (both emulsion and oil can be used, amounts of cutting fluid are large)
- minimal lubrication cooling (amounts of cutting fluids are some millilitres per hour)
- no fluids (dry cutting)

Flood cooling and high-pressure cooling are major trends. For now, how well dry machining is accepted depends on how the cost of staying out of trouble with environmental issues stacks up against the cost of going dry. The cost advantages of dry machining include: clean chips to sell, no coolant pumps, filters, or chillers to buy and maintain. Air-blast systems can handle some chip removal situations. Today, there is only a small application range for total dry machining. Instead, minimal lubrication is used, in which a mist or thin stream of through-the-tool lubricant is applied to the work area.

In addition to the base oil, cutting fluids contain many kinds of additives, such as emulsifiers, antioxidants, bactericides, tensides, EP-additives, corrosion inhibitors, agents for preventing foaming, etc. Although the cutting fluids are gradually being developed to be safer for the users and environment, they still have many disadvantages and risks that can not be eliminated. Cutting fluids are entrained by chips and work pieces, and on the other hand, they contaminate machine tools, floor and workers. Partly the fluids evaporate to the air and partly flow into the soil. If coolants must be used, their amount and usage can be influenced. The former recommendations on using large amounts must be considered critically. The coolants ought to be used for long periods of time.

The traditional methods that use coolants are now obviously becoming obsolete. Change is clearly taking place in the machine industry. Environmental laws are closing in on machining coolants. Many engineers are looking seriously at dry machining. Dry machining means cutting without using any fluids in production. The use of dry cutting has been an eagerly awaited objective worldwide. The minimized use of cutting fluids, where the usage of fluids is restricted to the least possible level, is a transitional form of both ordinary cutting and dry cutting. The fluid can also be replaced with gas cooling.

3. A cooling system using ionised air

Advanced techniques are alternative solutions for cutting fluids. Using gases in cooling cutting tool and work pieces is not entirely a new idea, but it is under constant development, in order to find the best and most suitable solutions. Especially gas media such as nitrogen and carbon dioxide have been found to be interesting when replacing cutting fluids in machining.

There have been positive results in using ionised air for this purpose. The key components of equipment are air input and ionising units. Air pressure and air volume can be adjusted separately. Air supply device is any common compressed air network.

Coolant use is only to a certain extent for lubrication and the rest for chip removal. An insert geometry that helps to get rid of chips, used in combination with a cooling gas, may be necessary.

Application of the ECO COOLING® -SYSTEM (Ionised Air Cooling-System) are:

-Main features of economic benefit	-The traditional system	-Totally waste-free system
-Purity and cleanness of the system	-Industrial wastes are produced	-No liquid leakage
-Liquid leakages	-Liquid leakages	-Higher when cutting difficult materials
-Cutting speeds	-Slow when cutting difficult materials	-Tolerances varies
-Tolerances the cutting process	-Tolerance varies during more slowly	-Better surface quality
-Surface quality	-Fixed cooling systems	-Easy adaptable system for different needs in machining
-Flexibility	-The Eco-cooling® system	

Benefits of the ECO COOLING® -SYSTEM (Ionised Air Cooling-System) for the client are:

1. Because the ionised air expands quickly from the tip of the cutting edge, the cutting tool is cooled, thereby ensuring good cutting performance and long tool life
2. Increased cutting speed
3. Several kinds of metals, such as steels, can be cut with this device
4. Better surface quality
5. The work piece can be processed further without washing
6. No coolant is needed any more > cutting tools and the work piece will remain clean, there is no liquid leakage
7. Environmental problems and taxes are eliminated
8. Health problems due to coolants are eliminated
9. Decreasing total cost of the cutting process
10. The system structure guarantees the real TQM (Total Quality Management)

4. Results

In experiments with this cooling system, the life of a tool is longer than that of a cutting tool with fluid cooling. We also conclude that the dry cutting of several materials using ionised air cooling is possible instead of using expensive and unclean cutting fluids.

5. Conclusions

Usage of coolant has become more problematic in terms of both employee health and environmental pollution. This research is a feasibility study for using a new cooling system.

This system does not use coolant as in the past. The system is designed for reducing the temperature of the cutting tool. The cooling system utilises a unit for ionising ejected air. Hence, it is clear that using a dry cutting system has great implications for resource preservation and waste reduction. Therefore using ionised air cooling proposes a technological, economical and ecological alternative for metal processing companies.