Lube-Tech

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Control and maintenance of metalworking fluids

Introduction

The need to manage finance, human resources and operations within organisations is accepted without question. Why then does it seem to be such a battle to convince some users of the need to manage metalworking fluids?

There are many possible reasons:

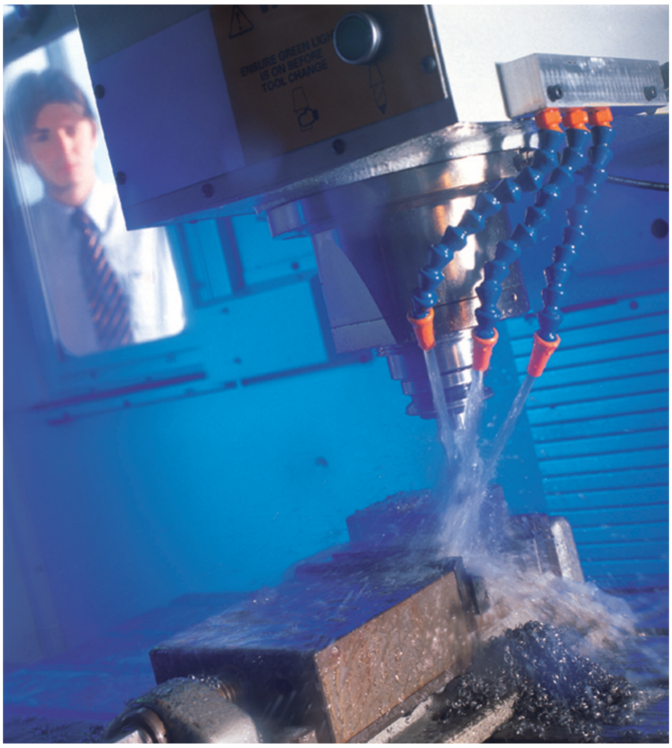
- metalworking fluids are not at the forefront of the minds of hard-pressed managers
- there is no time available for (what are perceived as) non-productive tasks
- there is no budgetary allocation for the extra capital and operating costs
- the requirement is regarded as just another example of 'red tape'
- no problems have been reported or recognised

For a moment let us set aside the objections and consider the arguments in favour of managing metalworking fluids:

- protects the health of machine operators
- prolongs the service life of fluids, saving money on purchasing and disposal costs
- protects machine tools
- improves tool life and promotes more consistent high quality production
- reduces impacts on the environment
- protects the company against the risk of enforcement notices or even prosecution

So perhaps the idea of managing fluids does make sense and could even reduce costs and improve quality as well as giving a boost to well-being and morale. There are sound reasons for the importance attached to this topic by the Health and Safety Executive, supported by the comprehensive guidance available on their website. Extensive ranges of fluids, services and equipment are available to enable users to achieve compliance.

Whether the motivation comes mainly from the carrot or the stick or a combination of both, the need to manage metalworking fluids correctly is a fact of life and this article aims to provide information and guidance on Monitoring, Control and Maintenance of fluids.



But first it is necessary to confront the potential dilemma which arises from the vast range of sizes of metalworking production organisations. Large companies would be expected to have greater resources available for activities such as risk assessment, fluid monitoring, health surveillance and purchase of equipment. However, it is indisputable that the operators in a small company, perhaps with only two or three machine tools, must have no lesser expectation of a safe and healthy working environment than their counterparts in the large organisation. My answer to this is that the requirement for managing metalworking fluids need not involve long or complex tasks or even very expensive equipment. Reasonableness still prevails and I have encountered very good examples of control and maintenance in small companies where one well-trained and motivated person, using straightforward techniques was able to achieve excellent results. The key lies in management support and a well planned, structured approach with adequate documentation. My aim is that the information in this article can be adapted to be applicable in any size of organisation.

Testing of metalworking fluids

Appropriate tests to be carried out on water-mix metalworking fluids in use are set out below. For routine monitoring purposes a limited group of tests is usually all that is needed for each machine/system; these are highlighted in red as a general indication and may be carried out in-house with relatively simple equipment. A wider range of tests may be required if more in-depth information is needed, for example to investigate a problem.

Appearance.
pH.
Concentration.
Tramp oil content.
Test for microorganisms (bacteria and fungus).
Solids content (fines).
Corrosion resistance.
Biocide content.
Further microbiological tests, for example to identify the types of microorganisms present.

Monitoring tests for neat oils generally require the use of more specialised laboratory facilities and it is therefore advisable to consult your fluid supplier for advice.

Planning a monitoring programme for metalworking fluids. Follow a step-by-step approach:

1. Make an inventory of machine tools and associated systems using fluids.
2. Find out any information about problems experienced such as contamination, smells, poor fluid life, reduced tool life, reports of dermatitis or other health issues.
3. Define the machines/systems to be monitored. Note the type of fluid and volume in each.
4. Specify the tests to be carried on each machine/system and their frequency.
5. Set the control limits for each test to provide triggers for corrective actions and identify personnel responsible for initiating these actions.
6. Specify the method of sampling, sampling points and personnel who will take the samples.
7. Note the hazards such as moving machinery and other workplace hazards, assess the associated risks and put in place appropriate precautions.
8. Assess training requirements such as knowledge of hazardous chemicals, sampling procedures and use of personal protective equipment. Ensure that appropriate health surveillance is in place – see HSE guidance on this subject for details.
9. Consider the means of communicating/displaying the results from monitoring, including history, trends and corrective actions implemented.
10. Determine the feasibility of planning and implementing the programme using in-house resources. Will it be beneficial to make use of external service providers for part or all of the work?

Once the monitoring programme is in place, changes will only be needed when new machines/systems are added or control parameters altered. Practical advice to help you set up the monitoring programme is usually available from your fluid supplier who may also offer testing services or even a complete fluid management programme. Guidance provided by HSE has been mentioned earlier. See also guidance available from the Engineering Employers Federation at **www.eef.org.uk/metalworkingfluids**

Corrective Actions

In principle most of the corrective actions required to keep metalworking fluids in good condition can be carried out in house. However, determination of the most appropriate action is not always straightforward. For example, when a very high **bacterial count** is found from dip slide testing, it may seem reasonable to treat the fluid with biocide. Moreover, the result of such action may seem to have been completely successful when a low count is found following the biocide addition. But although bacteria are very small, when there are millions of them they do have a finite mass and the dead disrupted cells are still floating around in your fluid releasing substances which can be injurious to health. It follows that it is far preferable to control bacteria at a relatively low level, rather than going for a mass kill when their numbers have grown out of hand.

Another example arises in **concentration control**. If the fluid concentration has become far too high you could just add plenty of water. The trouble with this strategy is that the resulting emulsion may not be stable, especially if tramp oil was also present. The preferred practice of keeping concentration in control and adjusting when necessary by moderate additions of half strength emulsion will give much better results.

Tramp oil is more straightforward – at least you can see it and the techniques described later are effective in its removal. One unfortunate effect of tramp oil is that it seals off the fluid surface from the air when the machine is shut down. This allows the anaerobic bacteria (those that can thrive in an oxygen-free environment) to proliferate with production of sulphurous smells, blackening of the fluid and even complete separation of the emulsion.

Solids (or fines as they are sometimes called) are not easy to measure accurately on the shop floor using simple equipment. A rough measure can be obtained by allowing a sample of fluid to settle and estimating the volume of sediment which forms.

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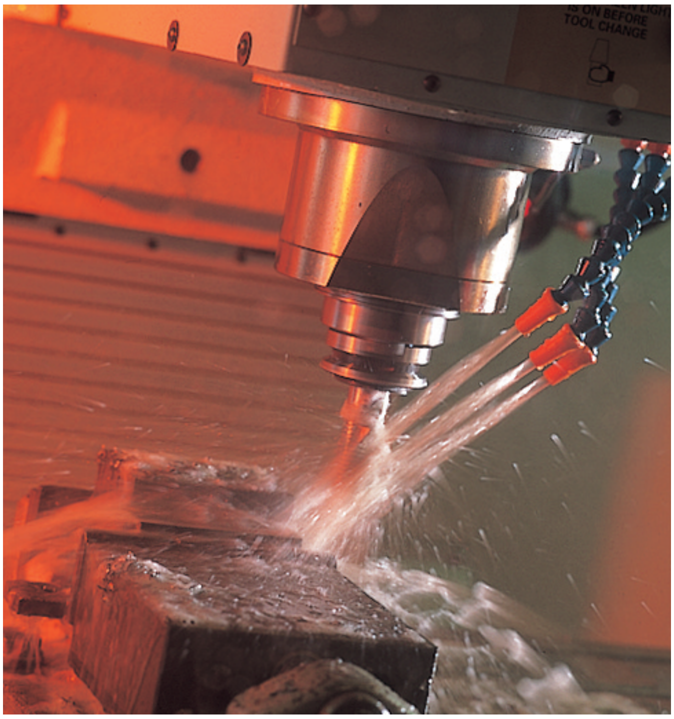

Although this will show gross variations in solids content, accurate measurement is a task for the laboratory. Equipment described later in this article can be used to maintain solids at very low levels, thereby protecting the health of operators and promoting consistently high quality.

Fortunately, maintaining concentration and general fluid condition go a long way to ensuring that pH stays in control. The **pH value** provides much information on fluid condition because growth of bacteria, low concentration, contamination and incipient separation may be signalled by a fall in pH. Specific additives can be used to restore pH to its correct value, but whether this is the right course of action is best decided by a specialist, taking into account the overall condition of the fluid.

Summarising the foregoing, decisions on corrective actions can be made in some cases by non-specialists, especially when operational experience with particular fluids is available. However, guidance from your fluid supplier is invaluable in avoiding the potential pitfalls. Make use of the knowledge and experience which are available by working in partnership with your fluid supplier.

"But I buy very little, who will bother to advise me?" is a reasonable question from a small user. My answer is that a good supplier will make sure that any customer, irrespective of size, has adequate information to ensure successful and safe use of metalworking fluids.

Fluid maintenance

The following paragraphs provide an overview of the methods used for maintenance of metalworking fluids. The aim is to acquaint readers with the types of equipment and processes available so that they can obtain more specific information from suppliers on the most appropriate choice for their applications.

Tramp oil skimmers come in a variety of configurations, most of which depend on a similar principle – oil is collected on a material which, owing to surface tension effects, has a greater affinity for oil than for the aqueous emulsion and then removed by physical means such as scraping or squeezing. The material may be in the form of a rotating disc, continuous belt, loop of tubular plastic or a mop, partially immersed in the fluid. The efficiency of the process is greatly improved if the skimmer is positioned at a point where the circulation of the fluid is slowed thus enabling oil to separate to the surface. An alternative design involves a container (separator) packed with plastic rings to which tramp oil adheres as the fluid passes through. Separate outlets enable clean fluid to flow back to the machining facility, while oil is collected in a container for disposal. In rolling mills or other large systems the mixture of fluid and tramp oil may be fed to the separator from floating suction heads.

Fines from ferrous metals may be removed by **magnetic separators** which are commonly fitted to grinding machines, the collected material being scraped off for disposal.

Weir systems are also used for removing high density fines.

Centrifuges are extremely effective in removing all types of fines. However, it is vital to empty the bowl in which the sediment collects regularly. If the bowl is overfilled not only does collection of fines cease, but the disc stack can become blocked resulting in a tedious manual cleaning process. A self-discharging centrifuge eliminates this problem by automatically emptying the bowl without the need to stop; however, such machines have a higher capital cost. Centrifuges are also capable of removing tramp oil from water-mix metalworking fluids.

Hydrocyclones (which have no moving parts) work on the same general principle as centrifuges, accelerating the effect of gravity by centrifugal force, to separate solids from fluids.

Removal of solids from metalworking fluids by **filtration** is carried out using paper, fabric and mesh filters.

Paper filters may be in the form of rolls (which are moved on automatically to expose a fresh filtration surface), sheets (used in plate and frame filter presses) or as pleated paper cartridges. Selection of the most suitable type depends on the quantity of solids to be removed and the degree of cleanliness required.

Paper roll filters and filter presses can remove much heavier solids loadings and are found on larger systems. Cartridge filters, with their much more limited dirt capacity, are more suitable for individual machine tools where cleanliness is critical. They are also useful for secondary filtration when the main bulk of solids have been removed. For neat oils which have become contaminated by moisture 'blotter' cartridges are available which absorb water as well as ensuring a high degree of cleanliness. Cartridge filters must be discarded when their dirt capacity has been reached and are relatively costly, being reserved for critical applications.

Fabric filters are available in rolls, as specially designed double sheets to fit recessed plate filter presses and in bag form supported in a cylindrical container.

Rotary drum filters, some models of which operate under vacuum, are capable of continuously removing substantial solids loadings from the fluid. They are available in a range of capacities, the largest serving major machining facilities.

Mobile filtration units can be wheeled from machine to machine, removing the contents of the sump (swarf and metalworking fluid) by suction. The fluid is filtered and returned to the machine using the onboard pump. Mobile units also enable the fluid to be held during thorough cleaning of the machine tool coolant system.

Some processes, such as cold forming in the manufacture of fasteners and seamless tubes, generate large quantities of fine, dense solids in the form of a 'sludge' which may require treatment in two stages, the first to remove the bulk of solids and the second stage to achieve the desired degree of cleanliness.

Many of the units for the foregoing treatments operate automatically and units combining more than one of the methods are available, for example magnetic separation and filtration. A further option is to incorporate fluid cooling into the treatment process. Complete turnkey installations for coolant treatment and swarf handling are also available.

Control of microorganisms (bacteria and fungi) is mainly effected by use of biocides although a number of physical methods are available or being developed. Some water-mix metalworking fluids contain a biocide (or biocides) in the concentrate as supplied, whilst others depend upon the inherent resistance of the constituents of the formulation to microbiological spoilage to protect the emulsion in use. 'Tankside' additions of biocide may be found to be necessary during service to maintain resistance to spoilage. Such additions should be based on the outcome of monitoring tests and made accurately by trained personnel.

Good fluid management practice, with correct control of concentration, offers a degree of protection against microbiological spoilage by ensuring that pH is maintained. The extent to which pH is an effective means of control of microorganisms is the subject of current research.

Alternative or complementary methods for control of microorganisms which have been investigated for use in water-mix metalworking fluids include exposure to heat, ultraviolet radiation, ozone, silver, ultrasound and bacteriophages. Although I have personal experience of trialling ultrasound as a means of sterilising metalworking fluids, I do not know whether these alternative methods have extensive application.

Following the large outbreak of respiratory diseases at the Powertrain plant, which are believed to have been associated with used metalworking fluids containing bacteria, research is being carried out with the objective of achieving a more fundamental understanding of the cause(s) of these disorders.

A specific group of metalworking fluids known as Bioconcept fluids are formulated to operate with a controlled population of 'friendly bacteria' which are intended to discourage the proliferation of undesirable bacteria. Good fluid management is still required for these fluids.

Although not strictly within coolant maintenance, **removal of airborne pollutants** is vital in achieving a safe workplace environment. Steps should be taken to minimise the creation and release of mists. The process should be enclosed and effective extraction provided where appropriate. Work processes which create mists in the workplace, such as the use of compressed air to blow down components, should be avoided where possible. Equipment is available to remove any combination of oil mist, fumes, odour and particulates from machining processes.

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Chairman of the Metalworking Fluids Product Stewardship Group

LINK
www.ukla.org.uk/MWFPS1.htm