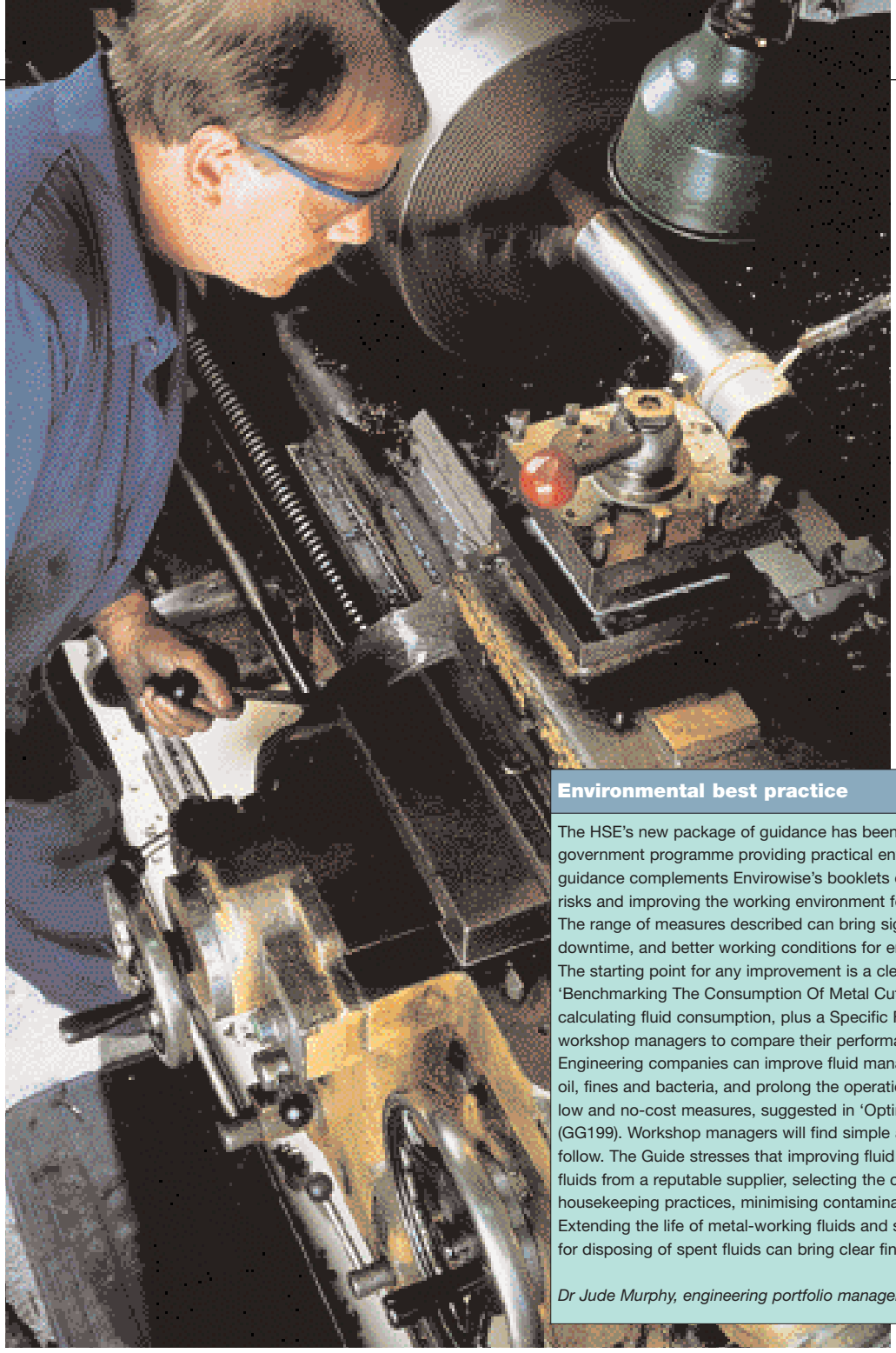


"There is an association between MWFs and dermatitis, bronchitis, and asthma"

Environmental best practice

The HSE's new package of guidance has been developed with the help of Envirowise, a government programme providing practical environmental advice for business. The HSE's guidance complements Envirowise's booklets on MWFs, which are aimed at reducing health risks and improving the working environment for employees, as well as improving profitability. The range of measures described can bring significant cost savings, reductions in machine downtime, and better working conditions for employees.

The starting point for any improvement is a clear picture of current performance. 'Benchmarking The Consumption Of Metal Cutting Fluids' (EG179) provides guidance on calculating fluid consumption, plus a Specific Fluid Consumption Benchmark table to enable workshop managers to compare their performance with that of others.

Engineering companies can improve fluid management, reduce the contamination from tramp oil, fines and bacteria, and prolong the operational life of cutting fluids through a number of low and no-cost measures, suggested in 'Optimising The Use Of Metalworking Fluids' (GG199). Workshop managers will find simple advice and practical examples that they can follow. The Guide stresses that improving fluid management depends on using good-quality fluids from a reputable supplier, selecting the correct fluid for the application, applying good housekeeping practices, minimising contamination and monitoring fluid condition regularly. Extending the life of metal-working fluids and selecting the appropriate cost-effective method for disposing of spent fluids can bring clear financial and environmental benefits.

Dr Jude Murphy, engineering portfolio manager, Envirowise

Managing health in METAL-WORKING

The UK engineering industry employs up to 200,000 workers, many of whom come into regular contact with metal-working fluids, which are used to cool and lubricate machinery. There are various health concerns associated with MWFs but they are generally treated with scant regard by the industry. This situation has prompted the HSE to launch good practice guidance on the use of MWFs. Martin Stear explains the reasons why.

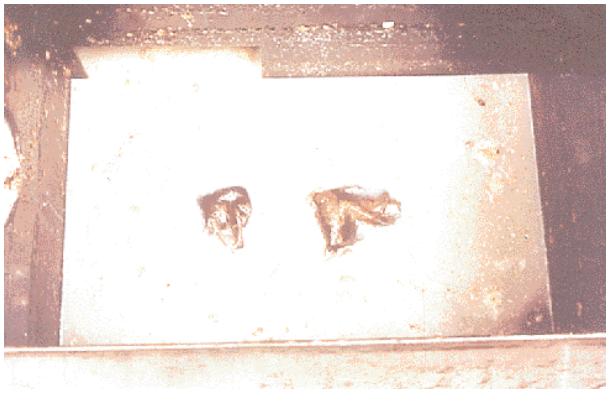
The 50,000, or so companies that operate engineering workshops in the UK range from SMEs through to multi-nationals, where manufacturing may involve one-off single components with a high degree of operator input, to fully automated plants, putting together large components, like car engines. A wide range of machining methods is used to shape and cut parts to the desired form. All of these methods create heat and so require cooling and lubrication. The family of fluids that provides this cooling and lubrication is called metal-working fluids. MWFs also prolong the life of the tool, carry away debris, and protect the surfaces of the work pieces. They are held in a machine sump, pumped to the machining point and run back to the sump. MWFs can be divided into two

main categories: neat mineral oils and water-mix fluids. The water-mix fluids can vary considerably in composition but may be further classified into mineral oil emulsions, semi-synthetic and synthetic fluids.

Health concerns

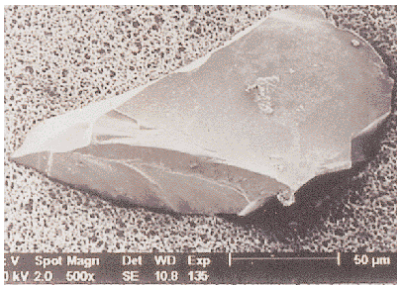
The main health problem associated with MWFs is dermatitis. Every year, around 200 cases of contact dermatitis – related to exposure to cutting oils and coolants – are reported to EPIDERM (a scheme under which dermatologists record cases of occupational skin disorders). The true number of cases is almost certainly higher, however.

There is also an association between exposure to these fluids and respiratory effects, including bronchitis and asthma. In recent years (1992-1997), an annual average of 22 new cases of occupational asthma related to exposure to cutting oils has been reported through SWORD (Survey of Work-related and Occupational Respiratory Disease). It is not known to which fluid type(s) these cases are related and, because of the confidentiality arrangements within which SWORD operates, it is not possible to investigate this aspect further.



machine fluid sump with food debris (teabags)

MWFs are an important part of the machining process but they are often treated with little regard. The machine sumps containing these fluids are sometimes used as rubbish dumps for unwanted food debris and cigarette stubs, and are even occasionally used as urinals. The abused metal-working fluids thus become a rich breeding ground for bacteria. Biocides are often added to combat this but the surviving bacteria quickly grow and the dead bacteria release endotoxins, which can produce a variable flu-like response and reduce lung function. In addition, exposure may exacerbate symptoms in those with pre-existing asthma. Bacteria and endotoxin contamination in MWF may also contribute to allergic contact dermatitis. Heavy bacterial contamination in MWF can deplete oxygen in the sumps, allowing sulphate-reducing bacteria to grow and release hydrogen sulphide, causing the 'rotten egg' or 'Monday morning' smell when machines are started after sumps have been left static for some time.



Electron micrograph of a metal fine

Metal machining produces metal waste, swarf and fines, which wash back in to the fluid sump. These are carried back to the machine tool with the next cycle, get on to surfaces and workers' hands. Fines appear to be nothing more than fine metal dust but they are actually tiny sharp pieces of metal (see picture), like tiny daggers that can scratch the workers' skin, the machine tool, or component. Depending on the alloys used, toxic metals (e.g. chromium, nickel and cobalt) can leach in to the fluid from the swarf and fines, finding its way in to the mist the workers breathe. The fluid can be too acidic or alkaline, contain too much concentrate or additives, and so on. All this can lead to dermatitis and respiratory ill health.

When metal-working fluids are managed effectively, however, the risk to health is minimised and the profitability of the business can be increased because using MWFs:

- decreases fluid purchase and disposal costs;
- prolongs the life of the fluid;
- reduces machine downtime;
- increases tool life; and
- improves machining performance.

Occupational exposure study

These concerns largely came to light in the late 1990s when the HSE carried out, in conjunction with the Health and Safety Laboratory, a study of occupational exposure to MWFs at 31 engineering companies. The HSE's National Engineering Group was the driving force behind this work and its inspectors selected a wide range of sites to reflect the broad spectrum of companies using MWFs.

New air-sampling techniques were used to measure workers' exposure to mineral oil and water-mix metal-working fluid mist (now published as *Methods for the Determination of Hazardous Substances* – MDHS 84 and 95, respectively). Information was also collected on the fluids and processes used, and on control procedures, in order to ascertain current practice in controlling exposure. In addition, fluid samples were taken from machine sumps to measure for bacteriological content, endotoxins, fines levels and other contaminants.

The highest mineral oil personal sampling result out of the 40 taken was 3.7 mgm^{-3} 8-hr TWA, with 90 per cent of results below 2.8 mgm^{-3} 8-hr TWA. The results for personal exposure to water mix MWF mist (298 samples) went as high as 13 mgm^{-3} 8-hr TWA, with 90 per cent below 0.8 mgm^{-3} 8-hr TWA. High bacteriological contamination and endotoxin levels were found in many sumps – up to $1.9x10^{8}$ colony-forming units/ml and up to $1.8x10^{6}$ endotoxin units/ml, respectively.

Proposals for the values to be included in the new HSE guidance (see below) were based on these results. Industry was consulted on the proposed values, which were found to be similar to many in-house limits adopted by UK engineering companies. They are not health-based, as the HSE was unable to determine a 'safe level' for airborne mist levels, or bacteriological contamination for what are complex mixtures. Rather, they represent good practice. The values published in the guidance are 3 mgm^{-3} 8-hr TWA for neat oil mist and 1.0 mgm^{-3} 8-hr TWA for mists arising from water-mix MWFs. Full details on what constitutes acceptable and unacceptable levels of bacteria, endotoxins and fines in sumps are also contained in the guidance.

Poor control

So why do so many users manage their fluids so badly? Is it simply because they are not seen as an important part of the machining activity? Or because good fluid management requires time, which many companies, particularly SMEs, haven't got? One general conclusion from the survey was that management of sump conditions was variable, but frequently poor. There was a number of pointers to poor control, many of which can have an impact on performance as well as health concerns. For example:

- Control of fluid strength was outside optimum performance limits, and on-site estimates of actual strengths were often very wide of the mark;
- Schedules for replenishing and cleaning sumps were often sporadic and arbitrary;
- Fluid monitoring was inadequate;
- Swarf and fines removal was irregular (there were reports of operators putting their bare hands into sumps to scoop out fines);
- Contamination of water-mix MWF with tramp oil (e.g. escaped lubricating oil from machines) was found.

Information on recent incidences of ill health was collected. The commonest reports (13) were of dermatitis or skin irritation, followed by effects on the respiratory tract (irritation, wheezing) and, in one case, chronic flu-like symptoms. These reports were anecdotal and relied on the willingness of workers/supervisors to report health issues, so under-reporting is likely. They do, however, represent approximately half of the sites visited.

Although there were varying degrees of poor fluid management across most companies there were also some

positives, with a handful of firms able to show they were effectively managing their fluids. These companies showed that metal-working fluids can be managed and this can not only reduce the risk of ill health but also increase the profitability of the business.

For example, when one Manchester foundry, operating 30 stand-alone milling, drilling, CNC and turning machines, changed to a higher-quality fluid more suitable for its application, it found that tool life increased by 20 per cent, cutting speed could be increased by 15 per cent, production went up by 20 per cent, and breakdowns and machine downtime were reduced. At the Birmingham site of Wild Manufacturing Group Ltd, which produces 10 million metal components daily for the automotive, aviation and electronics industries, simple improvements to the fluids regime increased tool life by 300 per cent and significantly extended fluid life. The changes included introducing regular checks of appearance, pH, refractive index and microbial activity.

Occupational Exposure Limits – a new approach

The results of the HSE's study were reported to the Advisory Committee on Toxic Substances (ACTS) as part of the review of the Occupational Exposure Standard (OES) for oil mist. The current occupational exposure limit for mineral oil mist comprises OESs of 5mgm^{-3} 8-hr TWA, and 10mgm^{-3} 15-min TWA. However, ACTS concluded at its March 2000 meeting that this OES should no longer apply to mineral oil metal-working fluids, given the potential for substantial variability in their composition and for contamination during industrial use. The Committee also felt that it was not possible to derive revised OES values for mineral oil metal-working fluids owing to the absence of evidence for a level of inhalation exposure, which would not cause any health effects, that would be applicable to all possible compositions of such fluids. (ACTS recommended, though, that the OESs should remain in place for other, non-metalworking applications of mineral oil.) The Committee further concluded that no occupational exposure limit could be derived for water-mix metalworking fluids, for the same reasons.

If, after consultation, the HSC agrees to remove metalworking fluids from the scope of the OES, this change is likely to appear in *EH40/2003: Occupational Exposure Limits 2003*. In the meantime, there is a need for a new source of standards for control. The HSE's major new package of guidance, *Metal-working Fluids Good Practice Reference Manual*, aims to fulfil that need. It has been developed with the help of industry trade bodies who represent the fluid and machine suppliers, the relevant trades unions, employers' representatives, as well as Envirowise, a government programme which provides practical environmental advice for business. The guidance pack includes laminated task sheets for operators and, as explained above, a guidance value for airborne neat oil and water-mix MWF mist levels and sump fluid contaminants. There is also a poster, monitoring charts and many more user-friendly materials.

The new guidance aims to achieve *Revitalising Health and Safety* targets by helping the engineering sector improve standards of control, thereby reducing the cases of work-related ill health and the number of working days lost. Most of the information is not new, but the way in which it is presented, together with existing guidance such as the Envirowise booklets, should help users both improve the occupational health effects of exposure to MWFs and follow environmental best practice. SHP

About the author

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