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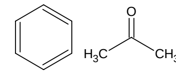
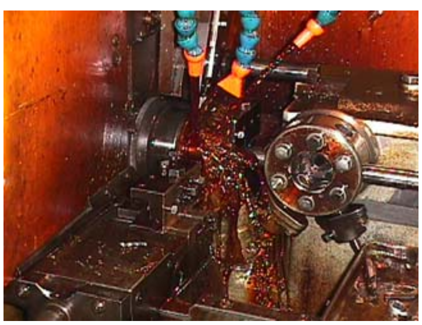


Recognition, Evaluation & Control

Environmental Health Newsletter December 2009

Metal Working Fluids (MWFs)

Metal Working Fluids (MWFs) are widely used in many industries during machining and grinding operations. Other terms used for MWFs include cutting fluids, cooling oils and lubricating fluids. They have two primary functions- to cool and to lubricate. When metal is removed during machining and grinding, large amounts of heat are generated. To prolong tool life MWFs carry away heat from the point of contact between the tool and the work piece. Lubrication reduces friction which also prolongs tool life and results in better cut finishes. Secondary functions of MWFs include carrying away cutting chips and debris known as swarf and protecting the work surfaces from corrosion. Workers exposed to MWFs have increased risk of respiratory and skin diseases.



Classification of MWFs

There are four classes of MWFs. These include:

- Straight Oils
- Soluble Oils
- Synthetic Fluids
- Semisynthetic Fluids

The classification is based on the nature of the MWF, its use, dilution potential with water and commonly used additives.

Straight oils are mineral (petroleum) or vegetable oils that are not diluted with water before use. MSDSs commonly refer to them as “severely refined” or “severely hydrotreated”. This is a refining process that is done to remove natural cancer causing agents known as polynuclear aromatic hydrocarbons (PAHs) that are present in crude oil. Straight oils may have additives that help prevent corrosion. They are generally used in older machines and in applications with slower cutting speeds since they are generally used for lubrication rather than cooling.

Soluble oils are also called emulsified oil. They contain 30-85% severely refined oil and emulsifiers that help disperse the oil in water. They are supplied as concentrates that are diluted with water. They provide good lubrication and better cooling than straight oils but may provide poor corrosion control.

Semisynthetic fluids contain lower amounts of severely refined base oil (5-30%). They are also supplied as concentrates that are mixed with water in the final MWF. They provide good lubrication, heat reduction and rust and corrosion control.

Synthetic fluids do not contain any petroleum oil and are detergent-like fluids that wet the part and include other additives that improve the performance of the fluid. Synthetic fluids are diluted with water and are usually the best fluids for heat reduction. They are usually the cleanest type of fluid and offer longer sump life than other fluids.

MWFs contain other substances designed to improve the qualities of the fluid. These include:

- Emulsifiers
- Stabilizers
- Corrosion Inhibitors
- Biocides
- Fragrances
- Extreme Pressure Additives

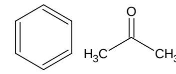
Exposure and Health Effects

Exposure to MWFs can occur through inhalation or dermal contact. Skin contact occurs when employees dip there hands into the fluids and when employees touch parts, tools and equipment covered with fluids.

Skin contact can also result from fluid splashes if the machine is not guarded and from contact with oil soaked rags.

Inhalation exposure results from breathing MWF mist or aerosol. Mist and aerosol formation is caused by a number of factors. These include:

- The pressure and flow rate of the fluid
- Splash guarding
- The type of MWF



- The size and type of MWF delivery nozzle
- Pump size and condition
- The MWF temperature
- Tool velocity and speed
- Exhaust ventilation systems
- Amount of entrained air
- System filtration
- Fixture and part configuration

The increased use of high speed tools and high fluid pressures have been major causes of increased MWF aerosol generation.

Dermatitis from MWFs can be caused by a number of components of the fluid. It is often unclear which components of the fluids create these conditions but they may be caused by specific chemical additives, contaminants introduced into the MWF during use or by microbial growth or degradation or combinations of these factors. Other factors include clothing contaminated with MWFs, poor personal hygiene, poor house keeping, metal shavings contained in the fluid and tramp oils. Tramp oil is hydraulic oil, gear oils, greases and other oils that accidently leak into the MWF from the metal working machinery and thus contaminate it. Employees working with water based, synthetic and semi synthetic MWFs are at higher risk for contact dermatitis than those who work with straight oil.

Inhalation of MWF mists and aerosols can cause respiratory, throat and nose irritation. Exposure can also aggravate existing lung disease. Symptoms include sore throat, red, watery itchy eyes, runny nose, cough and cold-like symptoms. Respiratory conditions attributed to MWFs include:

- Asthma
- Chronic bronchitis
- Hypersensitivity pneumonitis (HP)

Asthma involves inflammation of the airways reducing airflow and causing shortness of breath. Studies have shown that workers exposed to synthetic and soluble MWFs are at higher risk of asthma than those exposed to straight oils. Asthma appears to be caused by ethanolamine; other amines; pine oil; metals including chromium and nickel, which are produced from the base metal that is machined; formaldehyde; chlorine; acids and microbial endotoxin.

Chronic bronchitis is inflammation of the main airways in the lungs while HP is a disease characterized by coughing and flu-like symptoms that may develop into a chronic phase with lung scarring and permanent lung damage. HP has been associated with synthetic, semisynthetic and soluble MWFs which are all water based. Microbial contaminants in the MWFs are postulated as the most likely cause of these outbreaks.

A number of recent studies have found an association between MWF and a variety of cancers including cancer of the rectum, larynx, skin, scrotum and bladder. These studies have relied on the work history of workers which had been exposed many years ago. Since the 1980's, the composition of MWFs has changed drastically and more refined oils are used and many other potentially hazardous chemicals have been removed for health concerns. It is likely that these changes have reduced the cancer risk but the data is insufficient to conclude that all cancer risk has been eliminated.

Water based MFW are excellent nutritional sources for bacteria and fungi. Anaerobic bacteria may produce hydrogen sulfide and disagreeable rancid odors are indicators of a microbial problem. Mold growth can produce musty odors and fungi can produce slime that clogs orifices and transfer lines. Poor hygiene and housekeeping practices can contribute to the problem. Workers discarding food scraps, cigarette butts and trash into the cooling system are a major contributor to microbial problems.

Controls

Control of hazards associated with MWFs involves establishing a MWF management program, conducting exposure monitoring and providing employee training. An employee should be designated as the coordinator of the program with overall responsibility. A written standard operating procedure (SOP) should be established as part of the program and should include:

- Evaluation and selection of MWFs
- Procedures for testing and maintaining fluids
- Procedures for adding biocides and other additives to fluids
- Schedules for replacing and recycling fluids
- Use of Personal Protective Equipment (PPE)
- Maintenance and use of ventilation systems
- Procedures for conducting exposure monitoring
- Hazard Communication and employee training
- Recordkeeping

Fluid Maintenance

The key element of the MWF management program is fluid maintenance. Water based MWFs are designed to be used at a given concentration. This provides optimal cutting performance, cooling, corrosion resistance and resistance to microbial activity. Operating with too low a concentration decreased tool life and may result in growth of microbes. Too high a concentration may result in dermatitis, foaming and formation of residues. Actual machine concentrations should be checked frequently and adjusted as needed with pure water, concentrate or premixed fluid.

Biocides are added to MWFs to prevent or retard growth of bacteria and fungi. Only the concentration needed to meet the fluid specifications should be used. Adding too much biocide can lead to skin or respiratory irritation of workers. All parts of the system should be thoroughly cleaned when replacing MWFs to prevent microorganisms from contaminating the new fluid. Biofilms may be difficult to remove using normal cleaning methods and steam cleaning and use of commercial disinfectants may be required. Buildup of chips and metal fines in pipes and sluices provide excellent areas for bacterial growth. Periodic removal of this material will minimize the potential for bacterial growth and extend MWF life.

Tramp oil is introduced in MWFs from leaking machine hydraulic systems and lubricating oils. Tramp oil provides food for microbes and reduced fluid life. Regular machine maintenance will help reduce accumulations of tramp oil. Hand skimmers and separators can also be used to remove tramp oil which floats on the surface of the MWF when systems are not operating. Good housekeeping and training so employees do not throw debris into the tool sumps is also required.

Work Practices

Work practices can be used to help reduce employee exposure to MWFs. Whenever possible employees should avoid contact with MWFs. MWFs should not be allowed to accumulate on work surfaces. Clothing and rags should be regularly cleaned and laundered. Clothing that becomes soaked with MWFs should be changed immediately. Aprons and gloves should be used as necessary. When gloves are used, they must be used with great caution around moving parts and machinery. Employees should observe good personal hygiene and wash hands thoroughly at each break and when leaving at the end of the day. Employees should be encouraged to report any signs of skin irritation or dermatitis at the earliest stage so preventative measures can be made before a more critical skin condition develops.

Employees should be trained and instructed on personal hygiene practices as well as how to minimize exposure to MWFs. Hazard Communication training should also be provided.

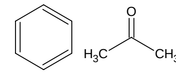
Engineering Controls

Engineering controls should be used as the primary means of reducing employee exposure to MWFs. Proper application of MWFs should eliminate splashing and mist generation.

Newer machines usually have doors and guarding that cover the working parts of the machine tools. These are effective in isolating the operator from the MWFs. Older equipment does not have these controls and splash guards may need to be fabricated to shield the operator from MWF splashes. Other controls include:

- Applying MWFs at the lowest possible pressure and volume that still cools and lubricates the part as necessary
- Apply MWFs so that contact with rotating equipment is minimized
- Cease fluid delivery when not performing machining
- Do not allow MWFs to flow over unprotected hands when loading or unloading parts from the machine
- Cover sumps and return trenches

Local exhaust ventilation systems may also be used to control mist and aerosol exposure. The exhaust hood should be located as close as possible to the source of emission so contaminants are collected at the source. The hoods should be connected to mist collectors that are designed for MWF aerosols.



Exposure Limits

When air sampling is done to evaluate employee exposures to chemical agents, the results need to be compared to standard so the degree of risk can be determined. There are a number of exposure limits that results can be compared to and it is important to understand exposure limits, their basis in science and the limitation of data when comparison to exposure limits is made when sampling is conducted.

The ACGIH (American Conference of Governmental Industrial Hygienists) TLV (Threshold Limit Value) Committee publishes exposure limits for selected chemicals annually. The ACGIH consisted of professionals employed by the government and academia but also solicits input from industrial specialists. The list of TLVs is prepared only for industrial hygienists and professionals, who can exercise their own professional judgment in applying the values and are not to be used for legal purposes.

The goal and philosophy of the TLVs is that these values "are airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects". It is important to note that because of variations in individuals, a small number of workers may experience discomfort from substances below the threshold limit. A few workers may be more seriously affected because of aggravation of preexisting conditions or because of an occupational illness, genetic factors, medications or unusual responsiveness due to hypersensitivity. These considerations must always be taken in account when applying TLVs or any exposure limit to a specific case or situation.

TLVs are based on the best available information from industrial experience as well as human and experimental testing. If possible, exposure limits are based on a combination of these sources. The rational for establishing a TLV differs from substance to substance. Protection from impairment is used for some while freedom from irritation, nuisance and stress are the basis for others.

OSHA has about 400 PELS (Permissible Exposure Limits). These limits were adopted in 1970 when OSHA came into existence and came from the list of 1968 TLVs which were adopted into the standard. They can be found in the Air Contaminants Standard (29 CFR 1910.1000). By 1989 many of the PELS were way out of date with the most recent hazard information that was available. OSHA updated the PELs at this time. There were many legal challenges to the updated PELS. These resulted in a US court of Appeals throwing out the 1989 PELs so the PELs reverted back to the 1968 TLV values. The outdated PELs have been an ongoing issue that OSHA is still trying to address.

Good industrial hygiene practice and risk management involves making decisions on the best available data. The OSHA PELs for most substances are over 40 years old and are out-of-date with the most current toxicological information and health data. The ACGIH TLVs are published on a yearly basis and reflect the most recent toxicological data for a particular substance based on industrial experience, and experimental studies. The ACGIH TLVs, for the most part, are lower than the OSHA PELs and reflect the most up-to-date information concerning health effects for a particular substance. Once in a while substances that do not have published TLVs or OSHA PELs are encountered. In the absence of these exposure limits, other exposure criteria should be used. These include the National Institute of Occupational Safety and Health (NIOSH) Recommended Exposure Limits (RELs), American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Level Guides (WEELs) or recommended exposure levels established by the chemical manufacturer.