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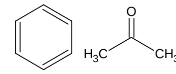
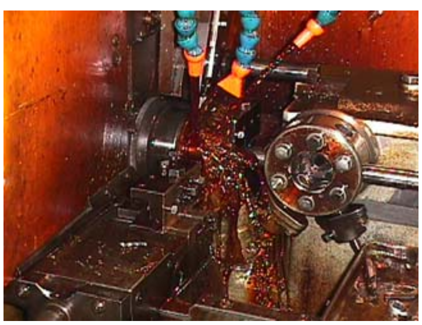


Recognition, Evaluation & Control

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

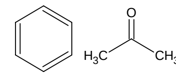
Exposure and Health Effects

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.

The most common skin disease associated with MWFs in contact dermatitis. There are two types of contact dermatitis. These are irritant contact dermatitis which is confined to the area contacted by the irritating agent and allergic contact dermatitis which manifests itself beyond the area of direct contact with the MWFs. A study conducted by NIOSH (National Institute of Occupational Safety and Health) found that 14 to 67% of employees exposed to MWFs are at risk for developing dermatitis.

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.

Exposure Limits

The ACGIH (American Conference of Governmental Industrial Hygienists) TLV (Threshold Limit Value) and OSHA PEL (Permissible Exposure Limit) for mineral oil mist is 5 mg/m^3. These exposure limits are only applicable to straight oils as defined above. To reduce potential respiratory problems associated with all MWFs including oil and water based fluids, NIOSH has a Recommended Exposure Limit (REL) of 0.4 mg/m^3 for thoracic particulate mass (the fraction of aerosol that penetrates below the larynx in the respiratory system), or 0.5 mg/m^3 as total particulate as a time weighted average (TWA) for up to 10 hours per day for a 40 hour work week. The NIOSH REL encompasses exposure to all types of MWFs and is the most conservative exposure limit and is more applicable to most exposures to MWFs since many are now water based products and not straight oils.

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. Period 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.

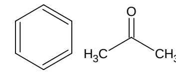
Good housekeeping and training so employees do not throw debris into the tool sumps is also required.

MWF Separator

Special equipment such as centrifuges to remove MWFs from chips and oil/water separators are often used in fluid maintenance areas. MWFs are recycled by these systems.

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

If exposures to MWFs are above the exposure limits, mist suppressants may help reduce exposure. These compounds enlarge the size of mist droplets so they don't remain suspended in air as long. 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.

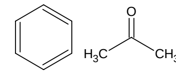
Evaluating Metal Working Fluid Exposures
When evaluating operations involving machining and metal working, loss control staff should be aware of exposures and controls relating to MWFs. Has past lost data showed problems with dermatitis or skin related conditions? Have there been respiratory claims? What types of MWFs are used- straight oil, soluble oil, semisynthetic, synthetic? Obtain copies of the MSDSs for MWFs used at the facility if there is a question about the type of MWF used. Does the company have a written fluid maintenance program? Is there a dedicated trained employee who tests the MWFs at the machines and is responsible for adding biocides and concentrate to the fluid as necessary? Keep in mind that if employees test and maintain MWFs at their own machines there are more employees handling chemicals and it is highly likely that they may not be handled or mixed properly. Have there been employee complaints concerning respiratory irritation or rancid or musty odors at certain machines or in certain areas? Has the account ever had exposure monitoring for MWFs? If, so get a copy.

What type of PPE is used by employees at the machining and metalworking equipment? Is the PPE clean and in good condition? Do employees wear uniforms that are regularly laundered? Do employees place their hands in the cutting fluid when loading/unloading parts from the machines? Does equipment have doors and covers that limit exposure and isolate the operator from exposure? Is there a local exhaust ventilation system or mist collectors at the machines? How is housekeeping? Are there large amounts of MWFs on the floor, equipment and tools handled by employees? Is there a HAZCOM Program and are employees trained in the hazards of MWFs and how to limit potential exposure?

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 during sampling.

Exposure limits grew out efforts in the early part of the 20th century to control hazards associated with



toxic materials. The process was fragmented with regulations developed through state agencies, labor unions and social reformers. In 1941 the ACGIH (American Conference of Governmental Industrial Hygienists) developed the TLV (Threshold Limit Value) Committee. The ACGIH consisted of professionals employed by the government and academia but also sought input from industrial specialists. In 1946 this committee published a list of 144 substances with their Maximum Allowable Concentrations. This list developed into the TLVs of today. The list of TLVs was prepared only for industrial hygienists, who could exercise their own professional judgment in applying the values and were not to be used for legal purposes. Revisions of the list occurred each year as information and studies became available to the committee.

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.

Originally, TLVs were primarily derived from human data with only a smaller number derived from animal studies. By 1992 almost 50% were derived from animal studies. Of the values derived from human exposure, most are derived from observations of workers who were exposed for many years. Observations of human responses based on exposure data are the basis for these TLVs. More recently, most TLVs for new chemicals are based on animal studies. Originally, most TLVs were established to prevent irritation and more acute effects of exposure. By 1993 50% were based on longer term systemic effects and 5% to prevent cancer.

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.

Since the OSHA PELs are static and have not kept pace with the annual updates to the ACGIH TLVs this leads to issues regarding application of these values when we do air testing at General Casualty. It is important that Loss Control Staff understand the difference between the TLVs and PELs and our company philosophy when applying these limits to exposure monitoring results.

Many of our accounts are concerned about OSHA compliance. That’s why we include reference to the OSHA PELs in our reports. 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. Therefore, exposure data in EH reports are also compared to the ACGIH TLVs but recommendations are based on the best available data which will usually be the ACGIH TLVs. Once in a while we run into substances that do not have published TLVs or OSHA PELs. In the absence of these exposure limits, other exposure criteria will 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.

Another issue that we sometimes run into are states with their own OSHA state plans. If a state has its own OSHA plan, they are required to develop standards that as a minimum meet federal OSHA standards. Most state OSHA PELs are the same as the federal PELs but that is not always the case. In Minnesota, for instance, state OSHA reduced the PELs in 1989 when federal OSHA reduced the PELs. When the federal PELs were thrown out by the courts and reverted to the 1968 values, Minnesota left the 1989 PELs in place.

We also run into MSHA (Mine Safety and Health Administration) regulations for quarries and surface mines we insure. MSHA came into existence in 1977 when many types of mines covered by a variety of laws were consolidated into one regulatory agency. MSHA's PELs are the same as the federal OSHA PELs. OSHA and MSHA have an interagency agreement that clarifies authority of the two agencies. As a general rule, MSHA has authority on mine sites and milling operations. However, where MSHA does not have standards that apply to a particular working condition or hazard, the OSHA act applies. OSHA also has authority over an employer who has control of working conditions at a mine site if that employer is neither a mine operator nor an independent contractor and it is more effective in citing this employer to correct conditions at the mine site.