Metal Working Fluids

Metal working fluids (MWFs), also called cutting fluids, cutting oils, or lubrication fluids, are widely used during machining and grinding of metal parts. These fluids reduce friction, which prolongs tool life; carry away debris; and protect the surface of the work pieces. Workers can be exposed to MWFs by inhaling aerosols (mists) and by skin contact with the fluids. Employees exposed to MWFs have an increased risk of respiratory and skin diseases.

Classification of metal working fluids

There are four types of MWFs. These include:

- **Straight oils (neat oil)** are severely refined petroleum oils or animal, marine, vegetable, or synthetic oils used singly or in combination with or without additives. These oils are not diluted with water.
- **Soluble oils (emulsified oil)** are combinations of 30% to 85% severely refined petroleum oils and emulsifiers that may include other additives. Soluble oils are diluted with water at ratios of 1 part concentrate to 5 to 40 parts water.
- **Semisynthetic MWFs** contain lower amounts of severely refined petroleum base oil in the concentrate (5% to 30%), a higher proportion of emulsifiers, and 30% to 50% water. The MWF is diluted with 10 to 40 parts water.
- **Synthetic MWFs** contain no petroleum oils and may be water soluble or water dispersible. The synthetic concentrate is diluted 10 to 40 parts with water.

Occupational exposures

Inhalation and skin contact with MWFs occurs during machining operations. Inhalation results from breathing MWF mist or aerosol caused by a number of factors. These include:

- Worker proximity to the operation
- High tool speed
- Deep cuts
- High MWF pressure
- Excessive fluid application
- Contamination of the fluid
- Improper fluid selection for the application
- Fluid maintenance

Skin contact occurs in a number of different ways. These include:

- Dipping hands in the fluid
- Flooding the machine
- Handling tools, parts and equipment covered with fluid
- Lack of personal protective equipment (PPE)

- Lack of splash guards on the equipment

MWFs may contain a wide variety of chemical additives and contaminants that can create adverse health effects. These additives include:

- Process chemicals
- Contaminants from metals and alloys being machined
- Water and cleaning agents used for routine housekeeping
- Tramp oils such as hydraulic and lubricant oils accidentally introduced from the machines
- Bacterial and fungal endotoxins produced by microbial growth in the MWF

Water-based lubricants are excellent nutritional sources for bacteria and fungi. Anaerobic bacteria may produce disagreeable odors and toxic gases as they grow in MWFs. Endotoxins produced by microorganisms may cause respiratory effects in some workers. Biocides are typically added to MWFs to control microbial growth. These biocides can pose a health threat especially if used in excess of recommended quantities.

Skin diseases

Workers exposed to MWFs suffer high rates of skin diseases including oil acne, irritant contact dermatitis, and less frequently allergic contact dermatitis. There are many factors causing dermatitis. These include:

- MWF class
- Amount of skin contact with MWFs
- Skin abrasion
- Individual susceptibility
- Personal hygiene
- Use of PPE
- Engineering controls
- Housekeeping
- Reuse of oil soaked clothing or rags
- Climate (heat, humidity)
- Dermatitis prevention

Early intervention and treatment can reduce the incidence of dermatitis and its severity. Employees should be instructed to immediately report any skin conditions. Other control measures include:

- Substitute less irritating additives to MWFs.
- Modify operations and equipment to reduce dermal contact with MWFs.
- Proper maintenance of MWFs
- Use of gloves, aprons and other protective clothing

Gloves and other protective equipment should be used with caution around moving parts and rotating equipment. Barrier creams can be used to protect hands and arms in areas where moving or rotating parts are a concern. Contaminated clothing is a common cause of dermatitis. Work clothes should be

regularly laundered and should not be worn home. Change rooms and shower facilities are recommended.

Respiratory diseases
Exposure to MWF aerosol can cause a number of respiratory conditions. These include irritation, chronic bronchitis, asthma and hypersensitivity pneumonitis. These conditions can be caused by the MWFs, additives to the MWFs, or by endotoxins produced by microbes growing in the MWFs. Studies have shown that synthetic MWFs pose the highest risk for development of asthma. Soluble oils pose less of a risk with straight oils posing the lowest risk for asthma. 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.

Recently there has been an increased incidence of hypersensitivity pneumonitis associated with synthetic, semisynthetic and soluble MWFs. This condition is characterized by an immune response to MWF aerosol. Microbial contaminants are thought to be the cause of this condition.

Safety & health training
Employees should be trained on the hazards of working with MWFs and measures to reduce exposures. These include:

- Detection of bacterial growth and MWF degradation
- Personal hygiene
- Housekeeping practices and procedures to reduce MWF contamination

Worksite analysis
A thorough worksite analysis should be performed to evaluate airborne concentrations of MWFs as well as identify dermal exposure sources.

MWF use
The right MWFs should be chosen based upon the machining application. MWFs should be as nonirritating and nonsesitizing as possible. Consult with the supplier or manufacturer when choosing a MWF.

- Apply MWFs at the lowest possible pressure and volume.
- Apply only at the tool/work interface.
- Cease fluid delivery when not machining.
- Do not allow MWFs to flow over unprotected hands when loading/unloading parts.
- Install mist collectors.
- Enclose machines and install splash guards.
- Keep equipment clean.
- Maintain chip handlers, chillers, skimmers and other equipment.

Fluid maintenance
A written MWF control plan should be developed which includes maintenance of fluid chemistry and delivery systems. A designated person should be responsible for monitoring and maintaining fluids.

- MWFs should be maintained at as low a temperature as possible to reduce microbial growth and water loss.
- Keep records of fluid levels, pH and concentrations.

- Maintain proper concentrations and care for MWFs according to the manufacturers recommendations.
- Wear PPE when mixing and diluting MWFs and adding biocides.
- Thoroughly clean all parts of the system when replacing MWFs to destroy microorganisms.
- Apply biocides according to the maunfacturer's recommendations. Never add more biocide than is recommended.