Microbial contamination of metalworking fluid bio aerosols and health risks to exposed workers.

METALWORKING FLUIDS- complex chemical formulations tasked to perform multiple functions in the machining process

- high level of cutting performance
- removing metal parts
- reducing heat
- lubricating properties
- chemical and biological stability
- corrosion protection
- environmental health and human safety

METALWORKING FLUIDS (MWF)

Coolants are formulated to control heat in the cut and flush chips from the cutting zone. Many are specifically formulated to optimize a specific application.

Cutting oils provide excellent lubrication properties for metal removal as well as chip evacuation from the cutting zone.

1. Neat oils (not mixed with water)

2. **Water miscible oils** (macro emulsions or micro emulsions containing more than 30 percent oil) also known as soluble oils

3. **Semi-synthetics** (micro-emulsions) comprised of less than 30 percent oil content and less than 1 micron oil droplet size

4. **Full synthetics**, containing no oil (true solutions)

Metalworking fluids require some form of maintenance.

Mixing with water - different potential problems are presented.

The coolant - excellent breeding ground for bacteria, fungi, yeasts and molds because it is dark, humid and provides an excellent nutrient source (the fluid itself) for bacteria to thrive on.

Proliferation of various species of bacteria as well as the potential for pathogenic germ growth may be caused by poor shop practices:

-machine operators introducing foreign substances

-Floor and glass cleaners can greatly influence the pH level of the fluid, causing chemical instability and metal attack.

The emulsion infection are always:

Mixed microbial communities

Example of frequent infections flow:

Initial pH 8,5-9,5

Initial infection – aerobic bacteria

The amount of oxygen in the container is reduced

Decreasing of pH – to pH 4

Redox potential decreasing (Eh) which favors the bacteria that cause corrosion

They create the conditions for growth sulphatoreducing bacteria, iron bacteria or fungi, molds and yeasts

Microbial infections are a result of improper maintenance of the space in which the emulsions are used

Visual and olfactory changes are the result of biochemical and chemical processes>

- **A brown coloration - bacteria (***Pseudomonas sp, Alcaligenes sp., Achromobacter sp.)*
- **Grayish discoloration - sulphatoreducing bacteria's / creates the iron (II) sulfide or anaerobes (metabolism which results in the formation of iron (II) hydroxide**
- **On the surface of emulsion in the tank - foam, thick layers of "pancakes" (clusters: fungi, molds, yeasts)**
- **Sulfates smell (Monday morning odor) in the period of stagnation anaerobic respiration of bacteria (***Thiobacillus spp***.) oxidation to form sulfate**
- **The smell of ammonia (ammonia forming bacteria degradation of nitrogen compounds)**
- **The smell of hydrogen sulfide - reducing bacteria** *Desulfovibrio***-sulfate, develops H2S,**
- **Separating the oil phase (metabolic products of microorganisms sulfates, sulfuric acid, bioemulgators etc.) Change the nature of lubrication and viscosity, droplet size emulsion ... It can not be determined by conventional chemical tests, but has a significant impact on production.**

MWF occupational exposure health risks:

- Irritation of the skin, lungs, eyes, nose and throat
- Eczema
- Cornea damage and keratolysis
- Respiratory Irritation and Asthma
- Hard metal pulmonary disease from cobalt dissolved in the fluid.
- Hypersensitivity pneumonitis

Causes:

- MWF chemical composition
- MWF microbial infection during use

Chemical composition is regulated by increasingly stringent regulations - restrictions in chemical composition: volatile organic compounds (VOCs) chlorine, boron, amines

Regulations concerning MWF usage – world :

Occupational Exposure conditions and Limits

Endotoxin levels, culturable airborne microorganisms, fluid mist, inhalable rates and air exchange rates

- MWF mist **5 mg m-3** The Health and Safety Commission (HSC) has approved an **occupational exposure standard (OES) 8-hour time-weighted average** reference period for MWF mist.
- NIOSH (National Institute for Occupational Safety and health) : 0.4 mg m-3 as thoracic fraction (0.5 mg m-3 as 'total' aerosol)
- Inhalable dust
- Air exchange rates
- Airborne endotoxin concentrations measured in EU m-3 Endotoxin concentration - 100 EU m -3 (International Commision of occupational Health treshold for lung irritation EU endotoxin units)
- Suggested minimum value for air exchange rates (standard 4 h-1)

Periodic endotoxin bioaerosol mapping surveyes into industry hygiene survelliance program
Minimizing aerosols in metalworking facilities

Regulations concerning MWF usage – Croatia :

There are none

Ordinance on safety at work for working and auxiliary rooms and spaces NN 6/84
(**no longer in force**)
Chapter 4. Workspace
Article 31st
Depending on the work process of construction and its components except for the conditions specified in Article 30 must comply with in terms of safety at work by:

1.High temperatures
2.Energetic radiation (infrared, ultraviolet, ionizing and light)
3.Chemical impact on the working environment (irritant and toxic gases, vapors, toxic and harmful fumes,
Dust, mist, corrosive liquids and solid agents.
4. Biological factors (bacteria, virus, fungi and parasites)

Ordinance amending the ordinance on occupational safety for working and auxiliary premises and facilities

NN 42/05

(**no longer in force**)

Article 31st

4. Biological factors (bacteria, virus, fungi and parasites)

Ordinance on work safety for the workplace

NN 29/13

General requirements for the workplace

Article 5.

point 2

At workplaces at which the present physical, chemical and biological hazards workers must be protected from their harmful effects according to safety regulations and other regulations

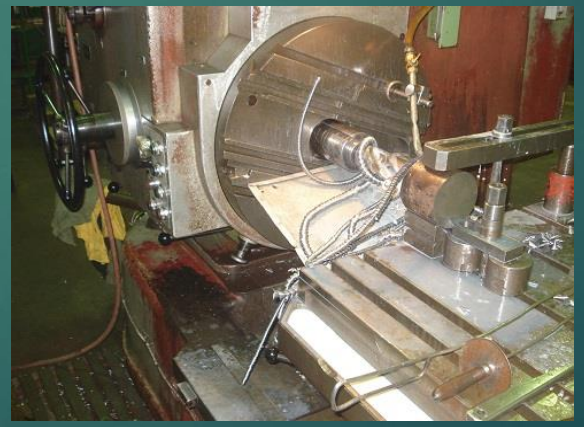
In the lathe workshop workers complain on skin changes on hands

In this work :
The microbial sampling of MWF aerosols (mists) was conducted on three different machine and the associated tank with MWF directly on the two different culture medium

The goal was :

determining the presence of microorganisms in MWF aerosols and mists and identification of the same which may be the cause of workers health problems.






Laboratrory testing

The appearance of isolated culture of yeasts and molds in culture medium in a petri dish

- Monitoring microbial emulsion condition and identifying individual microorganisms can provide very useful information for better action
- Microbial composition of infected emulsion is extremely complex, variable and with different dominant species over time and each with a different range of biochemical activities

Method of microorganism identification with proteomic approach:

Isolation of proteins from biological material, the two-dimensional separation of a mixture of proteins,
gel electrophoresis, identification of selected proteins using mass spectrometric methods of analysis and
comparison of the results with the available databases.

The protein-reading concept using CAF- /CAF+ reagent enables fast, highly accurate, reliable and easy to use identification of microorganisms down to the species level.

Benefits of using CAF- /CAF+ derivatization reagent: accurate, fast and reliable

The types of microorganisms identified in samples from machine tools, from aerosols and emulsion containers:

Shewanella putrefaciens
rare act as a human pathogen,
there have been cases of infections
and bacteremia

Alcaligenes faecalis
cause sepsis, meningitis, peritonitis,
enteric fever, appendicitis, cystitis,
chronic otitis media,
abscesses, arthritis, pneumonitis,
endocarditis, resistant to commonly used antibiotics.[6]

Methylobacter tundripaludum
Methane oxidizing bacterium from soil

Na razini roda:

Fusarium
Filamentous fungi, some species
produce mycotoxins

Enterobacter
Several strains of these bacteria
are pathogenic cause
opportunistic infections in
immunocompromised organisms

Citrobacter
Rare pathogen

Sphingobacterium
Rare bacteremia
Susceptible to common antibiotic,

Conclusions:

- The regulation of safety at work in the Republic of Croatia microbiological hazards are not recognized for workers in industry, TLV for mist, endotoxin amount or number of microorganisms are not established

- Ooccupational health professionals are not familiar with that kind of hazard,

- The risk assessment for the workplace in a lathe workshop microbial hazard is unknown

- For occupational medicine this kind of hazard is unknown

- Workers who complain of health problems like skin disorders are often perceived as slackers

- The first study was launched at the initiative of emulsion manufacturer due to the potential loss of profits

- After ten years of first testing the situation in the workshop is the same

- Entire procedure of testing and analyses was carried out in an industrial laboratory