

# CUTTING FLUIDS (COOLANTS)

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**Cutting fluid (metalworking fluid, coolant)** is a liquid used in metalworking operations for reducing friction between the work piece and the tool and for removal of the heat generated by the friction.

- ☐ **Metalworking operations**
- ☐ **Benefits of metalworking fluids (coolants)**
- ☐ **Factors of metalworking**
- ☐ **Types of metalworking fluids (coolants)**
- ☐ **Properties of some cutting fluids**

## Metalworking operations

Cutting (metalworking) fluids are involved in the following metalworking operations:

- ☐ Cutting (separation of metal from a work piece in the form of chips)
  - ☐ Milling
  - ☐ Turning
  - ☐ Boring
  - ☐ Drilling
  - ☐ Broaching
  - ☐ Threading
  - ☐ Sawing
- ☐ Abrading (rubbing away the surface by friction)
  - ☐ Grinding
  - ☐ Polishing
  - ☐ Lapping
- ☐ Metal forming (changing the shape of a work piece by a pressure)
  - ☐ Rolling
  - ☐ Forging
  - ☐ Extrusion
  - ☐ Drawing
  - ☐ Deep drawing
  - ☐ Stamping

## Benefits of metalworking fluids (coolants)

Lubrication and cooling effects provided by cutting fluids (coolants) result in the following benefits of metalworking:

☐ **Better surface finish.**

Cutting (metalworking) fluids lubricate the workpiece-tool metal-to-metal contact zone preventing tool galling and seizure, which assures good surface finish. Additives in lubricating oils#Extreme pressure additives|EP (extreme pressure) and other additives (sulfur, chlorine, phosphorous) enhance the lubricating effect of the fluids.

☐ **Longer tool life.**

Temperature of a tool properly cooled by a cutting fluid (coolant) does not exceed the critical value, beyond which the tool hardness drops and its wear rate increases.

☐ **Narrower tolerances of the work piece size.**

Cutting fluids provide both: decreasing the amount of heat generated in the workpiece-tool contact zone due to reduction of the friction (lubricating effect) and removing the heat (cooling effect). Thus cutting fluid stabilizes the work piece temperature providing better control of its geometry. Cutting fluids reduce the tool wear and prevent formation of built-up edges, which also results in more precise processing.

☐ **Lower energy consumption.**

Reduced friction provided by a metalworking fluid results in decreased work of the operation (cutting, abrading or forming).

☐ **Cleaner cutting zone.**

Cutting fluids remove the chips and fines formed in cutting (abrading) operations keeping the cutting zone clean and preventing the surface damage.

☐ **Better corrosion protection.**

Metalworking (cutting) fluids may contain Corrosion inhibitors. Such fluids form a protection film on the work piece surface, machine parts and chips.

## Factors of metalworking

Metalworking (cutting) fluids are formulated to work with particular Metals and under specific conditions.

The following factors should be taken into account for a proper selection of a metalworking fluid:

☐ **Metalworking operation process.**

For example: fluids used for cutting Aluminum alloys are not suitable for cold rolling the alloys.

☐ **Metal to be machined.**

Different cutting fluids (coolants) are used for working different metals.

☐ **Corrosion sensitivity of the metal.**

Rust protection is achieved by metalworking fluid containing mineral oil. Synthetic lubricants do not provide proper corrosion protection.

☐ **Hardness of the water.**

Special cutting fluids are used for mixing with hard water.

## Types of metalworking fluids (coolants)

### ☐ **Straight metalworking oils.**

These fluids are mineral oil based. They contain no water. Metalworking functionality of straight oils may be improved by various additives: fatty oils for better wettability; sulfur, chlorine or phosphorous for extra pressure conditions (EP) and better lubrication.

Advantages of straight oils: excellent lubrication, good corrosion protection, easy maintenance.

Disadvantages of straight oils: poor heat removal, toxic mist, high viscosity, flammable, expensive.

Straight oils are used in low speed applications, for metalworking Stainless steels and other poorly machinable metals and in the operations, in which good lubrication is necessary (honning, deep drilling etc.)

### ☐ **Emulsifiable metalworking oils.**

Emulsifiable oils are also referred to as water-soluble oils, which is not correct, since oils do not form true water solutions.

Emulsifiable oils are mineral oil based and contain emulsifiers, EP and other additives. Emulsifiers reduce interfacial tension between oil droplets and water, providing stable finely dispersed oil emulsion in water. Emulsifiable oils are mixed with water in a concentration 2-10%.

Advantages of emulsions: good lubrication, good cooling capability, some corrosion protection, low cost, nonflammable.

Disadvantages of emulsions: anti-bacteria additives and maintenance are needed, toxic mist, susceptible to hard water (may form insoluble precipitates).

### ☐ **Synthetic metalworking fluids.**

Synthetic metalworking fluids are water based solutions (or emulsions) of synthetic lubricants (soaps and other wetting agents), corrosion inhibitors, water softeners, EP, anti-bacteria additives (biocides), glycols and other additives.

Synthetic fluids are supplied in form of concentrates, which are mixed with water before use.

Advantages of synthetic fluids: very good cooling capability, good lubrication properties, good stability in hard water, good corrosion protection, low mist, easy handling, cleaning and maintenance.

Disadvantages of synthetic fluids: some toxicity, easily contaminated by foreign oils, relatively high cost.

Synthetic fluids are used in a wide variety of metalworking operations including poorly machinable alloys, heavy duty grinding, high speed cutting.

☐ **Semi-synthetic metalworking fluids.**

Semi-synthetic fluids are water based mixture (solution and emulsion) of synthetic lubricants, additives, emulsifiers and some amount (2%-30%) of mineral oil.

Semi-synthetic fluids combine advantages (and disadvantages at some extent) of mineral emulsions and synthetic fluids: They possess better corrosion protection than synthetic fluids and better cooling and wetting capabilities, easier handling and maintenance than mineral emulsions.

Disadvantages of semi-synthetic fluids: misting, relatively poor stability in hard water, contaminated by foreign oils, some toxicity.

## Properties of some cutting fluids

(Materials Data)

- ☐ Aluminum cutting fluid
- ☐ All purpose cutting oil
- ☐ Sawing fluid
- ☐ Thread cutting oil
- ☐ Synthetic cutting fluid concentrate

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