

CIMCOOL[®]

Technical Report

Milacron Marketing LLC | Cimcool Fluid Technology | Cincinnati, Ohio 45209

SYNTHETIC FLUIDS for METALWORKING APPLICATIONS

There are 3 types of water-based metalworking fluid concentrates. Each type is defined by the amount of *mineral oil* it contains. Soluble oil fluids contain the most mineral oil, while semi-synthetic or “micro-emulsion” fluids contain lower amounts of oil. Synthetic fluids contain *no mineral oil*.

Type of Fluid	% Mineral Oil in Concentrate
Soluble Oil	50 - 90%
Semi-synthetic	5 - 40%
Synthetic	0 %

The synthetic fluids discussed in this report form a transparent solution containing water-soluble lubricants, in place of mineral oil. (Synthetics that use emulsified water-insoluble lubricants are an exception that is not discussed here.) Each type of fluid also contains a variety of other chemicals that provide additional performance properties.

Synthetic Fluid Applications

Modern synthetic fluids can provide the lubrication and other performance properties needed for a broad range of metalworking operations. Products are available which can perform operations on most common metals and many other specialized materials. Typical parameters for a used mix follow:

Parameters	Values
Target Concentration	5%
Water Content	95% +
Typical “pH” Range	8.8 - 9.2 (see below)*
Tramp Oil Levels	Typically 1% or less
Temperature Range	60 - 90° F

* Fluids for Aluminum may be lower, 7.6 - 8.2

Operational Benefits of Synthetics

Improved Concentration Control

Synthetics reject tramp oil better than soluble oils and semi-synthetics. Tramp oil inhibits accurate readings of concentration control methods, such as, refractometer readings and certain chemical titrations. Accurate concentration control is the first step in establishing effective trouble-free fluid systems. It is important that synthetic fluids be kept within the concentration parameters specified by the manufacturer.

Lower Foam

Synthetic metalworking fluids are inherently lower foaming than soluble oils or semi-synthetics. Foam is primarily caused by chemicals, which are needed to emulsify the mineral oil found in soluble oil and semi-synthetic fluids. When foam generation is controlled, fluid losses from reservoirs are reduced. Operations using high-pressure and through-the-tool fluid application, are more effective without foam caused by entrained air.

Reduced Mist

Synthetics generate less mist in metalworking operations. The operation itself is the largest source of misting. Other causes of mist in a shop environment are high tramp oil levels in the mix and the product oil content. Since synthetics reject tramp oil and contain no mineral oil, they help promote lower mist levels. Visible improvements can be seen in the shop, making the required OSHA and other environmental regulations on air quality, easier to maintain.

	Recommended Exposure Limit for Mineral Oil
OSHA*	5.0 milligrams/m ³ PEL (Permissible Exposure Limit)
ACGIH**	0.2 milligrams/m ³ TLV (Threshold Limit Value)

*OSHA - Occupational Safety & Health Administration

**ACGIH - Amer. Conference of Govern. & Industrial Hygienists

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Production Benefits of Synthetics

Extended Sump Life

Synthetic fluids provide extended sump life. This is due to more accurate concentration control and the ability of synthetics to resist the typical oil contamination that occurs from operations in a metalworking environment. Synthetics also have good bacterial resistance. Extended sump life allows uninterrupted production operations.

Cleaner Operations

Synthetic fluids are very clean. Since they reject tramp oil better, machine tools, conveyors and gaging equipment stay cleaner, resulting in less downtime. Little or no post-process part cleaning may be required after the part is manufactured.

Reduced Setup Time

Synthetics are more transparent. This makes the tooling and workpiece more visible. Improved visibility can help to reduce machine setup time, especially for grinder and other close tolerance operations.

Maintenance Benefits

Machine Lubrication

Any metalworking fluid can physically wash off machine lubricants, especially when the fluid is applied under high fluid pressures. Synthetic fluids have a natural tendency to emulsify less oil. This is the result of a lower level of emulsifiers that are contained within the fluids. These properties help to resist lubricant removal from machine ways and other lubricated surfaces.

Work Area

Operators find synthetic fluids generally more pleasant to work in. Shop floors are less oily and slippery hazards are reduced, making the work area safer. Part handling and working on machines may be easier, since synthetics are cleaner than oil containing products.

Machine Surfaces

Machines stay cleaner when using synthetics. Less dirt and oil are deposited on machine surfaces. Surfaces painted with the correct type of penetration-resistant paint are extremely durable for metalworking fluid applications. Synthetics do not remove the paint from a properly painted machine tool.

Paint Type	Reaction Method (non-solvent)
Epoxy	Two-part catalyzed paint
Polyurethane	Two-part catalyzed paint

System Components

The same materials of construction and wetted parts used for soluble oil and semi-synthetics are also recommended for synthetic fluids. Used metalworking fluids are basically oily mixes of alkaline water. For sealing purposes, the most compatible materials are also the most common to the manufacturing industry. Synthetic rubber (elastomers) for metalworking fluid applications, must be high quality and resistant to contact with mineral oil and alkaline water. Based on the independent studies by the Southwest Research Institute, synthetic fluids were found to be compatible with elastomers.* The following two elastomers are the most commonly used sealing materials for machine tools:

Elastomer Type	Code	Specification Class**
Nitrile (Buna N)	NBR	BK, Nitrile, >40% ACN
Fluorocarbon	FKM	HK, Non-amine cured

*Manufacturing Engineering, June, 2001

**ASTM D2000

Economic Considerations

Lower Makeup Rates

In typical operations, synthetics have the advantage of less fluid carry-off and therefore require less makeup mix. The lower make-up rate, mean less concentrate usage, making synthetics more economical for the long term. For a mix to be maintained at a 5% target concentration, typical make-up rates are compared for each fluid type.

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Type of Fluid	Daily Make-up %
Soluble Oil	3 - 4%
Semi-synthetic	2 - 3%
Synthetic	1 - 2%

Improved Fluid Management

Synthetics are an excellent choice for central systems and “transfer line” operations. These systems require good filterability and a high degree of cleanliness. Good fluid management provides performance benefits, such as, the required lubricity, tool life, corrosion control, along with extended central system life. Compared to soluble oils and semi-synthetics, synthetics can be filtered to a finer degree. Critical operations, such as through-the-tool fluid delivery, require fine filtration (less than 10 microns).

Recycling and Reduced Disposal Costs

For operations that recycle fluids, synthetics are generally easier to process, since they reject tramp oil very well and have good biostability. The longer sump life achieved by synthetics means reduced disposal costs. A reduced number of DCR’s (dump, clean and recharge) provides more favorable economics.

General Guidelines

Mixing and Handling

It is recommended that a proportioner or premix system be used to provide mixing and accurate concentration control. Synthetic fluids generally have lower viscosity and therefore are more easily pumped from bulk delivery and premix systems. Synthetic fluids also easily mix with water, since there is no oil-in-water emulsion to be formed. Always add concentrate into water.

Metalworking Fluid Recommendations

A thorough review of **all** aspects of your metalworking operation is required to select the best fluid for your application. This may include everything from how to mix the fluid, measure fluid concentration, filter the product, recycle and finally, waste treat the product. As with any

metalworking fluid, it must be properly managed to provide optimum performance benefits. There are many CIMCOOL[®] metalworking fluids that are available to optimize your process. Consult your regional CIMCOOL[®] Technical Service Engineer for specific recommendations, or call Milacron CIMCOOL[®] Technical Service at 513-458-8199.