

Machine Shop Coolant Maintenance

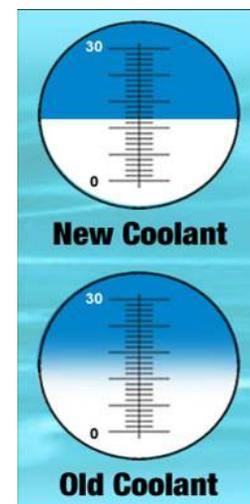
A guide for maintaining water dilutable metalworking coolants.

Concentration Control: It is absolutely critical to consistently maintain coolant concentration at the proper level. Low concentration will result in poor tool life and parts finish, rust on parts and machinery, rapid biological growth, and rancidity. Where concentration is too high, the coolant may foam excessively and produce skin irritations and residues on machinery.

Concentration should be measured and adjusted to the proper level every shift using a handheld refractometer. Place a few drops of coolant on the refractometer lens, close the lens cover, and look through the eyepiece. Bring the Brix scale into sharp focus using the focusing ring and record the value where the blue/white line crosses the scale. Multiply this value by the manufacturer's refractometer multiplier, given on the product data sheet, to obtain the coolant concentration in % volume. Tramp oil and other contaminants will blur the refractometer line and make an accurate reading impossible. Use a clean, running coolant sample whenever possible. Calibrate with clean water periodically.



One example of an inexpensive machine shop refractometer.

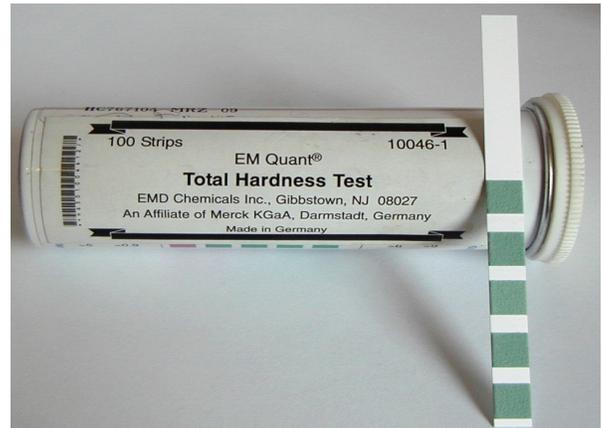


pH: This value describes the alkalinity or acidity of the coolant. Most coolants are designed to operate in the alkaline range and it is important to maintain pH near the values given on the product data sheet. Low pH generally indicates low coolant concentration, poor coolant mixing or instability, concentrate that is too old for use, or high rates of biological growth. Where pH is high, the coolant has likely been contaminated by high alkalinity materials such as floor cleaners and machine degreasers. pH is easily measured using pH test strips. Simply dip the test strip into a sample of the coolant, gently shake off any excess liquid, then match the strip color with the colors provided on the case. Read and record the corresponding pH value.



pH Test kit

Total Hardness: Calcium and magnesium ions in city or well water tend to build up in the coolant through evaporation and the addition of make-up water. It is helpful to measure total hardness with test strips to monitor the build-up of calcium as CaCO_3 in the coolant. Many coolants will perform satisfactorily at 450 ppm hardness or less. Above that level, it is increasingly likely that hard water soaps will form and the coolant may split. Dip a test strip in a sample of the coolant and observe the test strip for 60 seconds. There are 5 blocks on the strip and some will begin to change color, starting from the lower end, depending on the level of hardness. Each block that changes color represents 90 ppm of total hardness. 2 1/2 blocks changing color would represent about 225 ppm hardness. Where all five blocks gradually change color over the full 60 seconds, this represents 450 ppm hardness, nearing the alert level. Where all five blocks rapidly change color in less than 60 seconds, the result is 500+ ppm and the hardness is rated as excessive. (Use DI or RO water for make-up)



Total Hardness Test Kit



Chlorides Test Kit

Chlorides: Like calcium and magnesium ions, city or well water may also contain chloride ions. These can build-up in the coolant over time and interfere with the proper functioning of the coolant. As a rule of thumb, we like to see chloride levels below 250 ppm. Above this level, operators should be alert for any early indications of rust on parts and machinery. Values over 450 ppm are clearly excessive and will likely cause rust issues. Where chloride values tend to build-up rapidly, coolant performance will be greatly improved by using RO or DI water for coolant make-up. Chloride levels can be determined by chloride test strips. Submerge the lower end of the test strip in the coolant for several minutes until the orange band at the top of the test strip turns black. Remove the strip and find the value corresponding to the tip of the arrow formed on the test strip. Use the chart on the bottle to convert to ppm of chlorides.

Sump Cleaning: When coolant systems require cleaning or the fluid must be changed, it is important to add a strong sump cleaner prior to draining. Alkaline sump cleaners will loosen dirt and biomass in difficult-to-reach areas. Some cleaners are designed to run 24 - 48 hours in the used coolant during normal production. Other cleaners run for only 1 to 2 hours during a non-production flush. Once the used coolant with sump cleaner is drained, add a small amount of water with sump cleaner at 2% and circulate for 30 minutes to rinse and flush the unit. Drain this fluid and complete another short rinse with water and 2% of the new coolant. This will flush out any remaining soap/cleaner and avoid foaming when the fresh coolant is installed. Finally, add the new coolant at the recommended concentration. Take a sample of the fluid for baseline testing.

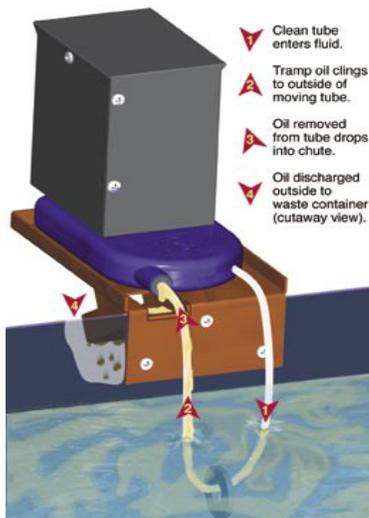
Tramp Oils: Machine oils and Hydraulic oils often leak into the coolant sump. It is important to use oil skimmers or coalescers to remove these oils on a consistent basis. Heavy tramp oil contamination exceeding 2% can produce smoke and mist in the shop and interfere with proper cooling of the tools. Also, tramp oil additives supply nourishment for biological growth, promoting bacteria, mold and rancidity. Left uncorrected, tramp oil contamination will eventually destabilize the coolant and create any number of performance issues. This is particularly troublesome where machines are left idle for several days with a heavy layer of tramp oil over the coolant. This promotes rapid growth of anaerobic bacteria and produces the "Monday morning stink" so common in machine shops. Poor tramp oil control is one of the most common problems in machine shops. With a small investment in tramp oil removal devices, coolant batch life and overall performance can be dramatically improved. In the field, coolant samples can be collected and allowed to sit at room temperature over night. Tramp oil levels can then be rated using the guide below.

Tramp Oil Ratings



Clean coolant Light Tramp Oil Moderate Tramp Oil Heavy Tramp Oil

Tramp Oil Removal: It is imperative to have some means available to eliminate tramp oil on a regular basis. Options range from low-cost skimmers and sidewinders to more expensive coalescers and full filtration units. Two of the common options are shown below.



The Zebra Sidewinder Tube Skimmer



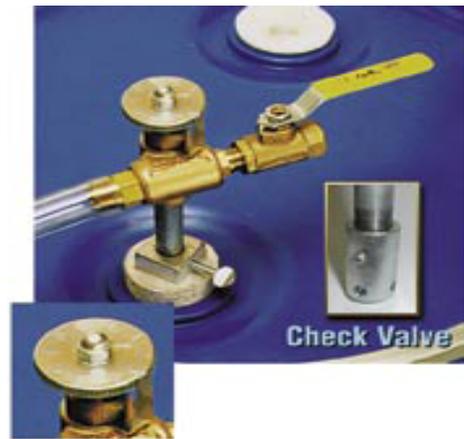
The Zebra Muscle Coalescer

Mixing coolant: In general, it is always best to add the coolant concentrate gradually to water, not the other way around. City water is usually good for the initial fill to provide a little hardness and avoid soft water foaming. The use of RO or DI water for make-up will give the best results by avoiding the excessive build-up of calcium, magnesium and chlorides. Many shops use proportioning valves to add diluted coolant at 1/3 to 1/2 the operating concentration while adding make-up water. This practice adds a small amount of fresh concentrate with each water addition and can be fine tuned to maintain concentration.

The picture (right) shows a simple and inexpensive proportioning valve installed neatly on a drum of coolant concentrate.



The Zebra machinist's mixer (below) is one of the better models available at low cost. It allows for easy concentration adjustments and there is a locking kit option. These devices are particularly helpful in shops with poor concentration control. With the proper settings for routine make-up, they ensure some fresh chemical is added to the sump with each water addition.



Biological Growth: Bacteria and Fungi can grow in coolant sumps creating rancid odors and building biomass that can clog filters and passages. Most coolants are biostable and can resist biological growth under normal conditions. Many coolants also have biocides to actively kill bacteria. It is not uncommon for coolants to have low levels of bacteria (10^2 - 10^4). Levels above 10^5 CFU will require immediate attention. In individual sumps, the best option is to add fresh concentrate raising the concentration to the upper limit of the target concentration range and holding it there until the bacteria subsides.

Central systems can be treated with the appropriate biocide following the instructions of the manufacturer. When monitoring metalworking fluids, it is not necessary to check for bacteria unless the pH is significantly low. This is the first indication of bacterial growth. Test for bacteria and fungus with Biosan two-sided dipslides. Simply dip the paddle in a sample of the coolant, shake off any excess liquid, and replace the paddle in the bottle. Allow the dipslide to sit at room temperature for the amount of time prescribed in the kit directions for bacteria and fungi. Bacteria is read from the white side of the paddle and fungi from the dark side.



BIOSAN SANICHECK B/F Test Kits

Summary of Common Coolant Tests

Test	Description	Normal Values (Typical Semi-Synthetic)	Issues With Low Value	Issues With High Values	Corrective Measures
pH	Measures the alkalinity or acidity of water-based fluids.	8.5 - 9.3	Indicates low concentration, poor emulsion stability, or excessive biological growth. Potential issues with poor tool life, odor, and corrosion. Poor wetting characteristics.	Indicates high concentration or contamination by high-alkalinity chemicals such as machine and floor cleaners. Leads to machine residues, paint removal, dermatitis, and foam.	Ensure concentration is checked and adjusted on a regular schedule. Eliminate draining or disposal of alkaline cleaners in coolant sumps. Control bacteria and fungus levels.
RI	Refractive index. A measure of emulsified solids based on light refraction in a refractometer.	3.5 - 4.5	See concentration below.	See concentration below.	Refractometer readings yield best results when a clean, running sample is used. Tramp oil interferes with accuracy. See corrective measures for concentration below.
% Concentration	A determination of the % by volume of the chemical concentrate in the total volume of sample. Measured by alkaline titration.	5.25% - 6.75%	Poor tool life, rust/corrosion, and reduced wetting characteristics. Biological growth and odor.	Foam, dermatitis, strong chemical odor, respiratory irritation, machine residues, and poor cooling in high speed machining.	Add water or concentrate to the system daily to maintain this value in the acceptable range.
Tramp Oil	The % of machine oils present in the sample. Determined by acid split and centrifuge.	3.0% MAX	None	Excessive smoke and misting. Poor cooling of the tooling in high speed machining, machine residues, biological growth, and poor emulsion stability.	Ensure tramp oil skimmers or coalescing filters are present and working properly. Repair machine leaks whenever possible.
Total Hardness by ICP	Measures the amount of calcium and magnesium in ppm through Inductively Coupled Plasma equipment. Monitors the build-up of minerals as a result of water evaporation and re-addition.	500 MAX	Low hardness contributes to foaming in some coolants.	Poor overall performance. Reduced emulsion stability and excessive machine residues, sump deposits (soaps), and foam.	Use RO/DI water for routine additions. Partial dump to lower value or system change-out.
Conductivity	Measures the conductivity of the sample due to the presence of dissolved metals.	4500 MAX	Same as hardness above.	Same as hardness above.	Same as hardness above.
Chlorides	Measures the amount of chloride ions in ppm.	300 MAX	None.	Rust and corrosion.	Partial dump or system change-out.
Bacteria	Measures the quantity of colony forming units per ml of sample.	1 X 10 ⁴ MAX	None.	Poor overall coolant performance, odor, residues, foam, plugged filters, and dermatitis.	Add fresh concentrate to maintain system at upper concentration value. Add biocide when advised by supplier.
Fungus	Measures the quantity of colony forming units per ml of sample.	1 X 10 ³ MAX	None.	Poor overall coolant performance, odor, residues and scum, plugged filters, dermatitis.	Same as bacteria above.
Cast Iron Chip Test	Measures the amount of rust formed in cast iron chip sample subjected to the used coolant.	3 MAX	None.	Rust and corrosion on machinery and parts.	Increase concentration to upper limit. Address root cause such as high hardness or chlorides.