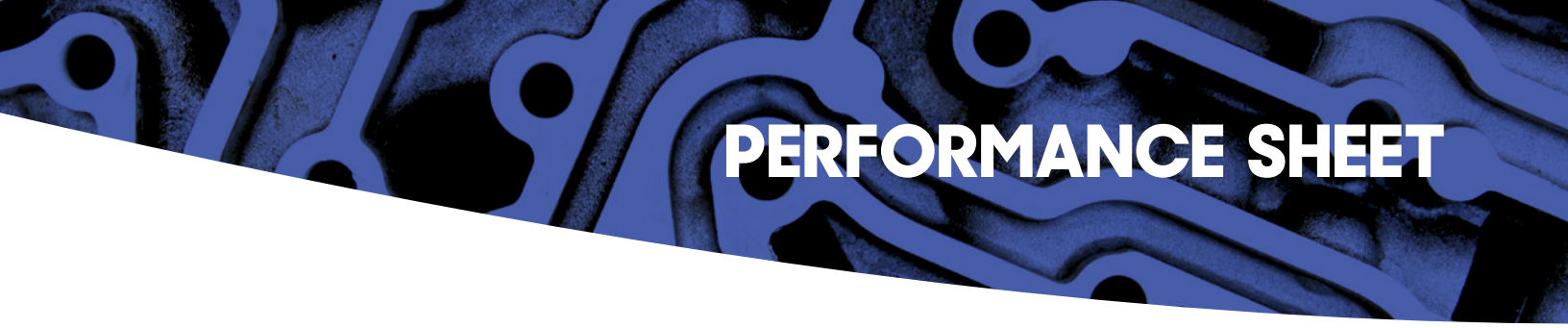

PERFORMANCE SHEET

QUAKERCOOL® 770 VS COMPETITIVE MINERIAL OIL FREE TECHNOLOGY

Background

- QUAKERCOOL® 770 is a high-performance mineral oil free micro-emulsion ideally suited to all operations demanding premium surface finish quality and consistent lubrication. Best suited for the machining of ferrous metals including stainless steels and other high-nickel, high-chromium ferrous alloys.
- QUAKERCOOL® 770 was evaluated against a competitive metalworking fluid for soap, foam and machining performance. The competitive fluid tested was a mineral oil free coolant

Product Comparison

PARAMETER	QUAKERCOOL® 770	THE COMPETITIVE PRODUCTS - A AND B
DCHA	No	No
Boron	No	Yes
Water Hardness Range	100-1000 ppm	100-1000 ppm
pH at (5%) dilution	9.7	9.5-9.7
Refract Factor	2.5	1.0 - 2.5
Lubrication Content (Polymers & Esters)	15% - 20%	15% - 20%

Key Applications - QUAKERCOOL® 770

- Ideal for machining ferrous alloys and is suitable for small sumps and large central systems
- Designed to provide the lubrication needed for critical ferrous machining operations such as drilling, reaming, tapping or thread cutting
- Delivers superior tapping performance on 4140 steel vs. the competitive fluid tested
- Offers excellent machining performance on titanium, stainless-steel and high-nickel, high-chromium alloys
- Secondary Amine Free for improved environmental and worker compatibility
- Mineral Oil Free to meet waste treatment requirements
- Boron-Free to meet customer and machine builder requirements
- Designed for water hardness of 100-1000ppm without foam, and does not foam in thru-the-tool elevated pressure conditions
- Excellent bio and emulsion stability for improved system longevity

Test Parameters

Key performance parameters that can be used to differentiate metalworking fluids are machining evaluations and soap/foam assessments.

Machining of AISI 4140 Steel

- This test serves as a useful method for assessing the performance capabilities of thread cutting fluids
- Two industry benchmark products that use mineral oil free technology were tested versus Quaker Houghton's QUAKERCOOL® 770 on AISI 4140 steel at 8% fluid concentrations prepared in water of 130ppm hardness. Testing was performed using a TiN coated HSS drill.
- To assess the coolant performance axial cutting forces and torque were measured during the drilling operation, along with tool flank wear measurements taken after machining, and each product's results were compared

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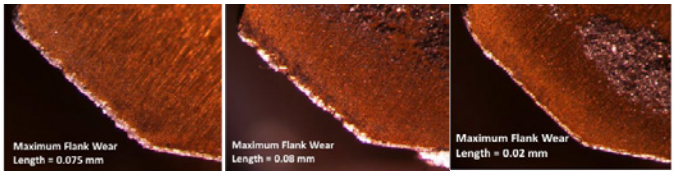
Test Results

- Data indicates that the QUAKERCOOL® 770 offers superior machining performance on AISI 4140 steel, relative to that provided by mineral oil free technologies Product A and Product B.

Process and Equipment

PRODUCT A	PRODUCT B	QUAKERCOOL® 770

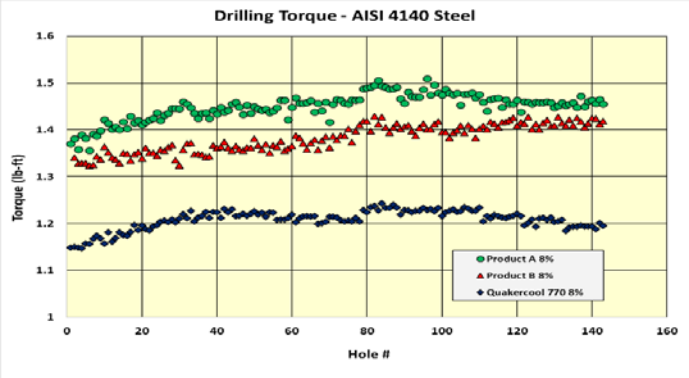
Following machining, the amount of tool wear on the flank face surface of the drill was measured. Microphotographs of the drills along with the amount of wear measured, for the three fluids are shown below. As seen, QUAKERCOOL® 770 machines with considerably less wear compared to both Product A and Product B.



Drilling and Cutting Operations

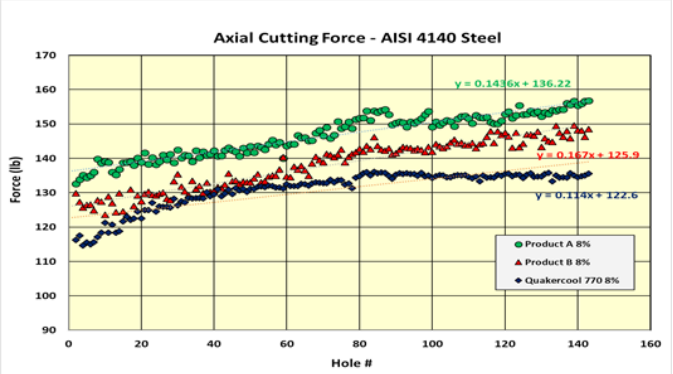
- The axial cutting forces and torque measured during the drilling operation provides a useful measure of the lubrication, chip removal capabilities, and cooling properties of a metalworking fluid. In particular, an increase in axial forces indicates changes occurring in the condition of the cutting tool during machining with higher forces indicating premature tool wear

FIGURE 1: Drilling Torque– AISI 4140 Steel



Drilling Torque over the average of 145 drilled holes. The data shows QUAKERCOOL® 770 offers superior consistent low torque values then those obtained using either Product A or Product B.

FIGURE 2: Axial Cutting Force – AISI 4140 Steel



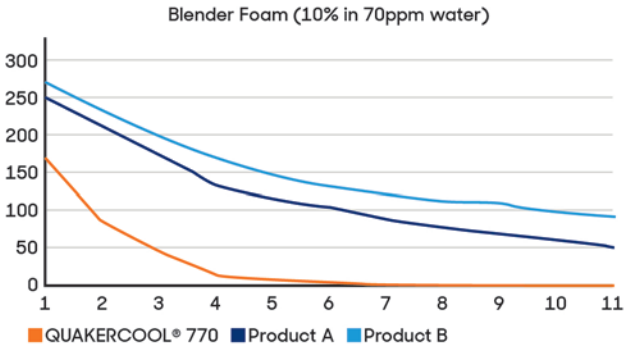
Axial Cutting forces over the average of 145 drilled holes. The data shows the QUAKERCOOL® 770 offers superior consistent cutting performance to that obtained using either Product A or Product B.

Foam/Soap

Blender Foam and Accelerated Aging Pump Test

- Many machining applications utilize through-the-tool coolant systems that require a metalworking fluid to operate at higher pressures without foaming and without forming excessive soaps due to hard water. Excessive foaming will adversely affect the coolant pumps and reduce the coolant delivery to the point of cut. Soap/residue formation can cause coolant delivery nozzles to clog, reduce filter cycle times and can interfere with sensors/part ejectors.

Test Results



Blender foam test: QUAKERCOOL® 770 outperformed the competitive products demonstrating lower initial foam height and faster foam break time than either of the industry benchmarks.

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QUAKERCOOL® 770 VS COMPETITIVE MINERIAL OIL FREE TECHNOLOGY

Accelerated Aging Pump Test [8% in 300 ppm water after 64 hours of recirculation, nozzle pressure 100psi, system turn-over-rate = 1x/min]

PRODUCT A	PRODUCT B	QUAKERCOOL® 770
		

A common challenge with industrial metalworking fluids is the effect of hard water on the emulsion properties of a fluid after long periods of recirculation which can lead to the formation of hard water residues/soaps which can be detrimental to part cleanliness, shorten filter index times and can cause the plugging of nozzles and coolant delivery lines.

As seen above, both Product A and Product B begin to form moderate to heavy residues after 64 hours of recirculation in 300ppm water in this accelerated emulsion aging study. On the other hand, QUAKERCOOL® 770, under the same test conditions, shows no soaps or residues forming a very clean, tight emulsion which can aid in part cleanliness and longer sump life before scheduled clean-outs.

Conclusion

QUAKERCOOL® 770 outperforms the competitive product in machining applications and has shown improved foam control in various water conditions. QUAKERCOOL® 770 also has a tight emulsion which can aid in part cleanliness and longer sump life before scheduled clean-outs.

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