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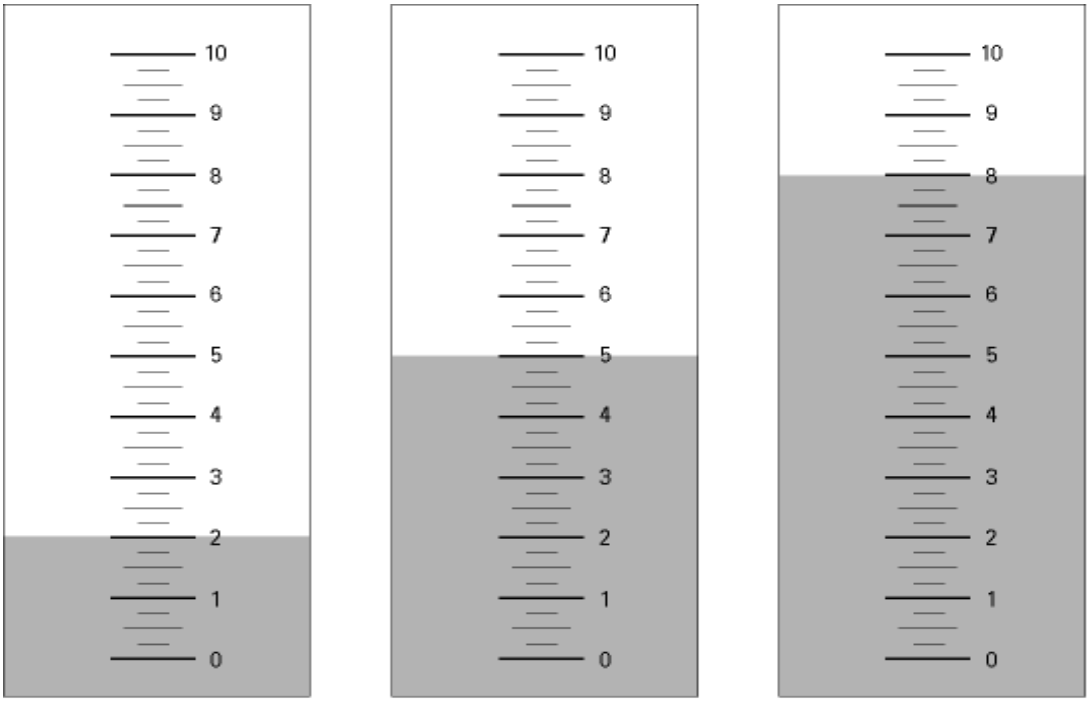
Accurately Measuring Cutting Fluid Concentration Levels Can Reduce Costs 35%!

It is well known that cutting fluid concentration levels are critical in meeting the production quality specifications demanded by today's manufacturing facilities, and in saving money on tooling expenses. For most synthetic, and semi-synthetic cutting fluids a handheld refractometer can be used to monitor concentration levels easily and accurately.

Refractometers actually measure the degree to which light is bent by a particular solution. As a solution becomes more concentrated versus water, light is bent at a greater angle. By placing a drop of the solution on the prism of the refractometer, passing light through it, and looking through the eyepiece, a reading can be taken. What you will see is the "bending" of light producing a shadowline which intersects a scale built into the refractometer. The following illustrates this:



(The three scales depict from left to right, readings of coolants with increasing concentration levels.)

The readout is based on an arbitrary concentration scale and must be converted into a percent concentration specific to each product. Scale readings for most popular synthetic coolants have been converted into concentration levels and published by their manufacturers. The following is a typical conversion for a popular synthetic coolant. At 40:1(2.5%), the reading on the REICHERT IFT10 or IFT40 Industrial Fluid Tester refractometers' scale would be approximately 1.0. The reading for a 20:1(5%) solution would be approximately 1.5. And for a 15:1(6.67%) the equivalent reading would be approximately 2.0.

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These very different concentration levels are only differentiated by 0.5 units on a refractometer. On a non-temperature compensated refractometer these readings would only be valid at 68 degrees Fahrenheit. This is due to the fact that as temperature increases, solutions become less dense and refractive index decreases proportionally. Readings will decrease unless the refractometer can adjust for this temperature change. Actual concentration remains constant however!

This is precisely the reason that all REICHERT brand handheld refractometers have automatic temperature compensation mechanisms built in. Instruments that do not have this feature will give inaccurate readings at any temperature other than 68 degrees Fahrenheit. REICHERT's Industrial Fluid Testers feature a temperature compensation range of 60 to 100 degrees Fahrenheit, making these the most versatile instruments available. They can be used in all four seasons, indoors and outdoors, morning, noon, and night. Other handheld refractometers which claim to have automatic temperature compensation mechanisms have much more limited ranges.

Several studies have been conducted which show the effect of cutting fluid concentration levels on tool life and product quality. In a study published in 1987, decreasing fluid concentration from 8% to 4% caused a 15% increase in tool wear, cutting fluid concentration was found to be the most important factor in tool wear(1). Further, it has been discovered that if the concentration was decreased from 5.5% to 2.5%, tool wear would increase by 35% when drilling carbon steel (2)! Increasing the fluid concentration level from 3% to 6% caused a 12% improvement in surface finish for holes drilled into Aluminum 390(3). A refractometer was used to maintain concentration levels. Further, it has been shown that an 8% difference in surface roughness results from varying concentration levels between 4% and 8% when drilling into Aluminum 390(4).

As an example, two concentrations of a synthetic, heavy duty cutting fluid were made. The first solution was 3%, and the other was 6% by weight. Readings were taken on the REICHERT IFT10; and two non-temperature compensated refractometers. One reading was taken after allowing the fluid, and refractometers to come up to temperature at 73 degrees Fahrenheit. The second reading was taken by allowing the refractometers and fluid to come up to a temperature of 85 degrees F. Readings resulted as follows:

Concentration	Temp.	Reichert IFT10	Non-Temperature Compensated Unit 1	Non-Temperature Compensated Unit 2
3%	73F	0.6	0.6	0.5
3%	85F	0.5	0.0	-0.3
6%	73F	1.3	1.3	1.0
6%	85F	1.3	0.8	0.5
Water	73F	0.0	0.0	0.0
Water	85F	-0.1	-0.6	-1.0

(Note: Some readings were below zero, because the scale demarcations do not extend that far, estimates were made.)

The REICHERT IFT10 read approximately the same in both temperature ranges, allowing the end user to control his fluid concentration levels accurately and easily.

The Non-Temperature Compensated Unit # 1 read the 3% solution as 0% and the 6% solution as roughly 3% when the temperature rose to 85ºF. The Non-Temperature Compensated Unit # 2 read the 3% solution as less than 0, and the 6% solution as 3% when the temperature increased to 85ºF. These results show that it is virtually impossible to control coolant concentration levels with a non-temperature compensated refractometer.

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In order to meet the demand for high quality, low cost machined parts, stringent production control is an absolute necessity. This type of control is only possible with a high-quality, temperature compensated refractometer.

References:

(1) H.R. Leep, R.W. Sims, 'Effects of Cutting Fluids on Drilling Aluminum Casting Alloy 390', *Journal of Synthetic Lubrication,* 1987-88m Vol.4, pp283-305.

(2) H.R. Leep, S.J. Kelleher, 'Effects of Cutting Conditions on Performance of a Synthetic Cutting Fluid', *Journal of the Society of Tribologists and Lubrication Engineers,* 1990, Vol. 46, 2, pp111-115.

(3) H.R. Leep, E.D. Halbeib, Z. Jiang, 'Surface Quality of Holes Drilled Into Aluminum 390', *International Journal of Production Research,* 1991, Vol.29, No.2, pp391-400.

H.R. Leep, 'Influence of Cutting Fluids on Surface Finish of Holes Drilled into Aluminum 390', *Journal of Synthetic Lubrication,* 1990, Vol.6, pp325-338.