A Turbidimetric Method for the Rapid Evaluation of Metalworking Fluids Emulsion Stability

Metalworking fluids are an emulsion of oil in water. The emulsion stability goes down with increased harness ions such as calcium and magnesium. Typical tests for emulsion stability involve the determination of oil losses due to dilution of water with specified harness over 24 hours. This test is impractical for daily operations and the researchers proposed using a turbidity test that takes only ten minutes. The short time allows for the manufacturers to monitor stability in real time rather than knowing what yesterday's stability was the next day with the standard test.

How does the turbidity test works?

The test uses a spectrophotometer that emits a known wavelength to determine turbidity of the metalworking fluid. When the metalworking fluid emulsion is hit with the light from the spectrophotometer the turbidity causes the light waves to deflect from the straight path. This deflection produces a numeric value to the turbidity. While turbidity is only a function of the number of particles, it becomes a function of both number and size when turbidity is graphed against wavelength. The turbidity versus wavelength is graphed on a log scale to get a linear slop called the wavelength exponent (function of particle number and size). Several turbidity measurements and wavelength exponent are calculated over a ten minute period. The wavelength exponent is then graphed against time. If the graph of wavelength exponent versus time shows a straight horizontal line then the emulsion is stable, meaning that particle size and number stayed the same over time. However, if the line has a negative slope then the emulsion is not stable. When hardness ions interfere with the emulsion, larger particles form which change the wavelength dependency, thus causing a decrease in the wavelength exponent.

How does the turbidity test compare to the standard 24 hour test?

The ten minute turbidity test showed the same results as the 24 hour test.