Refractive Index Measurements to Compare Chemical Purity

Refractive index, n, is a measure of how fast light travels through a substance. It is defined mathematically as Equation 1.

Eq. 1
$$n = \frac{speed\ of\ light\ in\ vacuum}{speed\ of\ light\ in\ medium}$$

As light moves from one medium to another, such as from air to water, it refracts at the interface and changes direction according to Snell's Law, given as Equation 2 and shown in Figure 1.

Eq. 2
$$\frac{\sin(\theta_1)}{\sin(\theta_2)} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

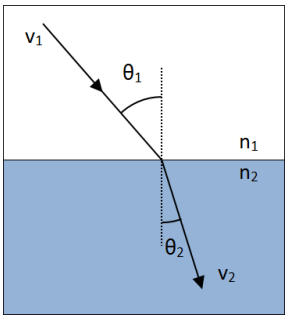

Figure 1. Illustration of Snell's Law.

The measurement of refractive index has a wide variety of applications. It is commonly used to identify a particular substance, determine its purity, or measure concentration. For example, it is used in the sugar processing industry to determine the mass fraction of sugar dissolved in water.

Acetone is an industrially useful chemical that is used as a solvent in industrial surface coatings, adhesives, pharmaceutical applications as well as cleaning laboratory glassware. It's most common use is as a chemical precursor, primarily in the manufacture of methyl methacrylate. In many of these applications, the purity of the the acetone is very important. Refractive index measurement is one of the fastest and easiest methods used to evaluate chemical purity.

Ebatco's NAT Lab tested three different samples of acetone using a J357 Refractometer (Rudolph Research Analytical, USA). The J357 uses the principle of internal reflection to measure refractive index to 5 decimal places. Equipped with high quality electronics, the J357 possesses a high degree of accuracy, ±0.00004, and repeatability, ±0.00002. In addition, the

instrument uses two peltier elements to heat or cool the sample from two sides, providing a high degree of thermal control and stability for refractive index measruements at desired temperatures. The results of the acetone refractive index measurements are presented in Table 1 and Figure 2.

Table 1 Acetone Refractive Index Measurement Results

Acetone	n	Deviation
Published Value	1.35880	N/A
A.C.S. Reagent Grade	1.35874	-0.00006
Commercial Acetone 1	1.36068	0.00188
Commercial Acetone 2	1.35908	0.00028

Although precisely determining the purity of the acetone samples requires establishing relationship between purity and refractive index, the deviation from the published value provides a quick method of comparing the three samples. The further the refractive index of a sample deviates from its published value, the less pure it is. This technique allows a chemical manufacturer to set upper and lower limits on the refractive index of their chemical and easily maintain process control.

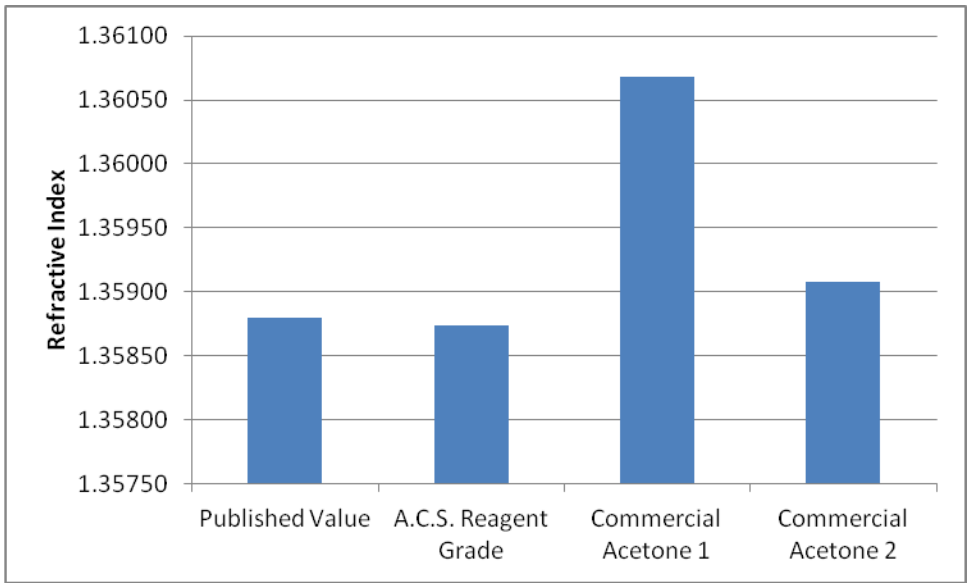

Figure 2. Refractive index of acetone specimens.