Refractometer Temperature Correction Vs Control

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Also see video: Refractometer, Temperature Correction & Control with a Rudolph J457

We are going to look at the effects of changing temperature on refractive index measurement and if Temperature Correction can compensate for temperature variances or if actual temperature control is required for accurate results.

To perform this test we will utilize a Rudolph J457 Digital Laboratory Refractometer. The J457 is equipped with on-board Refractometer Temperature Correction and full electronic sample Temperature Control. Many modern refractometers have on-board Temperature correction capabilities which are a built-in mathematical scale that are designed to compensate for varying measurement temperatures. Temperature Control is much different and actual heats or cools a sample to a user defined temperature – Example 20C. We will also use four different types of samples. We will use distilled water, cranberry juice, ethyl glycol (Antifreeze) and engine oil. We start by measuring all samples at 20C. The first sample will be distilled water; the sample is placed on the prism at room temperature. The Rudolph J457 refractometer is set to auto start. The instrument detects that the sample is there and starts to bring it to 20C.

The instrument is set to a delay 30 of seconds to make sure it's at exactly 20C. When that delay time is reached the refractometer will then read and display the measurement results on the screen.

Once the measurement is completed we wipe away the sample to prepare for the next measurement making sure the refractometer's sample well is completely cleaned and nothing is left to potentially contaminate the next measurement.

The next sample is cranberry juice, once again we repeat the measurement process. If the sample were highly evaporative we could also close the lid to prevent evaporation. This is not necessary with the sample we are using in this experiment.

It is important to note that all Rudolph J457 refractometer models include Rudolph's exclusive Dual Temperature Control System utilizing Peltier Technology that heats and cools the sample from both the top and bottom of the sample well.

To proceed with the measurements it is again important to clean the refractometer's sample well and prism surface between each measurement.

The next sample is Ethyl Glycol (Anti-Freeze) then the engine oil all measured at an actual temperature of 20C. We will now have a baseline of the four samples all taken at a known temperature of 20C that we can use as a comparison to other measurements we will take later.

Our next step will be to set the instrument to 25C and repeat the process with all four samples. 25C is the higher end of what people may refer to as "Room Temperature" as 20-25C is a reasonable variation in a normal, climate controlled room.

Temperature Variation concerns:

Minor variances in temperature can create inaccuracies.

Industry specific conditions demand superior levels of accuracy.

Temperature control is required depending on sample type.

Temperature Correction is of little value when measuring anything other then sucrose & water based samples.

Let's see what impact just the differences in room temperature can have on the 4 samples. From the chart below we can again see the difference is quite significant in many of the samples we have, well into the third decimal place.

We can conclude the accuracy of R/I measurements can be greatly affected by just room temperature variations. Industry related temperature variations can lead to costly inaccuracies & inconsistency such as:

- Quality Control
- Material Usage and thus
- Production Costs

We have completed our study of 20C, 25C, and measurements at 25C with Temperature Correction, and if we look at the chart below again, the quick summery is with water we got a measurement at 20C yet, we got a very different number at 25C, we recorded an error in fact of about 5 in the 4th decimal place.

When we switched on the Refractometer Temperature Correction feature, we received the same result we did at 20C which proves that with a water sample Temperature Correction works well. We also tried a beverage, in this case cranberry juice. Once again from 20C showed a big variation to 25C degrees, but with Refractometer Temperature Correction switched on and the sample temperature stable, the Temperature Correction removed the error and the system gave a reasonable result.

We can conclude: Variations in room temperature (a heated and air-conditioned lab environment) 20C – 25C can vastly impact the accuracy of measurement results. Temperature Correction may however be used to accurately adjust water & sucrose based samples.

This is not surprising because cranberry juice is mostly water and sugar and this is what Refractometer Temperature Correction is designed to work with. Thus we can conclude that Temperature Correction is designed to accurately compensate for temperature variances for sucrose & water based samples.

The situation becomes very different when we move to a chemical, in this case Anti-Freeze or Glycol. Even the small difference in temperature between 20C and 25C is giving us measurement variations in the third decimal place. Then we put Temperature Correction on. This does something to help, but we are still left with a very large error in the forth decimal place even after the instrument tries to use Temperature Correction.

The final sample we tried was engine oil and this shows the impact even more so. Once again the reading at 20C compared to the reading at 25C shows a very large difference of almost 2 in the 3rd decimal place. Using Temperature Correction helps a little but we are still left with an error that is almost in the third decimal place. This is again just the variance from what we would call room temperature, 20C – 25C.

Conclusion, significant errors will arise when using Refractometer Temperature Correction for samples other than sucrose or water based samples

Our initial experiment was to determine what happens at room temperature or the changes that might occur just within possible room temperatures. Let's take this further and look at what might happen in the real world in an industrial environment.

We then take the same samples and measure them all at 60C. 60C or about 140 degrees Fahrenheit is a fairly typical temperature a sample might be processed at. This is a temperature a juice might be pasteurized at or the sort of temperature that may be a common process temperature in a chemical company.

All samples were tested at 60 degrees Celsius (140 degrees Fahrenheit) – replicating industry specific standards.

Looking at the chart below again we can look down and see these differences. We actually have some dramatic differences, differences as great in the second decimal place between measuring at room temperature 20C and measuring at 60 degrees.

A direct correlation is found between sample type & temperature elevation.

This correlation is defined by an increase in percent error. Clearly if one is going to measure a process sample one has to do something about the temperature of that sample, the question is then will Temperature Correction be sufficient to compensate for the higher temperature and yield acceptable measurement.

Temperature variations and corrections on RI readings with various samples.

	Room Temperature		Variance	Corrected	Variance	Industry Application	Variance
RUDOLPH RESEARCH ANALYTICAL	20C	25C	Difference from 20C	25C with temperature correction	Difference from 20C	60C	Difference from 20C
Water	1.33299	1.33249	-0.00050	1.33299	0.00000	1.32706	0.00593
Beverage	1.35340	1.35279	-0.00061	1.35339	0.00001	1.34751	0.00589
Anti-Freeze	1.43289	1.43151	-0.00138	1.43238	0.00051	1.42191	0.01098
Engine Oil	1.47017	1.46828	-0.00189	1.46924	0.00093	1.45546	0.01471

Notes and Conclusions:

“Processed” samples which often include additives and preservatives have a Temperature Correction error greater than a basic solution. This is because the additives take the sample another step away from a pure sugar and water composition.

Even differences at room Temperature can affect sample measurements

Ob-board Refractometer Temperature Correction can be reliable & accurate when measuring any sucrose and/or water based samples

Non-sucrose and water samples will require Refractometer Temperature Control to accurately measure Refractive Index & Brix, Temperature Correction is inadequate.

Refractometer Temperature control is an essential component in industries that do not work with sugar and water based samples:

Chemical

Pharmaceutical

Toxicology

Petro-chemical

Flavor, fragrance, essential oils, cosmetics

Petroleum

Refractometer Temperature Correction is not used in such industries.