Haze: The Importance of being Earnest (About Zero)

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ABSTRACT

Measurement systems in the breweries no longer report data just to the operator and brewer; they now send data directly to automatic control systems. This data is subsequently placed in company-wide written reports. This puts extra emphasis on accuracy and calibration, as establishing the instrument zero (along with span) is the basis of brewery measurement systems, whether they report temperature, alcohol, flow, or turbidity.

In this work we show errors that do occur while adjusting instrument zero during calibration of haze meters—errors that occur even when the technician follows the manufacturer’s recommendations. Examples gathered are from scatter turbidity/haze measurement. The experimental data shows examples of how zero adjustment errors can cause undetected inaccuracies in over 100% of the readings. Guidelines for good practice are discussed, including suggested procedures/protocols for determining true haze zero without removing sensors, emptying pipes, using potable water, or packing the pipe with ultra-pure water.

Keywords: Beer Haze, Haze Standards, Haze Meter Calibration, Haze Measurement

INTRODUCTION

On measuring haze, with diatomaceous earth filter or polishing filter, more and more breweries are driven to smaller and smaller haze numbers. What used to be acceptable is now being rejected. Brighter and brighter brews are being called for with the belief that better quality is equivalent to lower particle count, and thus increased market share. In fact, there is evidence to support this theory (McNab unpublished study).

MARKET SHARE VERSUS TURBIDITY READINGS

Brewery managements have come to the conclusion that lower numbers in haze measurement will benefit in increased sales. The management believes that improvements made in measuring haze will result in two benefits: (1) For increased market share, and (2) longer colloidal shelf life (see “Evaluation of Rapid Physical Stability Tests”).

BACKGROUND

This study is to relate laboratory and production practices to a theory that such improved haze measurement requirements can be fully realized. It should be understood that the modern beer haze is very, very low. There are various techniques to measure this low level. There is the consumer’s eye (see “Human Visual Perception of Haze and Relationships with Instrumental Measurements of Turbidity”), the educated eye of the brewmaster in a light box, or with forward scatter and/or 90 degree
scatter instruments. One aspect of haze measurement, and a major error-contributing factor (that has not been discussed and is the object of this poster), is this critical choice of the element of zero calibration.

DATA

Using either a forward scatter or a 90° scatter instrument, various graphs presented are using various levels of zero reference standards. They are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Light off</td>
<td>Absolute zero: zero level of haze, no reflectivity accomplished by having no light scattered</td>
</tr>
<tr>
<td>2</td>
<td>Filt RO</td>
<td>“Filtered” reverse osmosis (RO): turbidity-free distilled water</td>
</tr>
<tr>
<td>3</td>
<td>Lab DI</td>
<td>Lab deionized turbidity free de-mineralized water</td>
</tr>
<tr>
<td>4</td>
<td>Filt tap</td>
<td>City tap water filtered 1.5 microns (simulate DE filtered)</td>
</tr>
<tr>
<td>5</td>
<td>Tap</td>
<td>City tap water not filtered</td>
</tr>
<tr>
<td>6</td>
<td>Tap 2</td>
<td>City tap water not filtered #2</td>
</tr>
<tr>
<td>7</td>
<td>Tap 3</td>
<td>City tap water not filtered #3</td>
</tr>
</tbody>
</table>
| 8   | Air      | Air as particle reference concentration (as being the basis for measurement for beer).

Presented in figures 1 to 6 is the relationship between various zero references 1 through 8 and ASBC haze meter readings. The equipment used is the laboratory Haze meter McNab DLB (Fig. 7 photo-DLB). Span calibration standard was 12.5 ppm, SiO2 as formazin, nominal 10 microns, and an independent lab meter to verify consistency of beer samples. The various zero chemistries were placed into the DLB optical chambers and the ZERO control was adjusted following the manufacturer’s instructions to have it read ‘zero’. Beer samples were then introduced into the measuring chamber. The independent laboratory meter was used to show that the beer sample remained unaltered: sample temperatures measured were at 25°C.
From the above six figures, the first thing that may occur to the readers is that the DLB “haze” meter is not trustworthy. The “haze” meter reads different hazes of beer where the beer sample has obviously been held constant. In figure 1, with absolute zero, the instrument gives the highest beer haze level and then, the haze level reading goes progressively down to a minus haze concentration.

It is to be recalled that the indicated haze reading is an actual value minus the field choice of zero value (RO, tap water, etc.) resulting in a “tare” instrument calculation.

A minus level is a false reading because what has not been fully considered is that the reference zero, being larger than beer, resulted in a negative calculation. A poor choice of zero fluid would explain such an absurd anomaly as having beer with a negative particle count. What is brought to the reader’s attention is that because the beer is so pure, the zero calibration water must be significantly purer in order to have reasonable meaning in the use of the instrument. With these variable results, haze instruments should not be classified as drifting, but rather a sign of laboratory or production procedure needing to catch up with brighter beer production. Further, it is also seen that the upscale mid-level haze reading is also affected due to change in zero standard.

In order to receive correct readings, the results indicate that zero calibration must be independently thought of from that of span calibration. Zero fluid must be the most particle-free water available (see Analytical ASBC(1) and EBC(2)). Work by others has specifically defined what is appropriate zero-based water (see ASTM D-1889-94 zero specification reagent grade water(3)).

Therefore, there must be made available special laboratory zero water that meets modern expectations of high accuracy (1% or 2%) and repeatability. The water must have the particle concentration of 1/100ths of that of the particle of beer. If, on the other hand, 10% accuracy is acceptable, the zero water must have 1/10th the particle concentration of beer. If the zero water and the beer have the same particle level, you will have a 50% or higher error. And of course, wherever there are “negative particles” in beer, it is just a major problem in calibration solution. This zero water reference variability is a condition which will require a laboratory to install specialized water producing equipment to ensure low particle counts as the reference zero water, so that it meets the criteria’s 1% or 10% as required.

In a laboratory environment, good zero water use is relatively straightforward and easy to accomplish. However, the production pipes of in-line haze meters could not be packed with reagent grade water without risking the purity of the water. Consequently, this method is flawed as it relates to in-line analysis.
TRANSFER CALIBRATION

Transfer calibration is typical when the laboratory haze meter (or eye) is used to adjust the in-line meter. Both in-line and laboratory meters need the same procedures for setting zero, otherwise unexplained differences would occur.

A solution has been suggested of removing the in-line haze meter from the pipe and setting ‘zero’ during bench calibration. The practical problem is in the inconvenient necessity of dismantling the sanitary piping system in order to reach the in-line equipment to verify the operation of zero.

An alternative zero method that is used by McNab and others is to fix the zero level optically, in this case, as a “hard zero,” as opposed to water calibrated zero, “soft zero.” This can be accomplished by ratioing down, full scale, the optical signal to where zero is made to equal 1/100th of full scale and assign that zero the value for calibration.

Alternatively, have the haze meter operate in such a way that the optics are running full tilt (for gain), and you will see absolutely no reflective particles. This can be achieved by removing the scatter illumination, or temporarily removing the illumination sources, by turning off the source light and seeing that the meter shows zero value. When this technique is employed, repeatability errors caused by variable zero reference are removed.

In McNab’s experience, roughly 40% of customers have complaints that revolve around the conceptual problem of zero particle counts. This is stated to us as drifting instruments, inconsistent readings, and non-matching readings. This issue can be resolved if the zero problem is understood and clearly addressed in the procedures or protocols used by the brewery’s laboratory and production departments.

CONCLUSION

The following conclusions can be drawn:

1. As the zero standard increases in particle count (poor standard), the apparent beer quality increases.
2. Where less brilliant beer is analyzed (with high turbidity), the zero calibration problem diminishes.
3. The “soft zero” varies constantly causing complaints regarding stability of instruments.

RECOMMENDATIONS

1. As the beer brightness increases, zero reference water purity must also increase, maintaining at least a 10:1 ratio over that of beer particle levels.
2. To achieve good correlation between various instruments (as in transfer of calibration), there must be a consistent zero basis (as well as other factors) of calibration between the instruments.

BIBLIOGRAPHY

4. DLB Laboratory Meter instruction book (#R54)
7. McNab Study - Unpublished “Market Share v. ASBC Haze”