Solids/Extract: Specific Gravity Method

Scope and Application

This method applies to the determination of dissolved solids in all alcoholic beverages. The terms, solids and extract, are used interchangeably to mean concentration of dissolved solids.

Distilled spirits products labeled "liqueur" or "cordial" must contain at least 2.5% sugar by weight (27CFR 5.22 (h)).

Wine solids, especially in ameliorated products, are subject to limitations prescribed in 27CFR 24.179.

Levels and Limitations

<table>
<thead>
<tr>
<th>Analyte / Matrix</th>
<th>Detection Limit</th>
<th>Quantitation Limit</th>
<th>Linear Range</th>
<th>Interferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extract / Wine</td>
<td>N/A</td>
<td>N/A</td>
<td>Not Applicable</td>
<td>Glycerol, Propylene Glycol, and other high-boiling liquids</td>
</tr>
<tr>
<td>Solids / Distilled Spirits</td>
<td>N/A</td>
<td>N/A</td>
<td>Not Applicable</td>
<td>Glycerol, Propylene Glycol, and other high-boiling liquids</td>
</tr>
<tr>
<td>Real Extract / Malt Beverages</td>
<td>N/A</td>
<td>N/A</td>
<td>Not Applicable</td>
<td>Glycerol, Propylene Glycol, and other high-boiling liquids</td>
</tr>
</tbody>
</table>

Equipment

Density Meter (Anton Paar or equivalent) reporting specific gravity to 5 decimal places, temperature controlled + 0.01°C.

Automatic Sample Changer (Anton Paar SP-3 or equivalent) or sample transport system or direct injection syringe.

Class A Volumetric Flask

Reagent and Sample Preparation and Handling

Samples must be at room temperature.
Carbonated samples must be de-carbonated before pipetting.
General Procedure

Wine, Distilled Spirit and Malt Beverages:

1. Determine the specific gravity at 20°C of the sample and record as $SG_{s}^{20/20}$.

2. Determine the specific gravity at 20°C of the alcohol-water distillate from SSD:TM:102 and record as $SG_{a}^{20/20}$. If the only datum available is the % v/v alcohol, obtain $SG_{a}^{20/20}$ from AOAC Table 913.02 and convert to $SG_{a}^{20/20} = 0.9988SG_{app}^{20/20} \pm 0.0012$.

Malt Beverages-Alternative Procedure:

1. For direct measurement of dealcoholized sample:
   a. Transfer the distillation residue from SSD:TM:102 to a volumetric flask and Q.S. with distilled water. The volume of the volumetric flask should be the same as the original volume of the sample before distillation.

   Alternatively, in an evaporation dish place enough sample that the total weight of the dish with sample is 200.00 ± 0.02 g. Evaporate the sample gently (steam bath or overnight in the hood) so that only about a third of the original volume of sample remains. Cool to room temperature and using DI water, bring the total weight of the sample back to 200.00 ± 0.02 g.

   b. Determine Specific Gravity of the dealcoholized sample and Record as $SG_{d}^{20/20}$.

Quality Control

1. Laboratory control samples (LCS) are to be measured in duplicate in accordance with laboratory protocol.

Sources of Uncertainty

1. Ensure DMA is calibrated and functioning properly

2. If using distillation residue, ensure that antifoam was not used during distillation process.

Calculations

1. Any apparent specific gravity values should be converted to in vacuo basis because the Brix and Plato tables are in these terms. The conversion is $SG^{20/20} = 0.9988SG_{app}^{20/20} + 0.0012$

2. Calculate the specific gravity at 20°C of the dealcoholized sample as $SG_{d}^{20/20} = SG_{s}^{20/20} - SG_{a}^{20/20} + 1 = 0.9988(SG_{app}^{20/20} - SG_{app}^{20/20}) + 1) + 0.0012$. 
3. Obtain % w/w solids in dealcoholized sample from AOAC Table 942.33 or 970.90 or from Ruppert’s formula, 
\[ 187f^3 - 229.8f^2 + 259.17f - 0.0061 \], where f is the fractional part of \( SG_{d}^{20/20} \) or \( SG_{d}^{20/20} - 1 \), and record as \( P_{d} \).

4. Solids as

5. Solids as \( g/100mL = 0.9982073P_{d}SG_{d}^{20/20} \). Note: The density of water at 20°C \( (\rho_{w}^{20}) \), 0.9982073 g/mL, is needed to convert \( SG_{d}^{20/20} \) to \( \rho_{d}^{20} \). This value for \( \rho_{w}^{20} \) is different from that of Chappuis (0.9982343 g/mL—still used in the tables of the AOAC and the ASBC) because the current standard mL is smaller by a factor of 1.000027. Also, it is not necessary to convert to sample units from dealcoholized sample units in the above equation because 100mL of one is identical to 100mL of the other.

6. Solids as \( g/100L = 998.2073P_{d}SG_{d}^{20/20} \).

**Reporting Results**

Report the results for **solids** as follows:

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Units</th>
<th>Precision</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled Spirits</td>
<td>g/100L</td>
<td>1 decimal</td>
<td>x.X</td>
</tr>
<tr>
<td>High Solids Distilled Spirits</td>
<td>% w/w</td>
<td>1 decimal</td>
<td>x.X</td>
</tr>
<tr>
<td>Wine</td>
<td>g/100mL</td>
<td>2 decimal</td>
<td>x.XX</td>
</tr>
<tr>
<td><strong>Malt Beverages</strong></td>
<td>% w/w</td>
<td>1 decimal</td>
<td>x.X</td>
</tr>
</tbody>
</table>

Note on the report the misclassification of a product labeled as (1) cordial or liqueur containing less than 2.5% w/w dissolved solids or (2) straight or blended whiskey containing more than 2.5% w/w dissolved solids.

**Safety Notes**

Normal laboratory safety protocol should be followed. High proof alcoholic products are flammable. Ethanol burns with an almost invisible blue flame.

**References**


Ruppert, J.R., JAOAC, 69 4 1986 pp709-711

SSD:TM:102

Location of Validation Package

No validation necessary. This method is a calculation.

Required Training, Certification and Re-certification

1. In-house training by a certified chemist.

2. At least 7 replicates of an LCS within established control limits.

3. Chemists will be competency tested periodically (e.g., every 5 years).

Revision History

Rev. 2 – General editorial changes and clarification as a result of the document review – 11/12/2008
Rev. 3 – edits to step 4 to more clearly describe the evaporation process, edit reporting digits for wine samples to two decimal places – 3/21/12
Rev. 4 – Consolidated the Procedure section. Added use of Antifoam to the Uncertainty section. Updated Reference section.