Improvements in manufacturing processes and equipment have allowed beer and wine producers to increase both the quantity and quality of the products. In the consumer products business, it is crucial to maintain good quality control practices. The higher throughput of manufacturing plants requires faster, more sophisticated analytical techniques to do this. Classical physical and sensory tests may have been suitable years ago, but today’s health and government standards usually specify specific tests for the major desired components and the trace contaminants.

The desired product of most fermentation-based operations is alcohol (or ethanol). The grades and qualities of most beers and wines are based primarily on the alcohol content. The determination of alcohol content can be done by physical measurement (hydrometry), spectroscopy (infra-red), and chromatography (GC/FID). Utilizing a gas chromatograph with a fairly short packed column and a general use flame ionization detector (FID) allows for a fast, simple, and very reproducible measurement of alcohol content. In addition, measurement by GC does not require any special sample preparation or handling. Such a system also allows for the determination of other compounds that arise from the fermentation process, mainly sugars, tannins, acids, and aromatic components.

Some examples of alcohol monitoring in beer are shown below, with an actual chromatogram and analytical conditions listed on the back. These analyses were researched and developed on a Buck Model 910 GC/FID system. Wine samples would be handled in an identical fashion.

Sample: An imported double-malt Lager
[Results are the average of triplicate runs on a GC system by manual injection]

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>Ferment Time</th>
<th>Avg. % Alcohol</th>
<th>R.S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Malt/Hop mix</td>
<td>0 hours</td>
<td>&lt;0.01%</td>
<td>7.3%</td>
</tr>
<tr>
<td>First Fermentation</td>
<td>8 hours</td>
<td>0.82%</td>
<td>4.1%</td>
</tr>
<tr>
<td>First Chilling</td>
<td>24 hours</td>
<td>1.68%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Second Fermentation (after supplementation)</td>
<td>36 hours</td>
<td>3.24%</td>
<td>3.9%</td>
</tr>
<tr>
<td>Final Product</td>
<td>7 days</td>
<td>4.13%</td>
<td>3.2%</td>
</tr>
</tbody>
</table>

Complex mixtures, which beers and wines certainly are, can be easily “resolved” into their individual components for precise and accurate analysis. The ultimate flexibility of the Buck 910 GC design permits a wide range of testing capability to be done very economically and efficiently with just one system, saving space, money, and time.

SIC: 2082, 2084
Rapid Measurement of Alcohol (Ethanol) in Beer and Wine Making

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Retention</th>
<th>Area</th>
<th>Area %</th>
<th>External</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methanol</td>
<td>1</td>
<td>19.483</td>
<td>8.28</td>
<td>0.56</td>
<td>1942.60</td>
<td>ppm</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>2</td>
<td>20.150</td>
<td>12.76</td>
<td>0.87</td>
<td>2.00</td>
<td>% vol</td>
</tr>
<tr>
<td>Ethanol</td>
<td>3</td>
<td>20.450</td>
<td>349.31</td>
<td>23.78</td>
<td>20.96</td>
<td>% vol</td>
</tr>
<tr>
<td>n-Propanol</td>
<td>4</td>
<td>20.883</td>
<td>12.88</td>
<td>0.88</td>
<td>2688.49</td>
<td>ppm</td>
</tr>
<tr>
<td>i-Propanol</td>
<td>5</td>
<td>22.533</td>
<td>84.29</td>
<td>5.74</td>
<td>6451.25</td>
<td>ppm</td>
</tr>
<tr>
<td>I-Butanol</td>
<td>6</td>
<td>22.716</td>
<td>37.65</td>
<td>2.56</td>
<td>2207.00</td>
<td>ppm</td>
</tr>
<tr>
<td>Acetone</td>
<td>7</td>
<td>23.750</td>
<td>133.21</td>
<td>9.07</td>
<td>4156.25</td>
<td>ppm</td>
</tr>
<tr>
<td>Acetic Acid</td>
<td>8</td>
<td>24.200</td>
<td>182.53</td>
<td>12.43</td>
<td>4.56</td>
<td>% vol</td>
</tr>
<tr>
<td>Propanaldehyde</td>
<td>9</td>
<td>24.466</td>
<td>141.49</td>
<td>9.63</td>
<td>232.05</td>
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</tr>
<tr>
<td>s-Butanol</td>
<td>10</td>
<td>24.633</td>
<td>158.00</td>
<td>10.08</td>
<td>742.98</td>
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</tr>
<tr>
<td>Butyraldehyde</td>
<td>11</td>
<td>25.533</td>
<td>150.91</td>
<td>10.27</td>
<td>1365.26</td>
<td>ppm</td>
</tr>
<tr>
<td>Butyric Acid</td>
<td>12</td>
<td>26.183</td>
<td>200.63</td>
<td>13.66</td>
<td>878.78</td>
<td>ppm</td>
</tr>
<tr>
<td>Inositol</td>
<td>13</td>
<td>26.800</td>
<td>6.92</td>
<td>0.47</td>
<td>39.80</td>
<td>ppm</td>
</tr>
</tbody>
</table>

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