Measuring Alcohol Concentration – Alcohol Proof Determination
Measuring Alcohol Concentration for Proof by measuring the Density of Alcohol.

Alcohol Concentration Determination Introduction
Pycnometers, hydrometers, and digital density meters are officially recognized methods for the determination / measuring alcohol (ethanol) concentration for quality control and to insure proper product labeling for declaration of alcohol content (Proof) for the payment of tax. In the United States the Alcohol industry is monitored and tax is collected by the US, TTB, with a required standard of measurement of % alcohol within 0.02% accuracy. Thus very precise measurements are required for proper labeling, tax remittances, and long term record keeping. Having records organized by batch, date, alcohol %, calibration, and temperature control is also of significant importance for an organized alcohol Distillery.

Alcohol Proof Measurement
Alcohol products are generally labeled with a stated alcohol Proof. This terminology began in the the UK however in the US, currently the term Proof is determined by multiplying the alcohol by volume (ABV) X 2. Thus an alcohol product labeled as 80 Proof is 40% alcohol by volume. An Alcohol product that is 50% ABV would be properly labeled at 100 Proof.

Measuring Alcohol Concentration with a Pycnometer
Pycnometers are not as accurate as other methods, are very time consuming, and require well trained laboratory personnel. Results are generally not very reproducible and prone to much human error. Difficulties in measuring alcohol concentration with a Pycnometer includes reading the measurements by eye and holding temperature at a consistent and accurate level. The need for considerable human judgment with visual readings leaves this method as being far to inconsistent and inaccurate to meet TTB labeling and taxation requirements.

Measuring Alcohol Concentration with a Hydrometer
Hydrometers are much less accurate then a modern highly accurate Density Meter or pycnometers. While hydrometers are reasonably easy to use, they require very large samples sizes between 300 to 500 ml per measurement and often need off-site calibration. User error is a significant problem with measurements made by eye and temperature control is also a difficulty. Significant time can needed to accurately bring and hold samples at temperature and again temperature levels are gauged by the users eyes.

An additional issue is of concern with pycnometers and hydrometers as the alcohol measurement results are difficult to validate and document. Traceability back to sample temperature at the time of measurement and calibration are difficult. The alcohol producer is also only able to keep a manually created log for Temperature, calibration, and % alcohol – there is no traceability back to a calibrated instrument and electronically recorded temperature reading. While many methods may be acceptable to the US TTB they are of little value if user error causes an inaccurate reading. In a shelf-pull or audit all that matters is accuracy in reporting alcohol by volume. Well organized Distilleries will want an instrument created log of precise

temperature, latest calibration, % Alcohol by volume, Proof, batch number, product name, and date.

Alcohol Concentration Determination with an Automatic Density Meter

A highly accurate Digital Density Meter such as the Rudolph DDM 2911 Plus provides the easiest means to measure the density of an alcohol/water mixture and automatically converting this measurement into an alcohol concentration and Proof determination. The measurement is fast, accurate, and highly reproducible. Only 1 to 2 minutes time and an approximately 2 ml sample is required to yield an accuracy of ±0.01 % vol/vol alcohol. This accuracy exceeds the US TTB required accuracy of 0.02%

Measuring Alcohol Concentration requires minimal Operator training using the DDM 2911 Plus Density Meter as the most common error of bubbles in the sample has been eliminated. The DDM 2911 Plus Density Meter gives the operator excellent visibility of the entire Oscillating Glass U-Tube to easily detect bubbles, and thus easily avoid inaccurate measurements. Alcohol measurements require very high precision and the presence of even the very smallest of bubbles will alter that precision greatly. However, Rudolph Research Analytical's exclusive VideoView™ ensures each sample is loaded into the density meter bubble free. The U-Tube that contains the sample is clearly displayed at 2-10X magnification so the operator can clearly see even the smallest bubble. The operator can view the U-Tube while loading the sample then magnify the view up to 10X if needed. In addition the user may use the scanning feature to examine the entire U-Tube before measuring.
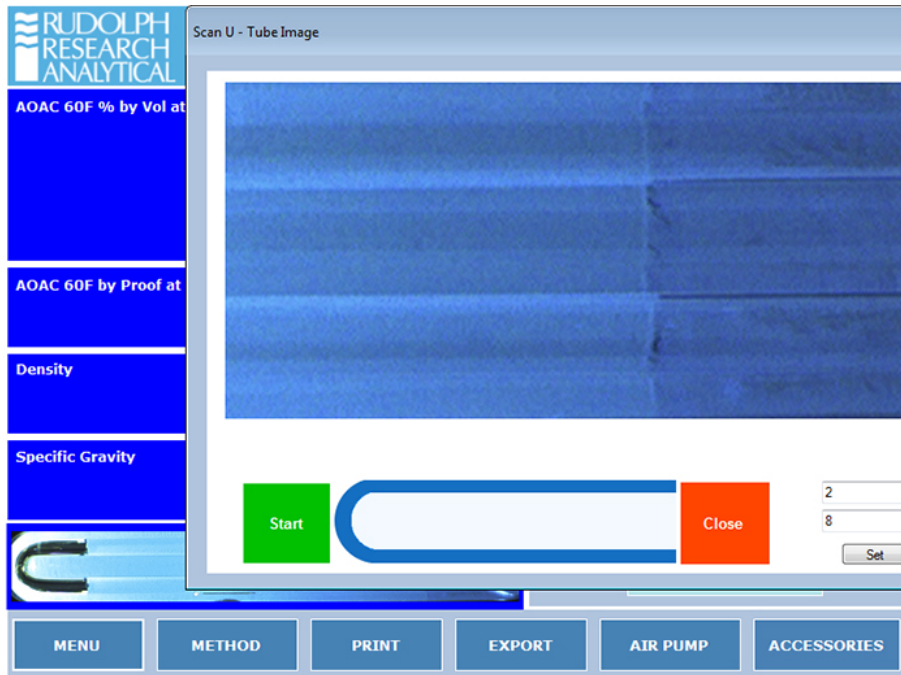
Method Management

NAME	TYPE	
AOAC Ethanol	Factory	**ADD**
Brix	Factory	**COPY**
Crude Oil	Factory	**HIDE**
Density	Factory	
Density Continuous	Factory	**RENAME**
Density through Temperature	Factory	
Density VC	Factory	**VIEW**
Factory QC Testing	Factory	
Fuel Oil	Factory	**RESULTS**
Lubricants	Factory	
OIML Ethanol	Factory	**METHOD CONFIGURATION**
		CLOSE

Alcohol % Determination – Density Meter Procedure

The DDM 2911 Plus is loaded for measurements by injecting a small 1 ml to 2 ml sample with a syringe. The temperature of this sample will be controlled automatically to within ±0.03 ºC of the required measurement temperature. The DDM 2911 Plus Density Meter will then accurately measure the sample's density and automatically perform the conversion of density, to alcohol concentration using one or more of the officially recognized alcohol tables; most often OIML, AOAC, or IUPAC. Alcohol concentrations may be determined in the full range of 0 to 100% with a single measurement. Units of concentration may be % vol/vol, %m/m, %wt/wt, or ºProof. The measurement results are displayed on the large 10.4 inch color Touch-Screen and may be saved locally or to any defined location on your network. The results may also be sent to any networked printer and can be used to generate a certificate of analysis, with your logo. Sample identification may be input manually or by the use of a bar code scanner or accessory keyboard. Additionally, the DDM 2911 Plus may be set in the "Multiple Measurement" mode whereas the same sample can automatically be measured any number of times as defined by the user and full statistical data of these measurement results will also be available on the display, can be printed out, and or saved on your network.

Easy Integration with your Distillery and network storage.

The DDM 2911 Plus utilizes the Windows 7™ Embeded Operating System which offers the user several advantages. Since the OS is Embedded it is impervious to malware or viruses as it cannot be overwritten or changed. The Windows 7™ environment is very much like a PC making it both familiar and easy to use. Additionally the DDM 2911 Plus can export files in a variety of popular formats such as text, PDF, and

CSV. For logs made of measurements of alcohol concentration, CSV files are very popular as they can be brought straight into an EXCEL™ file and stored in master logs of batches made by a distillery.

For additional information or to schedule a demonstration please contact Rudolph Research Analytical at 55 Newburgh Road, Hackettstown, NJ, 07840 P. 973.584.1558 | F. 973.584.5440 | info@rudolphresearch.com | www.rudolphresearch.com