DensiCheck TX

Measuring alcohol during distillation.
Industries: Whisky and brandy production, other alcohol production plant

Data sheet : DENSI_TX_Alcohol/**2012**

Introduction

Rapid and accurate in-line measurement of alcohol is of prime importance in the distilling industry to ensure successful and profitable management of the process. This applies equally to modern and traditional plant, especially in the current economic climate. Measurement and control is critical in determining the efficiency of the primary distillation process but is also required for efficient management of stocks and the final blending and reduction operations.

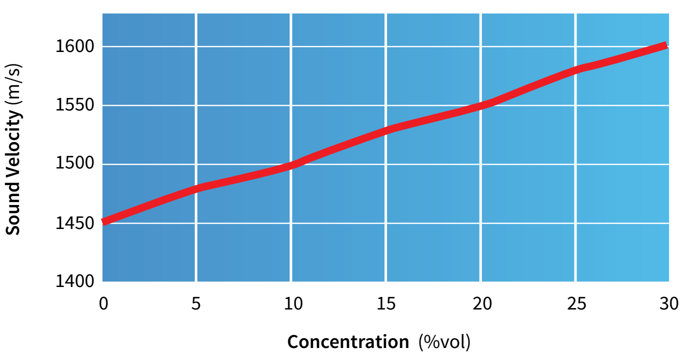
Sound Velocity Measurement

Ultrasound is a particularly effective technique for measuring alcohol content in distilling applications, where the main constituents are alcohol and water. The DensiCheck TX in-line liquid concentration analyser utilises this technique by measuring the time of flight of a short pulse of ultrasound at 1 to 5MHz. Sound velocity is an absolute physical property of a liquid or solution and in this respect resembles refractive index and density.

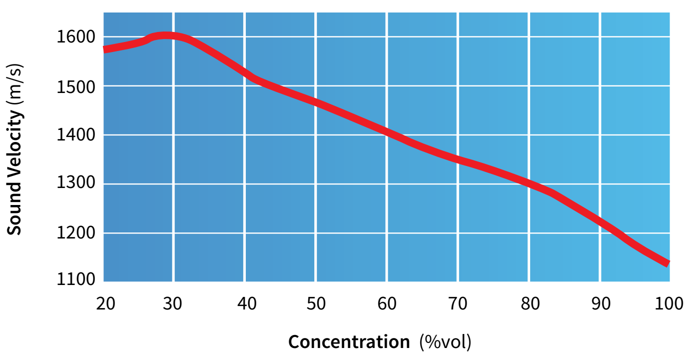
Measurement of Alcohol

Sound velocity in pure ethanol is much less than that in water but a strong interaction occurs in mixtures which results in an initial increase in the sound velocity until a peak is attained at 28% v/v ethanol. The peak velocity corresponds to a minimum intermolecular distance and compressibility which is the prime cause of the increased sound velocity and is the result of increased hydrogen bonding.

Alcohol 0..30% vol



Alcohol 30..100% vol



When all these factors are taken into account the relationship between ethanol concentration and sound velocity at different temperatures can be quite complex, but nevertheless it is well defined.

There are two ethanol concentrations for some velocity/temperature combinations. In practice this need not be a problem, as it is generally clear from the process which is the desired concentration. Ethanol concentration can generally be measured to 0.1% v/v except in the region where there is little velocity change for a large change in concentration. This occurs in the range of 28 to 35% v/v when the error can be up to 0.5% v/v.

Distillation Process

This instrument can be used in the distillery to measure the performance of the stills and control the diversion of the distillate to the appropriate collection vats. The ethanol concentration of the low wines from the wash still can be monitored and used to determine the cut-off point for distillation. In addition, if a flow meter were integrated into the line, it would be possible to calculate the average ethanol concentration of the low wines.

The balance between foreshots, spirits and feints is critical to the correct operation of the spirit still. The ethanol concentration of the distillate can be monitored to determine the spirit cut points. The inclusion of a flow meter would allow calculation of the average ethanol concentration and volume of each of the fractions which could be used by the stillman to obtain a steady charge to the spirit still.

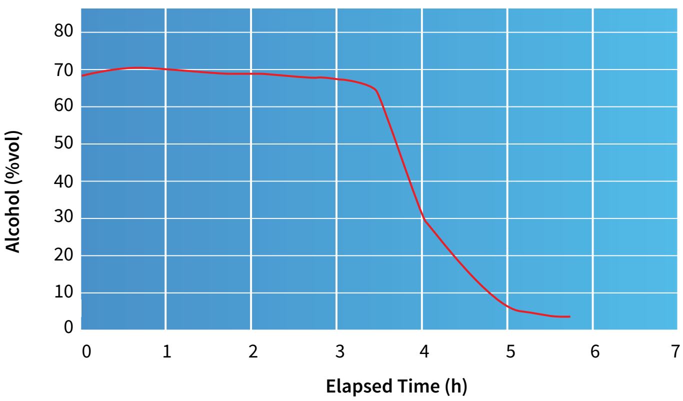
The performance of Coffey stills is largely determined by the design but the strength of spirit removed can be continuously monitored to ensure proper operation. There is potential to measure (and control) the concentration of hot and cold feints and the discharge of fusel oils, provided the relative proportion of their components is consistent.

Reduction & Blending

The final reduction in spirit strength before bottling is a critical area of operation. It is important to ensure that no under-strength product is packaged as this will cost time and money in terms of re-work required. However, it is also essential that the actual strength is tightly controlled and no over-strength product is packaged. In this situation, inline measurement of alcohol can be used to control the blending operation, or to monitor the strength immediately before packaging.

When the velocity/temperature calibration is carried out over a narrow band of product strength, it has been shown in practice that alcohol can be measured to 0.03% v/v. Perhaps a more important criterion for continuous measurement and control is the repeatability on the in-line

Spirit Still



measurement. This can be defined as the standard deviation of 20 successive discrete measurements. The repeatability of the alcohol measurement is 0.0035%v/v, which represents the ability to discriminate a change in alcohol of 0.01% v/v.

However, as with any in-line sensing device, ultrasonic sound velocity measures only what is present in the pipe at the instant of that measurement. It will, therefore respond to short-term fluctuation in the composition of the product, such as those introduced by blending systems which lack good mixing characteristics. In the case of ultrasonics, this can lead to unstable signals which cannot necessarily be smoothed mathematically.

However, the greatest problem for ultrasonics is the loss of signal strength due to highly attenuative solutions (e.g. sugar syrups), dense particulate matter or gas bubbles of a size which will scatter the sound waves. In these cases, it is necessary to consider continuous in-line measurement and plant design as an integrated whole, rather than as individual components, in order to minimise potential problems and achieve a successful installation. Fortunately, these are not generally problems associated with distilling applications.

Other Liquids

DensiCheck TX is being used in many different industries to measure the concentration of numerous different liquids including:

Substance	Chemical Formula	Substance	Chemical Formula
Acetone	C_3H_6O	Hydrogen Peroxide	H_2O_2
Ammonia	NH_3	Nitric Acid	HNO_3
Ammonium Sulphate	$(NH_4)_2SO_4$	Phosphoric Acid	H_3PO_4
Calcium Chloride	CaCl	Sodium Chloride	NaCl
Ethanol	C_2H_6O	Sodium Hydroxide	NaOH
Ethylene Glycol	$C_2H_6O_2$	Sodium Nitrate	$NaNO_3$
Fluorine	F	Sulphuric Acid	H_2SO_4
Glycerin C3H8O3 Toluene C7H8	$C_3H_8O_3$	Toluene	C_7H_8
Hydrochloric Acid	HCl	Tryptophan	$C_{11}H_{12}N_2O_2$

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