::: Application Report

Ethanol Production and the Determination of Density in the Distilling Process

Relevant for:

Fuel ethanol industry

History of the production process

Ethanol use as a transportation fuel can be traced back to Henry Ford and other early automobile pioneers.

It has always played a role as a supplement to oil-based fuels, and clean air programs in the 1990s have boosted the production from a mere 750 million liters per year 20 years ago to nearly 36 billion liters per year in 2004.

Ethanol ("drinking" alcohol) for use as a high-octane renewable fuel is produced by the fermentation of corn and other grain products. In the future it may also be economically produced from "biomass" or agricultural wastes.

Production of ethanol starts with grain (corn, barley or sorghum), cellulose or candy waste. This is hammer milled and then cooked, at which point yeast is added.

The mixture is fermented to produce CO_2 and a mixture of about 18% ethanol. This mixture is then cooked in a still where the ethanol concentration increases to about 50%.

The product then goes to a rectifying still where the concentration is increased to 95% (190 proof), and finally to dewatering, where it reaches 100% (200 proof).[1]

The Alcohol Monitor system from Anton Paar is the most accurate density trnaducer available, which continuously measures the density, % H_2O and alcohol concentration.

It consists of a density transducer DPRn 427(I) and an mPDS evaluation unit. Its high accuracy and reliability ensure efficient quality control and product monitoring.

The Alcohol Monitor can be used in the following positions in the production process:

At the rectifier columns and condenser: 190 Proof; 200 Proof

It is recommended that ethanol producers monitor the density and H_2O content (%) of both the 190 Proof and 200 Proof ethanol as a quality control check.

This is the crucial last stage in the production of ethanol and an absolute quality check point for ethanol producers.

After fermentation, a multi-column distillation system strips the alcohol from the mash by boiling.

After the final column, the 95% (190 proof) alcohol goes to dehydration where the remaining water is removed to produce 200 Proof alcohol as a last step in this process.

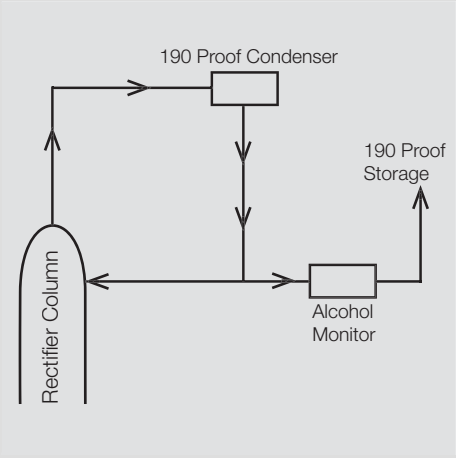

Fig. 1 Alcohol Monitor for 190 Proof at the rectifier column

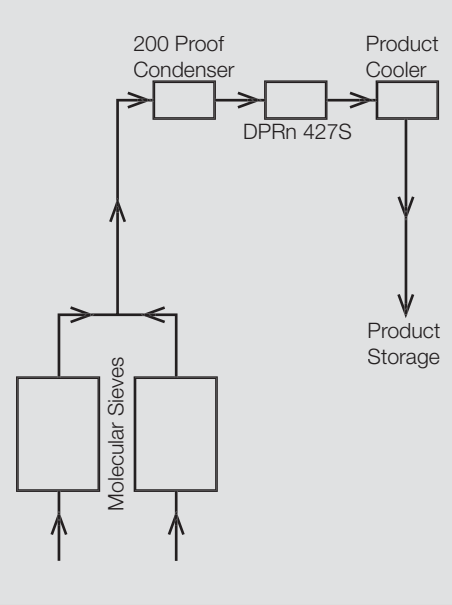

Fig. 2 Alcohol Monitor for 200 Proof at the molecular sieves

If ethanol has significant amounts of water in it (5% is a significant amount) its molecular structure will make it act more like water than ethanol when mixed with hydrocarbon solutions such as gasoline.

When "wet" ethanol is mixed with gasoline, the ethanol will separate out with all the ethanol settling to the bottom of the vessel and the gasoline to the top.[2]

The measurement of % H_2O is crucial at this point.

1. History of Ethanol Production: June 2002; Prepared by Joshua K. Buchheit; Rural Enterprise and Alternative Agricultural Development Initiative

2. Ethanol 101- Dehydration by Dr. Scott Kohl, Technical Connections, http://www.ethanol.org/documents/Ethanol101.7.pdf

How is the density measured?

Inside the DPRn 427(I) transducer is an oscillating U-tube system. It is excited and kept oscillating at its resonant frequency by two coils and an electronic circuit (see Fig. 3).

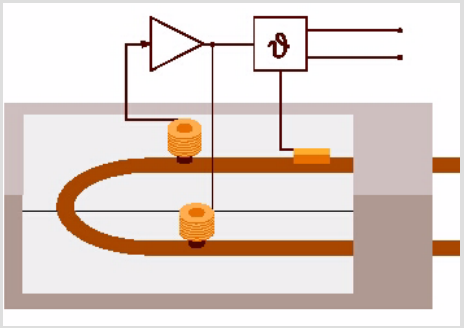

Fig. 3 The oscillating U-tube

The oscillation period and sample temperature are measured and transferred to an evaluation unit (mPDS 2000V3) for data processing and control purposes.

Your benefits

The Anton Paar Alcohol Monitor gives you an accuracy of 0.03%, equivalent to fine laboratory instruments (and unavailable through conventional flow meters).

Installing an Alcohol Monitor increases the profitability of an ethanol plant and pays off in a very short time.

The Anton Paar density systems are unmatched for accuracy, reliability and performance.

As they incorporate explosion-proof transformers and transducers, Anton Paar measuring systems are quickly gaining acceptance at ethanol plants around the world.

Call for a consultation with our specialists!

Alcohol Monitor - Features at a glance

- High resolution and repeatability up to 0.01% w/w (90 to 100%)
- Short response time (< 1 sec.)
- No moving parts, long working life
- Robust housing for operation under harsh process environments
- Water-proof to IP65
- Built-in high resolution temperature measurement
- German National Metrology Institute (PTB) approval for fiscal measurements (optional)
- Intrinsically safe to EEx ia IIC T6 (optional)
- All wetted parts made of Hastelloy C276
- Long life

System configuration

- DPRn 427 I intrinsically safe density transducer
- mPDS 2000V3 evaluation unit
- IPS 501 Intrinsically safe barrier
- Alcohol software: % alcohol, % H_2O, temperature, density, Proof
- DAVIS Windows-based recording software (optional)

Fig. 4 Alcohol Monitor: mPDS 2000V3 and DPRn 427 I

For more information and the technical representative in your area, contact us at:

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Technical specifications

Measuring range:

Alcohol

0 to 100% (v/v) or (w/w)

0 to 200 Proof

Water

0 to 100%

Temperature

-25 to 125 °C

Accuracy & repeatability:

Density

0.00005 g/cm^3 / 0.00001 g/cm^3

Alcohol

0.05 / 0.02% w/w (0 - 100%)

0.03 / 0.0% w/w (90-100%)

mPDS 2000V3 evaluation unit

Inputs/outputs:

- External product type selection for 255 products
- 4 analog inputs
- 3 analog outputs
- 2 relays for limit monitoring
- Serial interface RS 232/RS 485
- Profibus DP (optional)
- Custom formulas (optional)

All specifications are valid for constant measuring conditions and correct installation. Anton Paar reserves the right to make changes at it's discretion.