::: Application Report

Ethanol Production and the Determination of Density in the Distilling Process

Authors: Gregory Roy, Deborah Harding, Anton Paar USA

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 1990's 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 DPRn 427S from Anton Paar is the most accurate density transducer available which can be used in the following positions in the production process. Its high accuracy and reliability ensures efficient quality control and product monitoring

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

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 (95% v/v) and 200 Proof (100% v/v) 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 beer by boiling.

After the final column, the 95% (190 proof) alcohol goes to dehydration where the remaining water is removed. The presence of water enhances the molecular polarity of ethanol.

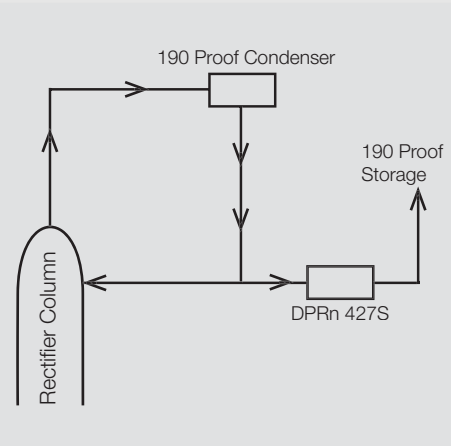

Fig. 1 DPRn 427S for 190 Proof at the rectifier column

Further dehydration to produce 200 Proof (100% v/v) alcohol is the last step in this process.

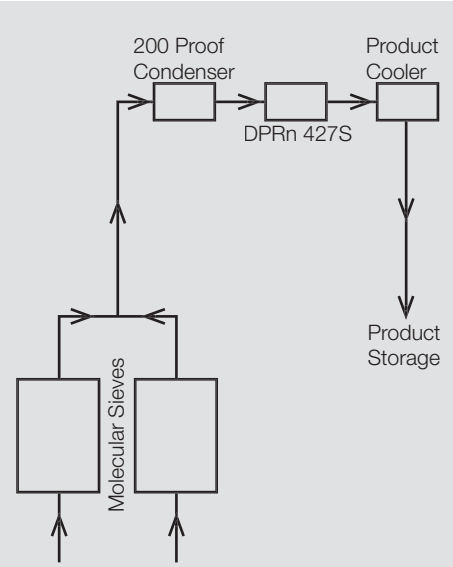

Fig. 2 DPRn 427S for 200 Proof at the molecular sieves

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]

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 427S 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).

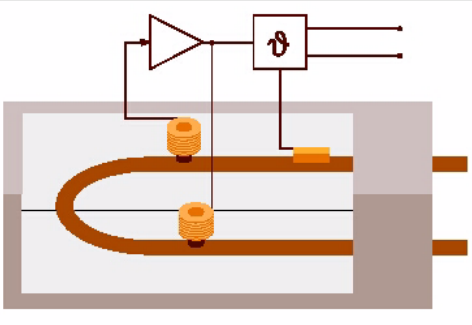

Fig. 3 The oscillating U-tube

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 DPRn 427 transducer along with the evaluation unit mPDS2000V3 give you an accuracy to 0.03%, equivalent to fine laboratory instruments (and unavailable through conventional flow meters).

Exhibiting an accuracy of ±5 to 10^{-5} g/cm^3 and a repeatability of 1 x 10^{-5} g/cm^3, 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 in ethanol plants. Call for a consultation with our specialists!

Fig. 4 mPDS 2000V3 evaluation unit

Features at a glance

- Robust housing made of stainless steel for operation under harsh process conditions
- Water-proof according to IP 65
- High resolution and repeatability up to 1x10^{-5} g/cm^3
- Short response time
- Built in high-resolution temperature measurement
- Low thermal inertia
- Virtually no influence of pressure, flow rate and viscosity
- All wetted parts are made of Hastelloy C 276 W. No. 2.4819 from a certified source and can be traced to the certification
- Maintenance-free, long life

Fig. 5 DPRn 427S density transducer

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

Anton Paar GmbH
Anton-Paar-Str. 20
A-8054 Graz
Austria - Europe
Tel.: +43 (0)316 257 -0
Fax: +43 (0)316 257 -257
E-mail: info@anton-paar.com
Web: www.anton-paar.com

Technical specifications

Sensor	
Sensor material:	Hastelloy C 276
Connection to the pipework:	Thread R 3/8“ DIN 259/1 (parallel)
Density	
Measuring range:	0 to 3 g/cm3
Repeatability:	1x10^{-5} g/cm3
Accuracy in the adjusted range:	5x10^{-5} g/cm3
Temperature	
Range - medium:	-25 to 125 °C
Range - ambient:	-25 to 125 °C
Accuracy in the adjusted range:	better than 0.1 K
Pressure:	0 to 50 bar
Dimensions	
Housing (LxWxH):	340x268x183 mm
Mounting (LxW):	240x100 mm
Weight:	23 kg

All specifications are valid for constant measuring conditions and correct installation. Deviations from the specifications are to be expected with temperature changes > 1 K/min.

B-R Controls Pty Ltd

Unit 3, 95 Hunter Street
PO Box 121
HORNSBY NSW 2077
Australia

Telephone: (+61) (02) 9476 2133
Facsimile: (+61) (02) 9476 2688
E-mail: mail@brcontrols.com.au
Website: www.brcontrols.com.au