AlcoholSense™
Ethanol Concentration Meter

Introduction

Integrated Sensing Systems Inc. (ISSYS) developed AlcoholSense™ as the first major advancement in liquid concentration measurement technology since the invention of the vibrating steel tube densitometer. The core technology in AlcoholSense is a patented* fluidic sensor utilizing silicon MEMS technology. The traditional components of a steel Coriolis density meter, are now fabricated using silicon-processing technology. The result is a sensor that provides superior density measurement in a package smaller than a fingernail. Silicon's low mass (1/3 that of stainless steel) and very high strength makes it a perfect material for density measurement.

Ethanol Distillation Process

Monitoring the performance of distillation columns is a key requirement for the economical operation of fuel ethanol plants. Changes in the purity of the produced ethanol will affect the plant's stable operation and reduce profits.

Distillation column operators routinely depend on hydrometer measurements to determine the proof or alcohol purity in the sales product. An alcohol sample is placed in a cylinder and a hydrometer floating in the liquid determines its specific gravity. After measuring the temperature of the fluid the operators consults a table to determine the alcohol concentration.

Laboratory personnel will use a titration method to confirm the alcohol concentration. This laboratory method provides high accuracy, but the slow measurement can be problematic when operators are diagnosing distillation problems.

A drop in ethanol proof can occur due to flooding of the rectifying column, causing crude ethanol to be carried over into the plant's 190 proof tank or molecular sieves. Molecular sieves are designed to remove water from a 95% pure ethanol stream. Any increase in water content will cause the molecular sieves not to be able to absorb the excess water.

Economics of Ethanol Measurement

Water content in the finished ethanol is important to the producer and purchaser. Producing ethanol with a higher purity than required can cost the plant revenue. For example, if a 50 MMgy plant sells ethanol at $2.50 a gallon and produces ethanol that is 0.1 proof (0.05wt percent) higher than required by their contract, the plant will lose about $0.00125 per gallon. This is approximately $63,000 per year of revenue is taken straight out of the profit of the plant.

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Traditional Ethanol Measurement Problems

Ethanol concentration measurement on-line has been difficult. Measurement of density and temperature must be in sync in order for the measurement to be accurate. Ethanol plant operation can cycle temperature by as much as 10F (6C) every few minutes. Heavy metal vibrating density meters have a problem correlating the fluid temperature to the measured density in rapid changing systems. The error between measured temperature and density results in ethanol concentration measurement errors.

AlcoholSense, The Solution for On-line Ethanol Measurements

The ISSYS AlcoholSense Ethanol Concentration meter uses a microCoriolis™ sensor fabricated from silicon. Silicon, has these fundamental advantages or stainless steel for density measurement.

Silicon is 1/3 as dense as stainless steel making silicon much more sensitive to density changes.
Silicon is 3 times stronger than stainless steel resulting in high strength thin walled sensors for increased sensitivity.
Silicon has 3 times the thermal conductivity of stainless steel resulting in fast temperature stabilization.

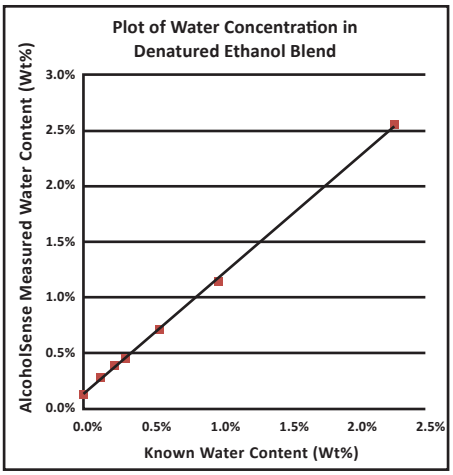
The very small internal volume of the microCoriolis™ sensor results very fast response to changes in density. A fast reacting platinum RTD temperature sensor built into the microCoriolis™ sensor provides close-coupled temperature measurement to assure the accuracy of ethanol measurement.

Use With Other Alcohols

Many industries use alcohols as solvents and cleaning materials. These alcohols can become contaminated with water. A trend is to purify these alcohols and reuse them in the process instead of disposal at hazardous waste sites. Higher order alcohols are being investigated as alternative fuels for transportation vehicles. AlcoholSense has been used to measure the purity of methanol, propyl alcohols and butanols containing water. Other applications involve created controlled mixes of alcohols and water for use as specialty chemicals.

Alcohol Pressure Compensation

The compressibility of alcohol (115ppm/atm for ethanol) must be taken into consideration when measuring trace levels of water in ethanol in an on-line application. AlcoholSense can adjust the calculated alcohol concentration for changing pressure conditions either through manual entry of pressure or using an external pressure sensor. The result is the most precise alcohol measurement possible.



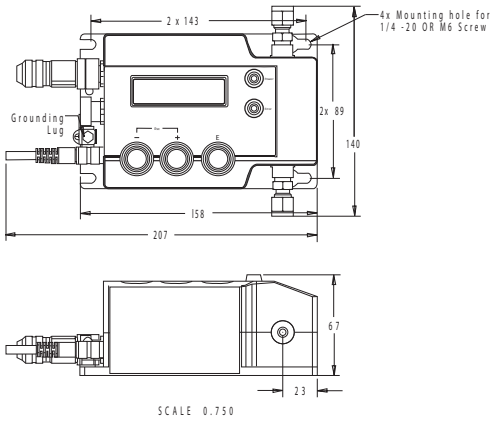
AlcoholSense Features

LCD Backlit Display With Push Button Programming
RS232/485 Communication Port or USB port
Modbus Protocol
Two 4-20ma Outputs (user selectable)
2 GB Internal Flash Storage
External Pressure or Temperature Sensor
UL, CUL, ATEX Certified Instruments

AlcoholSense Performance Specification

Liquid Density Measurement Range	:	0.6 to 1.3grams/cc
Liquid Density Measurement Resolution	:	0.000001 grams/cc
Liquid Density Measurement Accuracy	:	0.00003 grams/cc
Operating Temperature Range	:	-20 to 60C
Temperature Measurement Accuracy	:	+/-0.05C
Maximum Operating Pressure	:	300 psig
Alcohol Measurement Resolution	:	0.01wt%

AlcoholSense Dimensions



* US Patents 6,477,901, 6,499,354, 6,637,257, 6,647,778, 6,923,625, 6,932,114, 6,935,010, 7,059,176, 7,228,735, 7,263,882, 7,351,603, 7,381,628, 7,437,912, 7,568,399, 7,581.429, 7,628,082, 7,789,949, 7,823,445, 7,921,737B2, 8,016,798, 8,021,961 and Japanese Patent 4,568,763

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