Application note: N°F011

February 2012

Beer brewing

A pint of beer and a few ingredients...

Facts & figures:

Beer is the third most popular beverage in the world, coming in directly behind tea and water.

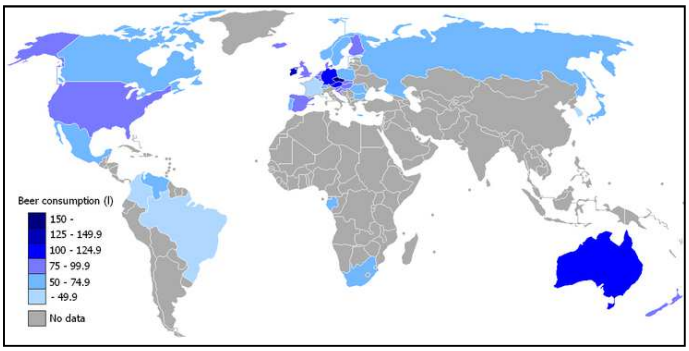
American beer is made mostly from rice. This was invented to give American beer a lighter taste and tap into the market of women buyers.

In the UK 28 million pints of beer are consumed every day, which equates to 100 litres per head each year.

Belgium has over 400 different beer brands.

Cenosillicaphobia is the fear of an empty glass.

Map of the world by beer consumption



Beer brewing in general

There is no exact date, as to when the first beer was brewed but already at the beginning of the fifth millennium BC, people in southern Mesopotamia, in a region known as Sumer (modern Iraq), were brewing beer.

Beer, like other commodities such as wheat and other grains, was used as a currency.

A clay tablet, dating from 6'000 BC contains one of the oldest known beer recipes.

The basic ingredients of beer are: water; a starch source: which is able to be fermented; yeast: to produce the fermentation; a flavouring such as hops.

There are several steps in the brewing process, which include ***malting***, ***milling***, ***mashing***, ***lautering***, ***boiling***, ***whirlpooling***, ***fermenting***, ***conditioning***, and ***filtering***.

Yeast is the microorganism that is responsible for fermentation. ***Saccharomyces cerevisiae*** is the species of yeast that is used for brewing.

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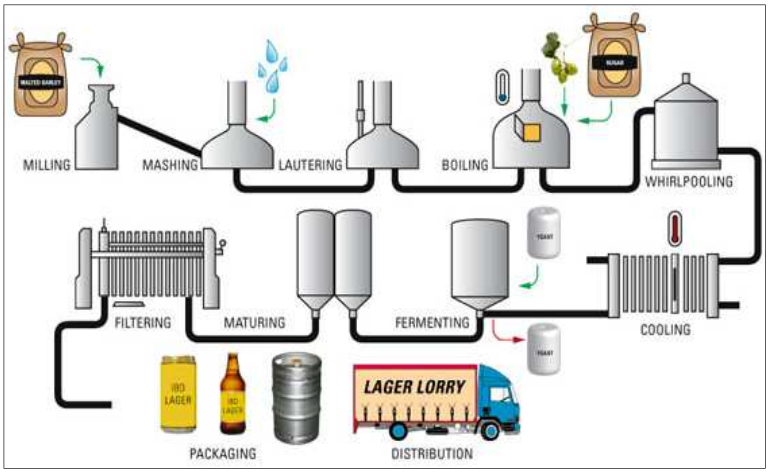
An example brewing process



Step by step brewing:

Malting: germination of cereal grains. The sprouted cereal is then kiln dried at around 55°C.

Milling: grinding of the malted cereal.

Mashing: the cereals are mixed with water and then heated.

Lautering: separation of the mash: the liquid (wort) is separated from the residual grains.

Boiling: the wort is boiled to ensure sterility and then hops are added for flavour!

Whirlpooling: the wort is sent into a whirlpool, removing the dense particles using centrifugal force.

Fermenting: yeast is added to the wort: conversion of the carbohydrates to alcohols and carbon dioxide - the chemical conversion of sugars into ethanol!

Conditioning: the tank is cooled and the yeast and proteins separate from the beer. This conditioning period is also a maturing period.

Filtering: the beer is filtered: stabilising the flavour.

Packaging: the beer is packed then to the customers

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LEADING IN HUMIDITY MEASUREMENT

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Why the need to measure the carbon dioxide?

Malting barley

Mashing

Fermentation

Carbon dioxide

Carbon dioxide (CO_2) is a naturally occurring chemical compound. It is a gas at standard temperature and pressure.

We inhale oxygen and exhale carbon dioxide. The carbon dioxide level in exhaled air is rather constant: around 3,8%.

When carbon dioxide is exhaled it will quickly be mixed with the surrounding air even indoors and provided that the ventilation is good, the concentration will be reduced to harmless levels.

Indoor carbon dioxide levels usually vary between 400 and 1'200 ppm (parts per million). Outdoor carbon dioxide levels are usually 350 - 450 ppm.

Beer brewing process:

Heavily industrialised or contaminated areas may periodically have a higher concentration of CO_2.

Carbon dioxide is released during the beer brewing process and as you will see below, CO_2 is toxic for living organisms.

In brewery environments where process generated carbon dioxide is widely present, the maximum permitted carbon dioxide concentration according to most standards is as high as 5'000 ppm (5%) during an 8 hour working period.

Beer storage:

Most beer leaves the brewery **carbonated**: beer and carbon dioxide are sealed in a container under pressure.

It can be **carbonated during fermentation** but it can also be **carbonated in the bottle**.

In this case the beer is allowed to ferment completely. It is left unfiltered which leaves active yeast suspended in it. A small amount of sugar is then added at bottling time. The yeast begins to act on the sugar: CO_2 is released and absorbed by the beer.

Beer can also be **force carbonated**, in which case it is allowed to fully ferment. Then CO_2 is pumped into a sealed container with the beer and absorbed by the liquid. In this case, a tank of carbon dioxide will also be required.

Undetected leaks in a gas system is a costly waste and a safety risk to personnel. While small leaks are inherent in any gas system, those of significant size raise the level of economic and safety risk.

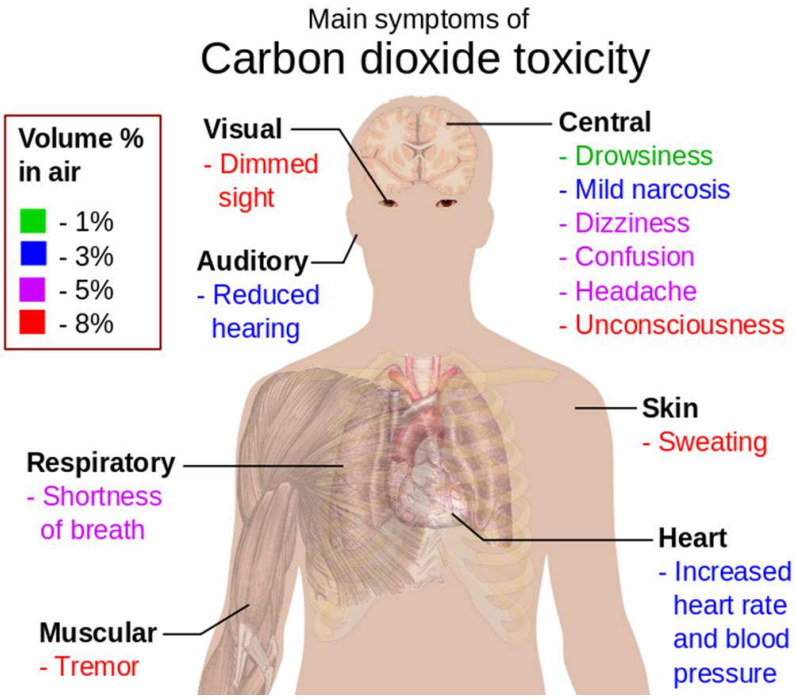
How does CO_2 affect the human body?

Due to the health risks associated with carbon dioxide exposure, there are regulations and laws in place to avoid exposure! The US National Institute for Occupational Safety and Health (NIOSH) states that carbon dioxide concentrations exceeding 4% are immediately dangerous to life and health.

In indoor spaces occupied by people: concentrations higher than 1'000 ppm will cause discomfort in more than 20% of occupants. At 2'000 ppm, the majority of occupants will feel a significant degree of discomfort and many will develop nausea and headaches.

Case study: The lake Nyos

The lake Nyos is a crater lake situated in Cameroon. In 1986, a pocket of magma from under the lake, leaked a large amount of CO_2 into the air. The result was suffocation of around 1'700 people and 3'500 livestock!



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What solutions can Rotronic offer?

CF3-W-US-Disp

Non-dispersive infrared technology:

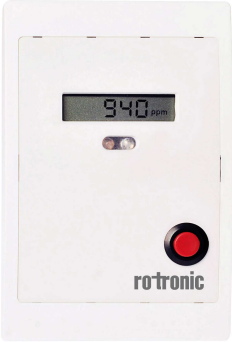
Non dispersive infrared technology relies on the fact that the molecules absorb light (electro-magnetic energy) at spectral regions where the radiated wavelength coincides with internal molecular energy levels. In accordance to well know quantum mechanical theory in physical chemistry, such energy resonances exist in the mid-infrared spectral region due to interatomic vibrations.

Since different molecules are formed by different atoms (with different masses) the vibrational resonance frequencies (and wavelengths) are different for every species. This fact is the basis for gas sensing though spectral analysis. By detecting the amount of absorbing light, within just a small spectral region that coincides with the resonance wavelength of the selected species, one gets a measure of the number of molecules of this particular species, free from interference of other species.

Rotronic products

Transmitters:

- ***CF3 series***
  0...2'000 ppm,
  ± 30 ppm
  24 VDC/VAC power supply,
  2 analogue outputs,
  Output 1: 0...10 VDC,
  Output 2: 4...20mA,
  Temperature range: 0...50℃,
  Optional display,
  Various mounting possibilities,
  Audible alarm,
  Light signal...
- ***CF5 series***
  0...2'000 ppm,
  ± 30 ppm
  0...50℃
  ± 2℃
  24 VDC/VAC power supply,
  2 analogue outputs,
  0...10 VDC or 4...20mA,
  Optional display...
- ***CF8 series***
  0...40'000 ppm,
  ± 200 ppm
  With or without temperature measurement,
  24 VDC/VAC power supply,
  2 analogue outputs,
  0...10 VDC or 4...20mA,
  Different relay options
  Temperature range: 0...50℃,
  Display,
  Various mounting possibilities...



CF3-W-US-Disp-FLI

Customer benefits

A CO_2 sensor controls the ventilation rate in occupied spaces. In the brewery, the principal source of carbon dioxide will be the fermentation process. Outdoor levels tend to be at a relatively low level and are fairly constant. An indoor CO_2 measurement can be compared to outside conditions to provide an indication of the amount of outside air ventilation , on a CFM-per-person basis, that is being provided to an occupied building space.

Energy saving:

Ventilation will be based on the actual occupancy of the space rather than the forecasted occupancy of the space. The CO_2 sensor here will reduce the ventilation when no beer is being produced but at the same time, during unoccupied hours whereas an air quality sensor may actually maintain ventilation all day round if there is a significant pollutant level in the building.

Calibration:

The Rotronic CO_2 product range comes calibrated/ adjusted!

The lifespan of the product is more than 15 years for normal applications.

The automatic baseline correction means the sensors require no further calibration if they are used in indoor air applications.

CF8-W-Disp-AL

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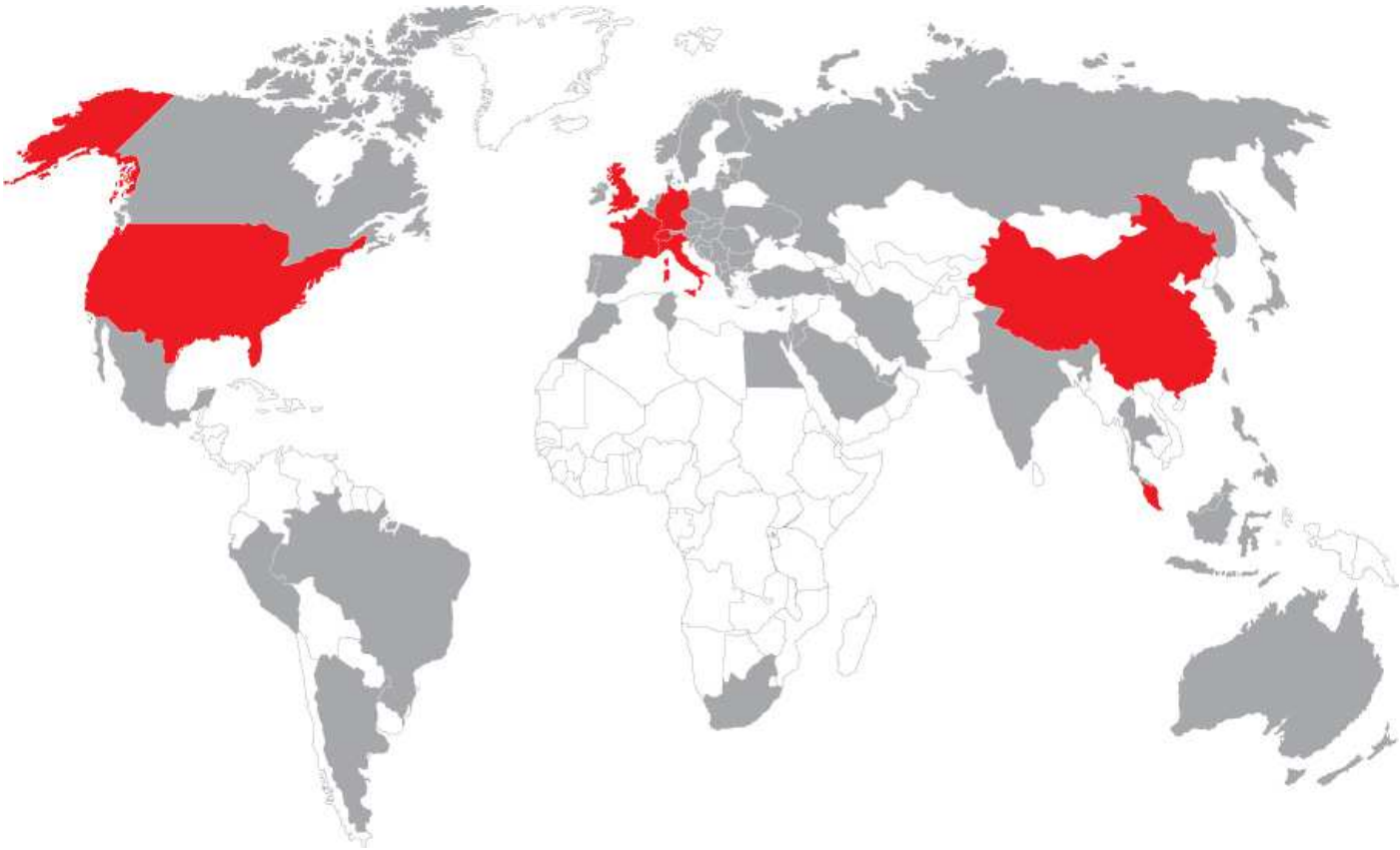
LEADING IN HUMIDITY MEASUREMENT

Contact us:

Rotronic is represented in more than 40 countries around the world. An up to date list of all our partners is available at www.rotronic-humiditiy.com/international



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