CO_2 production quality

What's in your feedgas?

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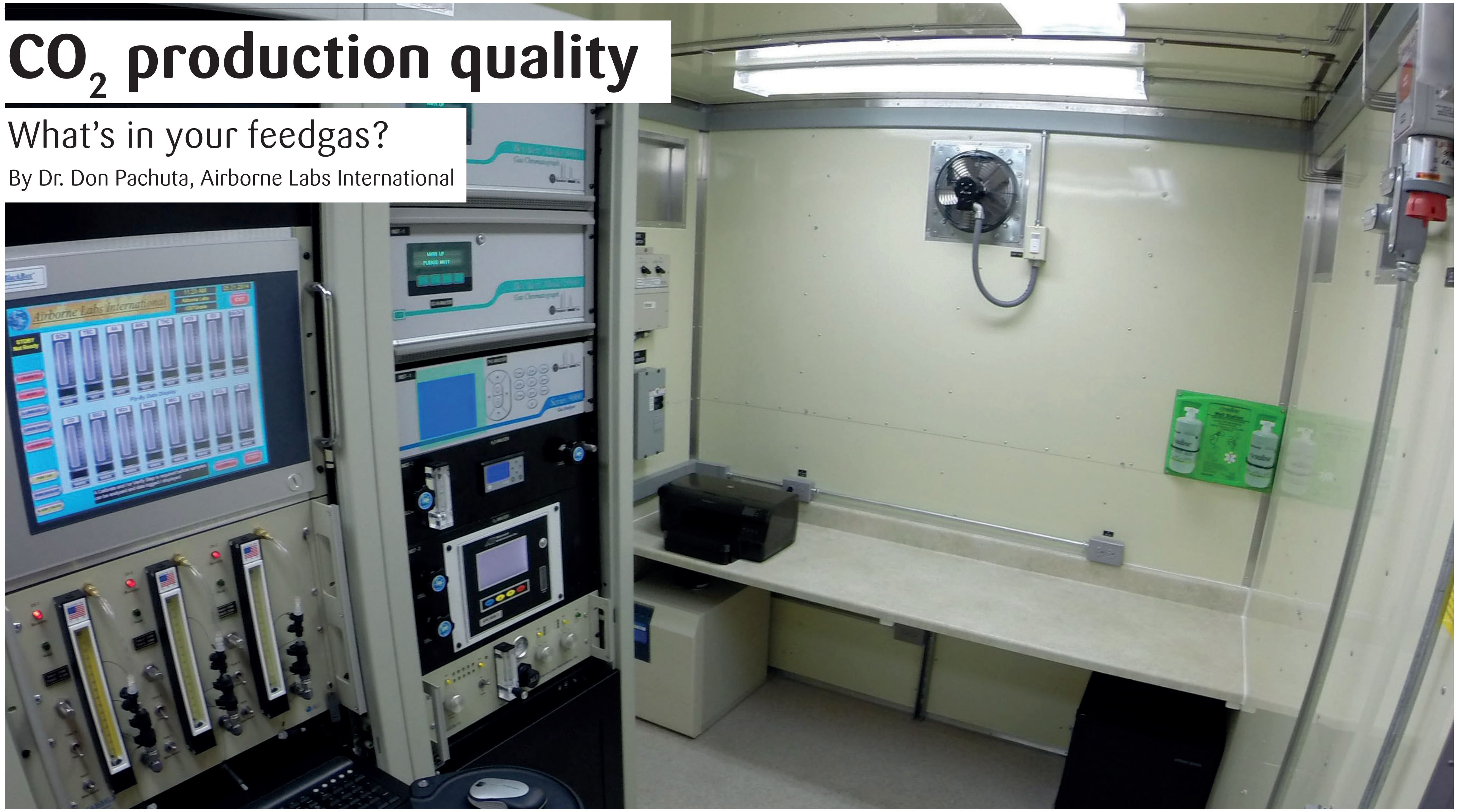

Unlike many gases that originate from air separation, where the list of potential impurities to deal with is relatively short, carbon dioxide (CO_2) is commercially produced from an ever-increasing range of feedgas sources. The CO_2 present is basically a 'waste product' from that source. Examples include the burning of various types of fuels, products of acid neutralisation or chemical synthesis, natural wells, and also many types of biomass sources through the fermentation or organic degradation process (for example, biogas).

Potential CO_2 impurities

The types and amounts of impurities that can be experienced during CO_2 production is quite feedgas dependent and in some cases highly complex and variable. Additional impurities can be generated during the production process as well. A good deal of background about this subject is offered in various International Society of Beverage Technologists (ISBT), European Industrial gases Association (EIGA) and Compressed Gas Association (CGA) documents.

Many CO_2 impurities can elicit an undesirable sensory impact in a carbonated beverage or food that it contacts. Such impurities are often volatile sulfur agents or oxygenated hydrocarbons. In addition, some possible feed source impurities have inherent toxic properties at higher levels such as benzene, hydrogen cyanide, vinyl chloride, oxides of nitrogen, and halogenated hydrocarbons. Therefore, the quality risks faced by CO_2 producers can be formidable. For example, historically a high percentage of publicised quality issues associated with beverage-grade CO_2 have been related to sulfur agents (for example carbonyl sulfide), acetaldehyde and benzene. Both adequate plant design for impurity removal and installation of proper monitoring tools are equally important.

The CO_2 quality toolbox

A range of analytical technologies are being employed for monitoring CO_2 production quality. Unfortunately, there is no 'magic box' for all CO_2 production applications. Each analytical 'tool' available has both strengths and inherent limitations. It is very important to understand what these factors are in order to select an optimal CO_2 monitoring system for a plant's specific environment and risks.

What needs to be considered are feedgas complexity, plant size/location, electrical power quality, testing environs, desired sampling points, system ruggedness, automation level needed, staff training/capabilities, critical impurities, testing frequency (for example continuous or infrequently [daily batch]), purity grade(s) produced, vendor expertise in CO_2 production applications, maintenance/training support capabilities, types and overall costs of supplies required – to name a few.

Analytical technologies

The majority of CO_2 producers employ an integrated mix of analytical technologies in order to monitor the CO_2 impurities that represent the highest risk to product quality. This includes:

- Gas detector tubes (DT)
- Individual specific analysers for water vapour, oxides of nitrogen, oxygen, total sulfur content, percent CO_2 purity
- Process gas chromatographs (GC) with selective detectors
- Process mass spectrometers (MS)
- Infrared (IR)/Ultraviolet (UV) spectrometers

The costs and complexity of these units vary greatly with detector tubes being the lowest cost, easiest to use and semi-automated when incorporated with a DT analyser. This technology works well for low frequency (batch) testing operations. Atypical on-line analyser data can often be quickly cross-checked using a DT. A DT analyser can also help to prevent prolonged 'purity data black-outs' that can result if/when a continuous, on-line analyser goes out-of-service. This is an especially important consideration for remote CO_2 plants.

Many CO_2 producers employ individual specific analysers along with process GCs or MS units for routine, continuous impurity monitoring. For GC and MS units it is important for both the vendor and plant staff to know the potential feedgas or production-generated impurities that can be present. With this information, an experienced vendor can often adjust the GC column employed or mass lines/ionization gas conditions accordingly. Analyser system 'tweaks' can help to prevent low risk 'nuisance' impurities from causing 'false alarms' in a high risk impurity measurement. These interferences can result in rejected 'good' loads and unnecessary, costly production delays. The more complex the CO_2 feedgas, the more difficult, yet critical it is to know what can cause measurement errors.

IR/UV spectrometric systems are also used in some CO_2 production facilities. This is a highly automated technology that employs computer-based chemometrics to find and measure the spectral absorption peaks of key target impurities. It also uses a chemometric routine to subtract out overlapping peaks from various co-impurities along with CO_2 and water bands. As with GC and MS, a thorough knowledge of the feedgas profile is essential. For IR/UV units all 'nuisance' component spectra need to be included in the spectral subtraction programme in order to prevent either false positive alarms or erroneously low results for high risk agents. For complex feedgas sources or samples containing small amounts of highly IR absorbing water vapour, this chemometric correction process can be challenging.

Summary

Each of the technologies discussed have a set of advantages and limitations that need to be clearly understood. There is no universal CO_2 analyser system due to the range and complexity of CO_2 feedgas sources. A list of questions to consider before installing a CO_2 analyser system was presented.

One common theme to the success of any analyser system is 'Know What's In Your Feed Gas'! With this information an application-experienced vendor should be able to make the appropriate equipment adjustments that can prevent false alarms, rejected good loads, costly, unnecessary CO_2 production delays, or bad loads from going undetected. gw