Application Note #22

Cost-Effective Purity Analysis in the Cryogenic Air Separation Process

Spark™

GASES & CHEMICALS | CEMS | ENERGY | ATMOSPHERIC | SEMI & HB LED | SYNGAS | LABORATORY

This application note details the use of our Spark™ series of Continuous-Wave Cavity Ring-Down Spectroscopy (CW-CRDS) analyzers for detection and analysis of moisture, carbon dioxide and methane in the cryogenic air separation process.

Improve Process Efficiency with the Spark™

Tiger Optics' trace gas analyzers offer many opportunities improve the air separation process by saving time and money, as follows:

- Freedom from calibration
- No consumables or service gases required
- All solid-state design; no moving parts
- Plug-and-play, easy to operate
- Accurate detection of moisture (H_2O), carbon dioxide (CO_2) and methane (CH_4)
- Fast speed of response; ideal for process control

Cryogenic Air Separation

Cryogenic air separation is the most efficient method for the production of gaseous and liquid high-purity nitrogen, oxygen and argon. The cryogenic process can be modified to manufacture a range of desired products and mixes. Even so, it typically calls for sequential steps, which are outlined in Figure 1.

How Tiger Helps

Following air compression, the air pre-treatment step consists of cooling and purification to remove process contaminants, such as moisture, carbon dioxide and hydrocarbons. The most common purification methods are Temperature Swing Adsorption (TSA), which exploits the difference in adsorption capacity of adsorbents at different temperatures, and Pressure Swing Adsorption (PSA), which operates similarly via pressure variations.

Purification is essential to this process, as impurities can freeze in the downstream heat exchangers and cryogenic separation equipment. As a result, product quality may be impaired, and the system itself can suffer damage. To avoid such mishaps, the Spark H_2O monitors the air emitted from the TSA and PSA to ensure complete moisture removal prior to entering the heat exchangers.

The Spark measures H_2O in nitrogen down to 15 ppb over a wide concentration range of 0–2000 ppm. As shown in Figure 2, the accuracy is within 15 ppb, similar to the LDL, and the repeatability is better than 0.5% (RSD) for repeated intrusions. With a specified speed of response of less than 3 minutes to 95% of intrusion level, the Spark provides fast moisture detection. As the results show, the response is often even faster than our stated specification in practice, when operated with an optimized sampling system.

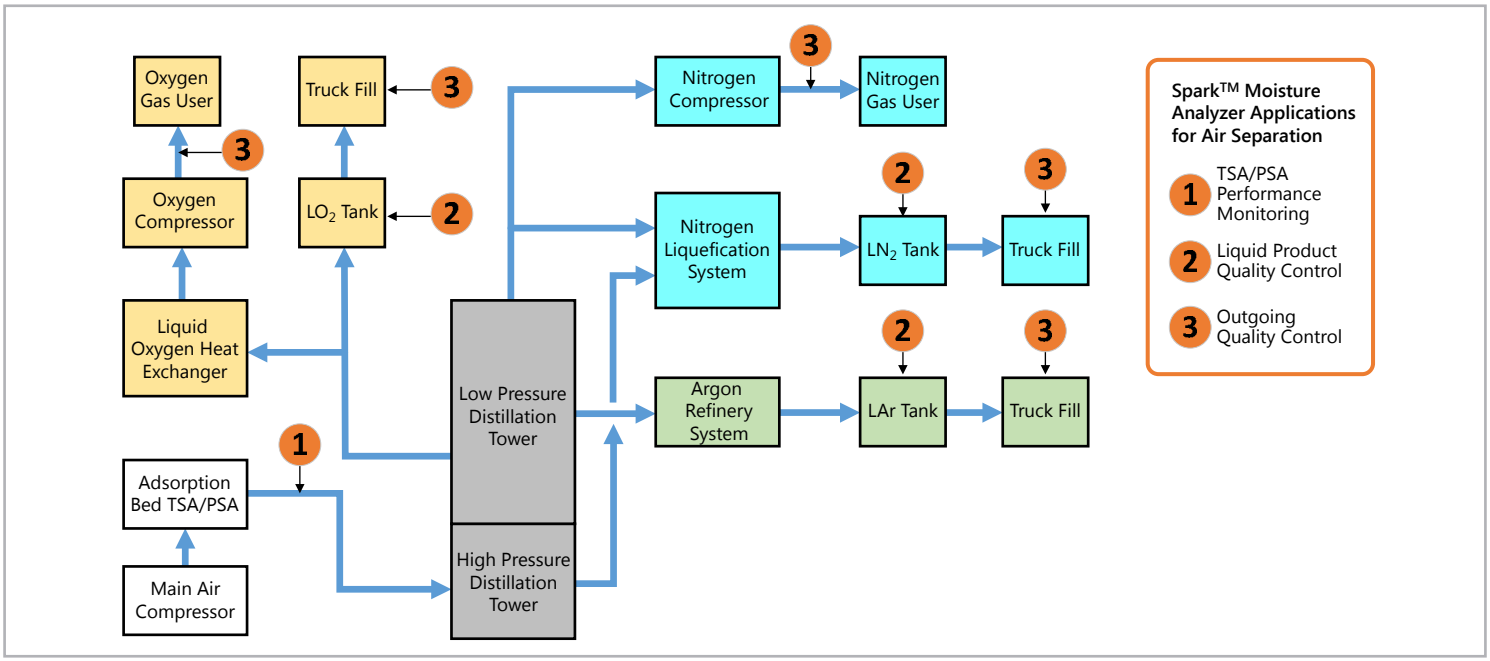

Fig. 1 Cryogenic air separation steps

Tiger Optics | 21ST CENTURY SPECTROSCOPY

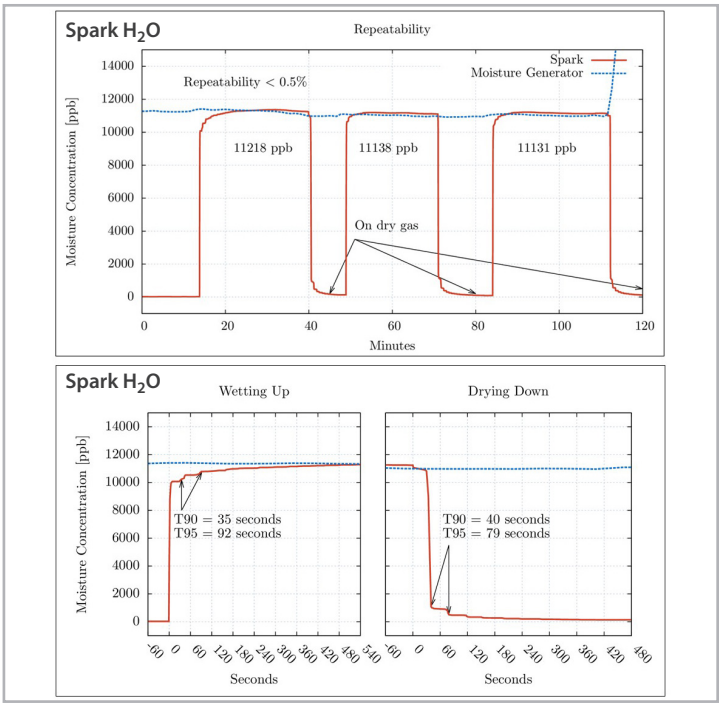

Fig. 2 Repeatability & speed of response of the Spark H_2O

The Spark CO_2 and CH_4 are ideal replacements for non-dispersive infrared (NDIR) and flame ionization detectors (FIDs). With its fast speed of response to detect excursions, the Spark is ideal for process control, where the incumbent technologies are typically employed. Unlike NDIR, Spark users achieve freedom from drift, which means no cumbersome calibration and maintenance protocols. In addition, the Spark CH_4 is a safer alternative to FID, as no hydrogen fuel gas is required. Users also eliminate all of the calibration and utility gases that go along with the FID. This typically saves up to eight cylinders!

Tiger Optics' Spark™ Specifications

Impurity	Gas Matrix	Range	LDL	Sensitivity
H_2O	Air (CDA)	0 – 1800 ppm	14 ppb	10 ppb
	Ar	0 – 900 ppm	6 ppb	4.5 ppb
	N_2	0 – 2000 ppm	15 ppb	12 ppb
	O_2	0 – 1000 ppm	7 ppb	6 ppb
CO_2	Air (CDA)	0 – 1500 ppm	200 ppb	150 ppb
	Ar	0 – 1500 ppm	150 ppb	115 ppb
	N_2	0 – 1500 ppm	200 ppb	150 ppb
	O_2	0 – 1500 ppm	175 ppb	135 ppb
CH_4	Air (CDA)	0 – 80 ppm	10 ppb	7.5 ppb
	Ar	0 – 70 ppm	9 ppb	6.5 ppb
	N_2	0 – 80 ppm	10 ppb	7.5 ppb
	O_2	0 – 50 ppm	7 ppb	6 ppb

Rapid Stream-Switching

Couple the Spark with a high-purity gas stream selector and eliminate the need for additional analyzers! Whereas traditional measurement equipment requires dedicated analyzers for the different gases, the Spark's fast speed of response supports rapid cycling between many gas streams for accurate, real-time impurity measurement in all process gases with a single analyzer.

Continuous-Wave Cavity Ring-Down Spectroscopy (CW-CRDS)

All Tiger Optics instruments are based on CW-CRDS. The key components of the system are shown in Figure 3 below. CW-CRDS works by tuning laser light to a unique molecular fingerprint of the sample species. By measuring the time it takes the light to decay or "ring-down", you receive an accurate molecular count in milliseconds. The time of light decay, in essence, provides an exact, non-contact and rapid means to measure contaminants.

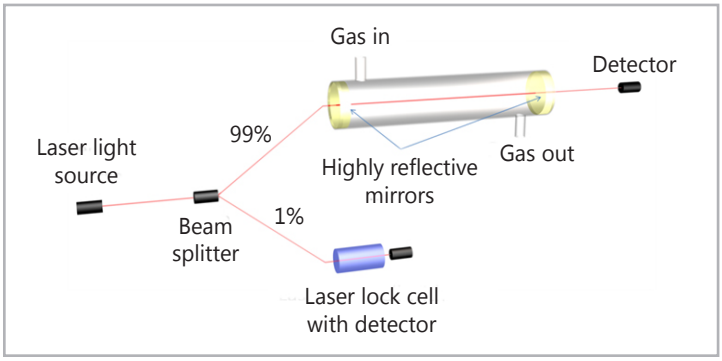

Fig. 3 Principle of CW-CRDS

Tiger Optics Overview

Founded in 2001, Tiger Optics offers a wide and proven array of customer-lauded gas analyzers, as well as atmospheric and environmental monitors. Based upon powerful CW-CRDS, Tiger instruments afford outstanding detection capabilities, speed of response, dynamic range, and accuracy, combined with continuous and automatic zero verification, ease-of-use, and freedom from moving parts and consumables. From the cleanest of semiconductor fabs to the harshest coal-fired stacks, our analyzers work to improve your yields, reduce costs and ease the burdens of regulatory compliance.

First ISO-Certified CRDS Company

Tiger Optics is also the first ISO 9001 accredited CRDS company, known for our quality, consistency and manufacturing excellence, as well as excellent global support.

Tiger Optics, LLC
250 Titus Avenue, Warrington, PA 18976
Phone: +1 (215) 343 6600 • Fax: +1 (215) 343 4194
sales@tigeroptics.com • www.tigeroptics.com

Tiger Optics | 21ST CENTURY SPECTROSCOPY