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Supplement 6 | **Second Quarter 2016**
www.specialtygasreport.com

SPECIALTY GAS REPORT

A supplement to CryoGas International, dedicated to the specialty and medical gases business

A Change in Supply

Gas Innovations Gets Innovative with Carbon Monoxide

By Ashley Madray

Industrial efficiency and safety continue to require innovations and changes to the way we perform all of our production, supply, transportation, and administration. Technologies that increase our efficiency and make our world safer and more sustainable long term are the technologies that drive our industrial gas industry to continued growth.

Over the past few years Haldor Topsoe (*www.topsoe.com*.) has developed technologies for the on-site production of carbon monoxide in purities that meet and exceed traditional supply modes. Now available are eCOs (electrolytic Carbon Monoxide solution) production systems for applications ranging from pharmaceutical to agricultural, chemical production as well as electronic and food industry applications.

"Haldor Topsoe is proud to have its first installation in the Americas at the Gas Innovations facility in La Porte, Texas, on the Houston Ship Channel. We also look forward to our relationship with Gas Innovations and working together in developing the carbon monoxide market for all industries including electronics," says Casper Hadsbjerg, Haldor Topsoe's Business Director for eCOs Solutions.

For the electronics industry, specifically for components such as reed relay switches and in the production of solar cells, a super clean silicium that is produced with the aid of carbon monoxide is used in the manufacturing process. The eCOs technology offers an advantage in terms of low carbonyl content due to plant operating temperature and procedures that do not favor carbonyl formation.

What makes the eCOs so appealing? Key issues include carbon monoxide's physical characteristics. In particular, its poison classification, make risk management a top priority for operations, site, plant, and safety managers. Some of the features and benefits of eCOs include better storage, transportation, purity for CO, and an attractive systems footprint.

Minimal storage of carbon monoxide is required using the eCOs. The primary product stored is carbon dioxide (CO_2) as the source for making the carbon monoxide. CO_2 is

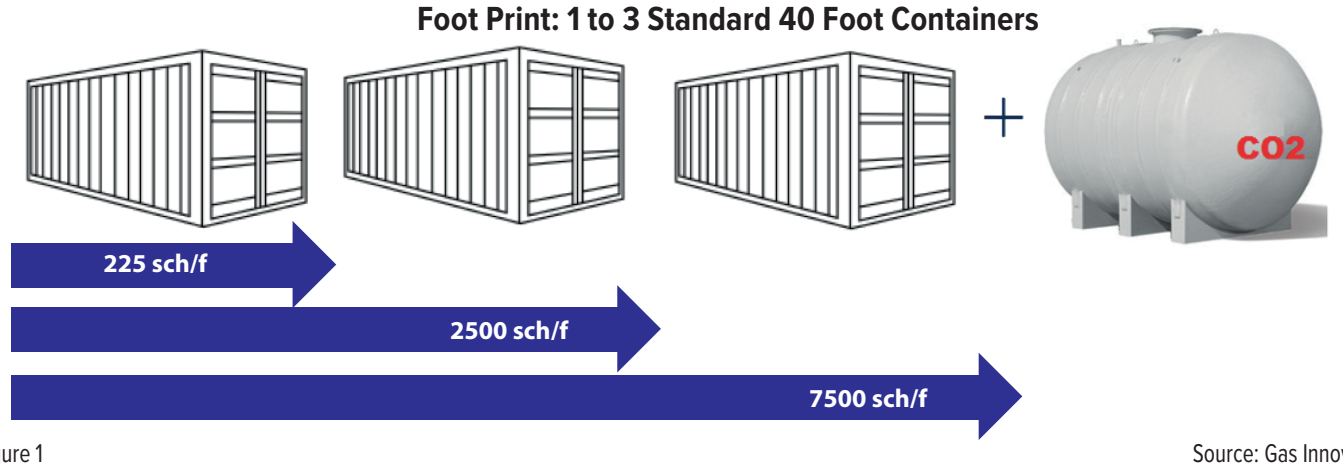

Figure 1

Source: Gas Innovations

piped into the eCOs where it is electrolyzed. The electrolytic solution refers to the solid oxide electrolysis cell (SOEC) that efficiently removes one oxygen from the CO_2 to make CO. Any remaining CO_2 is removed using a combination of PSA and polishers resulting in CO purities ranging from 99 percent to 99.995 percent with custom configurations.

Consumption Figures

	Per 100 scf CO Generated	Per 1 Nm3 CO Generated
Carbon Dioxide	200 scf	2 Nm3
Power	16 kw	6 kw
Protection Gas	4hrs at nominal capacity at start-up and shut down	

Figure 2 Source: Gas Innovations

How It Works

The SOEC is an energy conversion technology that can be operated to store or convert electricity and carbon dioxide as carbon monoxide and oxygen, with high efficiency and high reaction rates. The cells operate at relatively high temperatures (700-850 °C). This is because at high temperatures carbon dioxide can be split into carbon monoxide and oxygen using the heat and the SOEC cell, thereby self-cooling. The heat which is inevitably produced with electrical current is needed for the electrolytic process.

The SOEC consists of three parts: an electrolyte, an anode, and a cathode that are built of various ceramic (or solid oxide) materials. A cathode of an electrochemical cell is the electrode where reduction reaction occurs, and an anode is where oxidation reaction occurs. Using external electricity, SOECs are able to electrochemically convert carbon dioxide to carbon monoxide at the fuel electrode (cathode). At the same time, pure oxygen can be obtained at the oxygen electrode (anode). The two electrolysis products, carbon monoxide and oxygen, are formed on each side of the cell.

At the cathode, CO_2 dissociates to form CO and O_2. The oxygen atom reacts with the incoming electrons from the external circuit to form an oxygen ion. The oxygen ion is conducted through the electrolyte to the anode. At the anode, the oxygen donates the electrons to the external circuit to form an oxygen atom. Two oxygen atoms finally combine to form an oxygen molecule at the anode side of the cell.

Remote monitoring and operation by Haldor Topsoe's personnel provides peace of mind.

Space required for the eCOs is minimized using modular international shipping containers in twenty (20) and forty (40) feet lengths. Additional space for a CO_2 supply, additional compression, and inventory storage (if needed) may be minimal compared to tube trailer supply.

Transportation of carbon monoxide may be reduced with the eCOs. CO users not fortunate enough to have pipeline supply traditionally have trucked CO from trailer filling facilities, which are scarce across the world. Connections, tube trailer swaps, and traffic related to this activity are minimized using the eCOs.

Many applications or uses of CO are required intermittently. As such, on-site storage maybe required and then replenished with tube trailers. Using the eCOs for temporary or intermittent supply may present another alternative for users. In this scenario, an eCOs module could be delivered to the use point and connected to a CO_2 supply along with power and be operable within twenty-four hours. CO_2 may also be included in the scope for this scenario.

Remote applications without access to tube trailer delivery or pipeline access may be solved with eCOs. With a power source, CO_2 supply, and an eCOs system, CO can be produced effectively and efficiently.

Operational flexibility to a turn down ratio of thirty percent of capacity is available. Designs are modular and are available in ranges including 225 standard cubic feet per hour (scfh) up to as large at 7,500 scfh, and the 7,500 scfh units may be installed in parallel for the largest applications. Freedom to adjust volumes at any time allow the end-user to manage production and manufacturing costs compared to residual costs associated with traditional supply or tube trailers.

Optional features may be available. Some applications may require extreme pressures and peak and valley flow rates compared to the normal supply of the eCOs at 150 psig. Additional compression and surge tanks via storage tubes are also available. Storage may include carbon steel or aluminum where carbonyls may be a concern.

Haldor Topsoe's experience in fuel cells and separation technology have been the foundation of the development of the eCOs. That expertise has made the eCOs a safe, efficient, reliable, and cost effective system for the supply of CO, without personnel required by the users.

In Summary

Gas Innovations is happy to have found Haldor Topsoe for this project. The company had been searching for a high purity supplier of carbon monoxide when Casper Hadsbjerg of Haldor Topsoe called. Haldor Topsoe may have been as surprised as Gas Innovations was to discover their mutual interest in supply of carbon monoxide and in marketing the eCOs Solution to the electronic industry. Gas Innovations looks forward to working with and installing this innovate technology at many more project sites in the future. SGR

About the Author

Ashley Madray is Executive Vice President of Gas Innovations. For more information on Gas Innovations, visit gasinnovations.com

This article appeared on pages 24-25 of Specialty Gas Report Q2 2016. Specialty Gas Report is published quarterly by gasworld Publishing LLC., 5 Militia Drive, Lexington, MA 02421, USA; TEL: 781-862-0624; FAX: 781-863-9411, www.gasworld.com/magazines/specialty-gas-report/