SERVOMEX

Applications Brochure

Use of Infrared and Combustion Analysers on an Ethylene Plant

Servomex' infrared analysers play a key role in the on-line monitoring of feed streams and cracked gas products in ethylene plants. They employ a rugged design suitable for hazardous areas while offering high performance and long-term stability. In particular, one model in the range can measure trace levels of carbon dioxide with exceptionally low cross-interferences from hydrocarbons.

The ethylene process

Ethylene is a basic raw material for the chemical industry and is used in the manufacture of plastics, detergents, paints, antifreeze, packaging, drugs, cosmetics, solvents and other products. It can be produced by steam cracking a variety of hydrocarbon feedstocks such as ethane, propane, naphthas and gas oils. Depending on the feedstock, an ethylene plant can also produce a range of by-products including propylene, butadiene and aromatics.

In a typical process, the hydrocarbon feedstock is preheated and thermally cracked in the presence of steam in tubular pyrolysis furnaces. The hot pyrolysis gases exit the furnace at typically 760-870°C (1400-1600°F) and are rapidly quenched in transfer line heat exchangers producing high pressure steam. Further cooling is carried out and a final water quench enables any process steam and heavy gasoline to be condensed.

The cooled raw gas is compressed in a multi-stage centrifugal compressor, then dried and sent to a de-methaniser. The de-methaniser bottoms pass to a de-ethaniser from which the ethylene-ethane stream is fractionated in a distillation column with the ethane being recycled to the cracking furnace. Further downstream processing can involve the de-ethaniser bottoms being de-propanised and propylene produced, and the de-propaniser bottoms separated into mixed C_4's and gasoline streams.

Process analyser measurements

Infrared analysers are used to carry out various important measurements on an ethylene plant and typical examples are given for a plant cracking an ethane or mixed light hydrocarbon feedstock.

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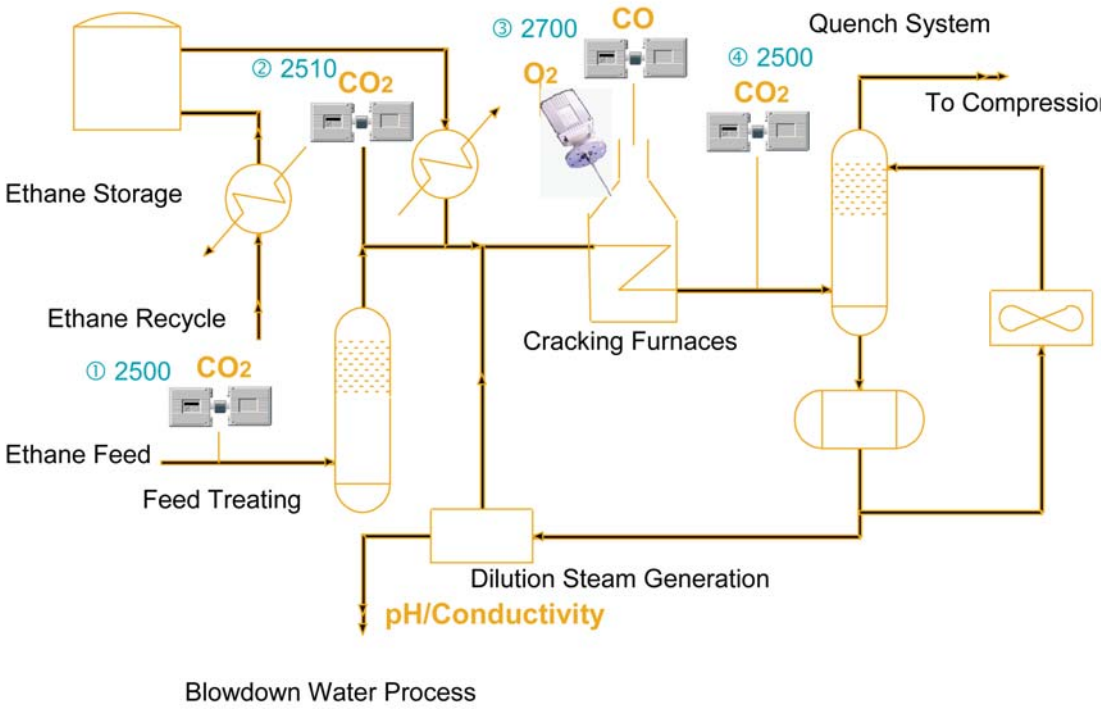
Feed Treatment, Cracking, De-coke



① The quality of the raw ethane feedstock (particularly if obtained from natural gas) is monitored for carbon dioxide in the range of 0-10% before the treatment plant.

② Since carbon dioxide can freeze out on the process equipment at the 'cold end' of the operation, it is removed to levels of below 100ppm (typically to 10ppm) in the treatment plant. An analyser measuring in the range of 0-1000ppm is used to monitor the outlet stream and show the performance of the treatment plant. The treatment plant can also be used to remove hydrogen sulphide traces from heavier feedstocks.

③ Another important process measurement on ethylene plants include the monitoring of the oxygen in cracking furnace combustion gases for efficient combustion control, and the monitoring of these flue gases for pollutants such as carbon monoxide to comply with emission regulations.

④ After every 20 days or so of operation, the cracking furnaces need to be decoked since they acquire a coating of carbon over time and lose efficiency. This is done by burning off the coke with air in a steam atmosphere. The progress of the decoking phase is monitored by measuring the amount of carbon dioxide (0-5%) in the effluent. It rises as the carbon is burnt off and then reduces to zero when the furnaces are clean again, and the plant can be returned to normal operation.

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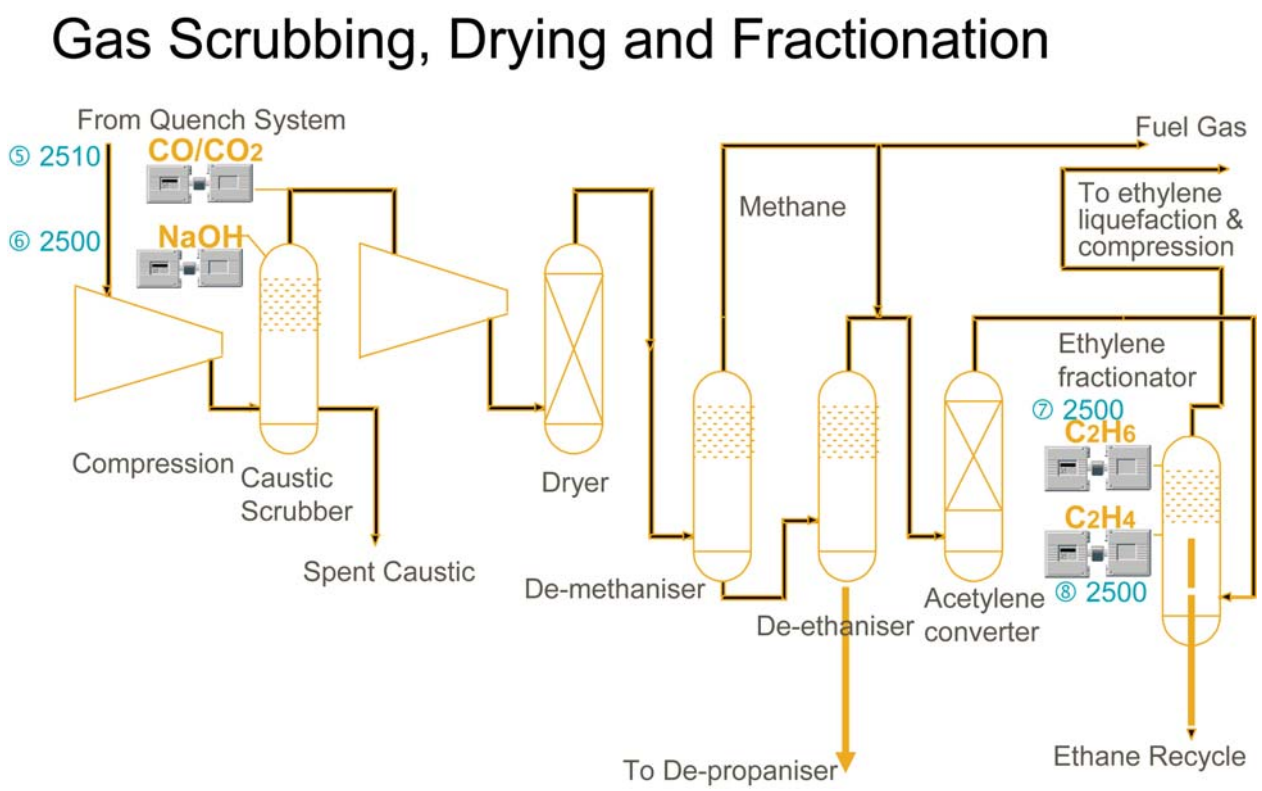

⑤ After quenching the cracked gas, residual carbon dioxide is removed by a caustic tower and any final traces monitored by the cracked gas analysers ⑤. By comparing analyser readings after the ethane treatment plant ② and before the scrubbing tower ⑤, the most economical operation can be obtained. The cracked gas analysers can also be used in monitoring for furnace upsets. In some plants, both low level CO_2 and CO are analysed.

⑥ The sodium hydroxide solution feed to the CO_2 scrubbing tower is monitored for correct concentration.

⑦&⑧ The ethylene fractionator is a distillation column in which the overhead product is ethylene and the bottoms are ethane. In principle, if the temperature on the tower is controlled and the temperature gradient known, the composition of the gas along the column is known.

In practice it is difficult to compensate for any small pressure changes in a temperature control system. The two analysers, measuring ethane in ethylene and ethylene in ethane, are used to monitor the composition at two key points to help in the operation of the column.

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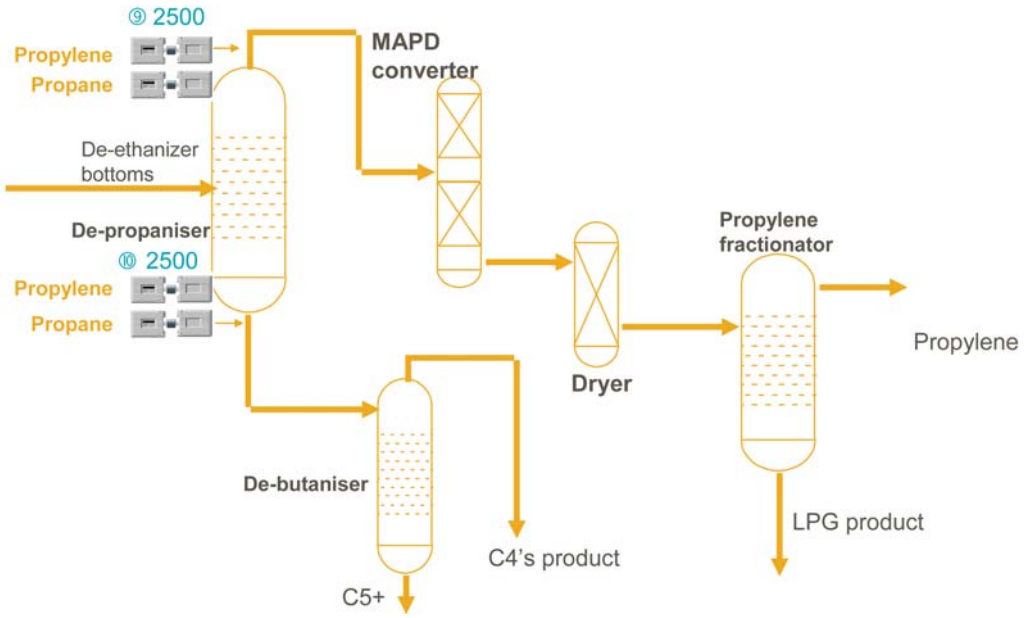
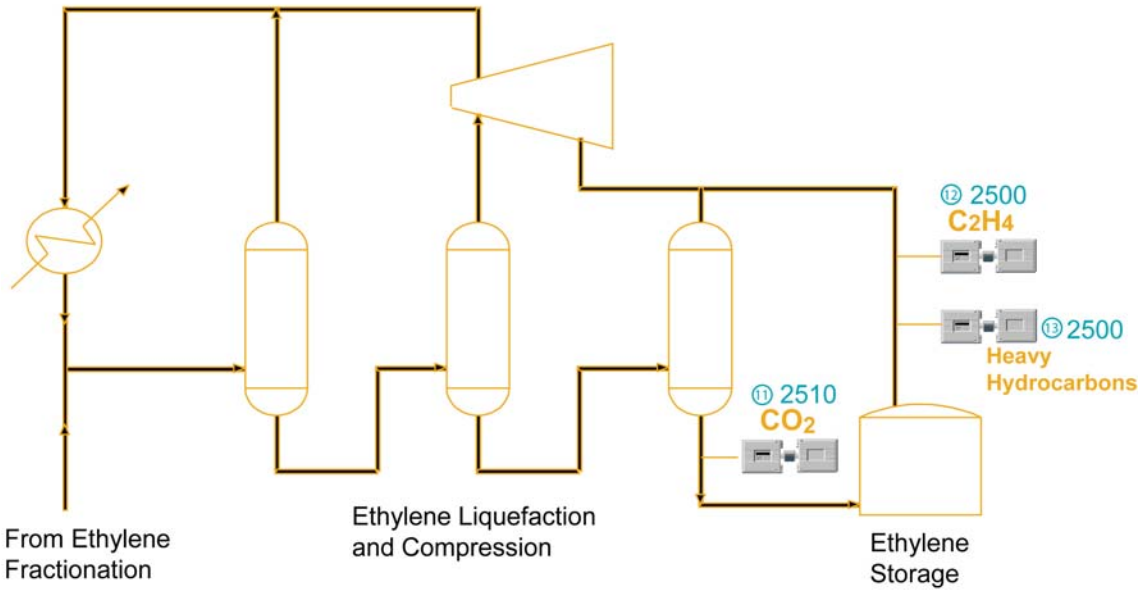
De-propaniser, De-butaniser, Propylene Fractionation



⑨&⑩ The de-propaniser separates C3's and C4's+. Then the propane is separated from the propylene in a fractionator. The de-propaniser bottoms are then sent to the de-butaniser to separate the C4's from C5's+

Ethylene Compression, Storage



⑪ ⑫ & ⑬ The ethylene product at the end of the process is monitored for residual CO_2 traces to check purity. The ethylene purity is also measured (99.9%), and the level of any heavy hydrocarbons.

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SERVOTOUGH SpectraExact (2500 Series) Infrared Analyser

SERVOTOUGH SpectraExact (2500) infrared process analysers employ a single beam, dual wavelength measurement technique which offers high performance, repeatability and long-term stability. In particular, measurement is virtually unaffected by build-up of sample cell contamination since it influences both wavelengths equally. A 50% loss of signal due to obscuration of the sample cell windows produces no more than 3% fsd error in the reading.

In addition, Servomex has developed a gas filter correlation (GFC) infrared analyser, the 2510, which can measure trace levels of carbon dioxide or carbon monoxide with exceptionally low cross-interferences from other hydrocarbons or flue gases. The GFC technology uses hermetically-sealed gas cells containing reference and inert gases in place of the usual interference filters, giving the benefits of extended sensitivity and excellent stability.

The 2510 is available with a minimum measurement range of 0-50 vpm (0-90 mg/m^3) CO_2 in mixed light hydrocarbons and its wide dynamic range enables it to measure higher concentrations as well as trace levels. An interference rejection target of equal or greater than 100,000:1 has been achieved for ethane, ethylene and propane, and interferences from other hydrocarbon components have been reduced to acceptable levels.

Servomex' analysers have been designed for modern process environments with emphasis on rugged construction, reliable performance and easy servicing. Full certification is available for use in hazardous areas. The analyser's control panel contains a bright vacuum fluorescent display for clear visibility and very simple control panel. The system is menu-driven and designed to be as intuitive as possible, requiring the minimum of operator familiarisation.

SERVOTOUGH Fluegas (2700) Combustion Analyser

The Servomex SERVOTOUGH Fluegas (2700) combustion gas analyser can monitor both oxygen and combustibles in flue gases. Oxygen is measured using zirconium oxide sensor technology. A thick film catalytic sensor optimised for carbon monoxide is used to detect ppm levels of combustibles.

These sensors are housed in a sensor head, mounted on the process wall, to which a sample is aspirated via a sample probe giving fast in phase response of both O_2 and COe. The range of probes available enables a fast, dynamic and accurate analysis in high temperature combustion applications.

Flame traps are supplied as standard and the COe sensor has auxiliary air to support measurement to give true CO reading (not clamped or derived), making the SERVOTOUGH Fluegas (2700) one of the safest combustion analysers on the market.

The sensors are protected from harsh conditions in a heated box making the unit low maintenance.

Sample conditioning

The gas sample presented to the analyser should be clean and dry. In a typical sample conditioning system, the pressure and flow of gas is first controlled to suitable levels for the analyser, and filtered to remove any particulate matter. However, some streams on ethylene plants (particularly the cracked gas if sampled before the quenching system, and the decoking steam mixture) do require special sample conditioning before they can be analysed. This would typically involve sampling components to remove condensibles and heavy hydrocarbon contaminants which would otherwise accumulate and block the analyser sample lines.

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Servomex range of products for the Hydrocarbon Processing Industry

	SERVOMEX EMISSIONS ANALYSERS	SERVOMEX COMBUSTION ANALYSERS	SERVOMEX PROCESS ANALYSERS
SERVOTOUGH (Hazardous Area)	SERVOTOUGH 2500 - SERVOTOUGH SpectraExact 2900 - SERVOTOUGH Laser	SERVOTOUGH 2700 - SERVOTOUGH Fluegas 2900 - SERVOTOUGH Laser	SERVOTOUGH 1900 Digital - SERVOTOUGH Oxy 1900 IR - SERVOTOUGH Spectra 2200 - SERVOTOUGH OxyExact 2500 - SERVOTOUGH SpectraExact 2900 - SERVOTOUGH Laser 1800
SERVOPRO (Safe Area)	SERVOPRO 4900		SERVOPRO 5400 - SERVOPRO MultiExact 4100
SERVOFLEX (Portables)		SERVOFLEX 5100 i.s - SERVOFLEX Micro i.s	SERVOFLEX 5100 i.s - SERVOFLEX Micro i.s 5100 Marine - SERVOFLEX MicroMarine

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