Online Process Gas Analysis in Ethylene Production Plants

Process Overview

Ethylene is one of the most common building blocks in the petrochemical industry with millions of tons produced around the world every year. A typical ethylene plant also produces a number of other important building block chemicals such as propylene and butadiene along with an aromatics-rich pyrolysis gasoline. Ethylene, propylene and butadiene undergo value-added processing in order to synthesize plastics, rubber, fibers and many other organic products.

Gas Analyzer Applications

Cracked gases such as ethane and propane from petroleum refining overheads and naptha streams are used as feedstock for ethylene and propylene production. The typical ethylene plant is divided into two basic sections: the cracking furnaces (hot side) and the fractionation train (cold side). The furnaces are often called by different names such as pyrolysis furnaces, naptha cracking furnaces, naphtha steam crackers, etc. After the cracking furnaces the gases are cooled, compressed and scrubbed. The liquid hydrocarbons and hydrogen are then sent to the fractionation train where they go through several stages of distillation to separate desirable end products and recyclables such as hydrogen, methane, ethylene, ethane, propylene, propane, butylenes, butadiene and gasoline.

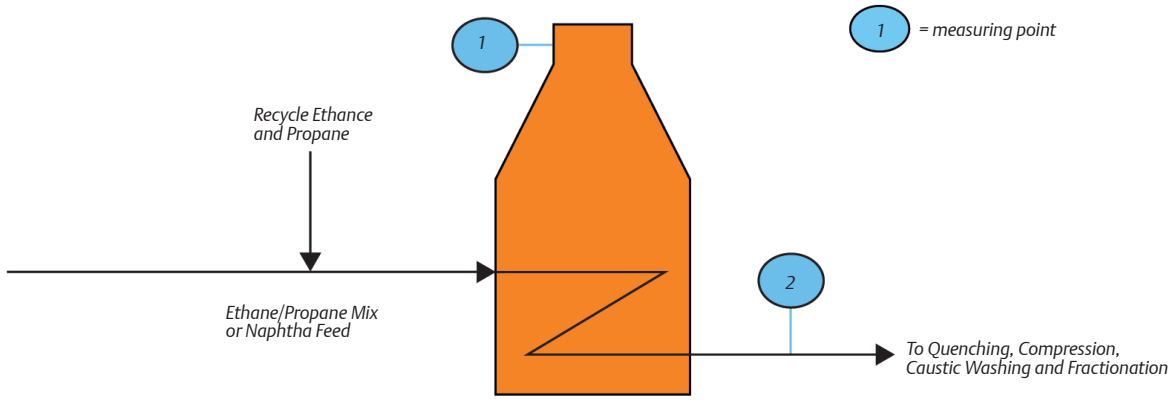


Figure 1 - Cracking Furnace

Measurement Point 1: Combustion in the Cracking Furnaces

Combustion flue gas analyzers placed after each burner ensure optimum fuel/air ratios for combustion efficiency, and also augment the heat balance of the furnace, helping eliminate “hot spots” which promote coking.

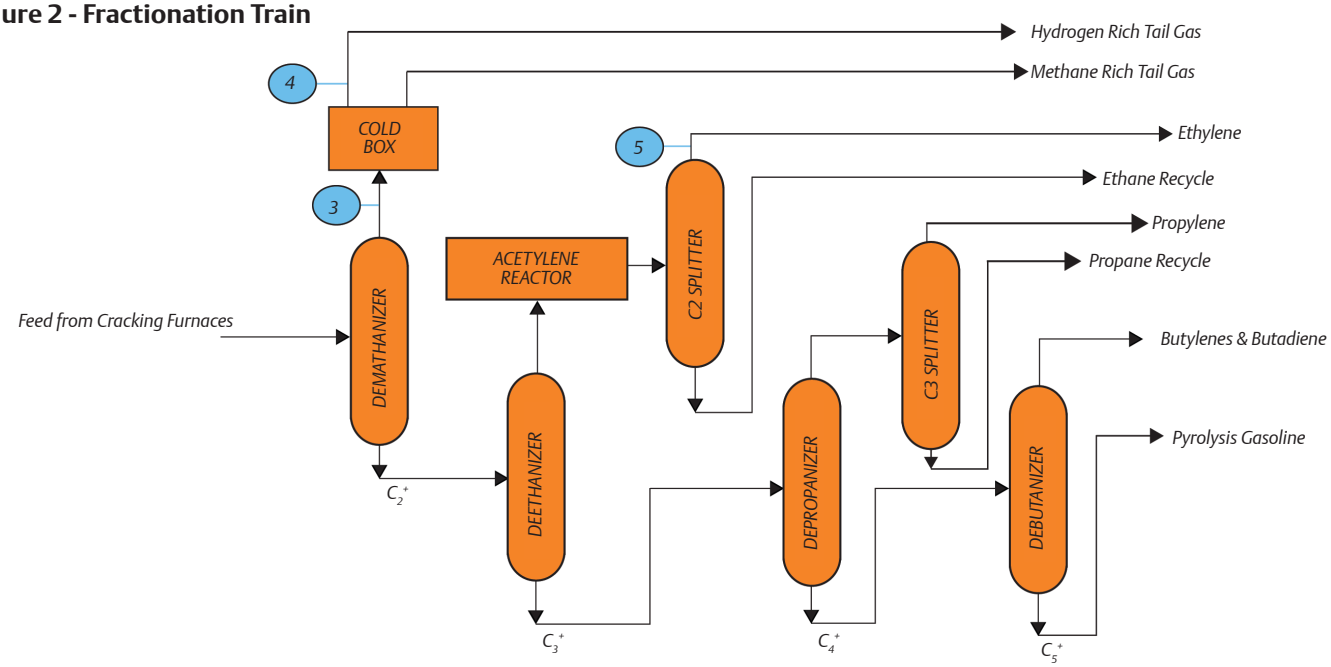
The OCX 8800 can be used to provide an oxygen measurement using a zirconium oxide sensor as well as a combustibles measurement. Special accommodations must be made for the high flue gas temperatures just downstream of each burner.

Measurement Point 2: Decoking of the Cracking Furnaces

After approximately every 20 days of operation, the cracking furnaces need to be decoked since the furnace coils 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 in the effluent. It rises as the carbon is burned off and then decreases to zero when the furnaces are clean again and the plant can be returned to normal operation.

Carbon dioxide concentration can be measured using an NDIR (non-dispersive infrared photometric detector in an X-STREAM analyzer. A specialized probe called a “pyrolysis” or “reflux” probe must first condition it. This probe strips out the tars and other contaminants from the sample before it is sent to the analyzer.

Figure 2 - Fractionation Train



Measurement Point 3: Ethylene in Demethanizer Overhead

Hydrogen and methane are removed in the first demethanizer for use in the fuel gas header system. A gas analyzer is used to measure ethylene concentration in the demethanizer overhead because loss of valuable ethylene product in the overhead of the demethanizer is undesirable. Operation of the demethanizer is adjusted to minimize the ethylene content in the fuel gas overhead.

Measurement Point 4: Hydrogen Purity in Demethanizer Overhead after Cold Box

The demethanizer overhead enters a cold box where the stream is further separated into hydrogen rich tail gas and methane rich tail gas. A gas analyzer is used to measure the hydrogen concentration of the hydrogen rich tail gas to confirm that, that it is pure enough to be used as needed in the ethylene plant.

Measurement Point 5: Ethane Impurity in Ethylene in C_2 Splitter

The C_2 splitter separates the ethylene product from ethane. The ethane is returned to the furnaces for cracking. A gas analyzer is used to measure ethane concentration in the C_2 splitter overhead. Operation of the C_2 splitter is adjusted to minimize the ethane impurity in the ethylene product. Sometimes the ethylene product purity is also monitored for residual carbon dioxide traces.

The X-STREAM analyzer is extremely well-suited to maken the ethylene, ethane, carbon dioxide, and hydrogenn measurements described above. The ethylene, ethane, and carbon dioxide concentrations are measured using NDIR photometrics detectors. The hydrogen concentration is measured using a thermal conductivity detector.

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