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Petrochemical Industry Polyethylene Plant

Process Gas Chromatograph Application Note

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The use of plastics and resins as a manufacturing building block has been consistently increasing over the past few decades. The most popular polymer in use worldwide is polyethylene due to its ease of manufacture and numerous forms. There are a wide variety of processes for making polyethylene, such as High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE) and Linear Low Density Polyethylene (LLDPE). Each process creates polyethylene for different industrial and consumer applications. For example, HDPE is the crystalline form of the plastic and would be used for rigid plastic applications, such as milk containers, plastic pipe, and reusable drinking bottles. LDPE is the powder form of plastic and would be used for applications requiring a flexible form of the plastic, such as cling wrap, dry cleaner bags, and plastic lids for containers.

A number of chemical plant designs are available to form long chain polymers by reacting ethylene with a catalyst. One type of high pressure polyethylene (HDPE) plant design is based on a loop reactor. This plant has four inlet streams: ethylene feed, comonomer, hydrogen, and diluents. Comonomer is added to customize certain properties in the final polyethylene polymer. Examples of comonomer added include hexene, butene-1, or propylene. Hydrogen is added to limit the growth of the polymer chain. A larger amount of hydrogen shortens the polymer chain length, which changes the polymer's melting point and viscosity. Finally, a diluent is used, such as butane, to keep the mixture in suspension as well as to facilitate the flashing operation where any unreacted compounds are separated from the polymer.

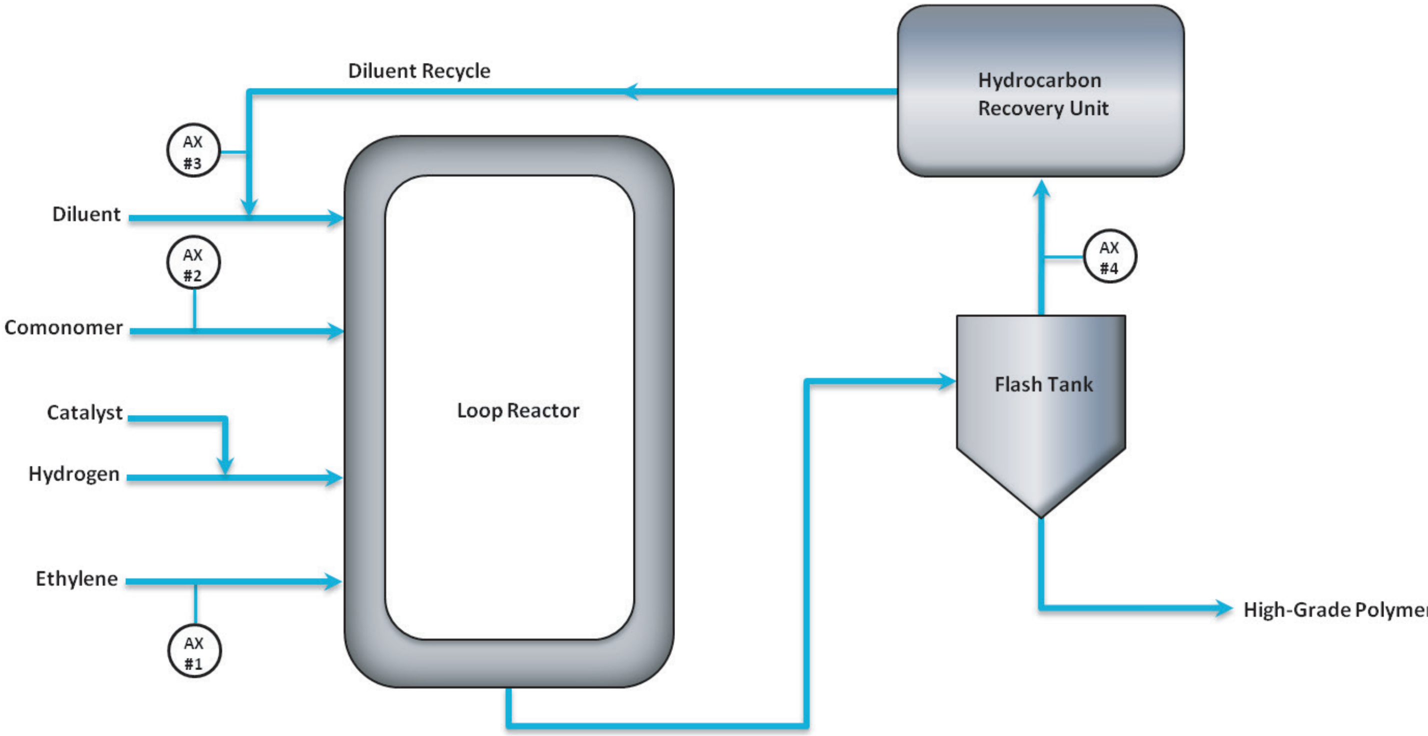
The polymer forms in the loop reactor and exits the reactor along with diluents and unreacted components, into a flash tank. Due to the flash tank's lower pressure, unreacted monomers and diluent vaporize and leave the top of the vessel. The polymer settles out of the bottom to be extruded into plastic sheets or pellets. The hydrocarbon vapors leaving the top of the flash tank are sent to a hydrocarbon recovery system for purifying and recycling back to the reactor feed.

Typical GC Measurements

Process gas chromatographs provide the process composition data needed for efficient plant operation. There are typically four gas chromatographs used in a polyethylene plant:

1. **Ethylene Feed** – monitors the ethylene purity for the feed to the polymerization reactor.
2. **Comonomer Feed** – monitors the purity of the comonomer entering the reactor.
3. **Diluent Feed** – monitors the diluent recycle stream for hydrocarbon impurities.
4. **Flash Tank Off-Gas** – measures the off-gas for the concentrations of the unreacted compounds to help control the severity of the reactions occurring in the reactor. The measurement can be difficult due to the presence of large amounts of polymer dust. Special sample probes are used to filter out the polymer dust using self-cleaning filter designs.

Polyethylene Plant



Analyzer No.	Stream	Components Measured	Measurement Objective
1	Ethylene Feed	CO_2, C_1, C_2, Acetylene	Monitors the impurities in the Ethylene feed
2	Comonomer Feed	CO_2, C_1, C_2, Acetylene	Monitors the impurities in the Comonomer feed
3	Diluent Feed	H_2, $C_2^=$, Comonomer	Monitors the impurities in the recycled diluents stream
4	Flash Tank Off-Gas	H_2, $C_2^=$, Comonomer	Provides feedback on reaction severity

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