pH Control in Ethylene Quenching

In the production of olefins, naphtha or natural gas feedstock is steam cracked at high temperatures in a cracking furnace. This sets off a variety of reactions that are brought to a halt by quenching the produced gas mixture with water. The mixture, containing approximately 38 percent ethylene, is then separated in several compression and fractionation steps. Emulsification problems after quenching can lead to severe fouling, or loss of efficiency and manufacturing capacity.

Background

Ethylene and propylene are arguably the most important basic organic chemicals. The global output of ethylene is currently around 130 million metric tons annually and is growing substantially. More than half of the total production of ethylene is used for the production of polyethylene. The biggest growth in ethylene production comes from the Middle East and Asia.

Process

Although various processes and feedstocks for the production of olefins exist, thermal cracking of saturated hydrocarbons is nowadays the predominant technology. The process can be divided into four steps:

1. **Steam Cracking:** Together with superheated steam, feedstock such as

naphtha is fed into a tube furnace. Here the saturated hydrocarbons crack under temperatures between 750 and 1000 °C.

2. **Quenching**: To avoid any undesired secondary reactions, the cracked gas mixture is rapidly cooled by direct quenching with water. Heat is recovered through steam production in heat exchangers.

3. **Purification**: Process water and pyrolysis gasoline are separated, and the gaseous hydrocarbons are compressed, condensed and washed with caustic to remove acid gases, such as hydrogen sulfide and carbon dioxide.

4. **Drying & Cryogenic Distillation**: Before the mixture is passed through a series of low-temperature fractional distillation columns, it needs to be dried in order to avoid the formation of ice.

Quench Tower

In the quenching step, heavy gasolines condense in water that circulates through the quench tower and gaseous products leave the tower from the top. The condensed gasolines and water separate in the sump of the tower or in an oil/water separator connected to the bottom of the tower. Many of the hydrocarbons in the sump have similar densities to that of water, which can lead to emulsion forming in the sump.

Breaking the emulsion can be very complicated, and together with the quench water, hydrocarbons can circulate back into the tower. This leads to greater fouling of the packed tower, reduced heat transfer and an increase in downtime.

The separation process can be controlled effectively, and emulsion forming largely avoided, by maintaining proper quench water pH values through injection of neutralizers such as caustic soda or organic amines.

Instrumentation

Depending on the feedstock, especially with natural gas feeds, the quench water can be highly contaminated. This makes pH measurement and control a complicated issue.

The InPro 4800 i pH electrode, with an annular PTFE reference diaphragm and extra long diffusion path, is designed for service in tough environments. It resists fouling due to hydrocarbon contaminants and sulfides, guaranteeing high accuracy and fast response throughout its long life. Featuring intelligent sensor management (ISM) technology, the sensor provides full diagnostics that advise the operator when maintenance is due.

The corresponding transmitter for the electrode is the M420, a two-wire pH analyzer that is fully certified for hazardous area use, and offers HART® communication and ISM diagnostic functionality. In cases of extreme fouling, the EasyClean 400 automatic, electrode cleaning and calibration system guarantees continuous availability and maximum reliability of the measurement.

For more information, please visit www.mt.com/pro *[1].*