Improving refinery isomerization unit performance with process gas chromatographs

Process gas chromatographs have been used since the 1950s to provide real-time compositional data to process control systems. Today, there are tens of thousands of process gas chromatographs in use throughout the process industry making the gas chromatograph the analytical workhorse for on-line compositional measurements. One example of how process gas chromatographs are used for improving process operations can be found in the isomerization unit in a refinery.

Many of the processes in a modern refinery are devoted to improving the octane value of chemical compounds that are used in blending gasoline. One important process for improving the octane value is the isomerization unit in the refinery. It takes low-octane, normal-paraffins and chemically reshapes them into higher-octane, iso-paraffins. The octane increase can be significant. For example, n-pentane (nC_5) has a Research Octane Number (RON) of 61.7; whereas, its isomer form, iso-pentane (iC_5), has an RON of 92.3. A typical feed to an isomerization unit of Light Straight Run (LSR) gasoline can have an overall RON boost from 70 to 84.

The isomerization unit

The feed to the isomerization unit in a refinery is typically a light straight run gasoline stream high in C_5 and C_6+ normal-paraffins. This feed enters the deisopentanizer tower that removes any iC_5 already present in the stream. It also removes the iC_5 created in the reactors that are returned to the feed as part of the nC_5 recycle.

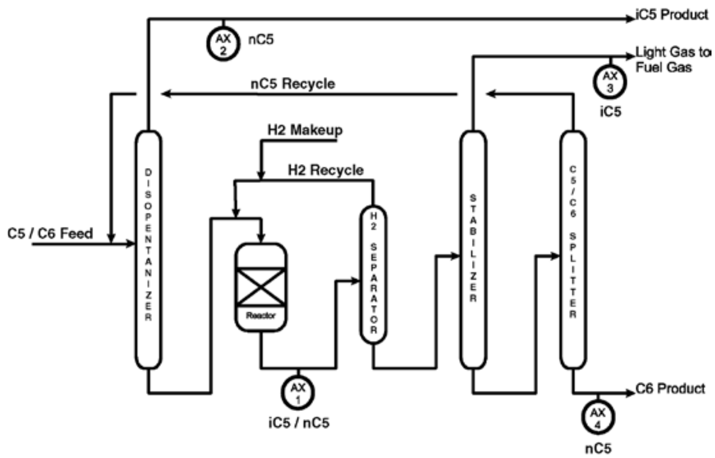

Figure 1 - Flow Diagram of a Typical Isomerization Unit in a Refinery

As the iC_5 is being sent out the overhead of the deisopentanizer tower, the balance of the feed stream is sent to the isomerization reactor. Hydrogen is also added to the stream to encourage the proper reactions and to help minimize coke formation on the catalyst.

After passing through the reactor, the stream enters a H_2 separation unit that removes and recycles the H_2 back to the feed of the reactor. The stream then enters a stabilizer tower that removes any light hydrocarbons made during the reactions. These light compounds exit the top of the stabilizer tower and will typically be blended into the refinery fuel gas system. The product stream leaves the bottom of the stabilizer tower and enters a C_5/C_6 splitter tower.

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At the C_5/C_6 splitter, the C_5s are sent out the top of the tower and are recycled back to the beginning of the process unit. The nC_5 in the C_5s will be reprocessed while the iC_5 will leave the top of the deisopentanizer as finished iC_5 product. The C_6 and heavier components leave the bottom of the splitter and either go to gasoline blending or to the reformer unit to be made into aromatics.

Improving isomerization unit performance with process gas chromatographs

A number of opportunities exist to use process gas chromatographs to improve the isomerization unit performance. The first process gas chromatograph (AX #1 in Figure 1) would monitor the product effluent leaving the conversion reactor. By measuring the iC_5 and nC_5 content, the reaction conversion ratio can be calculated. This helps the plant's control system maintain proper conditions inside the reactor for maximum conversion.

A gas chromatograph (AX #2 in Figure 1) is typically put on the overhead stream of the deisopentanizer tower to minimize the amount of nC_5 in the iC_5 product. Another gas chromatograph (AX #3 in Figure 1) monitors the stabilizer overhead by measuring the iC_5 content and minimizing loss of the iC_5 product to the fuel gas.

Finally, a gas chromatograph (AX #4 in Figure 1) would monitor the nC_5 levels and minimize the level to make sure most is sent overhead for reprocessing. A summary of these applications can be seen inFigure 2.

The Emerson Solution

Emerson has a long history of providing process gas chromatographs for the refining industry. Emerson's process gas chromatographs have set the standard for on-line process measurement by supplying analyzers that are both robust and capable of handling the analytical requirements.

Analyzer #	Stream	Components Measured	Measurement Objective
1	Reactor effluent	iC_5, nC_5	Maximize nC_5 conversion to iC_5
2	Deisopentanizer overhead	nC_5	Minimize nC_5 in product stream
3	Stabilizer tower overhead	iC_5	Minimize iC_5 losses
4	C_5/C_6 splitter bottoms	nC_5	Minimize loss of nC_5

Figure 2 - Summary of Process Gas Chromatograph Applications in a Typical Refinery Isomerization Unit

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