

# 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.

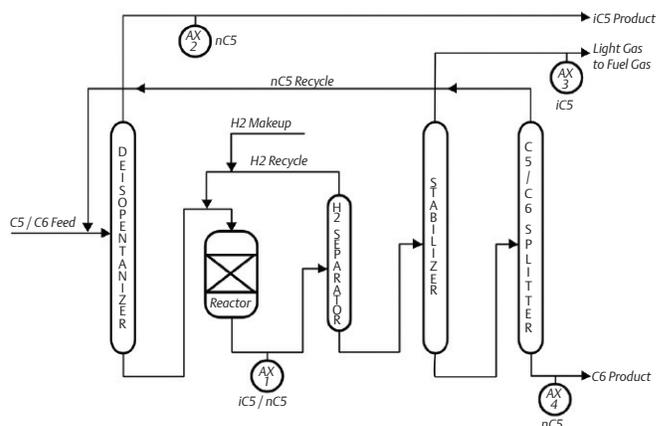
## The Isomerization Unit

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 deisopentimizer 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.

As the  $iC_5$  is being sent out the overhead of the deisopentimizer 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.

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



At the  $C_5/C_6$  splitter, the  $C_5$  are sent out the top of the tower and are recycled back to the beginning of the process unit. The  $nC_5$  in the  $C_5$  will be reprocessed while the  $iC_5$  will leave the top of the deisopentimizer 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 in Figure 2.

### The Emerson solution

Emerson has a long history of providing process gas chromatographs to 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.

**Table 1 - Summary of Process Gas Chromatograph Applications in a Typical Refinery Isomerization Unit**

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 the $nC_5$ in product stream
3	Stabilizer tower overhead	$iC_5$	Minimize the $1C_5$ losses
4	$C_5/C_6$ splitter bottoms	$nC_5$	Minimize loss of $nC_5$

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