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## **Question 6: What are the catalyst or design considerations that you employ to repurpose isom units for other services, or to repurpose another type of unit into an isom unit?**

**GAYL MERCADO** (Axens North America)

With increasing quantities of lower octane naphthas reaching the gasoline pool and potential for higher octane demand in the finished stocks, the octane boost from isomerization units has grown in importance. While the installation of new units is ideal, many refineries have been looking at utilizing idled units or converting existing units to isomerization type operation. Repurposing of older or idled units is ideal given isomerizations generally low severity operation and clean operating environment.

Axens has experience with converting benzene saturation units, fixed bed reformers, as well as less conventional idled units and equipment into isomerization units. More often, benzene saturation units are a first look to minimize capital investment for these revamps given the overlap in feed type and quality. More importantly, provided the below key concerns are managed when repurposing existing units into an isomerization unit, many existing equipment and units are potential candidates:

- Feed and hydrogen quality for catalyst deactivation
- Reactor liquid distribution to maximize isomerization reactions
- Heat integration to maximize isomerization equilibrium
- Product fractionation for RVP control

**HEIDI FRASER** (UOP)

In repurposing any type of unit into another type of unit certain considerations should be made. Conversion to or from a naphtha isomerization unit is no different.

- First, you should consider the general layout of the equipment available and the requirements of the desired unit. Is this a recycle gas unit with a reactor product separator and recycle gas compressor? Some processes require recycle gas and others can be operated hydrogen once through. In UOP's naphtha isomerization world, Par-Isom™ units are nearly always have recycle gas while Penex™ and Butamer™ units can be designed as either with recycle gas or hydrogen once through.
- Second, what is the operating pressure of the equipment available? Operating pressure is often set by the available pressure of the feed or makeup gas to the unit, or by the pressure of the destination to which the products will be sent. But operating pressure will often determine the type of metallurgy used in the construction of the equipment. And some catalyst systems will have better performance in certain pressure ranges. Also, the system pressure, along with hydrogen availability, will determine the hydrogen partial pressure achievable in the reactors which will also affect the catalyst performance. UOP's Penex and Par-Isom units are generally designed for a reactor system pressure of 450 psig but revamped units are in operation with

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reactor pressures as low as 250 psig. There is some debit in yields at pressures less than 450 psig.

- Also important are the size and type of the reactor(s) available. Are the reactors large enough to hold the required quantity of catalyst for good conversion? Are the reactors downflow or radial flow? Are modifications required to the reactor internals? Will the modifications affect the amount of catalyst the reactors can hold? All UOP Isom units have downflow reactors. If converting from a radial flow reactor the center pipe and scallops would have to be removed. Hydrogen-Once-Through Penex units and some Par-Isom units will require the addition of a vapor-liquid tray to the top of the reactor. This will reduce the amount of catalyst that a reactor can hold. The reactor vessel should be large enough to hold the required amount of catalyst after internals modifications. Penex units are generally designed for a LHSV of 1-1.5 hr<sup>-1</sup>. Par-Isom units normally have a WHSV between 0.9 and 3.0 hr<sup>-1</sup>. Butamer units are designed for LHSV of 4-6 hr<sup>-1</sup>. If less catalyst can fit in the reactor, the space velocities will be higher resulting in lower conversion.
- Another consideration is the operating temperature of the existing equipment as compared to the desired process. What type of heater is present or needed? For instance, hydrotreaters, reformers, and older zeolytic isom units operate at high temperatures and require a fired heater for the reactor charge. UOP's current generation of isomerization catalysts operate at lower temperatures, typically 200-400°F, and require only a steam heater or hot oil heater. Fired heaters would produce too high a temperature for these catalysts and could lead to temperature excursions.
- Metallurgy requirements should also be examined. UOP Isom units are designed with all killed carbon steel construction. Recent changes to the Nelson curve may indicate PWHT requirements for reactor sections. If an Isom unit were being repurposed for other service, the evaluation of the metallurgy could be important.
- When looking at repurposing units we tend to concentrate on the reactor section. However, consideration should also be made to the other equipment in the process, some of which is more easily replaced or revamped than others. Are compressors of appropriate size to supply the needed amount of makeup gas and/or recycle gas? Are distillation columns large enough to handle the expected flow rates and achieve the necessary separation? Look at column diameter, number of trays, reboiler and condenser capacity, and reflux pump sizing. Consider if extra feed treatment is necessary for the new process and whether vessels are available that could be put to that use. These would include chloride treaters or sulfur guard beds, driers for feed, makeup gas, or recycle gas streams

Repurposing of equipment to another process is possible. UOP has experience revamping hydrotreaters and semi-regen reforming units into UOP isomerization units. We have also converted older generation zeolytic isomerization units into newer generation isomerization units. We have less experience converting isomerization units into other processes but would expect it is possible.

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