# Isomerization Process (Light Naphtha )

Isomerization is the process in which light straight chain paraffins of low RON (C6, C5 and C4) are transformed with proper catalyst into branched chains with the same carbon number and high-octane numbers. The hydrotreated naphtha (HTN) is fractionated into heavy naphtha between 90–190 °C (190–380 F) which is used as a feed to the reforming unit. Light naphtha C5 - 80 °C (C5 - 180 F) is used as a feed to the isomerization unit. There are two reasons for this fractionation: the first is that light hydrocarbons tend to hydrocrack in the reformer. The second is that C6 hydrocarbons tend to form benzene in the reformer

## Reactor operating conditions

- Reaction temperature = 95–205°C.
- Reaction pressure = 1725–3450 kPa.
- Hydrogen to hydrocarbon molar ratio = 0.05:1

Hydrogen is used to minimize carbon deposits on the catalyst but hydrogen consumption is negligible.

## Typical feed and product composition of an isomerization unit

| LSR component | Feed weight | Product weight | RONC (unleaded) |
|---|---|---|---|
| Isopentane | 22 | 41 | 92 |
| Normal pentane | 33 | 12 | 62 |
| 2,2-Dimethybutane | 1 | 15 | 96 |
| 2,3-Dimethybutane | 2 | 5 | 84 |
| 2-Methylpentane | 12 | 15 | 74 |
| 3-Methylpentane | 10 | 7 | 74 |
| Normal hexane | 20 | 5 | 26 |
| Total | 100 | 100 | |

# Isomerization Catalysts

The most common catalyst for isomerizing n-butane is platinum (Pt) on alumina promoted by chloride. The high activity of this catalyst allows operation at relatively low temperature. Pt/alumina catalysts can't be regenerated, and they are highly sensitive to water and other contaminants. In units that isomerize n-pentane and n-hexane, the reactions are catalyzed either by Pt/alumina or Pt on zeolite. The zeolite catalysts require higher temperatures, but they are less sensitive to water. A comparison of the operating conditions for the alumina and zeolite processes is shown in Table below.

Comparison of operating conditions of isomerization

| Operating condition | Pt/Chlorine Alumina catalyst | Pt/Zeolite catalyst |
|---|---|---|
| Temperature (°C) | 120–180 | 250–270 |
| Pressure (bar) | 20–30 | 15–30 |
| Space velocity ($h^{-1}$) | 1–2 | 1–2 |
| $H_2$/HC (mol/mol) | 0.1–2 | 2–4 |
| Product RON | 83–84 | 78–80 |

## Isomerization Reactions

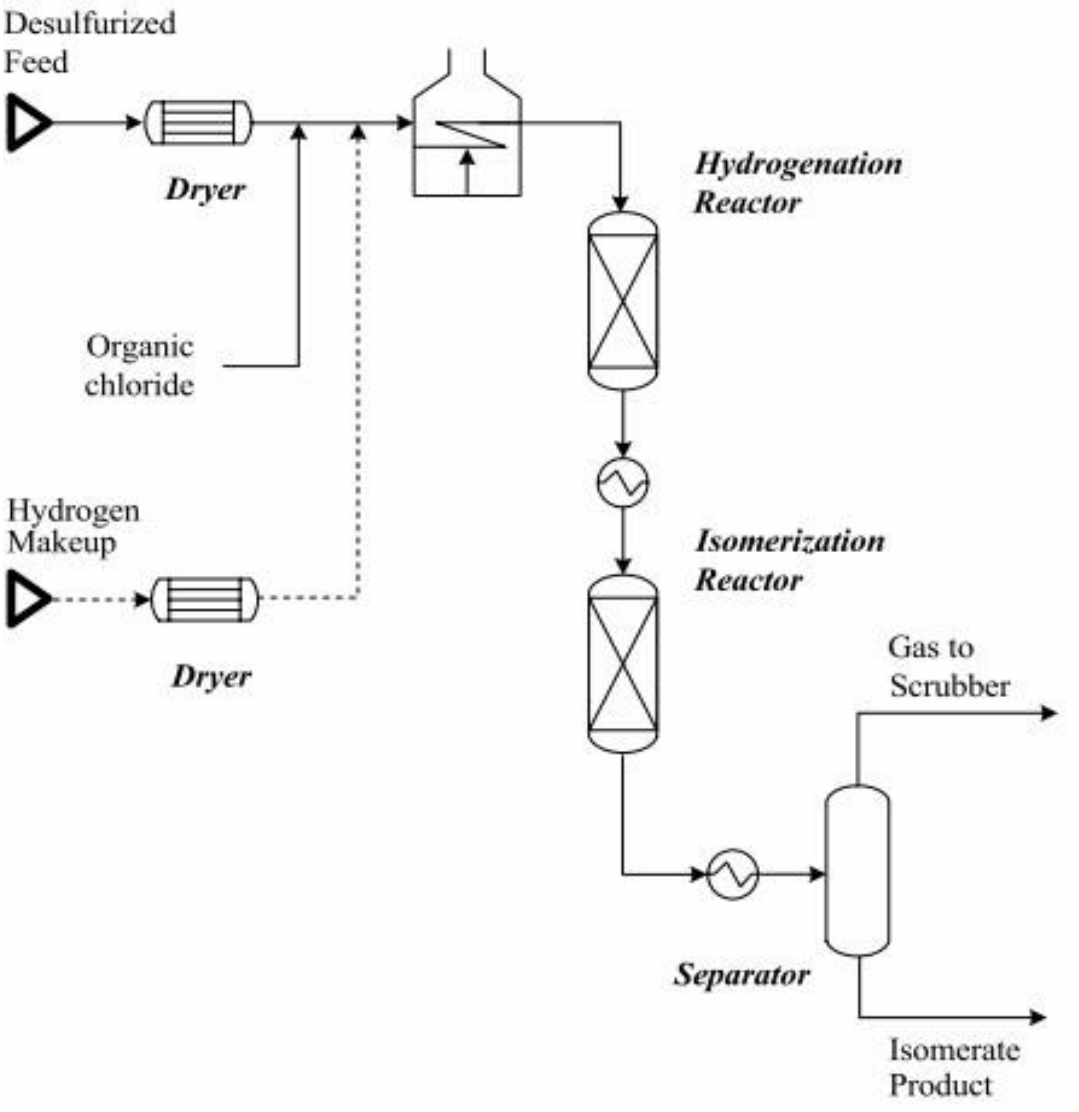
Isomerization is a reversible and slightly exothermic reaction:


The conversion to iso-paraffin is not complete since the reaction is equilibrium conversion limited. It does not depend on pressure, but it can be increased by lowering the temperature. However operating at low temperatures will decrease the reaction rate. For this reason a very active catalyst must be used.

## Process Flow: C5 C6 Isomerization (Process description)

Pentane/hexane (C5 C6) isomerization processes increase the octane of light gasoline. In a typical unit, dried, hydrotreated feed is mixed with a small amount of organic chloride and recycled hydrogen, then heated to reaction temperature. Process objectives determine whether one or two reactors are used. In two-reactor units

(Figure below), the feed flows first to a saturation reactor, which removes olefins and (to a large extent) benzene. After saturation, the feed goes to an isomerization reactor, where normal paraffins are converted to isoparaffins. The reactor effluent flows to a product separator, where hydrogen is separated from the other reaction products. Recovered hydrogen can go to a recycle compressor, which returns it to the reactors, or it can be treated and sent to the fuel gas system. Separator liquids go to a stabilizer column, which removes light gases and remaining dissolved hydrogen. The stabilized liquid goes to storage or gasoline blending. If sent to a fractionator, n-pentane and n-hexane can be recycled to the isomerization unit for increased conversion.




$C_5C_6$ isomerization: two reactors, once-through hydrogen

# Isomerization Yields

The reformate yield from light naphtha isomerization is usually very high (>97 wt%). Typical yields are given in Table below:

Isomerization yield

| Component | Yield (wt%) |
|---|---|
| $C_3$ | 0.348 |
| $iC_4$ | 0.619 |
| $nC_4$ | 1.770 |
| $C_5^+$ | 97.261 |

**Example: light naphtha with a specific gravity of 0.724 is used as a feed to the isomerization unit at a rate of 100 m3 /h. Find the product composition.**

**Solution: Appling the yield guidelines of Table above, the product composition are presented in Table below.**

Isomerization yields

| | wt% | kg/h |
|---|---|---|
| Feed | 100 | 72,400 |
| *Product* | | |
| $C_3$ | 0.348 | 251.9 |
| $iC_4$ | 0.619 | 448.2 |
| $nC_4$ | 1.770 | 1281.5 |
| $C_5^+$ | 97.261 | 70,417 |
| Total | | 72,399 |