Production of Iso- butene from Iso- butane in PFR With Recycle

Mr. Dhruv Bhanushali, Ms. Ritu Pande
Sarvajanik College of Engineering & Technology.

Background:
Isobutene is a colorless gas with a faint petroleum like odor. It is shipped as a liquefied gas under its own vapor pressure. Contact with liquid can cause injury to body tissue. Isobutene is used as a monomer for the production of various polymers such as butyl rubber, polybutene and polyisobutylene. The most important application of butyl rubber is the manufacture of tires for cars and other vehicles.

Description:
Pure isobutane is fed with Stream (S-01) at 25^0C and 5bar pressure which needs to be heated to 600 ^{0}C, so instead of using a heater we replaced it with a heat exchanger (HE-01). The hot utility we use here is outlet stream of PFR(RC-01) (S-04) at 600^0 C. Further the outlet stream of hot utility (S-06) from (HE-01) is sent to cooler (HE-02) and gets cool to 85^0C. Stream (S-08) enters compound separator (CS-01) where pure hydrogen is separated from Iso-butene and Iso-butane in stream (S-09). Outlet stream from (CS-01) is fed to splitter (SPL-01) to recycle 20% of product Stream (S-10) to the PFR. As to maintain 5bar pressure we use compressor (C-01) where mixture is compressed from 4.83bar to 5bar. Stream (S-13) enters the heater (HE-03) where we need to manipulate the outlet temperature in such a way that we get 600^0C as temperature of inlet stream to PFR (S-03). For this purpose, controller block (CON-01) is used to control the temperature of (S-03) by manipulating (HE-03). Stream (S-14) mixes with the stream (S-02) with help of mixer (MIX-01). Stream (S-03) enters in Multi – tube PFR (RC-01) at 600^0C and 5bar pressure. The outlet stream of PFR is sent to (HE-01) and this cycle is carried on by recycle block (REC-01) with 50 iterations, while recycle to PFR inlet is carried out with help of recycle block (REC-02). Product Iso-butene is withdrawn from Stream (S-11).

Property Package:
Peng Robinson (PR)

Reaction:
C_4H_{10} <=> C_4H_8 + H_2 (Dehydrogenation Reaction)

$$r = \frac{k(p_a - \frac{p_e p_h}{K})}{1 + k_{eh} p_e p_h + k_e p_e}$$

k = $8.9*10^5$ exp(-13.47/ T)
K = $1.4*10^6$ exp(-14.07/ T)
k_e = $2.5*10^5$ exp(-10.46/ T)
k_{eh} = $1.2*10^6$ exp(-9.50/ T)

System of Units:

Temperature: ^{0}C

Pressure: **bar**

Molar Flow: **kmol/ h**

Mass Flow: **kg/ h**

Flowsheet:

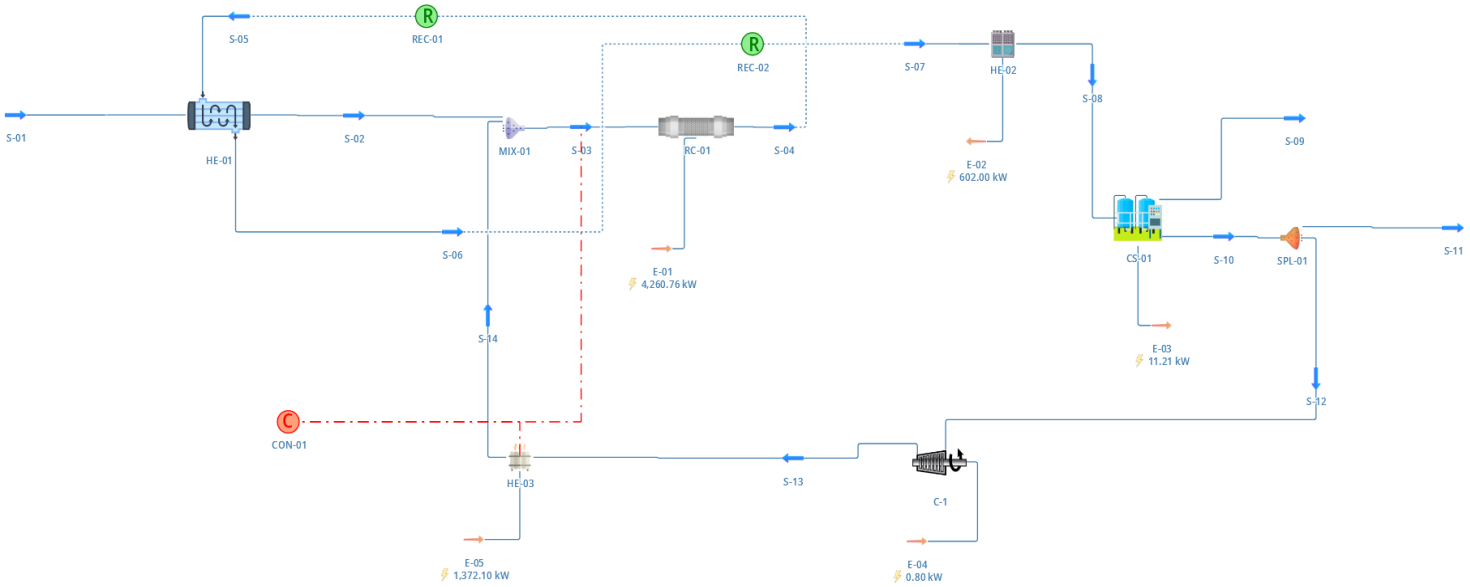

Figure 1: Production of Iso - Butene

Results:

Stream wise results						
Objects	**S-12**	**S-11**	**S-09**	**S-03**	**S-01**	
Temperature	**85**	**85**	**85**	**599.727**	**25**	**^{0}C**
Pressure	**4.83**	**4.83**	**4.83**	**5**	**5**	**Bar**
Molar Flow	**31.25**	**125**	**125**	**156.25**	**125**	**Kmol/h**
Mass Flow	**1753.32**	**7013.29**	**251.985**	**9018.6**	**7265.27**	**Kg/hr**

PFR		
Object	**RC-01**	
Volume	**8**	**m^3**
Tube length	**1**	**M**
No. of Tubes	**12**	
Catalyst loading	**1.2**	**Kg/m^3**
Catalyst Diameter	**1**	**mm**
Catalyst void Fraction	**0.6**	
Pressure Drop	**0.2498**	**bar**

Reference:

Kotel'nikov, G R, Mikhailov, R K, and Troitskii, A P. Production of isobutylene by catalytic dehydrogenation of isobutane. Chem. Technol. Fuels Oils; (United States).