

## Introduction

Sulfur is present in large amounts in crude oil in the form of thiols, mercaptans, etc. In many operations in the refining of crude such as fluidized catalytic cracking, platforming, etc; it may poison the catalyst used. Besides, there are strict norms on SO<sub>x</sub> emissions on fuels. Hence hydrogen is used to remove sulfur from organic compounds in the form of hydrogen sulfide.

## Objective

Simulation of Vacuum Gas Oil hydrotreater in Reliance Jamnagar Refinery visited as part of Course on Wheels in December 2019

## Challenges

There is not a single reaction but many reactions that occur in the reactor in the hydrotreater unit such as

1. Hydrocracking
2. Conversion of sulfur in compounds to hydrogen sulfide
3. Conversion of nitrogen to ammonia
4. Coke formation
5. Addition of hydrogen to unsaturated compounds

In addition, the feed to the hydrotreater consists of vacuum gas oil which itself is a mixture of hydrocarbons ranging from carbon number 20 to 30.

## Resolution and Approximations

1. Since the main purpose of this hydrotreater is the removal of sulfur, only one reaction considered
2. A representative compound icosane-1-thiol is used as feed.

## Unit Operations/Equipment Implemented

1. Absorption Column
2. Stripping Column
3. Hydrogen Compressor
4. Conversion reactor
5. Heat integration

## Process Conditions

It was known from the plant operators that the absorption takes place at very high pressure close to 90 bar. The reaction also takes place at high pressure.

Almost all the hydrogen sulfide formed in the reactor is absorbed in the amine absorption column leaving almost pure hydrogen in the gas phase. The liquid leaving the absorption undergoes stripping with steam to remove hydrogen sulfide in the liquid phase.

Absorption is generally a high-pressure, low-temperature process and stripping is a low-pressure high-temperature process.

## Results

Absorption tower

Vapour Stream leaving (MS 014): Almost pure H<sub>2</sub> stream

Hydrogen	0.99999965
Hydrogen sulfide	3.8032157E-12
Icosane-1-Thiol	8.8798247E-133
N-eicosane	8.4304696E-132
Methylethanolamine	0
Methyl DiEthanolAmine	3.4801223E-07
Water	0

Stripping Tower

Liquid Stream Leaving: Negligible hydrogen sulfide

Hydrogen	5.6209929E-77
Hydrogen sulfide	6.0943723E-77
Icosane-1-Thiol	0.083964978
N-eicosane	0.75469637
Methylethanolamine	0
Methyl DiEthanolAmine	0
Water	0.16133865