AspenTech-MITAOE PRAKALP'25

University Talents IDPS Competition

Date: 21st March 2025

Duration for model building: 2 Days

Approximate Time expected for model development: 2-3 Hours

Product Version: V12.1 and above

Presentation Time per (Batch or Individual): 10 Mins

Description

AspenTech is excited to present a challenging competition designed to test the skills and capabilities of young university talents in the field of simulation modeling using industry-leading software, Aspen HYSYS. This program aims to identify and nurture the next generation of chemical process engineers by providing an opportunity to solve real-world, industry-defined problems that are crucial in the fields of chemical, petrochemical, and petroleum refining industries.

Industry-defined problem-solving is a vital skill for emerging engineers, and AspenTech is committed to uncovering top-tier talents who can contribute to addressing the pressing sustainability challenges of tomorrow. In this competition, participants will have the chance to showcase their creativity, technical knowledge, and innovative thinking as they tackle complex problems using Aspen HYSYS.

We invite university students to test their expertise in simulation modeling, demonstrate their critical thinking, and provide new perspectives on sustainability in the chemical engineering sector. The competition offers a platform to shine, gain recognition, and potentially become an asset to leading industries.

Industry Defined Problem Statement: Gas Sweetening Process Modeling Using Diethanolamine (DEA)

Note: Develop the model from the scratch. No starter files available.

Process Description: In this problem, you are tasked with modeling a standard gas sweetening process using diethanolamine (DEA) as the absorbent. The key steps involved are as follows:

- A water-saturated natural gas stream is introduced into an amine contactor (Absorber).
- Diethanolamine (DEA) at a concentration of 28 wt. % in water is used as the absorbing medium.
- The contactor consists of **20 real stages**.
- The rich amine solution is then flashed from a pressure of **6900 kPa to 620 kPa** before it enters the rich/lean amine exchanger, where it is heated to a regenerator feed temperature of **95°C** (with optional temperature estimates of 40°C for the top stage and 70°C for the bottom stage).
- The rich amine exiting the separator needs to be pre-heated before being fed into the regenerator column.

The **regenerator** (modeled as a Distillation Column) consists of **18 real stages**.

- Acid gas is rejected from the regenerator at **45°C**, while the lean amine is produced at approximately **125°C**.
- The lean amine is then cooled and recycled back to the contactor.

Tasks:

1. **Utility Mass Flow Rates:**
    - Report the mass flow rate values for the major equipment involved (e.g., Absorber, Rich/Lean Amine Exchanger, Regenerator). Assign appropriate utilities for each piece of equipment and justify your choice of utility.
2. **Carbon Tax Impact (Scope 1 & Scope 2 CO2):**
    - Given a **carbon/carbon tax rate of $1.361e-2/lb**, calculate the **Scope 1 and Scope 2 CO2 equivalent** emissions for the process.
    - Explain the significance of predicting the **CO2 Index** and how it is calculated in **HYSYS**.
3. **Process Simulation:**
    - Using a process simulation tool like **HYSYS**, explain the fluid package chosen, unit operations used, and reaction sets added.

- Discuss the main results obtained from the simulation, including the performance of the **regeneration column** and the efficiency of the **acid gas sweetening process** modeled in the simulation.

Expectation from talents (Group / Individual)

- Present your findings in a **PowerPoint presentation** (max 5 slides), including:
  - An overview of the entire process and simulation setup.
  - The utility mass flow rate calculations and justifications.
  - CO2 emission calculations (Scope 1 & Scope 2).
  - Explanation of the CO2 index calculation in HYSYS.
  - Key insights from the simulation, focusing on the efficiency of the acid gas sweetening process.

Note: Make sure your presentation is clear and concise, detailing the technical aspects of the gas sweetening process while keeping the explanation accessible for a wide audience.

Feed Data

Name	Sour Gas
Temperature	25 °C (77 °F)
Pressure	6900 kPa (1001 psia)
Molar Flow	1245 kgmole/h (25 MMSCFD)
Component	**Mole Fraction**
Nitrogen	0.0016
H2S	0.0172
CO2	0.0413
Methane	0.8692
Ethane	0.0393
Propane	0.0093
i-Butane	0.0026
n-Butane	0.0029
i-Pentane	0.0014
n-Pentane	0.0012
n-Hexane	0.0018
H2O	0.0122
DEAmine	0.0000

Name	DEA to Contactor
Temperature	35 °C (95 °F)
Pressure	6850 kPa (993.5 psia)
Std Ideal Liq Vol Flow	43.15 m^3/h (190 USGPM)
Component	**Mass Fraction**
H2O	0.72
DEAmine	0.28

Column Dimension – DEA Contactor

Weir Height	25.0 mm (0.984 in)
Weir Length	1.0 m (3.281 ft)
Section Diameter	1.219 m (4.0 ft)

Name	L/R HX
Tube Side Inlet	Rich to L/R
Tube Side Outlet	Regen Feed
Shell Side Inlet	Regen Btms
Shell Side Outlet	Lean from L/R
Parameters	
Heat Exchanger Model	Simple Weighted
Tube Side Delta P	69 kPa (10 psi)
Shell Side Delta P	69 kPa (10 psi)
Worksheet	
Regen Feed, Temperature	95 °C (203 °F)

Name	Amine Regenerator
No. of Stages	18
Inlet Stream	Regen Feed
Inlet Stage	4_Main Tower
Condenser Type	Full Reflux
Ovhd Vapour Outlet	Acid Gas
Bottoms Liquid Outlet	Regen Btms
Condenser Energy Stream	Cond-Q
Reboiler Energy Stream	Reb-Q
Reboiler	
Configuration	Once-Through / Regular Hysys Reboiler
Pressure Profile	
Condenser	190 kPa (27.5 psia)
Condenser Pressure Drop	15 kPa (2.2 psia)
Reboiler Pressure Drop	0 kPa (0 psi)
Reboiler	220 kPa (31.9 psia)
Optional Estimates	
Temperature Estimates	Leave these blank (Not req'd)
Column Specs – Enter on Design | Monitor or Design | Specs	
First Spec - Column Temperature	
Stage	Condenser
Spec Value	45 °C (113 °F)
Status	Active
Second Spec - Column Duty	
Energy Stream	Reb-Q @ COL2 (Reboiler)
Spec Value	1.4 E+7 kJ/h (1.33 E+7 Btu/hr)
Status	Active
Third Spec – Column Draw Rate	
Draw	Acid Gas @ COL2
Spec Value	74.7 kgmole/h (1.5 MMSCFD)
Status	Estimate

Regenerator Column Internal

Column Type	Sieve
Column Diameter	1.0 m (3.281 ft)
Weir Height	50.8 mm (2.0 in)