CPED LAB PROJECT

SYNTHESIS OF METHANOL FROM SYNGAS

GROUP 2

GROUP MEMBERS:-

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• INTRODUCTION:-

Syngas, which is a mixture of carbon monoxide and hydrogen, is the primary feedstock for the production of methanol. The synthesis of methanol from syngas involves a catalytic process that takes place at high pressure and temperature.

The process can be divided into three main stages: **synthesis gas production, methanol synthesis, and methanol purification.**

In the first stage, synthesis gas is produced by the gasification of coal, natural gas, or biomass. The gasification process involves the reaction of the feedstock with oxygen or steam to produce a mixture of carbon monoxide and hydrogen.

In the second stage, the syngas is fed into a methanol synthesis reactor, which contains a catalyst that promotes the conversion of carbon monoxide and hydrogen into methanol. The catalyst is typically composed of copper, zinc oxide, and alumina.

In the third stage, the methanol is purified to remove impurities such as water, carbon dioxide, and other gases. The purification process typically involves distillation and other separation techniques.

We will use ASPEN PLUS to see how these processes can be simulated and methanol can be obtained.

• INPUT DETAILS:-

We have taken 1000 kmol/h of syngas, consisting of

- 6% CO
- 27% C02 and
- 67% H2, at 60^{o}C and 1 atm pressure.

Also we have used

- 3 simple heaters
- Isothermal reactor at 280 ^{o}C and 45 bar pressure
- 2 Membrane separators
  - One at 60 ^{o}C and 12 bar pressure
  - Another at 280 ^{o}C and 45 bar pressure
- 2 Isentropic Compressors
  - One (using ASME method) with 70% isentropic and 80% mechanical efficiencies
  - Another with 90% isentropic and 80% mechanical efficiencies

• BRIEF DESCRIPTION:-

In this Lab Experiment, we are dealing with reactions like:-

$$CO + 2H_2 \rightleftharpoons CH_3OH \quad (1)$$

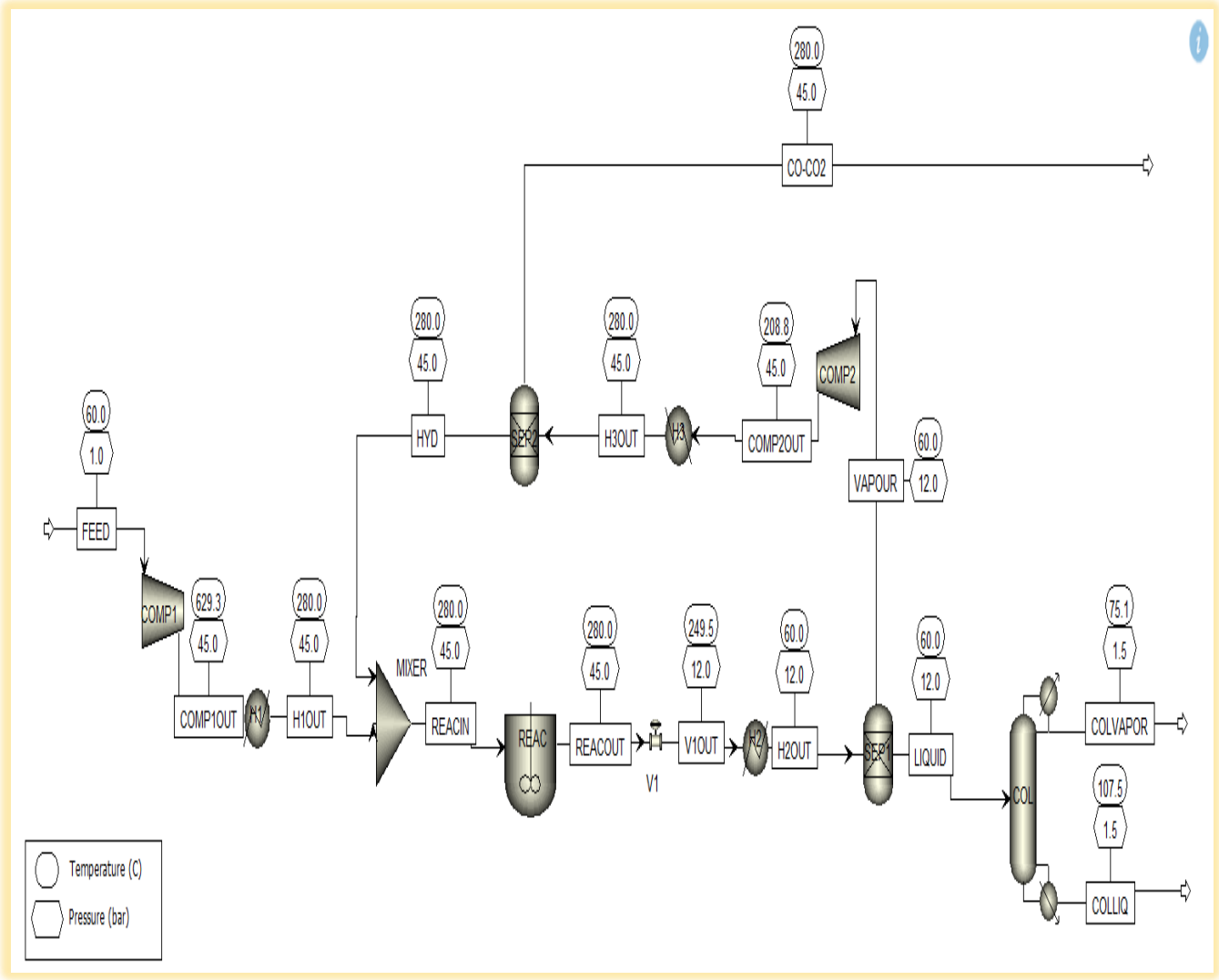
$$CO_2 + 3H_2 \rightleftharpoons CH_3OH + H_2O \quad (2)$$

water-gas shift reaction

$$CO + H_2O \rightleftharpoons CO_2 + H_2 \quad (3)$$

We have feed at 60 °C and 1 bar pressure. We are using a reactor (CSTR) operating at 280 °C and 45 bar pressure. To increase temperature and pressure we are using a heater as well as an isentropic compressor respectively. After that we have a 2-phase separator to separate vapour (mainly CO, CO_2, and H_2) and liquid (containing water and methanol). The unused H2 is separated from CO-CO2 with a separator and recycled back. Finally, we used a rigorous distillation column to separate water from methanol.

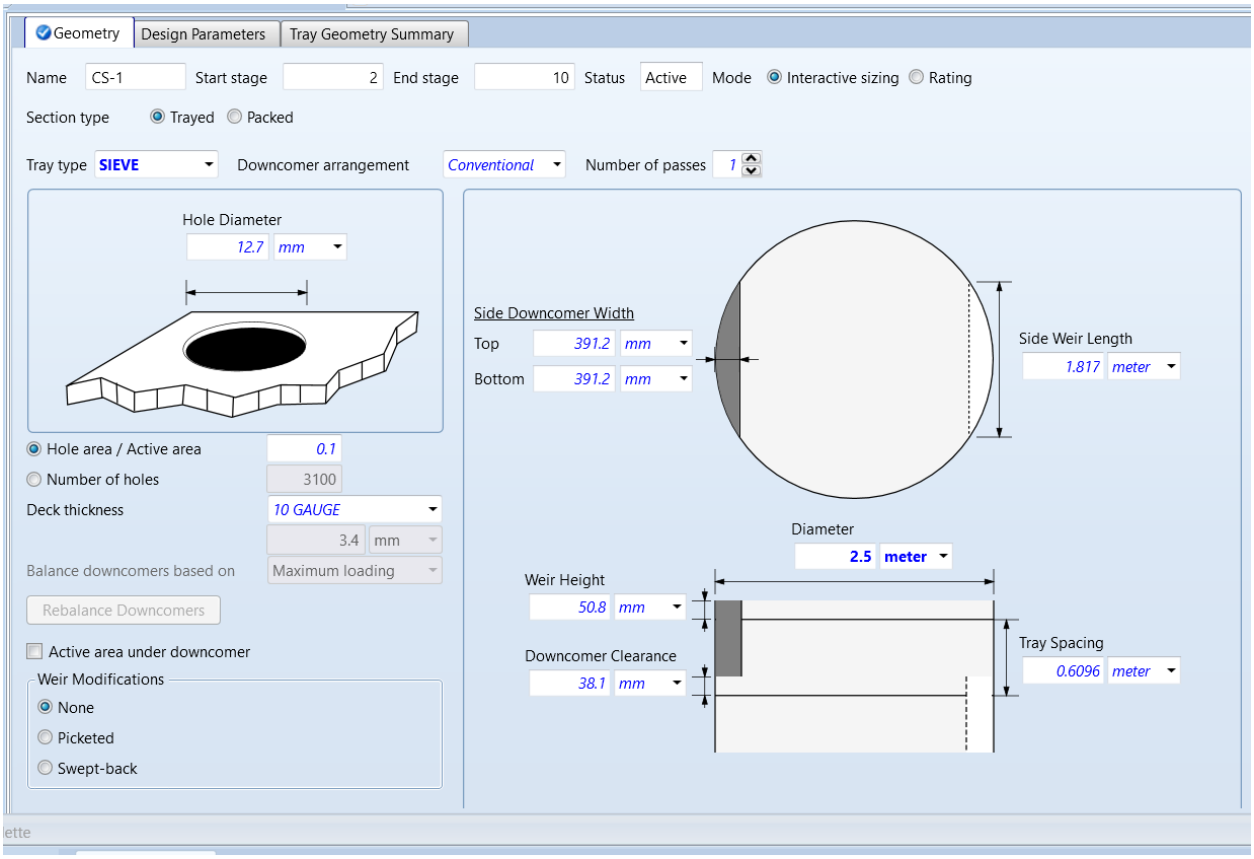
- **FLOWSHEET IMAGES:-**

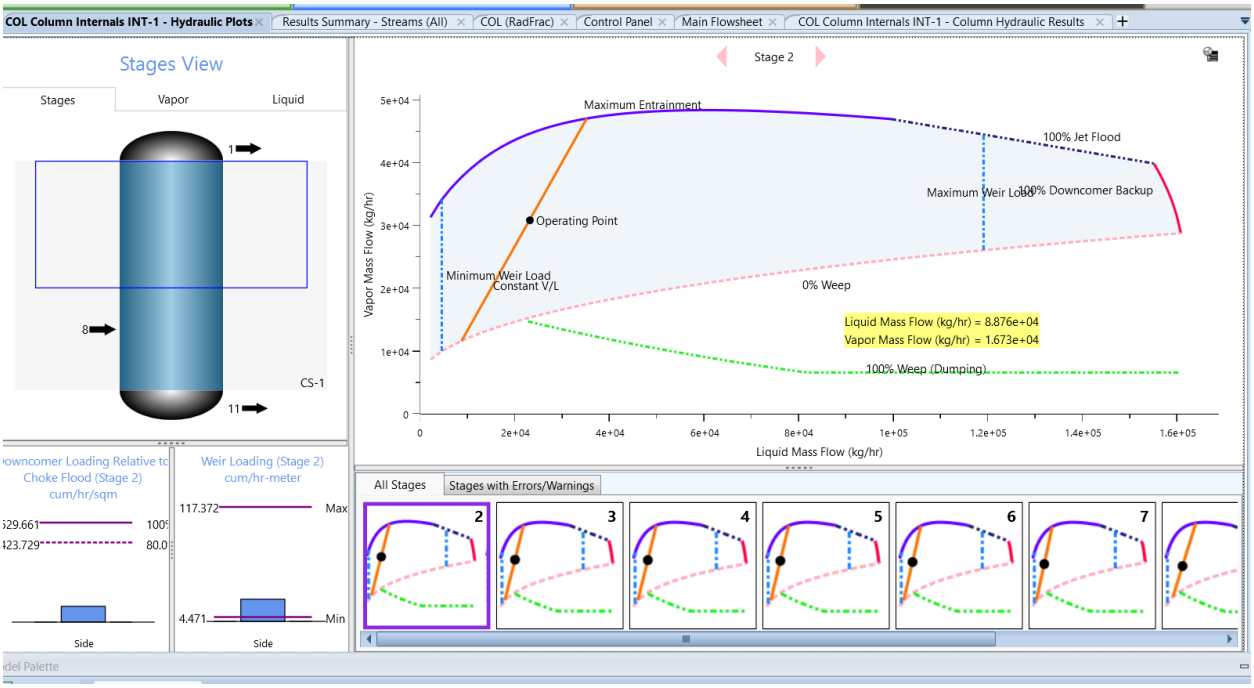


• STREAM RESULTS :-

	Units	FEED	COLLIQ	COLVAPOR	CO-CO2
Description					
From			COL	COL	SEP2
To		COMP1			
Stream Class		CONVEN	CONVEN	CONVEN	CONVEN
Maximum Relative Error					
Cost Flow	$/hr				
− MIXED Substream					
Phase		Vapor Phase	Liquid Phase	Liquid Phase	Vapor Phase
Temperature	C	60	109.341	74.9515	280
Pressure	bar	1.01325	1.5	1.5	45
Molar Vapor Fraction		1	0	0	1
Molar Liquid Fraction		0	1	1	0
Molar Solid Fraction		0	0	0	0
Mass Vapor Fraction		1	0	0	1
Mass Liquid Fraction		0	1	1	0
Mass Solid Fraction		0	0	0	0
Molar Enthalpy	cal/mol	-26698.2	-66633.6	-56180	-91072.3
Mass Density	gm/cc	0.000545612	0.698274	0.557986	0.0430218
Enthalpy Flow	cal/sec	-7.41616e+06	-3.41158e+06	-3.78487e+06	-2.1977e+06
Average MW		14.9139	18.1752	31.955	43.9001
− Mole Flows	**kmol/hr**	**1000**	**184.317**	**242.533**	**86.8728**
CO	kmol/hr	60	0	0	0.595726
CO2	kmol/hr	270	0	0	86.2771
H2	kmol/hr	670	0	0	0
H2O	kmol/hr	0	182.216	1.50722	0
CH3OH	kmol/hr	0	2.10117	241.026	0
− Mole Fractions					
CO		0.06	0	0	0.00685745
CO2		0.27	0	0	0.993143
H2		0.67	0	0	0
H2O		0	0.9886	0.00621447	0
CH3OH		0	0.0113998	0.993786	0
+ Mass Flows	**kg/hr**	**14913.9**	**3349.99**	**7750.15**	**3813.72**
+ Mass Fractions					

• HYDRAULIC PLOTS:-





• FINAL RESULTS:-

We get 3 final products:-

METHANOL:-

We get our main product methanol in the “COLVAPOR” stream from the rigorous distillation column

AMOUNT OBTAINED:- 241 kmol/hr (per 1000 kmol/hr of feed)

PURITY(%):- 99.37%

WATER:-

We get another product water in “COLLIQ” stream from the rigorous distillation column

AMOUNT OBTAINED:- 182 kmol/hr (per 1000 kmol/hr of feed)

PURITY(%):- 98.86%

CO2:-

We get another product water in “COLLIQ” stream from rigorous distillation

AMOUNT OBTAINED:- 86 kmol/hr (per 1000 kmol/hr of feed)

PURITY(%):- 99.31%

1. Column Internals Summary

Summary

Property	Value	Units
Number of Trayed/Packed stages	9	
Total height	5.4864	meter
Total head loss (Hot liquid height)	0.687866	meter
Total pressure drop	0.0398289	bar
Number of sections	1	
Number of diameters	1	
Total residence time	0.0127236	hr

Sections

Column 1	Start Stage	End Stage	Diameter (meter)	Section Height (meter)	Internals Type	Tray or Packing Type	Section Pressure Drop (bar)	% Approach to Flood	Limiting Stage
CS-1	2	10	2.5	5.4864	Trayed	SIEVE	0.0398289	56.6352	2