Bi-Weekly Report 3

Team number: 1

Team members:

Anas Ali (220137)

Ansh Sethi (220167)

Aryan Jadon (220223)

Jatin Madan (220475)

Lokesh Yadav (220594)

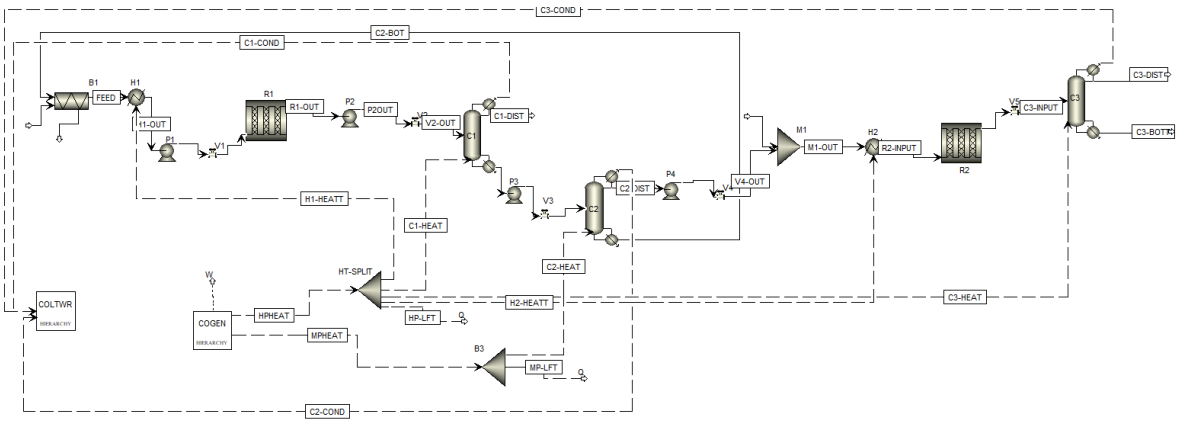
Madhav Lata (220597)

Pratyush Gupta (220813)

Punam Singh (220835)

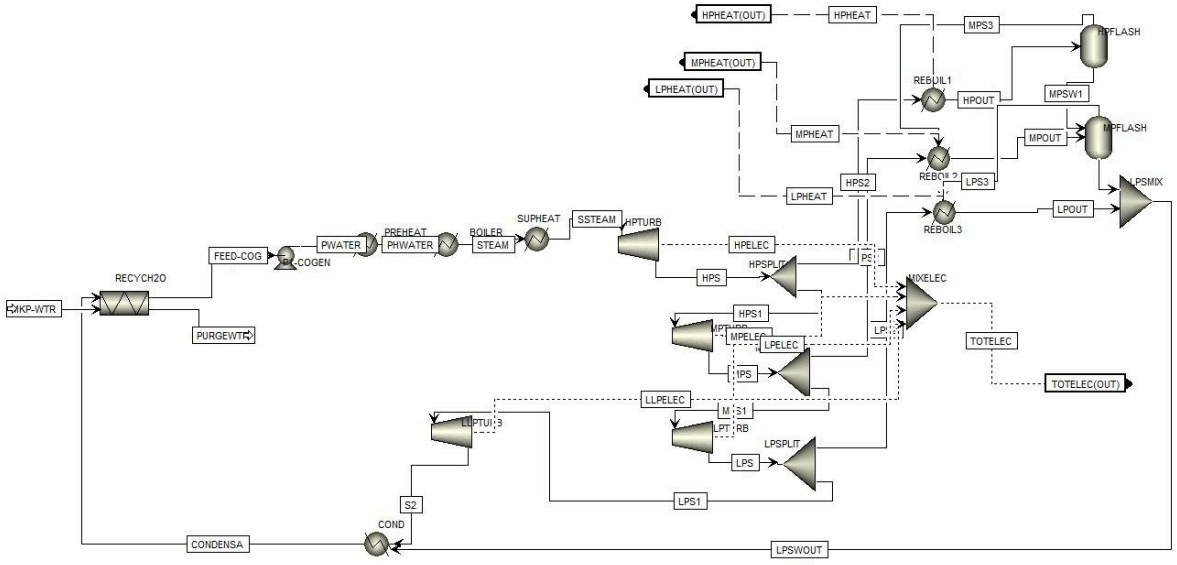
Objectives

This report focuses on three key deliverables: the design and sequencing of a distillation column to ensure efficient separation processes; the development of a sub-critical cogeneration power plant to optimize energy production and utilization; and the design of a cooling water loop to support effective thermal management within the system.



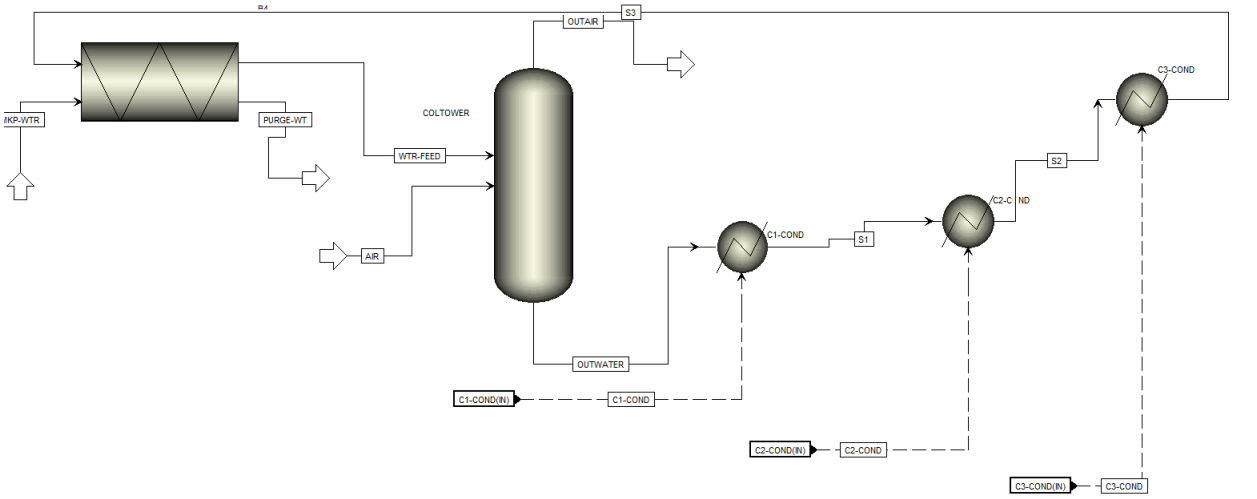
PROCESS FLOWSHEET

The process flowsheet outlines the cogeneration power plant, showing how steam is produced from fuel and then routed through turbines to generate electricity while also providing useful heat for downstream processes. The interconnected units such as the boiler, turbine, condenser, and generator highlight the dual purpose of energy generation and heat recovery, ensuring efficient use of resources.



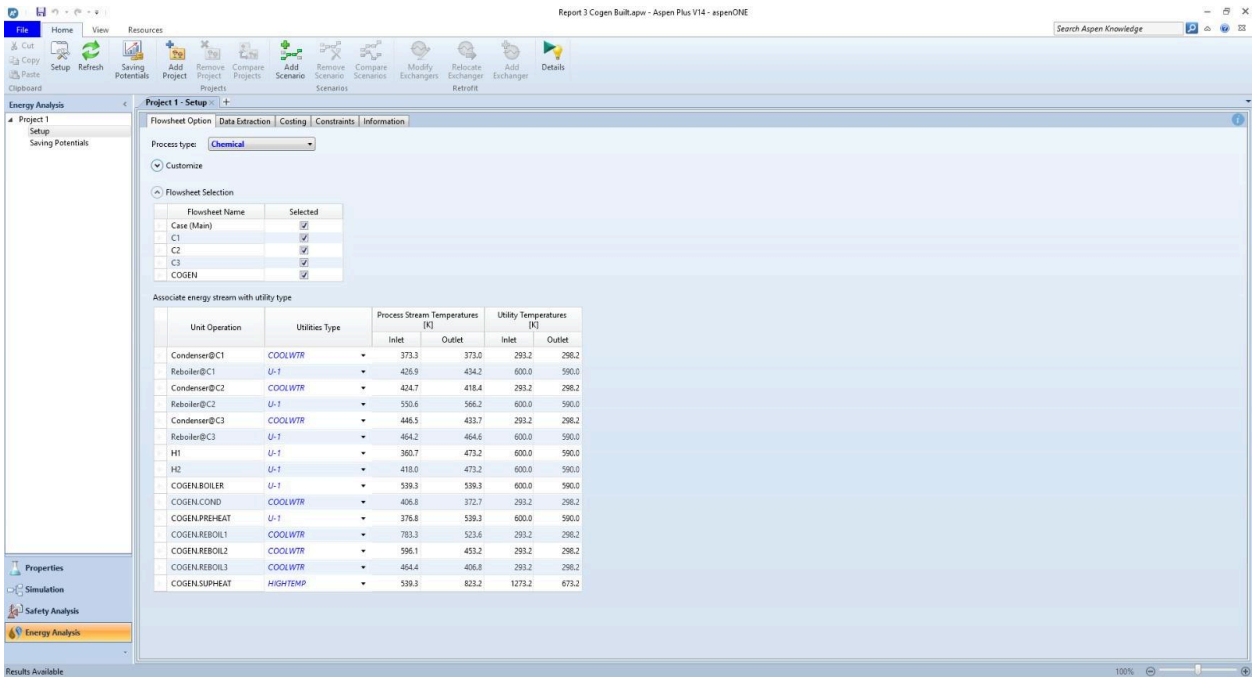
COGENERATION POWER PLANT

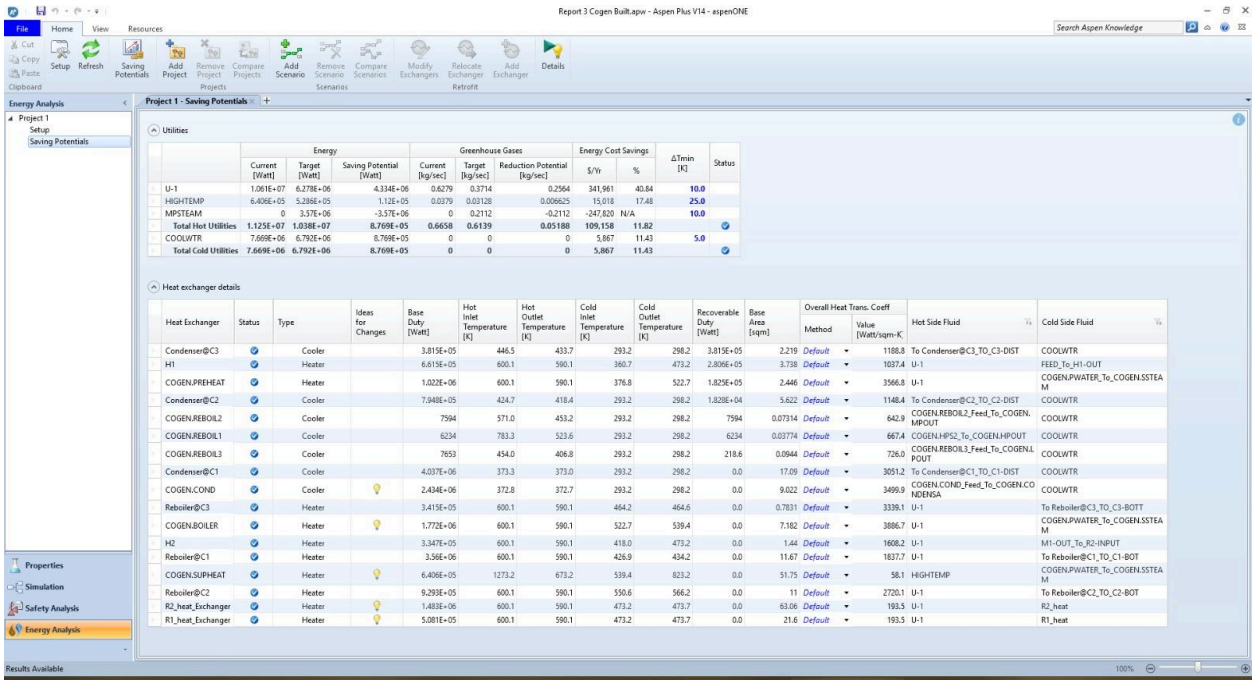
The cogeneration power plant operates by heating water to produce steam, which is expanded in stages to simultaneously generate electricity and supply process heat. Feedwater is preheated, converted to steam in the boiler, and superheated before entering the high-pressure turbine, where power is produced and high-pressure steam is extracted for heating. The remaining steam expands through medium- and low-pressure turbines, generating additional electricity while providing medium- and low-pressure steam for plant heating duties. All electrical outputs are combined, and steam condensate is recycled, ensuring efficient utilization of fuel energy for both power and heating needs.



COOLING WATER TOWER

The cooling tower schematic highlights the circulation of water used to remove excess heat from the system. Hot water from the plant is passed through the tower where it is cooled by ambient air before being sent back for reuse, creating a closed loop that maintains safe operating temperatures and prevents overheating of critical units.





ENERGY ANALYSIS

	Units	V1-OUT	R1-OUT	R2-INPUT	R2-OUT
− MIXED Substream					
Phase		Liquid Phase	Liquid Phase		Liquid Phase
Temperature	K	478.922	473.15	477.827	473.15
Pressure	N/sqm	110000	110000	2e+06	2e+06
Molar Vapor Fraction		0	0	0.652871	0
Molar Liquid Fraction		1	1	0.347129	1
Molar Solid Fraction		0	0	0	0
Mass Vapor Fraction		0	0	0.329565	0
Mass Liquid Fraction		1	1	0.670435	1
Mass Solid Fraction		0	0	0	0
Molar Enthalpy	J/kmol	-5.67047e+08	-3.55483e+08	-1.86429e+08	-4.56192e+08
Mass Enthalpy	J/kg	-7.085e+06	-7.33023e+06	-4.87063e+06	-5.99553e+06
Molar Entropy	J/kmol-K	-434330	-231445	-152946	-508351
Mass Entropy	J/kg-K	-5426.76	-4772.51	-3995.86	-6681.02
Molar Density	kmol/cum	13.9261	18.4137	0.752957	10.3654
Mass Density	kg/cum	1114.57	892.983	28.8203	788.69
Enthalpy Flow	Watt	-1.57513e+07	-1.62965e+07	-6.61713e+06	-8.1454e+06
Average MW		80.035	48.4955	38.2762	76.0887
− Mole Flows	**kmol/sec**	**0.0277778**	**0.0458433**	**0.0354941**	**0.0178552**
H2O	kmol/sec	0.00452082	0.0225863	4.74663e-08	4.74663e-08
H2	kmol/sec	0	0	0.0176389	0
GLYCEROL	kmol/sec	0.0232518	0.00518629	1.78077e-05	1.78077e-05
PROPDIOL	kmol/sec	0	0	0	0.0176391
ACETOL	kmol/sec	5.17326e-06	0.0180707	0.0178373	0.000198194

REACTOR RESULTS

	Units	V2-OUT	C1-BOT	C1-DIST	V3-OUT	C2-DIST	C2-BOT	C3-BOTT	C3-DIST
Stream Class		CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN	CONVEN
Maximum Relative Error									
Cost Flow	$/sec								
− MIXED Substream									
Phase			Liquid Phase	Liquid Phase		Liquid Phase	Liquid Phase	Liquid Phase	Liquid Phase
Temperature	K	404.772	434.185	372.906	430.393	418.347	566.132	464.553	433.688
Pressure	N/sqm	120000	123000	100000	110000	100000	119000	114000	100000
Molar Vapor Fraction		0.243434	0	0	0.0157645	0	0	0	0
Molar Liquid Fraction		0.756566	1	1	0.984236	1	1	1	1
Molar Solid Fraction		0	0	0	0	0	0	0	0
Mass Vapor Fraction		0.178336	0	0	0.0149521	0	0	0	0
Mass Liquid Fraction		0.821664	1	1	0.985048	1	1	1	1
Mass Solid Fraction		0	0	0	0	0	0	0	0
Molar Enthalpy	J/kmol	-3.55478e+08	-4.49756e+08	-2.81235e+08	-4.49711e+08	-3.97434e+08	-6.04135e+08	-4.58895e+08	-4.30232e+08
Mass Enthalpy	J/kg	-7.33012e+06	-5.75603e+06	-1.51398e+07	-5.75546e+06	-5.36369e+06	-6.56121e+06	-6.02971e+06	-5.73139e+06
Molar Entropy	J/kmol-K	-228822	-375699	-147689	-375568	-341409	-463789	-514740	-427129
Mass Entropy	J/kg-K	-4718.4	-4808.24	-7950.56	-4806.56	-4607.58	-5036.99	-6763.51	-5690.05
Molar Density	kmol/cum	0.145626	12.4479	49.5082	1.69064	12.3833	11.2229	10.4742	11.5164
Mass Density	kg/cum	7.06223	972.638	919.66	132.101	917.57	1033.36	797.146	864.488
Enthalpy Flow	Watt	-1.62963e+07	-1.03574e+07	-6.41621e+06	-1.03563e+07	-7.09627e+06	-3.12559e+06	-8.06146e+06	-123933
Average MW		48.4955	78.1365	18.5759	78.1365	74.0973	92.0767	76.1055	75.0659
− Mole Flows	**kmol/sec**	**0.0458433**	**0.0230289**	**0.0228144**	**0.0230289**	**0.0178552**	**0.00517366**	**0.0175671**	**0.000288062**
H2O	kmol/sec	0.0225863	4.74703e-08	0.0225863	4.74703e-08	4.74663e-08	2.72166e-12	3.32535e-12	4.7463e-08

COL 1 RESULTS

Phase			Liquid Phase	Liquid Phase		Liquid Phase	Liquid Phase	Liquid Phase	Liquid Phase
Temperature	K	404.772	434.185	372.906	430.393	418.347	566.132	464.553	433.688
Pressure	N/sqm	120000	123000	100000	110000	100000	119000	114000	100000
Molar Vapor Fraction		0.243434	0	0	0.0157645	0	0	0	0
Molar Liquid Fraction		0.756566	1	1	0.984236	1	1	1	1
Molar Solid Fraction		0	0	0	0	0	0	0	0
Mass Vapor Fraction		0.178336	0	0	0.0149521	0	0	0	0
Mass Liquid Fraction		0.821664	1	1	0.985048	1	1	1	1
Mass Solid Fraction		0	0	0	0	0	0	0	0
Molar Enthalpy	J/kmol	-3.55478e+08	-4.49756e+08	-2.81235e+08	-4.49711e+08	-3.97434e+08	-6.04135e+08	-4.58895e+08	-4.30232e+08
Mass Enthalpy	J/kg	-7.33012e+06	-5.75603e+06	-1.51398e+07	-5.75546e+06	-5.36369e+06	-6.56121e+06	-6.02971e+06	-5.73139e+06
Molar Entropy	J/kmol-K	-228822	-375699	-147689	-375568	-341409	-463789	-514740	-427129
Mass Entropy	J/kg-K	-4718.4	-4808.24	-7950.56	-4806.56	-4607.58	-5036.99	-6763.51	-5690.05
Molar Density	kmol/cum	0.145626	12.4479	49.5082	1.69064	12.3833	11.2229	10.4742	11.5164
Mass Density	kg/cum	7.06223	972.638	919.66	132.101	917.57	1033.36	797.146	864.488
Enthalpy Flow	Watt	-1.62963e+07	-1.03574e+07	-6.41621e+06	-1.03563e+07	-7.09627e+06	-3.12559e+06	-8.06146e+06	-123933
Average MW		48.4955	78.1365	18.5759	78.1365	74.0973	92.0767	76.1055	75.0659
+ Mole Flows	**kmol/sec**	**0.0458433**	**0.0230289**	**0.0228144**	**0.0230289**	**0.0178552**	**0.00517366**	**0.0175671**	**0.000288062**
+ Mole Fractions									
+ Mass Flows	**kg/sec**	**2.22319**	**1.79939**	**0.423799**	**1.79939**	**1.32302**	**0.476374**	**1.33696**	**0.0216236**
+ Mass Fractions									
Volume Flow	cum/sec	0.3148	0.00185001	0.000460821	0.0136214	0.00144188	0.000460993	0.00167718	2.50132e-05
+ Vapor Phase									

COL 2 RESULTS

	Units	V2-OUT	C1-BOT	C1-DIST	V3-OUT	C2-DIST	C2-BOT	C3-BOTT	C3-DIST
N2	kg/sec	0	0	0	0	0	0	0	0
O2	kg/sec	0	0	0	0	0	0	0	0
− Mass Fractions									
H2O		0.183024	4.75266e-07	0.960121	4.75266e-07	6.46338e-07	1.02926e-10	4.48085e-11	3.95429e-05
H2		0	0	0	0	0	0	0	0
GLYCEROL		0.21484	0.265439	6.71811e-60	0.265439	0.00123959	0.999195	0.00122667	3.20756e-17
PROPDIOL		0	0	0	0	0	0	0.995867	0.500699
ACETOL		0.602136	0.73456	0.0398793	0.73456	0.99876	0.000804558	0.00290681	0.499261
N2		0	0	0	0	0	0	0	0
O2		0	0	0	0	0	0	0	0
Volume Flow	cum/sec	0.3148	0.00185001	0.000460821	0.0136214	0.00144188	0.000460993	0.00167718	2.50132e-05
− Vapor Phase									
Molar Enthalpy	J/kmol	-2.74898e+08			-3.53191e+08				
Mass Enthalpy	J/kg	-7.73766e+06			-4.76576e+06				
Molar Entropy	J/kmol-K	-95296			-236240				
Mass Entropy	J/kg-K	-2682.34			-3187.69				
Molar Density	kmol/cum	0.0356569			0.0307397				
Mass Density	kg/cum	1.26679			2.27813				
Enthalpy Flow	Watt	-3.0678e+06			-128222				
Average MW		35.5272			74.1101				

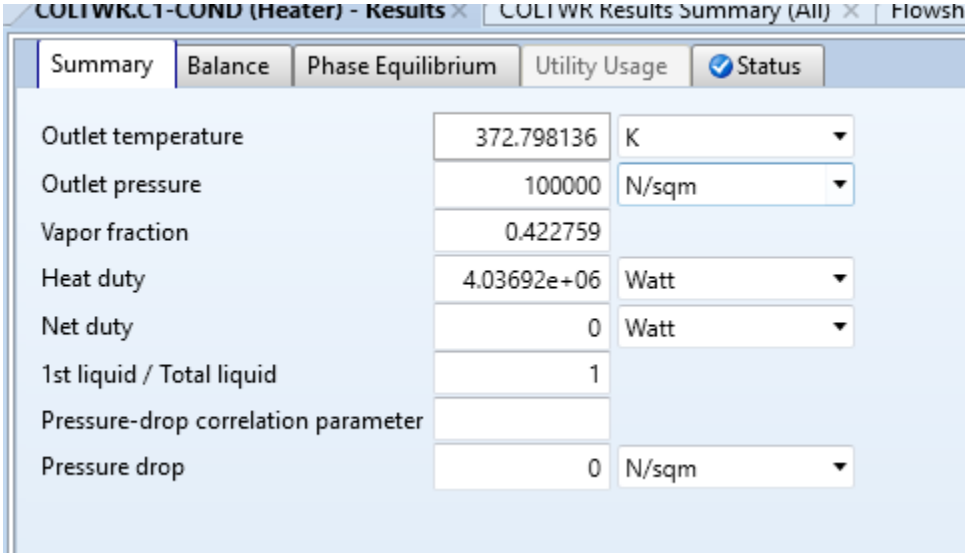
COL3 RESULTS

	Units	V1-OUT	R1-OUT	R2-INPUT	R2-OUT
ACETOL	kmol/sec	5.17326e-06	0.0180707	0.0178373	0.000198194
N2	kmol/sec	0	0	0	0
O2	kmol/sec	0	0	0	0
− Mole Fractions					
H2O		0.16275	0.492685	1.3373e-06	2.6584e-06
H2		0	0	0.496953	0
GLYCEROL		0.837064	0.113131	0.00050171	0.000997342
PROPDIOL		0	0	0	0.9879
ACETOL		0.000186237	0.394184	0.502544	0.0111001
N2		0	0	0	0
O2		0	0	0	0
− Mass Flows	**kg/sec**	**2.22319**	**2.22319**	**1.35858**	**1.35858**
H2O	kg/sec	0.0814439	0.406899	8.55119e-07	8.55119e-07
H2	kg/sec	0	0	0.0355579	0
GLYCEROL	kg/sec	2.14137	0.47763	0.00164	0.00164
PROPDIOL	kg/sec	0	0	0	1.34226
ACETOL	kg/sec	0.000383232	1.33866	1.32138	0.0146821
N2	kg/sec	0	0	0	0
O2	kg/sec	0	0	0	0
− Mass Fractions					
H2O		0.0366337	0.183024	6.29422e-07	6.29421e-07
H2		0	0	0.0261728	0
GLYCEROL		0.963194	0.21484	0.00120714	0.00120714
PROPDIOL		0	0	0	0.987985

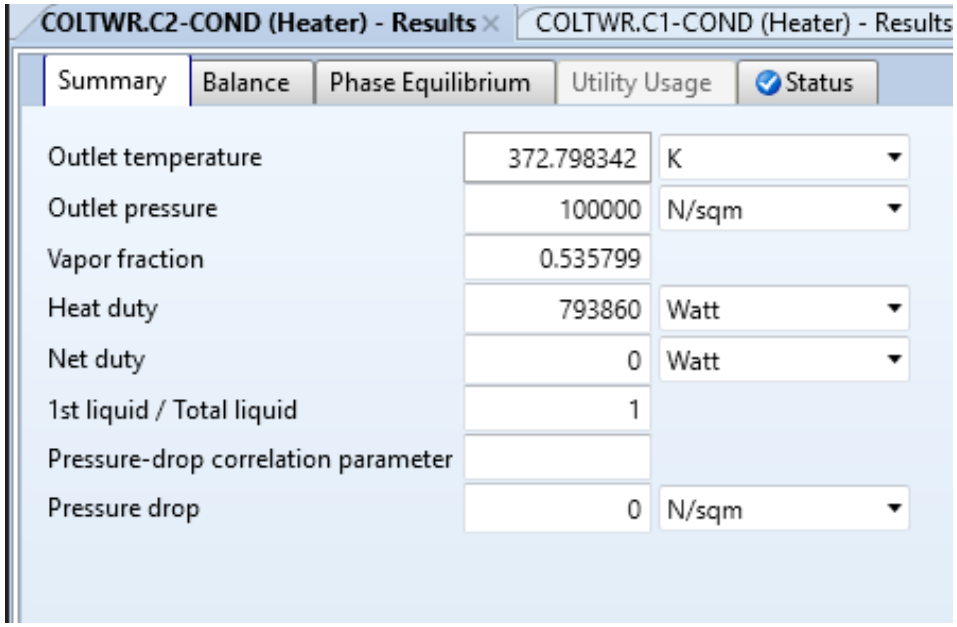
− Mass Fractions					
H2O		0.0366337	0.183024	6.29422e-07	6.29421e-07
H2		0	0	0.0261728	0
GLYCEROL		0.963194	0.21484	0.00120714	0.00120714
PROPDIOL		0	0	0	0.987985
ACETOL		0.000172379	0.602136	0.972619	0.010807

COOLING WATER RESULTS

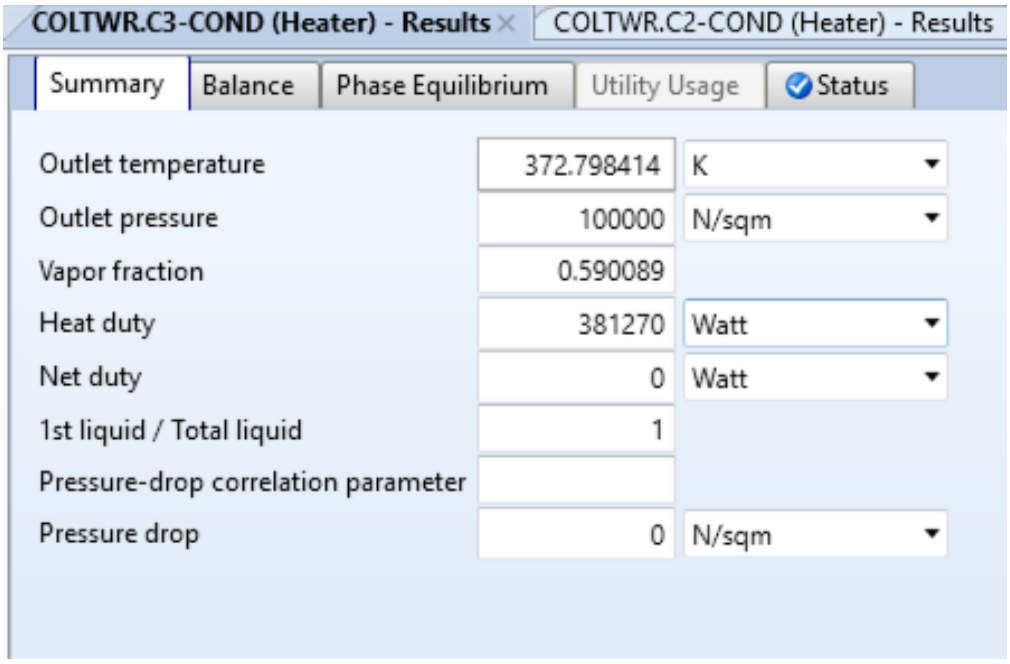
HEATER RESULTS



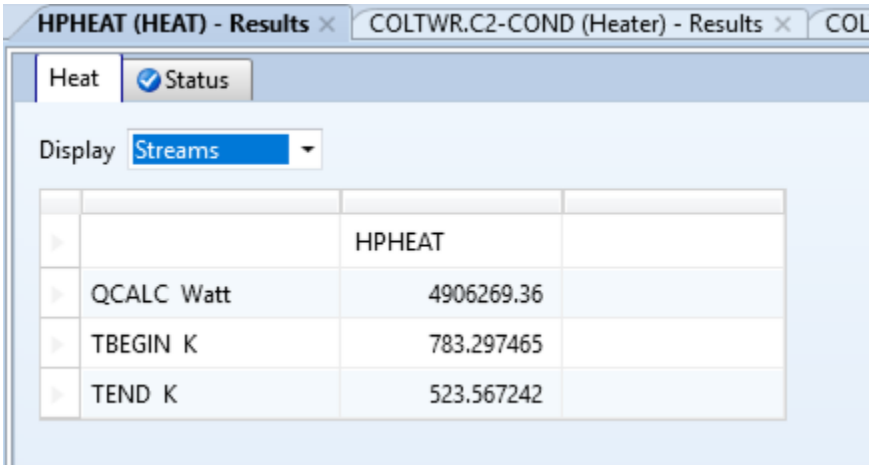
Heater1



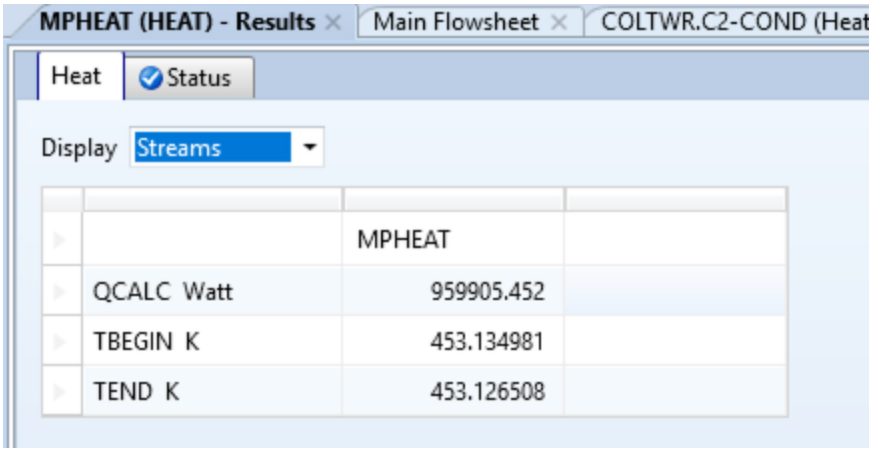
Heater2



Heater3



High Pressure Steam

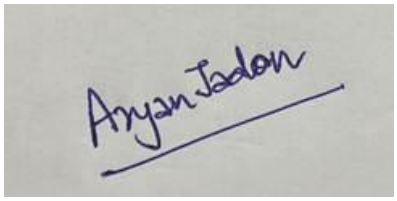
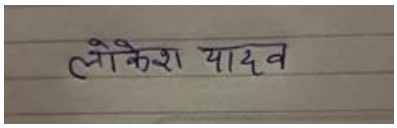


Medium Pressure Steam

Objectives that could not be accomplished with reasons: - None

Any other challenges: - None

Number of hours spent on Capstone project during this period: 15 hours

Name (Roll No.)	Contribution	Signature
Anas Ali (220137)	**Cooling Water Loop and Report preparation**	
Ansh Sethi (220167)	**Report making and Cooling Tower calculations**	
Aryan Jadon (220223)	**Flowsheet design and Report Preparation**	
Jatin Madan (220475)	**Cooling Water Loop and Report preparation**	
Lokesh Yadav (220594)	**Flowsheet design Cogeneration and Cooling Water Loop**	
Madhav Lata (220597)	**Prepared Flowsheet(Cogeneration and Cooling Water) , Aspen Simulation**	

Pratyush Gupta (220813)	**Prepared Flowsheet(Cogeneration and Cooling Water) , Aspen Simulation**	
Punam Singh (220835)	**Prepared Flowsheet(Cogeneration and Cooling Water) , Aspen Simulation**