Process flowdiagram for manufacture of formaldehyde

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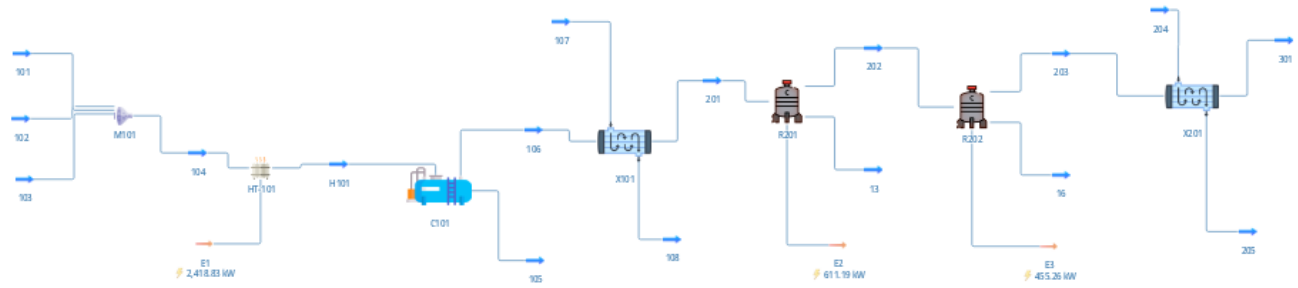
Background and Description:

This flowsheet examines how formaldehyde is made from methanol using the BASF (Badische Anilin und Soda Fabrik) process, an extensively used industrial technique renowned for its sustainability and efficiency. Worldwide demand is strong for formaldehyde, a crucial chemical intermediate with several uses in sectors like healthcare and building. Formaldehyde is produced via the BASF method, which oxidizes methanol over a silver catalyst in the presence of air. The mixer-which blends methanol, air, and water, the evaporator, the heat exchanger, which uses superheated steam to heat the gas stream, and the reactors are all located in the first part. The reactor and heat exchanger, which lower the stream's temperature to 150°C, are located in the second part. The methanol/water mass ratio that would be heated and supplied into the reactor at the gaseous output of the evaporator—which serves as a heater and gas-liquid separator—should normally be 60/40, according to the literature sources that were considered for this simulation. To model the reactor, some assumptions had to be made. Since the reaction is non-equilibrium, a stoichiometric reactor was employed rather than an equilibrium one. Initially, the processes that produced formaldehyde were mixed and applied in Reactor 1, yielding the intended 0.9715 total methanol conversion. The reactions using formaldehyde with a conversion of 0.08 were introduced using the second reactor.

Thermodynamic Package Used: Peng-Robinson

Flowsheet:



Master Property Table

Master Property Table																		
Object	H101	301	205	204	203	202	201	16	13	108	107	106	105	104	103	102	101	
Temperature	67.3	150	208.561	25	650	650	600	650	650	541.945	800	67.3	67.3	9.99374	25	25	25	C
Pressure	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	1.033	kgf/cm2
Mass Flow	12649	11220.8	3000	3000	11220.8	11220.8	11220.8	0	-2.4915 2E-12	15000	15000	11220.8	1428.16	12649	3000	2854	6795	kg/h

Calculation:

Calculation for conversion of methanol to formaldehyde

$$\frac{mole\ flow\ formaldehyde\ in\ 202}{mole\ flow\ methanol\ in\ 201} * 100 = \frac{78.894538}{83.046882} * 100 = 95\%$$

Calculation for overall conversion of methanol

$$\left(1 - \frac{mole\ flow\ methanol\ in\ 202}{mole\ flow\ methanol\ in\ 201}\right) * 100 = (1 - \left(\frac{2.3668361}{83.046882}\right) * 100 = 97.15\%$$

Conclusion:

The simulation of producing formaldehyde from methanol was successfully done in DWSIM with overall conversion of 97.15%.

References

https://www.researchgate.net/publication/330092667_Process_Description_and_ASPEN_Computer_Modelling_of_Formaldehyde_Production_from_Methanol?enrichId=rgreq-576210e2c77dc876863e64dd7ec33927-XXX&enrichSource=Y292ZXJQYWdlOzMzMDA5MjY2NztBUzo3MzA2OTI4MDc4MjMzNjFAMTU1MTIyMjE0OTUxNQ%3D%3D&el=1_x_2&_esc=publicationCoverPdf