Production of Methane from Carbon Monoxide and Hydrogen(using Recycle)

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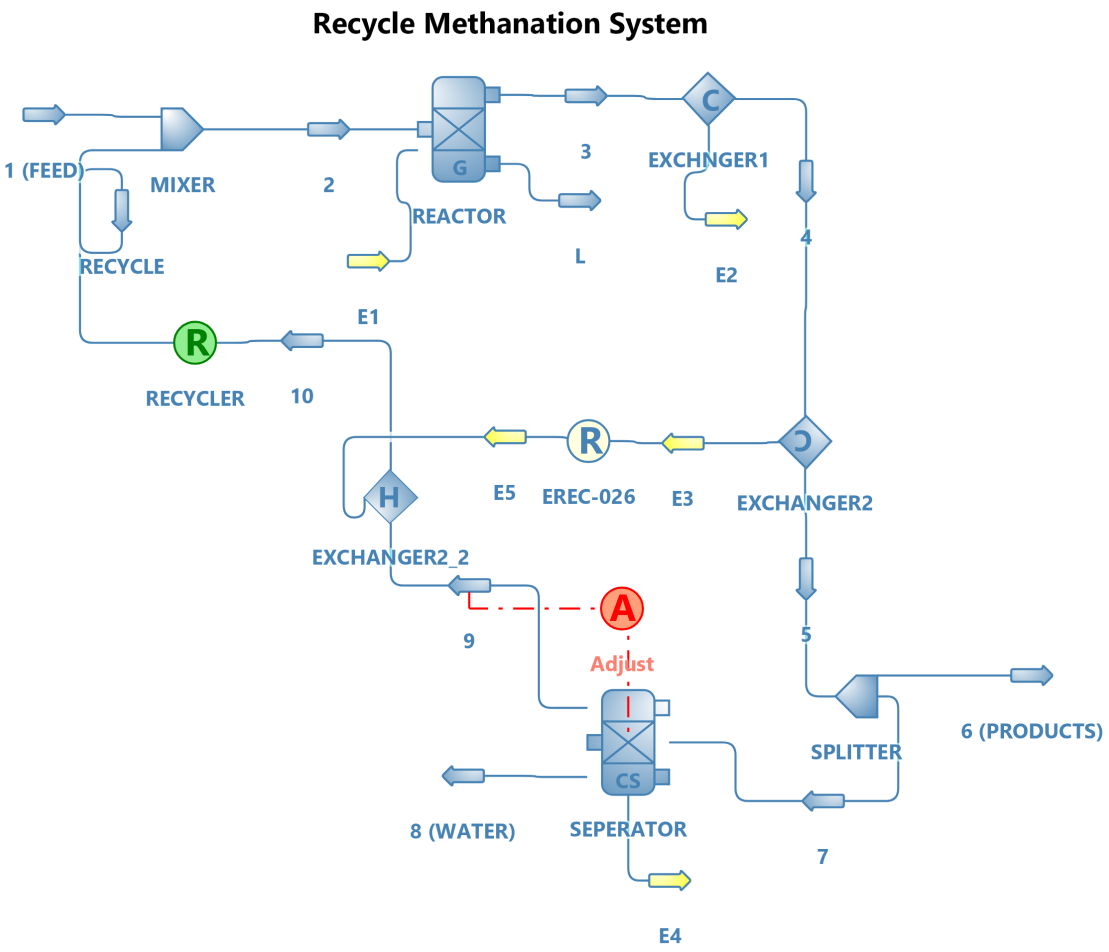
Background & Description:
A synthesis gas containing CO, H_2, and a small amount of CH_4 with a CO to H_2 ratio of 1:2.9 is upgraded to a higher methane content via the reaction

$$CO + 3H_2 \rightarrow CH_4 + H_20$$

The reactor is operated adiabatically with a maximum outlet temperature of 1000°F to produce a product stream containing 50% CH_4 and 12% CO. The heat removal rate in the heat exchanger is adjusted to cool the reactor effluent stream to 500°F. The separator is operated so as to result in a recycle gas stream containing 1% H_2O and a pure liquid water stream, both at 100°F. The recycle gas stream is sent back to mix with feed and enters the reactor. Both the feed and the product streams are at 200°F. The entire system is operated at 100 psia. Separation in DWSIM has been achieved by using compound separator.



Results:

Object	RECYCLE	L	9	8 (WATER)	7	6 (PRODUCTS)	
Temperature	310.92778	810.9278	366.4833	366.4833	366.4833	366.4833	K
Pressure	92350	92350	92350	92350	92350	92350	Pa
Mass Flow	1.61607	0	1.61607	0.16206	1.77813	0.32866	kg/s
Molar Flow	120.59454	0	120.5945	8.99574	129.5903	23.9527	mol/s
Molar Fraction (Mixture) / Carbon monoxide	0.11646	0	0.11646	0	0.10837	0.10837	
Molar Fraction (Vapor Phase) / Hydrogen	0.28911	0	0.28911	0	0.26904	0.26904	
Molar Fraction (Mixture) / Methane	0.58446	0	0.58446	0	0.54389	0.54389	
Molar Fraction (Mixture) / Water	0.00997	0	0.00997	1	0.07869	0.07869	
Object	5	4	3	2	10	1 (FEED)	
Temperature	366.4833	533.15	810.9278	326.7173	310.9278	366.4833	K
Pressure	92350	92350	92350	92350	92350	92350	Pa
Mass Flow	2.10679	2.10679	2.10679	2.10678	1.61607	0.49015	kg/s
Molar Flow	153.543	153.543	153.543	175.175	120.5945	54.6161	mol/s
Molar Fraction (Mixture) / Carbon monoxide	0.10837	0.10837	0.10837	0.15673	0.11646	0.24618	
Molar Fraction (Vapor Phase) / Hydrogen	0.26904	0.26904	0.26904	0.42105	0.28911	0.71394	
Molar Fraction (Mixture) / Methane	0.54389	0.54389	0.54389	0.41498	0.58446	0.03988	
Molar Fraction (Mixture) / Water	0.07869	0.07869	0.07869	0.00723	0.00997	0	

Table 1: Streamwise Results for Production of Methane Flowsheet