

## Rectisol Wash Process for Removal of H<sub>2</sub>S and CO<sub>2</sub> from Sour Syngas

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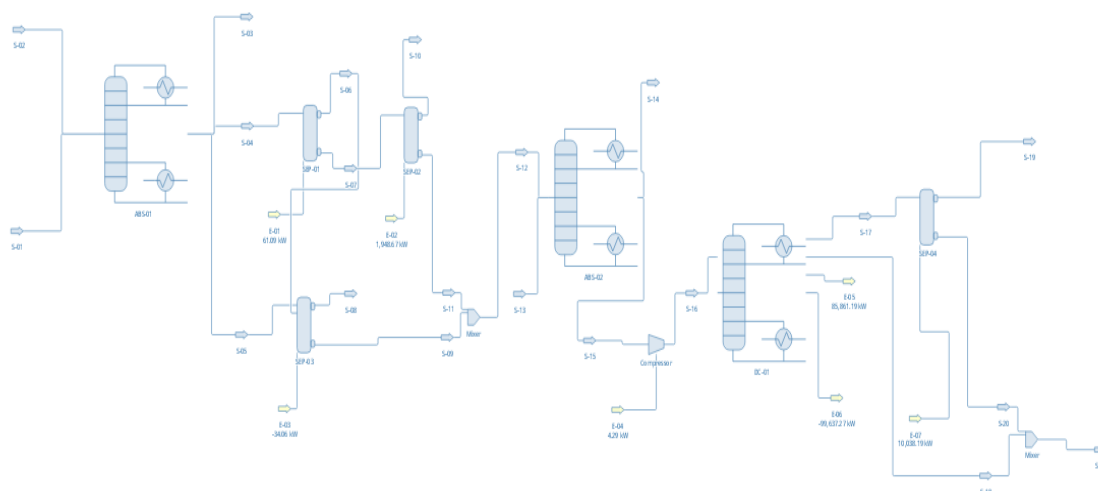
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### A. Background

There are several sour gas treatment techniques like chemisorption, physisorption and membrane separation for the removal of H<sub>2</sub>S. Of these, physisorption is an efficient and economical process for treatment of sour gas. Rectisol wash process is one such physisorption based treatment method. It uses Methanol as solvent at about -20°C to -70°C and high pressure to remove H<sub>2</sub>S and CO<sub>2</sub> simultaneously. Methanol has a greater absorption capacity towards sour components and hence favours absorption of both CO<sub>2</sub> and H<sub>2</sub>S at lower temperatures than most of the other common solvents. Moreover, methanol is also highly stable at lower temperatures making it a better candidate as solvent. This further help in reduction of solvent requirements and regeneration.

### B. Process Flowsheet Description

The process flowsheet for Rectisol process is developed in DWSIM (ver 7.3.1) and is based on the process depicted by Fig. 4. on Sun and Smith (2013). The crude syngas at about -20.59°C and 34 bar pressure and the pure methanol at -50°C and 44 bar pressure is supplied to an absorption column ( Chemsep). The absorption column has 60 stages. The Peng Robinson property package is used for the entire process. The top product from the column is obtained at -47.57°C and consists of purified syngas with more than 99% H<sub>2</sub>S removed. The CO<sub>2</sub> rich stream is drawn from the middle of the column and is flashed at 11 bar and 5 bar respectively to remove CO<sub>2</sub>. The bottom product from the Chemsep column is flashed at 12 bar to remove H<sub>2</sub> and CO. The CO<sub>2</sub> devoid middle stream and the H<sub>2</sub>S rich bottom product is stripped with N<sub>2</sub> at reduced pressure of about 0.2 bar to remove the absorbed CO<sub>2</sub> as tail gas. The H<sub>2</sub>S rich stream from this column is subjected to distillation to separate H<sub>2</sub>S and methanol.



**Figure 1.** Rectisol wash configuration.

### C. Results and Discussion

Syngas with more than 99% H<sub>2</sub>S removed is obtained that can be further used for other production processes. Results for important streams developed in the flowsheet are shown in Table 1.

Variable	S-01	S-02	S-03	S-10	S-19	S-21	Units
Temperature	-20.59	-50	-47.5745	-17.9697	64	64.3578	C
Pressure	34	44	33	5	1.01325	1.01325	bar
Mass Flow	90775.5	163990	28550.1	25625.7	25790.6	139177	kg/h
Molar Flow	4221	5118	2796.12	583.203	802.39	4343.52	kmol/h
Molar Fraction Argon	0.001141	0	0.0016702	6.62E-05	8.17E-05	2.06E-08	
Molar Fraction Hydrogen	0.4607	0	0.692974	0.0005273	5.91E-06	4.06E-10	
Molar Fraction Nitrogen	0.0028	0	0.0041403	8.37E-05	5.59E-05	1.04E-08	
Molar Fraction Carbon monoxide	0.19009	0	0.284536	0.0011459	1.71E-05	1.75E-09	
Molar Fraction Methane	0.0018	0	0.0025974	0.0001915	0.0001253	4.60E-08	
Molar Fraction Carbon dioxide	0.34189	0	0.014054	0.996115	0.0051765	1.18E-05	
Molar Fraction Hydrogen sulfide	0.00129	0	1.13E-23	9.87E-06	0.0197606	0.000183	
Molar Fraction Methanol	0.000289	1	2.81E-05	0.0018606	0.974777	0.999805	

**Table 1.** Results for important streams

In addition to this a comparison of the above flowsheet with practical data and also the recreation of the same in ASPEN is shown below.

Practical Process						
		RAWGAS	MEOH	Purified Syn Gas	Bottom Product	Side Product
Temp	C	-20.59	-50	-38.8	-19.1	-20.9
Pressure	Bar	34	44	33	33	33
Mole Flows	kmol/h	4221	5118	2830	2821	6840
H <sub>2</sub>	kmol/h	1944.6147	0	1929.211	6.4883	15.732
N <sub>2</sub>	kmol/h	11.8188	0	11.603	0.093093	0.2052
CO	kmol/h	802.36989	0	780.514	9.3093	23.256
AR	kmol/h	4.816161	0	4.528	0.05642	0.1368
CH <sub>4</sub>	kmol/h	7.5978	0	7.075	0.22	0.5472
CO <sub>2</sub>	kmol/h	1443.11769	0	96.786	593.5384	1412.46
H <sub>2</sub> S	kmol/h	5.44509	0	0	5.7266	0.001368
METHANOL	kmol/h	1.219869	5118	0.3396	2195.02	5368.03

DWSIM						
		RAWGAS	MEOH	Purified Syn Gas	Bottom Product	Side Product
Temp	C	-20.59	-50	-47.5689	-19.207	-17.9697
Pressure	Bar	34	44	33	33	33
Mole Flows	kmol/h	4221	5118	2796.12	1457.88	5085
H2	kmol/h	1944.6147	0	1937.64	1.55785	5.41812
N2	kmol/h	11.8188	0	11.5768	0.0542797	0.187713
CO	kmol/h	802.36989	0	795.595	1.5257	5.24876
AR	kmol/h	4.816161	0	4.67015	0.0329334	0.113077
CH4	kmol/h	7.5978	0	7.26266	0.0755548	0.25959
CO2	kmol/h	1443.11769	0	39.2967	322.919	1080.9
H2S	kmol/h	5.44509	0	0	5.4125	0.0325929
METHANOL	kmol/h	1.219869	5118	0.0785861	1126.3	3992.84

ASPEN VERSION						
		RAWGAS	MEOH	Purified Syn Gas	Bottom Product	Side Product
Temp	C	-20.59	-50	-48.02	-18.44	-16.78
Pressure	Bar	34	44	33	33	33
Mole Flows	kmol/h	4221	5118	2787.118499	1551.881501	5000
H2	kmol/h	1944.6147	0	1940.733999	0.922567236	2.95813401
N2	kmol/h	11.8188	0	11.58217771	0.056552222	0.18007007
CO	kmol/h	802.36989	0	796.4916547	1.411781802	4.46645346
AR	kmol/h	4.816161	0	4.670190216	0.03510016	0.11087062
CH4	kmol/h	7.5978	0	7.25081128	0.08343337	0.26355535
CO2	kmol/h	1443.11769	0	26.31751796	350.2056481	1066.59452
H2S	kmol/h	5.44509	0	0	5.381183928	0.06390607
METHANOL	kmol/h	1.219869	5118	0.072148501	1193.785234	3925.36249

## D. Further Works

The H<sub>2</sub>S stream obtained as distillate can be further flashed and sent to Claus process for desulfurization. The methanol bottom product can be passed to dehydration column to obtain anhydrous methanol for circulation. The dynamic nature of the columns can be explored by using the controllers in Chemsep columns.

## E. Reference

Adapted from Fig. 4. of Sun L. and Smith R., Rectisol wash process simulation and analysis, Journal of cleaner production. 39 (2013) 321- 328. <http://dx.doi.org/10.1016/j.jclepro.2012.05.049> .