Hydrogenation of Carbon Dioxide to Produce Methanol

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Background

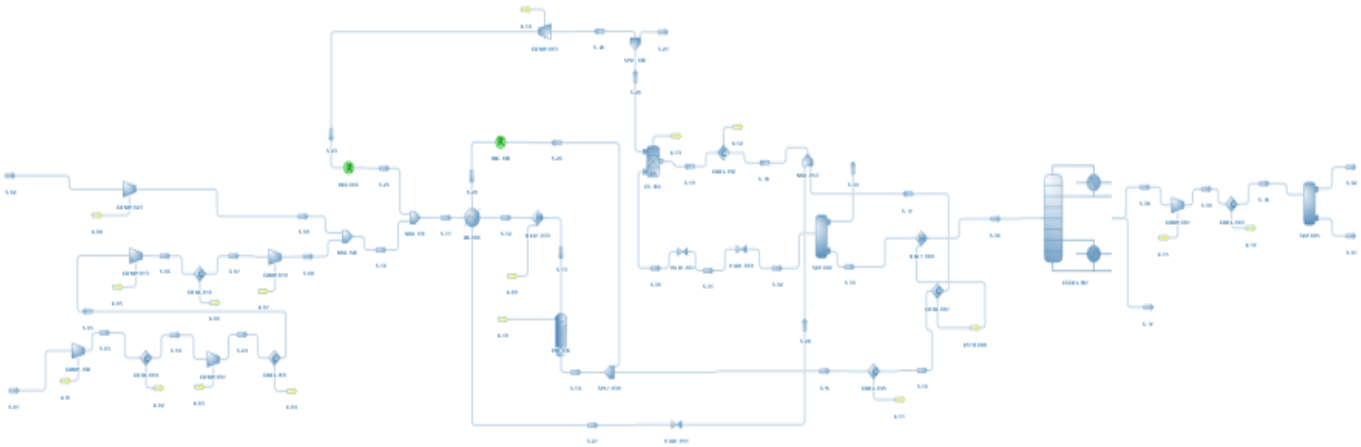
Carbon dioxide emissions, due to human activities related to the manufacture of products and obtaining energy have increased considerably in last years. This is a consequence of the high dependence on the use of fossil fuels to obtain energy for the development of industrial processes.

As a measure to mitigate carbon dioxide emissions, capture and storage, chemical treatment and treatment with sea algae have been carried out. Chemical treatment is the preferred proposal since chemicals products can be obtained. Hydrogenation of carbon dioxide is a type of chemical treatment, in which carbon dioxide reacts with hydrogen gas at temperatures above 200 ºC and with pressures above 50 bar, using catalysts based on transition metals such as Cu / ZnO / Al2O3 or Cu / AlCeO. The products obtained from this process are low molecular weight fuels and chemical products like Methanol.

Flowsheet Description

CO_2 and H_2 are compressed from 1 to 78 Bar, after that the two streams are mixed in Mix-031 and re-mixed with the recycle non converted gases. The resulting stream is preheated and then heated to 210 ºC and it is feeded to adiabatic plug flow reactor, the products that leave reactor are divided in two streams. The first one contain 60 % of reactor outlet stream and it is used to preheat the feed stream. The second one is cooled to 156 ºC, after that it is cooled to 79 ºC in a second cooler, the energy of this is used to heat distillation column feed. The two streams are mixed and then cooled, after that water and methanol are separated from non-converted gases in CS-066, 1% of them gases are purged before they return to reactor inlet.

The bottom product of CS-066 is expanded to 1.2 Bar in two valves, then residual non converted gases are separated in SEP-086, the liquid product is heated and then feeded to a distillation column, where methanol is purified and comes out of the column at vapor phase and water comes out at bottom stream (S-37). Purified methanol is compressed to 1.2 Bar and cooled to 40 ºC, it is separated in SEP-085, non-converted gases with some water comes out at top stream and methanol comes out at bottom stream (S-41).



Plant of Hydrogenation of Carbon Dioxide to Produce Methanol

Results

Object	S-42	S-41	S-37	S-34	S-21	S-02	S-01	
Temperature	41.825	47.0433	102.302	34.2824	35	25	25	C
Pressure	1.2	1.2	1.1	1.2	73.7274	30	1.01325	bar
Mass Flow	0.86634	59266	33862.2	6952.37	2146.95	12100	88000	kg/h
Mass Flow (Mixture) / Methanol	0.40968	59262	0.0792139	1680.9	8.02699	0	0	kg/h
Mass Flow (Mixture) / Water	9.59678E-06	3.76566	33862.1	211.209	4.48837	0	0	kg/h
Mass Flow (Mixture) / Carbon dioxide	0.395328	0.180801	2.50863E-16	4317.92	916.481	0	88000	kg/h
Mass Flow (Mixture) / Carbon monoxide	0.0190659	0.00871971	5.18205E-15	259.483	256.916	0	0	kg/h
Mass Flow (Mixture) / Hydrogen	0.0422565	0.0279711	1.59823E-17	482.861	961.034	12100	0	kg/h

Reference

VAN-DAL, É.S. y BOUALLOU, C., 2013. Design and simulation of a methanol production plant from CO 2 hydrogenation. *Journal of Cleaner Production* [en línea], vol. 57, pp. 38-45. ISSN 0959-6526. DOI 10.1016/j.jclepro.2013.06.008. Disponible en: http://dx.doi.org/10.1016/j.jclepro.2013.06.008.