Industrial Spent Caustic Wastewater Treatment by Wet Oxidation Method

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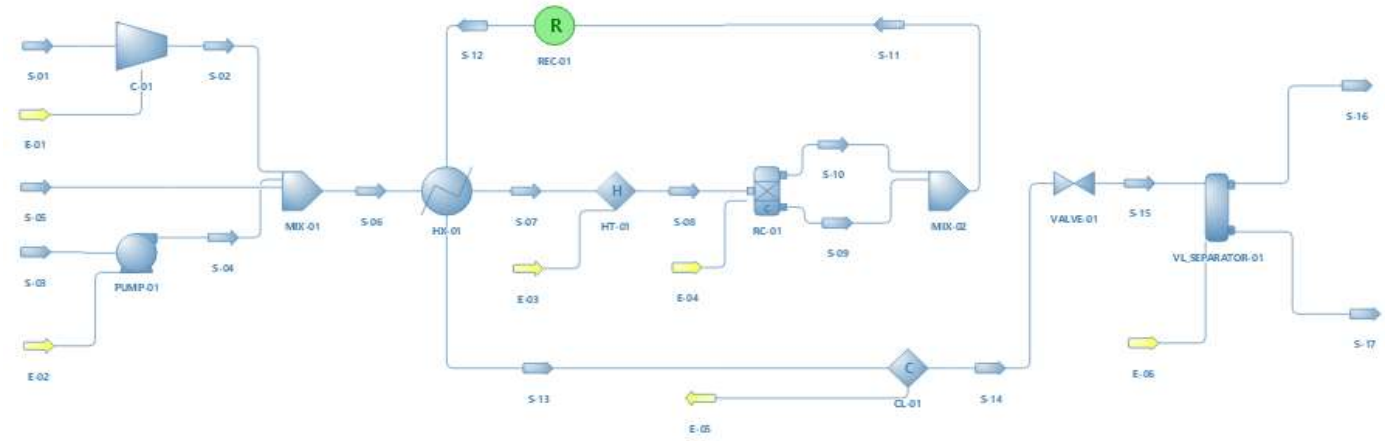
Background and Description

Industrial wastewater includes hazardous and toxic chemicals along with the heavy metals like sulphur, zinc, copper, iron, cadmium and manganese. Most commonly, NaOH (Sodium Hydroxide - Caustic) is used in petroleum and petrochemical refineries for the elimination of acid components like hydrogen sulphide (H_2S), cresylic acids, mercaptans and naphthenic acids from the subtle product streams. When sodium hydroxide is used to treat the above components then the resultant waste is defined as Spent Caustic. Wet Air Oxidation (WAO) method is one of the common methods used for treatment of Spent Caustic. During the conversion of NaHS (Sodium Hydrosulphide), Na_2SO_4 is the product by WAO method. Similarly, CH_3SSCH_3 (Dimethyl Disulphide) is product formed from conversion of mercaptans by WAO method. Increase flow rate of this compound is desired as it is less harmful than mercaptans.

$$NaHS + NaOH + 2O_2 \rightarrow Na_2SO_4 + H2O$$

$$4CH_3SH + O_2 \rightarrow 2CH_3\,SSCH_3 + 2H_2O$$

WAO is the oxidation of suspended compounds in aqueous environment using 21% oxygen in air. During the flowsheet, oxygen is taken as 21% whereas 79% is taken as nitrogen. Initial feed streams (S-05, S-01 and S-03) contains Oxygen, Sodium Hydroxide and Sodium Hydrosulphide respectively. Their total mass flow becomes 13.7064 kg/sec. Oxidation reaction happens at the temperature of 593 K. Pump (Pump-01) is used to raise the pressure of spent caustic feed whereas compressor to increase pressure of oxygen. After, both are mixed in a mixer (Mix-01) before the heat exchanger. The pressure remains same where as temperature is increased. After this, the operating temperature and pressure, are set depending upon the compounds, in spent caustic feed. Oxidation reaction where, reactants in spent caustic and oxygen lead the production of simpler forms of products. The separator operates at lower pressure; thus, the high-pressure effluent is reduced to low pressure using the control valve. Thus, liquid effluents which consist of several components is partially vapourised at certain temperature and pressure. The vapour is taken off from the top as the off-gas stream, while, liquid comes from the bottom goes in the treated effluent stream where it will be treated.



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Results

Master Property Table									
Object	S-17	S-16	S-15	S-14	S-11	S-05	S-03	S-01	
Temperature	369.226	369.226	369.225	400	593	298.15	298.15	298	K
Pressure	191190	191190	191190	1.19119E+06	1.19119E+06	911130	101325	101325	Pa
Mass Flow	5.44795	8.2585	13.7064	13.7064	13.7064	3.9997	4.81075	4.896	kg/s
Molar Flow	145.819	242.11	387.928	387.928	387.928	100	112.994	165.416	mol/s
Volumetric Flow	0.0146472	3.88731	3.90195	0.638227	1.1182	0.0110448	1.81277	4.0447	m3/s
Mixture Density	371.944	2.12448	3.51271	21.4758	12.2576	362.134	2.6538	1.21047	kg/m3
Mixture Molar Weight	37.3611	34.1105	35.3324	35.3324	35.3324	39.997	42.5751	29.5981	kg/kmol

References

S Chandraseagar, A H Abdulrazik, S N Abdulrahman and M A Abdaziz, (2019), “Aspen Plus simulation and optimization of industrial spent caustic wastewater treatment by wet oxidation method”, IOP Conf. Series: Materials Science and Engineering, 702, 2-7, doi:10.1088/1757-899X/702/1/012011