Study of VOC removal from contaminated air by compression and cooling using DWSIM Process Simulator

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VOC removal of exit air from a contaminated process stream plays a key role in industrial safety, economics and environmental norms as per Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA). There are several methods available for purification such as cryogenic distillation, membrane Pressure Swing Adsorption (PSA), Vacuum Pressure Swing Adsorption (VPSA) etc [1]. Compression and natural draft air cooling method [2] are also common to remove the VOC from contaminated air. The present study deals with a range of chemicals of different boiling point mixed with humid air and generate data for the out let air purity and quantity of VOC removed by compression. The Air and VOC mixture is first compressed from ambient conditions isothermally and collected in a pressure vessel with automatic liquid drain and finally passed through a natural draft air cooling system to lower the gas mixture temperature back to nearly ambient temperature and condense the volatile impurity. The gas next passes through a constant-pressure bulk liquid separator in which the liquid phase is separated by gravity and the one of the outgoing high pressure steam contains nearly pure air while the other with concentrated liquid phase which is discharged through automatic drain valve. Now inlet air is carrying moisture and VOC with specific ratio and the objective is to generate pressurized air free from moisture and maximum possible removal of VOC.

Peng Robinson EOS has been utilized to define the gas liquid phase equilibrium for air mixture [3]. Three chemical impurities such as Benzene, toluene and methyl salicylate is considered to be mixed in humid air (RH 55% and VOC 5000 ppm) at atmospheric condition and the system need to deliver purified air mixture at 10 atm pressure. Sensitivity analysis done to visualize the effect of change in total liquid removal with various process conditions like pressure of compression , molar flow rate and cooling load on three chemicals. Results obtained for % VOC removal with various chemicals, flow rate, cooling rate and compressor pressure. It is found that there is a general correlation between operating condition process parameter and dew point of the exit air mixed with several VOC' s also critical temperature and pressure governs the phase envelop.

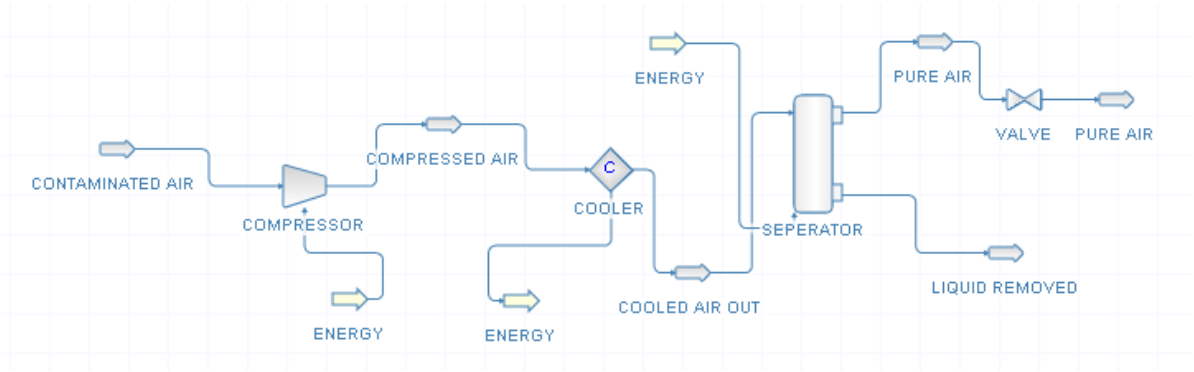

Fig.1: Flow chart for process Simulation

References:

1. Trougott, H.K., Yuan, S.W.K.," Cryogenics-Low Temperature Engineering and Applied Science" , 1986
2. David M. Himmelblau , James B. Riggs ; " Basic Principles and Calculations in Chemical Engineering (Eighth Edition)",2018.
3. Elke Goosa1, Uwe Riedela, Li Zhaob, Ludger Blumb, " Phase diagrams of CO2 and CO2 -N2 gas mixtures and their application in compression processes" Energy Procedia 4 (2011) 3778–3785.