Process Development for Production of 900 TPD of Phthalic Anhydride (PAN) by oxidation of O-Xylene

Achanta Srinivasa Kalyan, P. R. Naren*

School of Chemical and Biotechnology, SASTRA Deemed to be University

Email ID: asrinivasakalyan2001@gmail.com , prnaren@scbt.sastra.ac.in *

Background:

Phthalic anhydride (PAN), an anhydride of phthalic acid, is in a lustrous white colour solid state and is in the form of needles with a mild distinctive odour. Its molecular formula is $C_8H_4O_3$ and its IUPAC name is 2-Benzofuran-1,3-dione. Its CAS No. is 85-44-9. PAN is used as a precursor to manufacture plasticizers, alkyd resins, polyester resins, dyes, and pigments.

Process Settings:

System of units: C5

Special components used: Phthalic Anhydride, created using Component Creator using data from Chemeo

Process description:

The raw reactants oxygen and o-xylene at 25 ℃ are mixed using a mixer (MIX-1) and are preheated and introduced to a conversion reactor (RCONV-1) which is operated at 80% conversion at 350 ℃, since the reaction is exothermic, the produced heat is used to preheat the reactants. The reactor outlet consists of PAN, water, oxygen and o-xylene at 350 ℃ are cooled to 154℃ to condense PAN and a vapor-liquid separator (V-1) is used to separate PAN, and the exit stream pressure is reduced to 0.2 bar to evaporate the excess water at reduced pressure and separate using vapor-liquid separator (V-2) and the stream is pumped to atmospheric pressure. This exit stream (S16) of Pump 1 contains a very negligible amounts of oxygen (2.15E-12 mol%) and water (3.19E-3 mol%) and is removed using component separator (CS-1) and is cooled to room temperature using the cooler (CL-2). The final stream S19 contains PAN with 99.6 wt% purity with 37565.36 kg/h (~901.5 TPD).

Result:

The final product Phthalic Anhydride is produced in stream S19 with a purity of 99.6 wt% in liquid state at 25 ℃ at a rate of 901.5 TPD. The key stream details are mentioned in Table 1.

Table 1: Stream results for key streams involved in the process from the flowsheet developed using DWSIM

	S01	S02	S05	S07	S09	S10	S17
Temperature (°C)	25	25	350	154.814	154.814	136.5477	185.0355
Pressure (bar)	1.0133	1.0133	1.0133	1.0133	1.0133	0.2	1.0133
Mass Flow (kg/h)	36382.64	40236.54	76619.17	76619.17	41191.20	41191.20	37716.23
Molar Flow (kmol/h)	1,137.00	379	1,516.00	1,516.00	318.3894	318.3894	254.9843
Molar Fraction (Mixture) / O-xylene	0	1	0.05	0.0558	0	0.0764	0.1291
Molar Fraction (Mixture) / Oxygen	1	0	0.15	0.15	0	0	0
Molar Fraction (Mixture) / Phthalic anhydride	0	0	0.2	0.2	0.8425	0.8425	0.9952
Molar Fraction (Mixture) / Water	0	0	0.6	0.6	0.1377	0.1377	0

Further Works:

Recycling of unreacted streams can be implemented, P&ID can be included, comparing with packed distillation column can be done using custom model designing, Phthalic Anhydride can be crystallized and separated to get in the solid state.

Reference:

Lorz PM., Ullmann's Encyclopedia of Industrial Chemistry, volume 27, 2007, 132-180.

Jara, J. A. and A. Garea, 2005. Simulation of O-Xylene Oxidation into Phthalic Anhydride: Rigorous Multitubular Catalytic Reactor Modelling and Exportation into the Process Flowsheet.

Sinnott, R. K., Coulson and Richardson's Chemical Engineering, Elsevier Butterworth-Heineimann, USA, 2005