Aspirin Production

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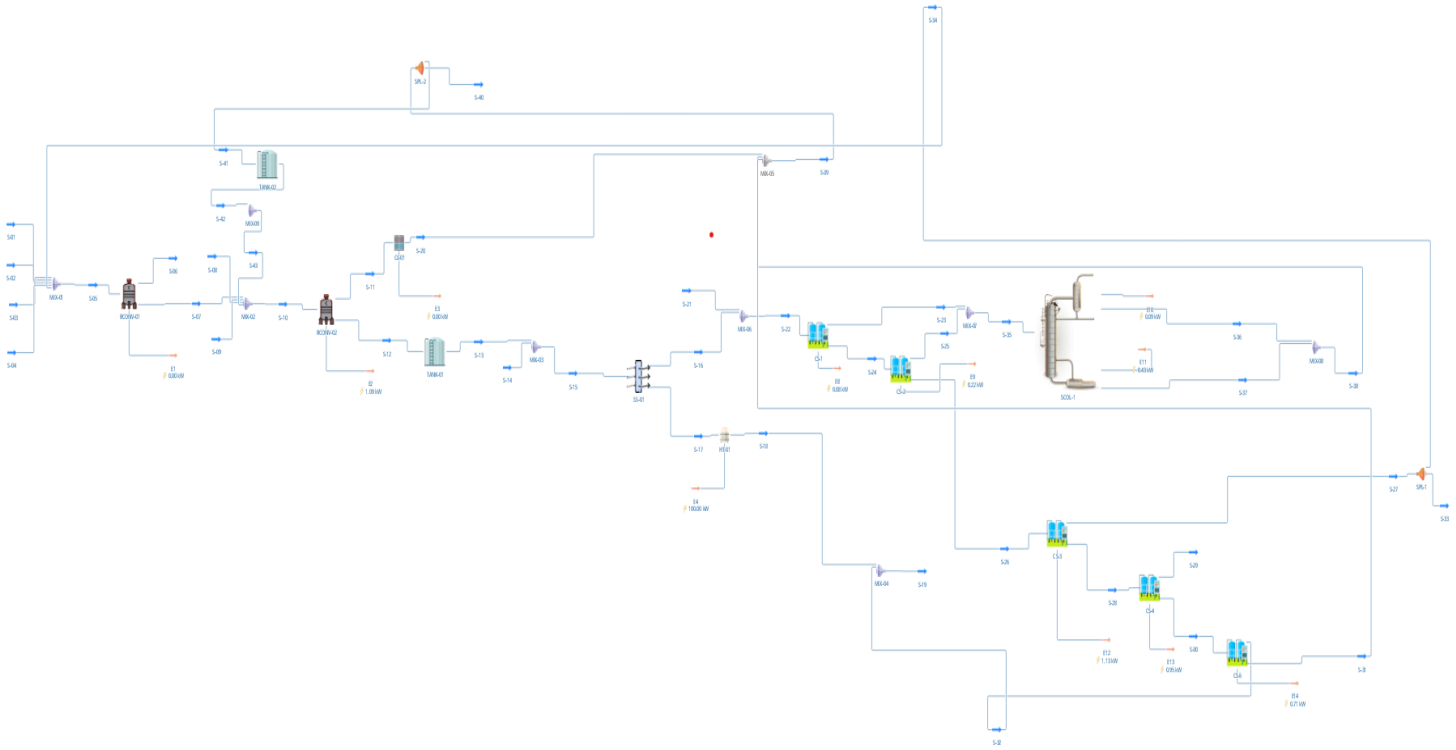
Background:

Acetylsalicylic acid, commonly known as aspirin, is a pivotal therapeutic agent in modern medicine, offering a broad spectrum of clinical applications. Its therapeutic properties, including analgesic, anti-inflammatory, antipyretic, and antiplatelet effects, have been extensively documented. The production of aspirin is classified as an esterification reaction. When salicylic acid reacts with acetic anhydride, the hydroxyl group of salicylic acid is transformed into an ester group, resulting in the formation of aspirin. Additionally, acetic acid is produced as a byproduct during this reaction. Typically, a catalyst such as sulfuric acid or phosphoric acid is utilized in small quantities, while the use of an organic diluent, such as acetic acid, xylene, or toluene, is not necessary but it enhances the overall process.

Flowsheet Description:

The acetylsalicylic acid production process assumes the use of high-purity salicylic acid and acetic anhydride while utilizing acetic acid as a diluent to improve the rheological properties of the reaction mixture and phosphoric acid as the esterification catalyst. The longest step in the process takes 6.35 hours. Acetylsalicylic acid formation and acetic acid hydrolysis occur in RCONV-01. Ethanol acetylation and Ethyl acetate formation occur in RCONV-02. Adding solvents and agitation triggers the complete dissolution of Aspirin (crystalline form), converting it into Acetylsalicylic Acid (dissolved form). The addition of the antisolvent (water), along with the reduced temperature, gradually decreases the solubility of the acetylsalicylic acid in the solution, causing crystals to form and precipitate. The final product is obtained after drying. The rest of the solvents are recycled after removal of excess water.

Flowsheet:



Thermodynamic Package: Peng-Robinson / Lee-Kesler (PR/LK)

Results:

Object	S-01	S-02	S-03	S-04	S-07	S-08	S-09	S-14	S-19	Units
Temperature	298.15	298.15	298.15	298.15	263.689	298.15	298.15	298.15	321.579	K
Pressure	101325	101325	101325	101325	101325	101325	101325	101325	1325	Pa
Mass flow	0.0356	0.04068	0.00109	0.00131	0.07868	0.0196	0.1441	0.0737	0.046763	Kg/s
Molar flow	0.257746	0.398477	0.018151	0.013356	0.68773	0.425454	7.99877	4.09097	1.81086	Mol/s
Molar Enthalpy (Mixture)	-8 5709.3	-58285	-4 7096.7	-109639	-7 4459.6	-4 4007.7	-4 7394.7	-4 7394.7	-3041.78	KJ/ Kmol

CL-01	Volume	1	m3
CL-01	Efficiency	100	
CL-01	Outlet Temperature	296.59	K

SCOL-1	Reflux Ratio	1.5	
SS-01	Solids Separation Efficiency	74	%
SS-01	Liquids Separation Efficiency	86	%

CS-1	Energy Balance	0.079286	kW
CS-2	Energy Balance	0.221477	kW
CS-3	Energy Balance	1.12574	kW
CS-4	Energy Balance	0.952001	kW
CS-5	Energy Balance	0.710086	kW

HT-01	Volume	1	m3
HT-01	Pressure Drop	100000	Pa
HT-01	Efficiency	90	
HT-01	Outlet Temperature	362.884	K
HT-01	Heat Added	100	kW

Conclusion:

The obtained mass flow rate of the product without recycle (S-18) is 975.89 kg/batch of aspirin whereas the reference value obtained was 971.01 kg/batch of aspirin. The obtained value is almost the same as the reference value. To further improve separation, we have added (S-32) from CS-5 to the previously isolated stream (S-18) using a mixer so that residual aspirin obtained from the other stream in the solid separator (S-16) is recycled. The mass flow rate in (S-19) after recycling is found to be 1067.562 kg/batch which is a 9.4% increase from original value.

Reference:

Kontovas, Stoilas Stylianos & Misailidis, Nikiforos & Mustafa, Amir & Petrides, Demetri. (2023). Aspirin Production – Process Modeling and Techno-Economic Assessment (TEA) using SuperPro Designer.. 10.13140/RG.2.2.25475.68649.