Energy Efficient Hybrid Separation Processes

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Abstract:

Acetic acid is the second simplest carboxylic acid (after formic acid). It consists of a methyl group attached to a carboxyl group. It is an important chemical reagent and industrial chemical, used primarily in the production of cellulose acetate for photographic film, polyvinyl acetate for wood glue, and synthetic fibers and fabrics. In households, diluted acetic acid is often used in descaling agents. In the food industry, acetic acid is controlled by the food additive code E260 as an acidity regulator and as a condiment. In biochemistry, the acetyl group, derived from acetic acid, is fundamental to all forms of life. In this flow sheet the final product Pure Acetic acid which is produced by methods of Energy Efficient Hybrid Separations of Acetic acid and water using ethyl acetate as a solvent.

Hybrid Separations utilize distillations, extraction, absorptions and other concepts. These methods increase the efficiency with reducing costs of production. They also help in saving energy by reducing its consumption. Therefore, this method is becoming widely known and is being used for manufacturing several chemicals of industrial importance.

Process Description:

First the acid water feed is fed into the extractive distillation column at a temperature of 298.15K and 101325 Pa pressure. Solvent recycled from the Decanter is also added to this column. At the end of this process we have an Extract and Raffinate.

The Extract is sent to the acid recovery column to produce a top product and an acid product. The acid product is removed and the top product is cooled using a cooler to 298.15K This mixture is then sent to a decantation unit.

The Raffinate is sent to the mixer where water from the decanter is mixed and it goes to solvent recovery unit in which steam is also added at 373.15K and 101325 Pa pressure. The top product is sent to a cooler which after cooling is sent to the decantation unit.

Therefore, there are two feeds coming into the decantation unit. Both cooled to 298.15K. After Decantation takes place, the bottom product which is water is send to mixer for further use in the solvent recovery unit and the top product is sent to a mixer where make up ethyl acetate is added. This mixture is recycled back to the first distillation column and enters the distillation column with the acid water feed.

The molar flow rate of acetic acid, ethyl acetate and water is shown in the Results table below.

Therefore, high purity acetic acid is obtained by Hybrid Separation Processes which are energy efficient, considerably reducing costs.

Results:

Master Property Table												
Object	Water	To treatment	Steam	Solvent	Recycle	Recovery Feed	Raffinate	MakeUp EA	Extract	Acid Water Feed	Acid Product	
Temperature	298.15	371.33064	373.15	298.15	298.15	298.15	298.15	298.15	298.15	298.15	389.12791	K
Pressure	101325	101325	101325	101325	101325	101325	101325	101325	101325	101325	101325	Pa
Molar Flow (Mixture) / Water	12.974835	49.521113	1.0203305	9.7506311	9.7506311	49.520409	36.545574	0	22.130743	48.939905	0.42485989	mol/s
Molar Flow (Mixture) / Ethyl acetate	0.16856761	8.9071202E-17	0	40.74806	40.622062	0.64370629	0.47513868	0.12599789	40.146567	0	1.6054989E-19	mol/s
Molar Flow (Mixture) / Acetic acid	0.13119753	0.48934463	0	1.2465599	1.2465599	0.50213275	0.37093522	0	7.2399683	6.3594226	5.8750301	mol/s

References:

1. http://www.chemsep.com/downloads/data/AAEAcW_Energy_Efficient_Hybrid_Separation.png
2. Lucia, Angelo, et al. “Energy Efficient Hybrid Separation Processes.” *Industrial & Engineering Chemistry Research*, vol. 45, no. 25, 2006, pp. 8319–8328., doi:10.1021/ie060035t