Glucose Syrup three-effect evaporation system

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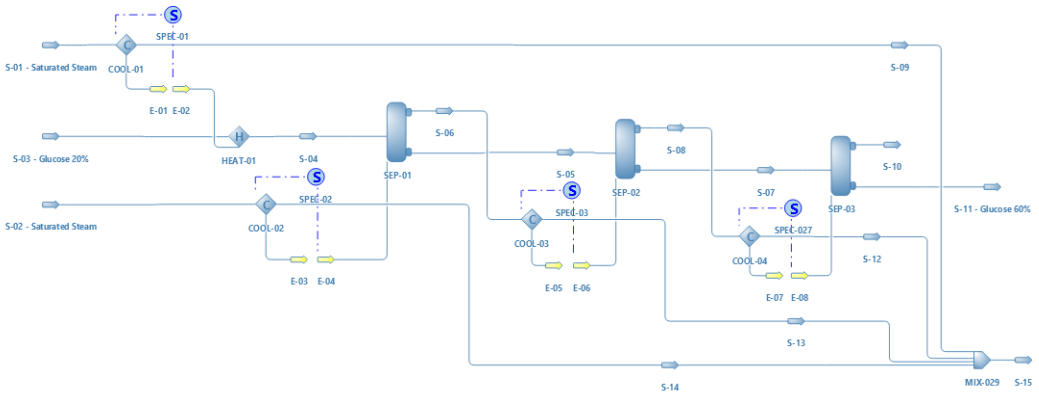
1. Background & Description

According to (McCabe, Smith, & Harriott, 2005) evaporation is the operation where we concentrate a solution by eliminating the solvent through boiling. The purpose of evaporation is to concentrate a solution of a non-volatile solute and a volatile solvent. Industrially, the steam from one of the evaporators is used in the heating element of a second evaporator, in order to reduce the total energy consumption. When using a series of evaporators, the process is called multiple effect evaporation.

The present study presents a process of concentrating a 20% dry solid glucose syrup, obtained through an enzymatic conversion process. The syrup is concentrated in a three-effect evaporation system, in order to obtain a final concentration of 60% dry solid. (Singh & Heldman, 2013)

Initially the 20% glucose stream is heated to 100ºC through a heat exchanger and fed to the first evaporator. This heating aims to reduce the total heat exchange area of the evaporator, equipment with a higher cost than a plate heat exchanger. The heating of this stream, as well as the first evaporation stage, is carried out with saturated steam at 3 bar.

2. Flowsheet



3. Results

	S-03 - Glucose 20%	S-04	S-05	S-07	S-11 - Glucose 60%	Units
Mass Flow	0,2778	0,2778	0,2160	0,1543	0,0926	kg/s
Glucose Mass Fraction	0,2000	0,2000	0,2572	0,3600	0,5999	
Temperature	298,15	373,15	374,09	363,15	353,15	K
Pressure	101325	101325	101325	66452	41254	Pa

Figure 1 - Glucose concentration (% Dry Solids) obtained in the evaporator currents

	Evaporator 1	Evaporator 2	Evaporator 3	Units
Pressure	101325	66452	41254	Pa
Temperature	374,09	363,15	353,15	K

Figure 2 - Evaporators operating pressure and temperatures

4. Conclusion and Recommendations

The DWSIM software proved to be highly efficient in the calculation of multiple effect evaporation systems, being easy to use and obtaining results compatible with those presented in the literature.

It's highly recommended to perform a simulation in advance containing only the mass balance in the evaporators in order to calculate the concentration of solids present in the outputs of each of the three evaporators.

The pressure and operating temperature of the evaporators is obtained by calculating the vapor pressure of the glucose stream, taking into account a temperature gradient of 10ºC between the heating steam and the boiling temperature of each stage.

5. Bibliography

McCabe, W. L. (Warren L., Smith, J. C. (Julian C., & Harriott, P. (2005). *Unit operations of chemical engineering*. McGraw-Hill.

Singh, R. P., & Heldman, D. R. (2013). *Introduction to Food Engineering.* Academic Press [Imprint].