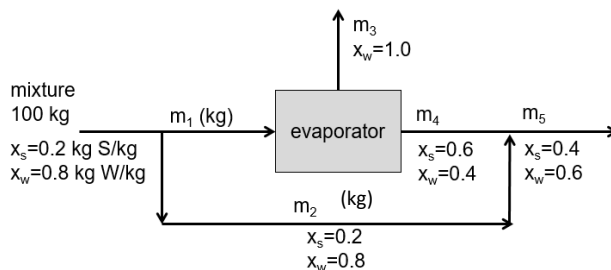


ECHE 260: Intro to Chemical Systems Homework #2B

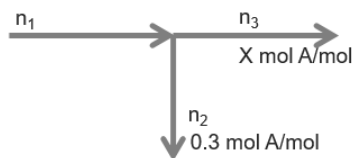
Homework is due as a single PDF submitted to Canvas by 2:15PM on the due date. There is no excel component to this HW assignment.

Conceptual Questions and Short Answers (7 points)

1. (4 points) Which balance would result in zero degrees of freedom?



- a. Evaporator
 - b. Overall
 - c. Splitting point
 - d. Mixing point
2. (3 points) The mole percent of A in stream 3 is _____ the mole percent of A in stream 1.
- a. Greater than
 - b. Less than
 - c. Equal to



Quantitative Problems

3. **(20 points) Erin Brockovich and hexavalent chromium.** Natural gas is a common heating source for residential and commercial buildings. At a natural gas production facility, hexavalent chromium was added to cooling water in a natural gas compression station to inhibit corrosion in the pipes. The water contained 5.15wt% hexavalent chromium and was discharged from the plant as a waste stream. The waste stream is fed to a treatment unit which rejects some of the Cr. The rejected Cr and water are called the retentate. The retentate is recycled back the compression plant. 95% of the Cr fed to the treatment plant is rejected. The permeate (residual liquid stream leaving the treatment unit) is sent to a waste lagoon. The treatment unit has a maximum capacity of 4500 kg wastewater/hour. If the wastewater leaves the compression station at a rate higher than the capacity, the excess wastewater bypasses the reverse osmosis treatment unit and combines with the permeate leaving the treatment unit before going to the waste lagoon. If the wastewater leaves the compression plant at 6000 kg/hr, what is the mass flow rate of the stream entering the lagoon? What is the mass fraction of hexavalent chromium of the stream entering the lagoon?
- a. (15 points) Using the general procedure from class, determine if this problem is solvable. If yes, state why but do not solve any equations. If no, state why and indicate what information is missing. Be sure to clearly define the naming convention for the streams.
 - b. (5 points) Why is it necessary to treat the wastewater before sending it to the lagoon? In the US, what regulatory agency would set the maximum contaminant limits for industrial emissions? For additional information, read about the work of Erin Brockovich, an

environmental activist and paralegal, who was portrayed in the 2000 academy award winning film starring Julia Roberts.

4. **(20 points) Soybean Oil Production.** Soybean oil is one of the most widely used vegetable oils in the world and is valued for its versatility in cooking, food processing, and as a source of essential fatty acids. Soybean oil is extracted from soybeans in a multistep chemical engineering process.

In the production of soybean oil, soybeans containing 90% solids and 10% oil are ground and fed to a stirred tank (extractor) along with a recycled stream of solvent. The feed ratio is 3 kg of fresh solvent per kg of beans. The ground beans are suspended in the liquid solvent and all the oil from the crushed beans is extracted and transferred to the solvent. The extractor effluent contains residual solids and the oil/solvent mixture. The effluent is fed to a filter to separate the solids from the liquids. The filter cake contains 75wt% bean solids and the balance is the liquid mixture. The bean oil and the solvent are in the same ratio as they were entering the filter. The filter cake is discarded as waste. The liquid filtrate is fed to an evaporator which vaporizes the solvent and leaves the soybean oil as a liquid. The final soybean oil product is packaged in drums and shipped to customers. The evaporated solvent passes through a total condenser which liquefies all the solvent then it is recycled to the extractor.

What is the yield of soybean oil (kg soybean oil per kg of beans fed)? What is the recycle ratio of the solvent (kg solvent recycled/kg solvent fresh feed)?

Using the general procedure from class, determine if this problem is solvable. If yes, state why but do not solve any equations. If no, state why and indicate what information is missing. Be sure to clearly define the naming convention for the streams.

Reflection

1. (3 points) We have now concluded units 1 & 2 on unit conversions, dimensional homogeneity and the general procedure for nonreactive single- and multi-unit processes with recycle and bypass.
 - a. Is there anything about the content that you still find confusing?
 - b. What (if anything) about the class is prohibiting your learning?
 - c. What (if anything) about the class is helping your learning?