**ENGR 121 Homework 14**

**NOTE:** Use engineering format for problems 1-3, and use non-engineering format for problems 4-6. This is an individual assignment.

1. Assume that a cylindrical tank with an internal diameter of 3cm and a water depth of 4cm contains salt water with a concentration of 0.10% NaCl by weight. You would like to add the correct amount of 1% NaCl to bring the concentration to 0.15% NaCl. However, when you add a certain mass of salt water, an equal mass of water leaves the system through an overflow. If 20% of the overflow is 1% NaCl and the rest is 0.10% NaCl, then what is the amount of 1% NaCl salt water that you should add to your system? m=1.96g

**Given: h=4cm, d=3cm, NaCl%=0.10%**

**Request: 1% Salt water mass**

**Solution: V=pid^2h/4=3.14\*(3cm)^2\*4cm/4=28.26cm^3**

**28.26cm^3 \* g/cm^3 = 28.26 g**

**IN: 28.26 g 0.1% sw, Xg 1% sw**

**OUT: Y g 0.15% sw, X \* 0.2 g 1% sw, X \* 0.8 g 0.1% sw**

**28.26(0.001) + X(0.01) = Y(0.0015) + (0.2X\*0.01) + (0.8X\*0.0001)**

**0.02826 + 0.01X = 0.00155Y + 0.002X + 0.0008X**

**0.02826 + 0.0072X = 0.0015Y**

**Y = 18.85 + 4.8X**

**28.26g + X = Y + X**

**28.26g = Y**

**28.26g = 18.85g + 4.8X**

**9.4248g = 4.8X**

**X = 1.96g**

**Discussion: I set the total of the mass in to the total of the mass out, made a relationship between the unknown mass and the outgoing mass, substituted that relationship in the equation of the system, and then solved for the unknown.**

1. Maple syrup, consisting of 34% water and 66% sugar by weight, is created by boiling sap (97% water and 3% sugar) to force water in the sap to evaporate. If the bottling plant can process 1500 kg of sap per hour, how much water must be evaporated per hour, and how much syrup will result?

water=1431.8kg/hr & syrup=68.2kg/hr

**Given: Syrup:**

**34% Water**

**66% Sugar**

**Sap:**

**97% Water**

**3% Sugar**

**Request: Rate of loss of water kg/hr, mass of syrup/hr**

**Solution: IN: 1500 kg Sap/hr**

**OUT: X hg/hr Syrup, Y kg/hr water**

**Water:**

**1500kg/hr = Y + X**

**0.97(1500kg/hr) = Y + 0.34X**

**1450 kg/hr = Y + 0.34X**

**Sugar:**

**.03(1500kg/hr) = 0.66X**

**45kg/hr = 0.66X**

**Syrup rate:**

**(45kg/hr)/0.66 = X**

**68.182 kg/hr = X**

**Evaporation rate:**

**1500 kg/hr = y + 68.182 kg/hr**

**(1500 – 68.182)kg/hr = Y**

**1431.82 kg/hr = Y**

**Discussion: I set the mass of incoming elements to the mass of outgoing elements. I used ratios in water and sugar content to derive first the mass per hour of syrup produced, then subtracted the mass of the syrup from the incoming mass to get the remaining mass of the water leaving the system.**

1. An industrial engineer at a paper plant oversees the paper making process. She is currently conducting an efficiency analysis on the dryer section of the process. The paper entering the dryer contains 70% water (by weight), and the finished paper that leaves the dryer section contains 5% water. If 1200 lbs/min of water is removed through evaporation in the dryer section, find
   1. the rate (lbs/min) that finished paper is wound up on the take-up reel (next phase of the paper making process). 1753.8lb/min
   2. the rate (lbs/min) that paper is entering the dryer 553.8lb/min

**##########THESE ANSWERS ARE BACKWARDS**

**##########IF THE PAPER LOSES WATER DURING THE BATCHING, THE MASS OF THE OUTPUT WILL BE LOWER THAN THE MASS OF THE INPUT##############**

**Given:**

**IN:**

**X lbs paper/min**

**70% Water**

**OUT:**

**Y lbs finished paper/min**

**5% Water**

**1200 lbs Water/min**

**Request: lbs finished paper / min, lbs wet paper / min**

**Solution:**

**X = Y + 1200 lbs/min**

**Using given water ratios:**

**0.7X = 0.05Y + 1200 lbs/min**

**0.7(Y + 1200lbs/min) = 0.05Y + 1200 lbs/min**

**0.7Y + 840lbs/min = 0.05Y + 1200 lbs/min**

**0.7Y – 0.05Y = (1200 – 840) lbs/min**

**0.65Y = 360 lbs/min**

**Y = (360 lbs/min) / 0.65**

**Y = 553.846153 lbs/min (FINISHED PAPER)**

**X = Y + 1200 lbs/min = (553.846153 + 1200) lbs/min**

**X = 1753.646153 lbs/min (WET PAPER)**

**Discussion: Set rate of incoming material to rate of outgoing material. Used ratios of water in inputs and outputs to relate the two by the amount of water in them, and substituted the rate of inputs with respect to water with the rate of outputs in the system since they are equivalent, and found the rate of outcoming dry paper. I then added the rate of the dry paper to the rate of the water lost to evaporation to get the original rate of wet paper.**

1. Work with your group to finish the salinity control program from class. Each individual should include the sketch and a screen shot of the serial monitor, printing out when you are entering and leaving various functions as well as all variables and calculated values. Be sure to identify variables as they are printed. Bring your working system to class.

1. Print out the final system evaluation form on the downloads page under Class 14. Fill out the first page of information for your fishtank system. You do not have to fill out the sections on deadtime compensation and gain (we will discuss these next class).

1. Using the Internet and any other sources, learn about the world’s supply of non-renewable energy (oil, gas, coal, other). Consider implications of your findings on environmental sustainability, quality of life, the economy and the engineering profession. Write a paragraph in your own words describing what you have learned; be thinking about how the topic of energy could impact your career. We expect you to spend about half an hour completing this problem; this is not meant to be an exhaustive study of the topic.

Non-renewable energy is energy garnered from sources that do not replenish themselves as quickly as they are consumed. The primary ingredient in modern sources of non-renewable energy is Carbon. Whenever these resources are consumed, the carbon bonds in the material decompose and the carbon is released into the atmosphere with a handful of other gasses as molecular carbon or carbon dioxide. These gasses are great insulators and therefore apply a strong greenhouse affect upon our atmosphere, causing the global temperatures to rise over time. This could lead to major environmental concerns in the future, and raises the opportunity in the present for engineers to apply their problem-solving skills to search for solutions to this looming threat or viable and cost-effective clean alternatives to current non-renewable energy sources.