Chem 2990 Refractive Index: Assigned Problems Dr. Walker

1. A person brings you a liquid sample of alcohol mixed in water. He is not sure whether the alcohol is ethanol or methanol. Can you use refractive index to identify the type of alcohol? Is it possible to give a good estimate of the alcohol concentration? If so, what value would you estimate if n_D^{20}= 1.3407 for the mixture?

2. Out in the factory, a technician is not sure if she added enough water to the current batch of orange juice. She started with 6,000 pounds of 5x concentrate and is not sure how much water she added. She doesn't want to ruin the batch, so she asks for your help in testing the juice. You quickly pull out your pocket-sized, hand-held refractometer and test the juice, getting reading of 26.10°Bx. Referring to the U.S. Customs table in the lab, tell her how many pounds of water she added and how much more she should add. The specification for the final juice should be for "undiluted juice" in the same table. Assuming the diluted (1x) orange juice has a density similar to water ($\sigma \approx$ 8.75 lb/gal or 1.048 g/cm^3), what is the minimum tank size needed for this batch?

3. A railroad tanker has just rolled up the dock and is ready to deliver 255,000 pounds of high-fructose corn syrup (HFCS) for your beverage bottling operation. The specification for HFCS states that it must contain 75-76 grams of total sugar per 100 grams of solution. A small sample is tested, yielding a refractive index value of 1.4791. Can you accept this shipment? If so, what sized tank would you need to handle the complete tanker of liquid? (Assume the density of HFCS is 1.380 g/ml.)

4. A sample of cooling liquid containing ethylene glycol and water is brought to your lab. The cooling tower contains 2,500 tons of this coolant to keep the chillers at an oil refinery working properly. It is critical that the concentration of the ethylene glycol be maintained at a concentration of 44.0±0.5*%(w/w)*, to prevent freezing and transfer the heat properly. Since it's late and an unexpected cold front has the plant manager worried, you decide to use the refractometer to run this test as fast as possible, yielding a result of 1.3687. Based upon published literature values, does the coolant meet its specification? If not, calculate how much water or ethylene glycol should be added to correct the situation. Would the final volume fill an Olympic-sized pool (660,000 gal)?

5. Out on the Great Salt Lake, the brine in the large salt evaporation ponds must be pumped through a series of different ponds, moving from one pond into the next when the sodium chloride reaches the right concentration as the water evaporates. In this case, it's time to move the brine when the concentration of salt is 22%*(w/w)*. You test the brine with your portable refractometer, yielding a Brix value of 22.1°Bx. Is the brine ready to move to the next pond? Do you start the pump… or wait a day or two more?

6. A food producer is concerned that his honey supplier is "watering down" his honey. It seems a little less viscous and doesn't seem to be the same as honey he obtains from other suppliers. When he tested the honey from his prior supplier, it always came back at 80.0±0.2% total dissolved solids (TDS). This batch in question has a refractive index of 1.4765. Does it have the same TDS as before? If not, how much water was added? What effect on R.I. would be observed if HFCS were used to dilute the honey?