GJ

The University of Calgary
Department of Chemical & Petroleum Engineering

ENCH 501: Transport Processes Quiz #1 **September 16, 2008**

Time Allowed: 25 mins. **Name:**

---

1. (5 points)

"Tar sand" is a mixture of bitumen, water and sand. At Syncrude and Suncor, the tar sand is strip-mined and the bitumen is extracted by the hot water process. Often, the mined paste is dumped in a pile and could stay exposed to the elements for weeks before processing. In this interval, the tar sand undergoes aging or weathering. Part of this involves loss of water (which decreases processibility) and some light components of the bitumen.

A batch of tar sand contains 6% water, 18% bitumen and the balance is sand grains, all on a weight basis. If after a month of exposure to the elements, the composition is now 2% water and 15% bitumen, how much water has been lost per kilogram of the bitumen left in the tar sand? Given that the densities of water, bitumen and sand are respectively 998, 920 and 2460 kg/m ^{3}, by what volume percent would 1 m^3 of fresh tar sand shrink after the weathering?

2. (5 points)

There are apparently at least two ways food items placed in freezer get "freezer burn". One is that the food that is not properly wrapped loses moisture to the wall of the freezer and in the process dehydrates and becomes discolored. The second way is that small ice crystals grow and are dispersed inside the food item, through withdrawing moisture from the local surrounding in the product. One observes this with foods that are re-frozen after thawing and this leads to the unacceptable crunchy texture and strange taste.

Slabs of steak are fast frozen at -77°C and then transported from Brazil to Toronto in refrigerated containers. In transit, the refrigeration failed and the meat was thawed to 0°C. On arrival, the meat was re-frozen to -18°C. However, in the process, the moisture content of the meat dropped from 63.2% to 42% by weight while the "lost water" formed small ice crystals throughout the meat. How much water has formed ice per kilogram of dry meat? Any comments?

ENCH 501 Quiz #1 Solution Sept. 16, 2008

a Basis: 100 kg of fresh tar sand

	% by wt	mass (kg)
Bitumen	18	18
Water	6	6
Sand	76	76

Mass of sand, 76 kg, is conserved in process.

Aged tar sand

	% by wt	Mass (kg)
Bitumen	15	$x = 13.7349$
Water	2	$y = 1.8313$
Sand	83	76

Mass of water lost = $6 - 1.8313 = 4.1687$ kg

mass of water lost / mass of bitumen left

$$= \frac{4.1687}{13.7349} = 0.3055 \longrightarrow$$

This is a porous structure with the bitumen and water within the interstitial space. The tar sand is not expected to shrink measurably. →

b Basis: 100 kg fresh meat

	% by wt	mass (kg)
Dry meat	36.8	36.8
Water	63.2	63.2

After re-freezing

	% by wt	mass (kg)
Dry meat	58	36.8
Water	42	$x = 26.6483$

∴ Mass of water forming ice = $63.2 - 26.6483$

$= 36.5517$ kg

mass of ice / mass dry meat = $\frac{36.5517}{36.8} = 0.993$

Comment: More water has been removed from the meat than remains.