GJ

The University of Calgary
Department of Chemical & Petroleum Engineering

ENCH 501: Transport Phenomena Quiz #3 **September 29, 2009**

Time Allowed: 30 mins. **Name:**

Samples of tar sands are continuously recovered from open pits in Fort MacMurray and sent to the laboratory for analysis of the bitumen and water contents. Loss of material from the samples due to evaporation must be avoided as the compositional data is used to specify operating conditions for the hot-water extraction process. The request to the field engineer from the laboratory is that samples should weigh 1 kg and be placed in covered glass jars. The engineer used a crude scale in the field but claimed that all samples collected at least weighs 1 kg each. He said nothing about how long it took him to cover the jars after collecting a sample, but it is known that he can be forgetful.

The masses of 35 samples recorded (in kg) by the laboratory assistant are as in the table below::

0.91	1.09	1.01	1.10	1.14	1.16	1.11
1.04	1.16	1.13	1.17	1.14	1.03	1.17
0.95	1.09	1.09	1.15	1.06	1.95	1.16
1.08	1.07	1.14	1.11	1.05	1.06	1.18
1.00	1.10	1.07	1.03	1.62	0.89	1.11

a) Estimate the mean value, the average deviation and the standard deviation for the data set. Explain your approach to the problem.
b) What is an estimate for the error in the mean value?

ENCH 501 Quiz #3 Solution Sept. 29, 2009

Inspect the data set. Most values are above or at 1.0 kg. For three samples, the masses (0.91, 0.95 and 0.89) were less than 1 kg. It is possible that the field engineer lost some components of the samples by not quickly covering them up. Also, two other values (1.95 and 1.62) appear to be "outliers". The calculations will be based on 30 samples

x_i	$x_i - \bar{x}_{est}$
1.04	− 0.06
1.08	− 0.02
1.00	− 0.10
1.09	− 0.01
1.16	+ 0.06
1.09	− 0.01
1.07	− 0.03
1.10	0
1.01	− 0.09
1.13	+ 0.03
1.09	− 0.01
1.14	+ 0.04
1.07	− 0.03
1.10	0
1.17	+ 0.07

x_i	$x_i - \bar{x}_{est}$
1.15	+ 0.05
1.11	+ 0.01
1.03	− 0.07
1.14	+ 0.04
1.14	+ 0.04
1.06	− 0.04
1.05	− 0.05
1.16	+ 0.06
1.03	− 0.07
1.06	− 0.04
1.11	+ 0.01
1.17	+ 0.07
1.16	+ 0.06
1.18	+ 0.08
1.11	+ 0.01
Σ 33.0	

(a) mean value

$$\bar{x}_{est} = \frac{\sum_{i=1}^{N} x_i}{N} = \frac{33}{30} = 1.10$$

→

Assume the data is correlated – all the samples collected by one person and all measurements conducted by one assistant.

Average deviation

$$\pm \Delta x_{av} = \frac{\sum_i |x_i - \bar{x}_{est}|}{N} = \frac{1.26}{30} = 0.042$$

→

Standard deviation

$$\pm \sigma_x = \sqrt{\frac{(x_i - \bar{x}_{est})^2}{N-1}} = \sqrt{\frac{0.0752}{29}} = 0.0509$$

→

(b) The estimate of the error in the mean value is given by

$$\Delta(\bar{x}_{est}) = \frac{\pm \Delta x}{\sqrt{N}}$$

For Δx, use either the average deviation or the standard deviation estimated above

$$\Delta(\bar{x}_{est}) = \frac{0.0509}{\sqrt{30}} = 0.0093$$

$$\therefore \quad \bar{x}_{\text{expected}} = 1.10 \pm 0.0093$$

→