

**1/28/2003**

<b>FABE 325</b>	<b>Instructor:Dr. Kaletunç</b> <b>TA : Kelley Yosick</b>
<b><u>Homework #4</u></b>	<b>Winter 2003</b>

**Homework Due 2/4/2003**

**Problem 1:** An adult takes about 12 breaths per minute; inhaling roughly 500ml of air with each breath. The molar compositions of the inspired and expired gases are as follows.

Species	Inspired Gas (%)	Expired Gas (%)
O <sub>2</sub>	20.6	15.1
CO <sub>2</sub>	0.0	3.7
N <sub>2</sub>	77.4	75.0
H <sub>2</sub> O	2.0	6.0

The inspired gas is at 24°C and 1 atm, and the expired gas is at body temperature and pressure - 37°C and 1 atm. Nitrogen is not transported into or out of the blood in the lungs, so that  $(N_2)_{in} = (N_2)_{out}$ .

- Calculate the masses of O<sub>2</sub>, CO<sub>2</sub>, and H<sub>2</sub>O transferred from the pulmonary gases to the blood per minute.
- Calculate the volume of air exhaled per milliliter inhaled.
- At what rate (g/min) is this individual losing weight by merely breathing?

**Problem 2:** Coal containing 5.0wt% S is burned at a rate of 570kg/min in a boiler furnace. All of the sulfur in the coal is oxidized to SO<sub>2</sub>. The product gas is sent to a scrubber in which most of the SO<sub>2</sub> is removed, and the scrubbed gas then passes out of a stack. An Environmental Protection Agency regulation requires that the gas in the stack must contain no more than 0.018 lb<sub>m</sub> SO<sub>2</sub>/ lb<sub>m</sub> coal burned. To test compliance with this regulation a flowmeter and an SO<sub>2</sub> analyzer are mounted in the stack. The volumetric flow rate of the scrubbed gas is found to be 81 m<sup>3</sup> /s, and the SO<sub>2</sub> analyzer reading is 42. Calibration data for the analyzer are given in the table below.

### SO<sub>2</sub> Analyzer Calibration Data

C(g SO <sub>2</sub> / m <sup>3</sup> gas)	Reading (0-100 scale) R
0.3	10
0.85	28
2.67	48
7.31	65
18.2	81
30.0	90

a. What is the equation that relates SO<sub>2</sub> concentration in g/ m<sup>3</sup> to the analyzer reading? (Use MATLAB for curve fitting)

b. Is the EPA regulation being complied with?

**Problem 3:** Text book 1.5-10

**Problem 4:** Gasoline (C<sub>7</sub>H<sub>17</sub>), diesel (C<sub>14</sub>H<sub>29</sub>), and propane (C<sub>3</sub>H<sub>8</sub>) are used currently as vehicle fuels. For a complete combustion of each fuel (all the fuel and oxygen will react) under theoretical conditions, calculate the air to fuel (A/F) (mass of air to mass of fuel) ratio for each fuel. (Hint: write the combustion reaction and balance it.)