AIR POLLUTION

PROBLEMS (I)

Problem 1.- During aerosol characterization experiments covering a globally representative range of natural and anthropogenically perturbed environments, atmospheric concentrations of dimethyl sulfide (DMS) between 250 and 500 $ng \cdot m^{-3}$ were determined. Convert this range of concentration (in ppt_v) at sea level and 298 K.

Problem 2.- In a metropolitan region, with an area of 400 square kilometers, there are 2.5 million vehicles on the move. On average, these vehicles travel a distance of 12,000 km per year and the NO_x emission factor of the fleet of this city is 2.1 grams of NO_x per kilometer. The city road network totals 1,600 km and the traffic is homogeneously distributed over the city. Calculate the total annual NO_x emissions from traffic in this city (g $NO_x \cdot y^{-1}$) and the daily NO_x emissions per square meter (g $NO_x \cdot m^{-2} d^{-1}$).

Problem 3.- There are 92 people in a public establishment of 16 x 12 x 2.5 meters. Of these, half are smokers and, on average they smoke 2 cigarettes per hour. One of the many toxic chemicals present in tobacco cigarettes is formaldehyde (methanal). Each cigarette, when smoked, releases 1.4 milligrams of formaldehyde. When this toxic compound is present in the air at levels at or above 0.05 ppm, it can lead to acute physical symptoms such as watery eyes, burning sensations in the eyes and other irritating effects. Assume that 10% (volume) of the formaldehyde escapes through opened windows and doors and that 60% (volume) of the formaldehyde retained inside the building is oxidized to carbon dioxide. The ambient temperature and the pressure in the establishment are 25°C and 100.66 kPa, respectively.

3.1. Determine whether, after an hour of exposure to tobacco smoke, individuals present in the establishment are likely to feel irritating effects.

3.2. Calculate the concentration of CO_2 (in ppm_v) resulting from the oxidation of the formaldehyde in the air.

DATA MW formaldehyde= 30 $g \cdot mol^{-1}$

Problem 4.- A city emits 0.012 $mg \cdot m^{-2} s^{-1}$ of sulfur dioxide. The mean wind speed is 3 $m \cdot s^{-1}$ and the pollutant is mixed up to 600 m altitude, where a thermal inversion is present. The city extends 15 km in the wind direction and 10 km perpendicularly. The concentration of SO_2 before the air reaches the city is insignificant. Assuming uniform mixing throughout the city and steady-state emission and atmospheric conditions, determine the concentration of SO_2 in the city (in $\mu g \cdot m^{-3}$) using the box model.

Problem 5.- A power plant with no sulfur removal equipment burns 30 tons of coal per hour to generate electricity. A monitoring instrument placed at the chimney periodically extracts samples of the exhaust gases. The analyses of these samples show that the average sulfur dioxide concentration is 2,000 ppm_v. The exhaust gas flow is 25,000 $m^3 \cdot min^{-1}$ at a temperature of 460°C and an overpressure of 0.05 atmospheres. Determine the emission of sulfur dioxide (in $g \cdot s^{-1}$) and the concentration of sulfur in coal (%mass).