CEL 793

Indian Institute of Technology
M.Tech. Environmental Science and Engineering
I Semester (2006-07)
MAJOR TEST

Date: 27.11.2006 Total Marks:35
Time:10.30-12.30
Venue:V317

1(a) A mixture of gas at 1 atmospheric pressure comprises of 74% Sulfur dioxide, 16% Nitrogen oxide and 10% Carbon monoxide. Calculate partial pressure of each gas in this mixture and name the law involved in the calculations. 2

1(b) The air quality standard for Carbon monoxide is fixed at 10 ppm and of Sulfur dioxide as 80 $\mu g\ m^{-3}$. Calculate the air quality standards of CO in $mg\ m^{-3}$ and of Sulfur dixide in ppm. Molecular weights of CO and Sulfur dioxide are 28 g and 64.1 g respectively. 2.5

2(a) Name the general categories of bent over plumes and basis for the same. Derive buoyancy flux parameter and also give it's units. 4

2(b) The heat emission rate associated with a stack gas is 5400 kJ/s, the wind and the stackexit speeds are 6 and 15 m/s, respectively, and inside diameter at the top is 3 m. Estimate which of the plume rise formulae amongst Moses and Carson (general), Holland and the Concawe will result into the maximum value of the plume rise? 4

3(a) Using the Gaussian plume diffusion formula for a continuous release at an effective height H above the reflecting surface, derive the expressions for maximum ground level concentration (GLC) and it's distance from the source , assuming that at short distances the plume dispersion parameters can be approximated by the power law relations $\sigma_y = ax^b$ and $\sigma_z = bx^q$. 4

3(b) Estimate the maximum GLC and it's downwind distance from the source for a power plant emitting Sulfurdioxide at the rate of 5 kg/s with an effective release height of 200 m. Consider the following meteorological situations and compare the results for the meteorological situations when (i) wind speed at 10 m height is 1.2 m/s and insolation is strong (b) wind speed at 10 m height is 6 m/s and the sky is overcast. Use power law relations for dispersion parameters. Use a,b,p and q as 0.3658, .00025, 0.9031 and 2.1250

respectively for unstable conditions and 0.1474, 0.30, 0.9031 and 0.6532 respectively for neutral conditions. 4

4 (a) Where is narrow plume hypothesis used? Explain with a figure. 2

4(b) How would you estimate plume centerline GLC for a series of industries located along a river when the wind direction is normal to the line of emission and when the wind direction is not perpendicular to the line source but makes an angle which is more than 45 degrees? 3

4 © The traffic density for an interstate highway is 12,000 vehicles/hour and the average vehicle speed is 90 km/hour.The wind speed perpendicular to the highway is 3 m/second. The average carbon monoxide emission is 25 g/km. 4

(i) Calculate average number of vehicles travelling in one kilometer

(ii) Calculate the rate of emission in g/s.m

(iii) For an overcast sky, estimate the CO concentration 200 m downwind from the highway. Assume that the direction of wind is perpendicular to the highway and dispersion coefficients are calculated from the information provided in 3 (b) above.

5 (a) Give 2 effects each from the pollutant gases namely, Carbon monoxide and Nitrogen dioxide on human beings when their concentrations are more than the air quality standards. 1.5

5(b) Name and give atmospheric conditions, shape and the impact on the GLC of each type of the stack plume. 4