CHAPTER 8 : CALCULATION OF THE MASS EMISSIONS OF POLLUTANTS

1. Scope : This chapter describes the calculation procedures for the mass emission of pollutants and correction for humidity for oxides of nitrogen.

2. The mass emission of pollutants are calculated by means of the following equation :

$M_i = V_{mix} * Q_i * k_H * C_i * 10^{-6} / Ds$

M_i = Mass emission of the pollutant i in g/km

V_{mix} = Volume of the diluted exhaust gas expressed in cu.m/test and corrected to standard conditions 293 K and 101 kPa

Ds = distance covered in km

Q_i = Density of the pollutant i in kg/cu.m at normal temperature and pressure (293 K and 101 kPa)

k_H = Humidity correction factor used for the calculation of the mass emissions of oxides of nitrogen. There is no humidity correction for HC and CO.

C_i = Concentration of the pollutant i in the diluted exhaust gas expressed in ppm and corrected by the amount of the pollutant i contained in the dilution air.

3. VOLUME DETERMINATION :

3.1 Calculation of the volume when a variable dilution device with constant flow control by orifice or venturi is used. Record continuously the parameters showing the volumetric flow, and calculate the total volume for the duration of the test.

3.2 Calculation of volume when a positive displacement pump is used .

The volume of diluted exhaust gas in systems comprising a positive displacement pump is calculated with the following formula :

$V = V_o * N$

Where,

V = Volume of diluted exhaust gas expressed in cu.m/test (prior to correction)

V_o = Volume of gas delivered by the positive displacement pump on testing conditions, in cu.m/rev.

N = Number of revolutions per test.

3.3 Correction of the diluted exhaust gas volume to standard conditions . The diluted exhaust gas volume is corrected by means of the following formula :

$V_{mix} = V * K_1 *(P_B - P_1)/ T_P$ (2)

in which :

$K_1 = 293$ K/101 kPa = 2.9009 ($K.kPa^{-1}$) (3)

Where,

P_B = Barometric pressure in the test room in kPa

P_1 = Vacuum at the inlet to the positive displacement pump in kPa relative to the ambient barometric pressure.

T_P = Average temperature of the diluted exhaust gas entering the positive displacement pump during the test.

4. Calculation of the Corrected Concentration of Pollutants in the Sampling Bag

$$C_i = C_e - \left(C_d * \left(1 - \frac{1}{Df} \right) \right)$$

Where,

C_i = Concentration of the pollutant i in the diluted exhaust gas, expressed in ppm and corrected by the amount of i contained in the dilution air.

C_e = Measured concentration of pollutant i in the diluted exhaust gas, expressed in ppm.

C_d = Measured concentration of pollutant i in the air used for dilution, expressed in ppm.

Df = Dilution factor

The dilution factor is calculated as follows :

$$Df = \frac{13.4}{C_{CO_2} + (C_{HC} + C_{CO}) * 10^{-4}}$$

where

C_{CO_2} = Concentration of CO_2 in the diluted exhaust gas contained in the sampling bag, expressed in percentage volume.

C_{HC} = Concentration of HC in the diluted exhaust gas contained in the sampling bag, expressed in ppm carbon equivalent.

C_{CO} = Concentration of CO in the diluted exhaust gas contained in the sampling bag, expressed in ppm.

5. Determination of the NO_x Humidity Correction Factor :

In order to correct the influence of humidity on the results of oxides of nitrogen, the following calculations are applied:

$k_H = 1/((1-0.0329 * (H-10.71))$
in which :
$H = 6.211 * R_a * P_d / ((P_B - (P_d * R_a * 10^{-2}))$
Where,
H = Absolute humidity expressed in grams of water per kg of dry air
R_a = Relative humidity of the ambient air expressed in per cent
P_d = Saturation vapour pressure at ambient temperature expressed in kPa
P_B = Atmospheric pressure in the room, expressed in kPa