

Spreadsheet Program for EPA Method 202
Condensible Particulate Matter Emission Rate
and Concentration Calculations

This spreadsheet calculates flue gas concentrations of condensible particulate matter (CPM) from raw field data obtained from EPA Method 202. The purpose of the spreadsheet is to aid the user by quickly giving results that are normally obtained from rather lengthy and tedious equations. Provided below are instructions to guide the user through the spreadsheet as well as equations used by the spreadsheet and their sources.

1. Retrieve the Lotus 1-2-3 spreadsheet program (the initial spreadsheet should be blank).
2. Press /FR. Type A:\202 (if the computer is using the B drive, type B:\202) and press ENTER.
3. Enter the date of the test in cell C4, the plant that was tested in cell C5, and the run number in cell C6. If the run number consists of a number and a letter, type the run number as follows: '1A.
4. Using the arrow keys, move the cursor to the first space in the data column. Enter the type of units (metric or English) used in cell G8. (NOTE: Be consistent with units throughout the spreadsheet.) Using the down arrow to move to the different cells in the DATA column, proceed to enter the following information:
 - barometric pressure (mm Hg, in. Hg), cell G9
 - stack static pressure (mm H₂O, in. H₂O), cell G10
 - stack area (m³, ft³), cell G11
 - nozzle diameter (mm, in.), cell G12
 - pitot tube coefficient, C_p, cell G13
 - dry gas meter calibration factor, Y, cell G14
 - initial DGM reading (liters, dscf), cell G15
 - final DGM reading (liters, dscf), cell G16
 - total run time (min), cell G17
 - leak rate correction factor used? Yes(1) No(2), cell G18
5. When data entry is completed, press ALT B to move to the next screen and enter the following information:
 - dry stack gas molecular weight, cell O8
 - particulate mass in probe rinse (mg), cell O9
 - particulate mass in filter catch (mg), cell O10
 - water vapor condensed in impingers (ml), cell O11
 - water vapor collected in silica gel (g), cell O12
6. When data entry is completed, press ALT C to move to the next screen and enter the following information:

CPM Data

weight of CPM in MeCl₂ blank (mg), cell X5
weight of CPM in water blank (mg), cell X6

weight of organic CPM (mg), cell X7
weight of dried inorganic fraction (mg), cell X8
volume of impinger contents sample (ml), cell X9

IC Results

volume of aliquot taken from sample (ml), cell X10
sulfate concentration in sample (mg/ml), cell X11
chloride concentration in sample (mg/ml), cell X12

Optional NH₃ Titration

normality of NH₄OH solution, cell X13
volume of sample titrated (ml), cell X14
volume of titrant (ml), cell X15

correction needed for Cl⁻? Yes(1) No(2), cell X17
correction for NH₄ (1) of NH₄ and H₂O (2)?, cell X18
NH₃ titration used? Yes(1) No(2), cell X19

7. When data entry is complete, press ALT D to move to the next screen and enter the field data information as follows:

run time (min), column A
delta p reading (mm H₂O, in. H₂O), column B
delta H reading (mm H₂O, in. H₂O), column C
average DGM temperature (C, F), column D
stack pressure (mm H₂O, in. H₂O), column E
stack temperature (C, F), column F
vacuum reading (mm Hg, in. Hg), column G
filter temperature (C, F), column H

8. When all data has been entered into the spreadsheet, press ALT E to see the first of two sets of results. The spreadsheet uses the following nomenclature and equations to obtain these results:

NOMENCLATURE

Θ = total run time (min)
A = stack area (m³, ft³)
A_n = cross-sectional area of nozzle (mm², in.²)
B_{ws} = moisture content (%)
C_p = pitot tube coefficient
C_{part} = concentration of particulate in flue gas (g/m³, gr/ft³)
C_{CPM} = concentration of CPM in flue gas (mg/dscm, mg/dscf)
C_{SO₄} = concentration of SO₄⁻² in sample (mg/ml)
delta H = average pressure differential across orifice (mm Hg, in. Hg)
m_c = mass of NH₄₊ added to sample to form (NH₄)₂SO₄ (mg)
m_{cl} = correction factor for chloride
m_b = weight of CPM in MeCl₂ and H₂O blanks (mg)
m_i = weight of inorganic CPM (mg)
m_n = total particulate collected (mg)

m_o = weight of organic CPM (mg)
 m_r = weight of dried inorganic fraction (mg)
 N = normality of NH_4OH (mg/ml)
 m_s = molecular weight of stack gas (g/g-mole, lb/lb-mole)
 Δp = velocity head of stack gas (mm H_2O , in. H_2O)
 P_{bar} = barometric pressure (mm Hg, in. Hg)
 P_s = absolute stack gas pressure (mm Hg, in. Hg)
 P_{std} = standard absolute pressure (mm Hg, in. Hg)
 Q = volumetric flow rate (dscmm, dscfm)
 V_b = volume of sample taken for IC analysis (ml)
 V_{ic} = volume of impinger contents sample (ml)
 V_{1c} = volume of water collected (ml)
 V_m = volume of gas measured by DGM (dcm, dcf)
 $V_{m(std)}$ = volume of gas sampled, corrected to standard conditions (dscm, dscf)
 $V_{w(std)}$ = volume of water vapor in gas sample, corrected to standard conditions (scm, scf)
 v_s = stack gas velocity (m/sec, ft/sec)
 V_{sample} = volume of impinger sample (ml)
 V_t = volume of NH_4OH titrant
 T_m = absolute average DGM temperature (K, °R)
 T_s = absolute average stack gas temperature (K, °R)
 T_{std} = standard absolute temperature (K, °R)
 Y = DGM calibration coefficient

A. Standard dry gas volume (dscm, dscf)

$$V_{m(std)} = K_1 V_m Y \left[\frac{P_b + \frac{\Delta H}{13.6}}{T_m} \right]$$

where $K_1 = 0.3858$ K/mm Hg for metric units
 $= 17.64$ R/in. Hg for English units

Equation 5-1 from 40 CFR Part 60, Method 5, Section 6.3.

B. Stack gas velocity (m/s, ft/s)

$$v_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}}$$

where

$$K_p = 34.97 \frac{m}{sec} \left[\frac{\left(\frac{g}{g\text{-mole}} \right) (mm\ Hg)}{(K) (mm\ H_2O)} \right]^{\frac{1}{2}} \text{ for metric units}$$

$$K_p = 85.49 \frac{ft}{sec} \left[\frac{\left(\frac{lb}{lb\text{-mole}} \right) (in.\ Hg)}{(R) (in.\ H_2O)} \right]^{\frac{1}{2}} \text{ for English units}$$

Equation 2-9 from 40 CFR Part 60, Method 2, Section 5.2.

C. Standard volumetric flow rate (dscmm, dscfm)

$$Q = 60 (1 - B_{ws}) V_s A \left(\frac{T_{std}}{T_{s(avg)}} \right) \left(\frac{P_s}{P_{std}} \right)$$

Equation 2-10 from 40 CFR Part 60, Method 2, Section 5.3.

D. Standard volume of water vapor in sample (scm, scf)

$$V_{w(std)} = K_3 V_{lc}$$

where $K_3 = 0.001333 \text{ m}^3/\text{ml}$ for metric units
 $= 0.04707 \text{ ft}^3/\text{ml}$ for English units

Equation 5-2 from 40 CFR Part 60, Method 5, Section 6.4.

E. Moisture content (%)

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

Equation 5-3 from 40 CFR Part 60, Method 5, Section 6.5.

F. Isokinetics

$$I = K_4 \frac{T_s V_{m(std)}}{P_s V_s A_n \Theta (1 - B_{ws})}$$

where $K_4 = 4.32$ for metric units
 $= 0.0945$ for English units

Equation 5-8 from 40 CFR Part 60, Method 5, Section 6.11.2.

G. Particulate concentration (g/m³)

$$\text{Part Conc} = \left(\frac{0.001 \text{ g}}{\text{mg}} \right) \left(\frac{m_n}{V_{m(std)}} \right)$$

Equation 5-8 from 40 CFR Part 60, Method 5, Section 6.9

H. Particulate mass emission rate (kg/h, lbs/h)

$$\text{Particulate mass emission rate} = K C_{part} * Q$$

where $K = 0.06 \text{ (min kg)/(hr g)}$ for metric units
 $= 0.00857 \text{ (min lbs)/(hr gr)}$ for English units

I. Calculated correction factor

$$m_c = K C_{SO_4^{-2}} V_{ic}$$

where $K = 0.0205$ when correcting for NH_4^+ and H_2O
 $= 0.1840$ when correcting for NH_4^+ only

Equation 202-1 from EPA Method 202, Section 7.2.

J. Weight of total corrected inorganic CPM (mg)

$$m_i = m_r \left(\frac{V_{ic}}{V_{ic} - V_b} \right) - m_c - m_{Cl^-}$$

Equation 202-2 from EPA Method 202, Section 7.3.

L. Corrected concentration of CPM (mg/dscm, mg/dscf)

$$C_{cpm} = \frac{m_o + m_i - m_b}{V_{m(std)}}$$

Equation 202-3 from EPA Method 202, Section 7.3.

M. CPM emission rate (kg/hr, lb/hr)

$$ER_{cpm} = K C_{cpm} Q$$

where $K = 6.0E-5 \text{ (kg min)/(mg hr)}$ for metric units
 $= 1.32E-4 \text{ (lb min)/(mg hr)}$ for English units

N. Calculation of sulfate ion concentration using NH_3 titration

$$C_{SO_4^{-2}} = \frac{48.03 V_t N}{100}$$

Equation 202-4 from EPA Method 202, Section 8.1.2.

9.To print the spreadsheet, press ALT P. To return to the beginning of the spreadsheet and edit data, press ALT A.

10.To save the spreadsheet, type /FS and then enter a filename for the saved spreadsheet. Press ENTER. The spreadsheet program disk is write-protected so another disk is required to save the spreadsheet.

11.To calculate another set of data using the spreadsheet, repeat step

2 and proceed with entering the necessary data.

12. To quit Lotus, press /QYE.