Stack Flow Analyzer Equations

Stack Velocity - Calculate the velocity of the stack gas using stack temperature and delta P measurements.
Reference: 40 CFR 60, Appendix A, Method 2, Equation 2-9

$$v_S = K_p \times C_p \times \sqrt{\Delta P_S} \times \sqrt{\frac{T_S}{P_S \times MW_S}}$$

Volumetric Stack Flow STP conversion – Calculate volumetric stack flow using stack velocity.
Reference: 40 CFR 60 Appendix A, Method 2, Equation 2-10

$$Q_{sd} = 60\ (1 - B_{ws})\ v_S\ A \left(\frac{P_S}{P_{STD}}\right)\left(\frac{T_{STD}}{T_S}\right)$$

where:

Q_{sd} - Dry standard volumetric stack flow, dscf/min
v_S - Stack velocity, ft/sec (calculated)
T_S - Stack temperature, °R = °F + 460 (measured)
T_{STD} - Absolute stack temperature, fixed value of 528 °R
ΔP_S - Stack differential pressure, in. H_2O. (measured)
K_p - Pitot Constant, fixed value of 85.49, dimensionless
C_p - Pitot Coefficient, fixed value of 0.84 (typical for S-pitot type)
P_S - Stack barometric pressure, in. Hg (operator entered constant)
P_{STD} - Standard absolute pressure, fixed value of 29.92 in. Hg
MW_S - Gas density, lb/lb-mole (operator entered constant)
$Area_S$ - Cross-sectional area of the stack, sq. ft (operator entered constant)
B_{ws} - Proportion by volume of water vapor in gas stream,(%H_2O/100) (operator entered constant)
60 - Conversion factor, sec/min

Volumetric Flow is calculated as follows:

a. AWCFM = (FPS) (Stack Area) (60)

b. SWCFM = (AWCFM) $\left(\frac{528}{TS+460}\right)\left(\frac{PS"Hg"}{29.92}\right)$

A more comprehensive look, at the equations involved, is listed as follows:

Data Input:

(1) Stack or Duct Dimensions _____ ft.

(2) Stack or Duct Area _____ sq. ft.

(3) Gas Constituents: % H2O _____
% CO2 _____
% O2 _____

(4) Gas Density _____lb/lb-mole

(5) Gas Velocity _____fps

(6) Standard Dry (cfh) _____sdcfh

(7) Actual Wet (cfm) _____

(8) Stack Temperature (Ts) _____Deg F
(assumed or measured)

(9) Stack Pressure (Ps) _____"Hg
(assumed or measured)

B_{ws} = Decimal equivalent of percent moisture.

[1]Gas Density (Dry) = 0.44 (_____%CO_2) + 0.32 (_____%02) + 0.28 (_____%N2 + _____ % CO) = _____lb/lb-mole (Dry)

Gas Density (Wet) = (Gas Density {Dry}) (1-B_{ws}) + (18xB_{ws}) = _____lb/lb-mole (Wet)

Use the following for velocity calculations.

[2]fps = (85.49) (cp) $\sqrt{dp}$ $\sqrt{(Ts\ A/Ps"Hg\ l\ b/lb-molewet)}$

[3]sdcfh = 3600 (1-B_{ws}) (fps) (sq.ft.) ({528/TsA} {Ps "Hg/29.92})

[4]awcfm=$\frac{\text{(sdcfh) (100/\{100-\%}H_20\text{\}) (29.92/Ps "Hg) (TsA/528)}}{60}$

(10) Chemical Species (molecular weight) _____MW

(11) Chemical Species (concentration) _____ppm

PPH = $\frac{\text{(60x10-6) (MW/N/V) (AWCFM) (ppm)}}{\text{N/V = 359 (TsA/492) (29.92/Ps)}}$

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