Example Calculations

Run Number: M5-1 **Date:** 6/6/2003 **Time:** 0751-0858

Emission Calculation Symbols

Required Input Data

PB	=	30.06	barometric pressure, (" Hg)
AS	=	12.57	area of stack, (ft^2)
DN	=	0.221	nozzle diameter, (inches)
TT	=	63	total sampling time, (minutes)
Y	=	0.991	dry gas meter calibration factor
CP	=	0.84	pitot tube coefficient, dimensionless
SQRT DP	=	0.900	average velocity pressure (square root), (" H_2O)
DH	=	0.78	average orifice pressure differential, (" H_2O)
TM	=	71	average dry gas meter temperature, (^oF)
PS	=	0.68	stack static pressure, (" H_2O)
TS	=	251	average stack gas temperature, (^oF)
VM TOT	=	30.831	volume of gas sampled, (ft^3)
VI	=	314	total moisture collected, (ml)
CO_2	=	4	CO_2 in stack gas (dry basis), %
O_2	=	13.4	O_2 in stack gas (dry basis), %
CO	=	0	CO in stack gas (dry basis), %
N_2	=	82.6	N_2 in stack gas (dry basis), %
MN	=	0.97	total analyte collected, (milligrams)

Fuel Analysis Input

%H	=	12.80	percent by weight of hydrogen in fuel
%C	=	85.20	percent by weight of carbon in fuel
%S	=	0.12	percent by weight of sulfur in fuel
%N	=	0.01	percent by weight of nitrogen in fuel
%O	=	1.84	percent by weight of oxygen in fuel
GCV	=	19595	gross calorific value of fuel, Btu/lb
T STD	=	68	standard temperature, (^oF)
P STD	=	29.92	standard pressure, (" Hg)
LP	=	0.001	final leak rate of sampling train, (ft^3/min)
LA	=	0.02	allowable leak rate of sampling train, (ft^3/min)

1. Volume of Dry Gas Sampled (DSCF), dry standard cubic feet

DSCF = (VM TOT) x (Y) x [(T STD + 460) / (TM + 460)] x [(PB + (DH/13.6)) / 29.92]

DSCF = 30.58 dry standard cubic feet

2. Moisture In Stack Gas (%H_2O), percent

% H_2O = 100 x [(0.04707 x VI) / [DSCF + (0.04707 x VI)]

%H_20 = 32.58 percent

3. Stack Gas Wet Molecular Weight (MWS), lb/lb-mole

MWS = $[(0.44 \times CO_2) + (0.28 \times CO) + (0.28 \times N_2) + (0.32 \times O_2)] \times [1 - (\%H_2O/100)] + (0.18 \times \%H_20)$

MWS = 25.53 lb/lb mole

4. Average Stack Gas Density (DST), pounds per cubic feet

DST = (0.0458) x MWS x [(PB + (PS/13.6) / (TS + 460)]

DST = 0.0495 pounds per cubic feet

5. Excess Air (EA), percent

EA = $100 \times [(O_2 - (0.5 \times CO)) / (0.264 \times N_2) - (O_2 - (0.5 \times CO))]$

EA = 159.4 percent

6. Stack Gas Velocity (FPM), feet per minute

FPM = 5129.4 x CP x SQRT DP x SQRT [(TS +460) / (PB + (PS/13.6)) x MSW]

FPM = 3729.1 feet per minute

7. Actual Volumetric Flow Rate (Q), actual cubic feet per minute

Q = FPM x AS

Q = 46875 actual cubic feet per minute

8. Standard Volumetric Flow Rate (Q STD), dry standard cubic feet per minute

Q STD = $Q \times [1 - (\%H_2O/100)] \times [(T\ STD + 460)/(TS + 460)] \times [PB + (PS/13.6) / 29.92]$

Q STD = 23617 dry standard cubic feet per minute

9. Isokinetic Factor (IK), percent

IK = [5.67 x (TS + 460) x DSCF] / [(PB + (PS/13.6)) x FPM x TT x (1 - (%H_2O/100)) x (DN^2 x 0.7854)/144]

IK = 97.0 percent

10. Actual Analyte Concentration (C), grains per actual cubic feet

C = [0.01543 x MN x (T STD + 460) x (PB + (PS/13.6)) x (1 - (%H_2O/100)] / (DSCF x (TS + 460) x 29.92)

C = 0.000247 grains per actual cubic feet

11. Actual Analyte Concentration Corrected To Stack Conditions (Cd), micrograms per actual cubic meter

Cd = [1000 x MN x (T STD + 460) x (PB + (PS/13.6)) x (1 - (%H_2O/100))] / (0.02832 x (TS + 460) x 29.92)

Cd = 564.3 micrograms per actual cubic meter

12. Analyte Concentration Corrected To Dry Standard Conditions (Csm), milligrams/dry standard cubic meters
Analyte Concentration Corrected To Dry Standard Conditions (Cs), grains/dry standard cubic feet

Csm = (MN / DSCF) x 35.31

Csm = 1.12 mg/dscm

Cs = 0.01543 x (MN / DSCF)

Cs = 4.89E-04 grains/dscf

13. Analyte Emission Rate (ER), pounds per hour

ER = 0.008571 x Cs x Q STD

ER = 0.099069 pounds per hour

14. F - Factor (F), DSCF per million British thermal units

$$F = 1000000 \times [(3.64 \times \%H) + (1.53 \times \%C) + (0.57 \times \%S) + (0.14 \times \%N) - (0.46 \times \%O)] / GCV$$

F = 8991 DSCF per million Btu

15. Analyte Emission Rate (EBTU), pounds per million Btu

$$EBTU = 0.0001429 \times Cs \times F \times (20.9 / (20.9 - O_2))$$

EBTU = 0.00 pounds/million BTU

16. Analyte Concentration Corrected to Dry Standard Conditions and 12% CO_2 (Cs 12%CO_2), mg/dscm at 12% CO_2

$$Csm12\%CO_2 = Csm \times (12 / CO_2)$$

$Csm12\%CO_2$ = 3.4 mg/dscm @ 12% CO_2

17. Analyte Concentration Corrected to Dry Standard Conditions and 7% O_2 (Cs @7%O_2), mg/dscm at 7% O_2

$$Csm7\%O_2 = Csm \times [(20.9 - 7.0) / (20.9 - O_2)]$$

$Csm7\%O_2$ 2.08 mg/dscm @ 7% O_2