Conversion Factors For Emissions Calculations

Preparing emissions estimates for environmental authorities can be difficult because they often ask for emissions expressed in units not available through existing data. Here are the conversion procedures for some of the more commonly-used measurement systems:

1) **ppm at 3% O_2 (15% excess air) in dry flue gases to lb./million Btu**
(ppm)(F_3) = lb./million Btu

Values of multiplier F_3 for various fuels and emissions

Various Fuels	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As: Methane	Unburned Hydrocarbons, Measured As: Propane	CO_2	SO_2
Birmingham Nat. Gas*	.001187	.000722	.000781	.000416	.001147	.001147	.001672
Propane	.001185	.000721	.000780	.000415	.001146	.001146	.001669
Butane	.001212	.000735	.000798	.000424	.001172	.001172	.001707
#2 Oil**	.001317	.000801	.000867	.000461	.001273	.001273	.001854

2) **lb./million Btu to ppm at 3% O_2 (15% excess air) in dry flue gases**
(lb./million Btu)(f_3) = ppm @ 3% O_2, dry

Values of multiplier f_3 for various fuels and emissions

Various Fuels	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As: Methane	Unburned Hydrocarbons, Measured As: Propane	CO_2	SO_2
Birmingham Nat. Gas*	842	1385	1280	2404	872	872	598
Propane	844	1387	1282	2410	873	873	599
Butane	825	1361	1253	2358	853	853	586
#2 Oil**	759	1248	1153	2169	786	786	539

3) **ppm at 0% O_2 in dry flue gases to lb./million Btu**
(ppm)(F_0) = lb./million Btu

Values of multiplier F_0 for various fuels and emissions

Various Fuels	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As: Methane	Unburned Hydrocarbons, Measured As: Propane	CO_2	SO_2
Birmingham Nat. Gas*	.001017	.000617	.00067	.000356	.000983	.000983	.001432
Propane	.001018	.000619	.00067	.000356	.000984	.000984	.001434
Butane	.001042	.000634	.000686	.000365	.001007	.001007	.001468
#2 Oil**	.001133	.00069	.000746	.000397	.001096	.001096	.001596

* 1002 Gross Btu/cubic foot, 8.48 Cubic feet dry flue products at stoichiometric ratio.
** Calculated as heptadecane, $C_{17}H_{36}$, 19,270 Gross Btu/lb.

(continued on page 99)

4) **lb./million Btu to ppm at 0% O_2 in dry flue gases**
(lb./million Btu)(f_0) = ppm @ 0% O_2, dry

Values of multiplier f_0 for various fuels and emissions

Various Fuels	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As:		CO_2	SO_2
				Methane	Propane		
Birmingham Nat. Gas*	983	1621	1493	2809	1017	1017	698
Propane	982	1616	1493	2809	1016	1016	697
Butane	960	1577	1458	2740	983	983	681
#2 Oil**	883	1449	1340	2519	912	912	627

5) **ppm at 3% O_2 or 0% O_2 in dry flue gases to lb./year**
First, calculate lb./million Btu with Step 1 or 3 on the first page. Then convert to lbs./year with the following relationship:

(lb./million Btu) (Maximum Burner Input, million Btu/hr.) (operating hrs./year) = lb./year

6) **lb/year to ppm at 3% O_2 or 0% O_2 in dry flue gases**
lb./year ÷ operating hrs./year ÷ Maximum Burner Input, million Btu/hr. = lb./million Btu

Convert lb./million Btu to ppm with Step 2 or 4.

7) **ppm at 3% O_2 or 0% O_2 in dry flue gases to gm/Nm^3**
(ppm)(G) = gm/Nm^3

Values of multiplier G for various emissions

Emission	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As:		CO_2	SO_2
				Methane	Propane		
G	.002031	.001235	.001341	.000716	.001969	.001965	.002861

8) **gm/Nm^3 to ppm at 3% O_2 or 0% O_2 in dry flue gases**
(gm/Nm^3)(g) = ppm

Values of multiplier g for various emissions

Emission	NO_X Measured As NO_2	CO	Aldehydes, Measured As Formaldehyde	Unburned Hydrocarbons, Measured As:		CO_2	SO_2
				Methane	Propane		
g	492.4	809.7	745.7	1396.6	507.9	508.9	349.5

* 1002 Gross Btu/cubic foot, 8.48 Cubic feet dry flue products at stoichiometric ratio.
** Calculated as heptadecane, $C_{17}H_{36}$, 19,270 Gross Btu/lb.

Correcting Emissions Readings to 3% O_2 or 11% O_2 Basis

Many environmental authorities, including the U.S. EPA and several European agencies, require that gaseous pollutants, like NO_x and CO, be reported in ppm (parts per million by volume) corrected to a based of 3% excess O_2—or 15% excess air—in the flue gases. Japan, on the other hand, customarily uses a base of 11% O_2.

Emission readings taken at different oxygen levels can be easily converted to a standard base using a multiplier:

$$ppm_{corrected} = ppm_{test} \text{ x multiplier}$$

The multiplier is calculated from the oxygen reading taken during the test and the base oxygen reading required by the regulation:

$$\text{multiplier} = \frac{21 - \%\ O_2 \text{ base}}{21 - \%\ O_2 \text{ test}}$$

For your convenience, a table of multipliers is presented to the right.

	Multiplier For:	
%O_2	**3%O_2**	**11%O_2**
0	.86	.48
1	.9	.5
2	.95	.53
3	1	.56
4	1.06	.59
5	1.13	.63
6	1.2	.67
7	1.29	.71
8	1.38	.77
9	1.5	.83
10	1.64	.91
11	1.8	1
12	2.0	1.11
13	2.25	1.25
14	2.57	1.43
15	3.0	1.67
16	3.6	2
17	4.5	2.5
18	6	3.33
18.5	7.2	4
19	9	5
19.5	12	6.67
20	18	10
20.2	22.5	12.5
20.4	30	16.67
20.6	45	25
20.8	90	50