500 W Wood St. Palatine, IL 60067
800-223-3977

TI-89 Calculator

Pre-programmed with isokinetic sampling calculations

Part # 0006

Program User Guide

Questions? Contact us at 800-223-3977 or online at www.cleanair.com

CleanAir Engineering, Inc. License Agreement

Please read this license agreement carefully and be sure you accept its terms before using your calculator. By using the calculator and/or CleanAir Engineering Program User Guide, you consent to be bound by the terms and conditions of this agreement.

1. GRANT OF LICENSE. CleanAir Engineering, Inc. grants you and you accept a license to use the programs and materials delivered with this calculator. These programs **may not be copied** to another calculator or to a computer except solely for the purpose of making a single backup copy. In no event shall two or more persons use the programs at the same time.

2. COPYRIGHT. The calculator programs are owned by CleanAir Engineering, Inc. and both the programs and accompanying user guide are protected by United States copyright laws and international treaty provisions. Therefore you must treat the programs and accompanying material like any other copyrighted material (e.g. book or musical recording), except as stated above in the GRANT OF LICENSE. You may not copy the user guide in whole or in part.

3. OTHER RESTRICTIONS. You may not rent or lease the programs provided. You may transfer the programs and accompanying written materials on a permanent basis provided you retain no copies of the programs or user guide and the recipient agrees to the terms of this agreement.

Warranty Information

LIMITED WARRANTY. CleanAir Engineering, Inc. warrants that the programs supplied with the calculator will perform substantially in accordance with the accompanying printed materials for a period of (90) days from the date of receipt. In the event of a memory failure of the calculator, CleanAir Engineering, Inc. will reload the programs provided with the calculator at no charge to the customer for the (90) day warranty period provided the calculator is returned to CleanAir Engineering, postage prepaid. Some states do not allow limitations on duration of implied warranties, so the above limitation may not apply to you.

CUSTOMER REMEDIES. CleanAir Engineering's entire liability and your exclusive remedy shall be, at CleanAir Engineering's option, either (a) return of the price paid or (b) repair or replacement of the programs or hardware that does not meet CleanAir Engineering's Limited Warranty and that is returned to CleanAir Engineering, Inc. with a copy of your receipt. This Limited Warranty is **void** if failure of the programs and/or calculator has resulted from an alteration of the programs, deliberate resetting of the calculators memory, abuse, misuse or accident.

NO OTHER WARRANTIES. Except as specifically stated above, CleanAir Engineering, Inc. makes no other warranties, expressed or implied with respect to the calculator, programs or user guide, including but not limited to implied warranties of merchantability and fitness for a particular purpose. The warranty and remedies set forth above are exclusive and in lieu of all others, oral or written, expressed or implied. This limited warranty gives you specific legal rights. You may have others, which vary from state to state.

NO LIABILITY FOR CONSEOUENTIAL DAMAGES. In no event will CleanAir Engineering, Inc. be liable for loss of profits or goodwill or other indirect, special, incidental, or consequential damages resulting from any defect in the software calculator or user guide. CleanAir Engineering's liability for damages to you or others will in no event exceed the total amount paid by you for the software and calculator. Because some states do not allow the exclusion or limitation of liability for consequential or incidental damages, the above limitations may not apply to you.

Table of Contents

IMPORTANT…..READ THIS BEFORE YOU BEGIN!

Do not reset your calculator RAM as described in the TI-89 Manual. This will erase your programs. If you have purchased a Texas Instruments 94327 Ti Graphlink USB cable and software kit, save a copy of the programs to disk for backup purposes. Note from which calculator the program originated as it will only work with that one.

To begin the CleanAir program, follow the instruction listed in Section 1.0 Introduction (see page 2).

The first time you run the program be sure to enter all the values. On subsequent runs, the previously entered value of each variable will be posted. You may choose to accept these values or enter new values. To completely reset all values, use the Reset Variables function under the Isokinetic sub-menu (see Section 2.3 for details).

If you want the K Factor function to auto-select your nozzle you must execute the program from the Isokinetic sub-menu. Each time you run this function, it will calculate the ideal nozzle size and set the nozzle to the next largest diameter, but you can still change it if you desire. To override the nozzle selection, enter a different nozzle diameter and press [Enter].

To run a validation check on the K Factor and Parameter functions do the following (you must run the functions in this order for the validation to work):

- From the Isokinetic sub-menu, run the Reset Variables function.
- Run the K Factor function. Move through each variable and enter data.
- Run the Parameter function. Move through each page variable and enter data.
- Run the Validation function. The program will pause when variables fail.

To enter a negative number use the [(-)] key, which is located to the left of the [Enter] key.

If your screen is blank when you try to turn the calculator on, see Section 3.0 Troubleshooting (see page 9).

Lastly, there is a list of variable names used by the programs in Appendix A. Be sure none of your programs use the same names.

1.0 INTRODUCTION

Your TI-89 calculator has fifteen functions. They include:

- Math -Average
  -Square Root Average
  -Quadratic
- Flow -Primary
  -Particulate
- Isokinetic -K Factor for determining your isokinetic rate and test results
  -Parameters for resetting the variables used in the programs
  -Reset Variables for resetting the variables used in the program
  -Validate for validating the K and P results with dummy data
- Points -Method 1 for a circular stack
- Calibration -Full
  -Meter
  -Orifice
  -Delta H@
- WetBulb -Determines moisture content

These functions can be run from the main menu.

To switch between English and metric units, select option 7 from the main menu.

To begin the CleanAir program:

- Press the [ON] button of your calculator.
- Move the cursor to highlight the "Home" option accompanied by a picture of a calculator. Press [Enter]
- From the home screen, press the second [2nd] key followed by the minus [-] key (same as VAR-LINK).
- Scroll down to the 'MAIN' folder. Select 'cleanair' and hit [Enter]. This will return you to the home screen.
- Press right parenthesis [)] and then [Enter]. You should see the CleanAir logo.
- Press [Enter] to get to the CleanAir program main menu. If you get a message saying, "Resetting K Factor Variables Reset Completed" simply press [Enter] again to get to the CleanAir program main menu.

Note: It is strongly recommended that you read through the "Introduction" and the "Getting Started" sections of the Owners Manual supplied with the calculator. Be careful not to erase the memory of your calculator as the manual directs. Your calculator has already been reset and loaded with programs. Resetting the RAM will erase those programs.

General Program Conventions

While entering any data on any of the display pages the following rules apply:

- Once you enter a function, the **only** way to escape is to press [Enter] until you reach the end.
- When entering data, the program will display the name of the variable, expected units, and the previously entered value. Press [Enter] to use this value or type in a new value and press [Enter].
- After all variables have been entered, the program will clear the screen to display results. Press any button to return to the main menu.
- Press [ESC] to exit the program from the main menu.

2.0 ISOKINETIC PROGRAMS

2.1 The K Factor Function

The K Factor function calculates the ideal nozzle diameter and corresponding K factor, as well as the expected sample volume and moisture content based on manual inputs. The expected test condition values should be used for each variable. Refer to Appendix A for a list of the variables.

Please note the following:

- The program automatically calculates the percentage of nitrogen based on the oxygen and carbon dioxide percentages.
- Bwo is always considered to be the moisture fraction and not the percent moisture. The program only accepts values between 0 and 1.
- Enter the average of the square root of ΔP, and not just ΔP.
- If your K factor is too high (i.e. you can't pull the required flow rate), reduce your nozzle size. Then repeat the run and increase your test time to meter the required volume.

The program will show the estimated volume of dry gas you will meter (Vm) and the same volume correct to standard conditions (Vmstd). The program will also estimate the volume of water you will collect (Vlc).

Automatic Nozzle Selection
To have the program select a nozzle size for you, do the following:

- Run the K Factor function from the Isokinetic sub-menu. The program will calculate the ideal nozzle for you based on the test conditions and required volume entered. Then it will use the next largest diameter as the nozzle size. You also have the option to manually enter a different nozzle diameter.
- If you run the Parameters function, the program will not calculate the ideal nozzle size or reset the nozzle.

In general, use a nozzle of equal or greater diameter to increase the likelihood of sampling the minimum required volume. **Be sure to enter the actual nozzle size you will be using**. The program will calculate a K factor based on the actual nozzle size.

2.2 The Parameter Function

The Parameter function calculates the following test results: isokinetic percentage, volume metered, moisture content, molecular weight, gas velocity, volumetric flow rate, and emission rate (English mode only). Be sure to note all results before continuing to the next screen, because the program does not allow you to return to previous screens.

Please note the following:

- Enter the total volume of water collected plus the silica gel weight gain under Vlc.

- The last page is used to calculate the emission concentrations based on the fuel factor (Fd) and the weight, in grams, of particulate collected (Mn). If the oxygen content is 20.9 percent or higher, the Fd factor method is not valid for calculating the lb/MBtu emission.

Saturated Conditions
The program will check for saturated conditions. Bsat represents the moisture content at saturation for the given stack temperature. Bwo is the stack moisture content based on the volume of water collected. If Bwo is greater than Bsat, the stack gas is saturated. If this condition exists, the program will alert you and use Bsat to determine the isokinetics and molecular weight.

2.3 The Reset Variables Function

The Reset Variables function will reset the program variables and enter dummy data to be used with the Validation function. See Section 2.5 for a list of the variables that are initialized.

2.4 The Validation Function

Your calculator is equipped with a function for validating the K Factor and Parameter results. To run a validation check, follow these steps:

From the Isokinetic sub-menu

- run the Reset Variables function
- run the K Factor function
- run the Parameter function
- run the Validation function

The program will display each variable as they are validated until it reaches a variable which fails validation, at which point the program will pause and no other variable will pass.

For the K Factor function, the variables validated include:

Vlc	Volume of water collected
KF	K factor
Vm	Volume metered
Dn	Nozzle diameter

For the Parameters function, the variables validated include:

VD	Volume dry, corrected to standard conditions
VW	Volume dry
Qs	Flow rate, corrected to standard conditions
Qa	Actual flow rate
Vs	Velocity of stack gas
I	Isokinetic counter
Bwo	Moisture content
Bsat	Saturation moisture content
Md	Dry molecular weight
Ms	Wet molecular weight
GD	Grains per dry volume, standard conditions
PH	Pounds per hour
LM	Used - check - lbs/MBtu

The program will indicate whether the functions passed or failed validation. Each variable that passes will be displayed until a variable fails. It will return to the main menu after the user hits any key. If you suspect a problem with the validation program itself, you may check the results against those shown in the following section.

2.5 Manual Validation of Results

You may also validate the results by comparing them with those listed below. Running the Reset Variables function will initialize the variables shown below. (If the validation failed, be sure the following variables were initialized by the Reset Variables function). The sample calculations in Appendix B are based on the values shown. (A large number of significant figures are shown for the metric equivalents, in case you wish to use English or metric results).

Variable	Imperial	Metric	Description
%O2	9.0 %	9.0 %	% oxygen in the stack
%CO2	11.9 %	11.9 %	% carbon dioxide in the stack
%N2	79.1 %	79.1 %	% nitrogen in the stack
Bwo	0.0500	0.0500	Moisture fraction (0-1)
Pb	29.60 in. Hg	751.84 mm Hg	Barometric pressure
Pg	-6.0 in. H_20	-152.4 mm H_20	Static pressure in the stack
Ts	180°F	82.222 °C	Stack temperature
√ΔP	0.9500 Root in.	4.7878 Root mm	Average of the sq. root of ΔP
ΔH@	1.800 in. H_20	45.72 mm	Orifice reading @ 0.75 cfm
Θ	60 min	60 min	Duration of test
Tm	75.0 °F	23.888 °C	Temperature of the meter
Cp	0.84	0.84	Pitot calibration factor
Vr	30.00 ft^3	0.8495 m^3	Required volume

Once the dummy data has been loaded by running the Reset Variables function, the K Factor function should yield the following results if the calculator is working properly:

Variable	Imperial	Metric	Description
KF	1.00	1.00 K factor.	K factor
Est. Vmstd	30.77 ft^3	0.8716 m^3	Estimated dry volume @ STP
Est. Vm	31.44 ft^3	0.8906 m^3	Est. volume @ meter conditions
Est. Vlc	34.40174 ml	34.4 ml	Est. volume of moisture
Dn	0.187 in.	4.75 mm	Nozzle diameter

The Reset Variables function will also initialize the following variables for validating the Parameter function.

Variables	Imperial	Metric	Description
Yd	1.0000	1.0000	Dry gas meter calibration factor
As	10.00 ft^2	0.92903 m^2	Stack area
Dn	0.187 in.	4.75 mm	Diameter of nozzle
Vm	31.4381 ft^3	0.8906 m^3	Volume metered
ΔH avg.	1.00 in. H_20	25.4 mm H_20	Avg. DGM orifice readings
Mn	0.050 grams	0.050 grams	Weight of filtered particulate
Fd	9780 scf/Mtu	-	Coal fuel factor

You should receive the following results if the Parameter function is working properly. Be sure to first run both the Reset Variables function and K Factor function before validating results or comparing to those listed here.

Variables	Imperial	Metric	Description
Vmstd	30.77 ft^3	0.8716 m^3	Volume metered at STP
Vwstd	1.6199 ft^3	0.045875 m^3	Volume of the water vapor
% Iso*	100 %	100 %	Percent isokinetic
Bwo	0.0500	0.0500	Moisture fraction (0-1)
Bsat	0.5242	0.5242	Saturation moisture at Ts
Vs*	58.68 ft/sec	17.89 m/s	Velocity of the stack gas
Qstd*	26888 dscfm	45696 dscmh	Gas flow rate @ STP
Qact*	35208 acfm	59836 acmh	Actual gas flow rate
Md	30.26 lb/lb-mole	30.26 g/g-mole	Stack gas dry molecular weight
Ms	29.65 lb/lb-mole	29.65 g/g-mole	Stack gas molecular weight
concentration	0.0251 gr/dscf	-	Stack particulate grain loading
emission rate	5.779 lb/hr	-	Particulate emission rate per hr
	0.0615 Ib/MBtu	-	Particulate emission rate per MBtu fuel burned

*Note: The metric and English K factors found in EPA Method 2 are not equivalent to the full four significant figures. Converting the English factor of *85.49* to metric yields 34.96, not 34.97. Therefore, the English and metric results for Vs, Qstd, Qact, %I, and emission rates can only be compared to three significant figures.

If your calculator does not yield these results with the initial data listed on the previous page, the program has been corrupted and should be replaced.

3.0 TROUBLESHOOTING

3.1 Blank Screen

Problem: *I get a blank screen when I turn my calculator on.*

Solution:

1. The contrast on your screen may be too low.

To increase the contrast, hold down the diamond [◊] key while repeatedly pressing the plus [+] key until the desired contrast level is reached.

To decrease the contrast, hold down the diamond [◊] key while repeatedly pressing the minus [-] key until the desired contrast level is reached.

2. There may be a negative charge built up in the battery case.

To eliminate the charge, follow these steps:

- Turn the calculator over and remove the battery cover
- Remove one AAA battery
- While one battery is removed, press the [ON] button ten times
- Replace the battery
- Press the [ON] button
- If the screen is still blank, repeat solution 1.

This procedure should not erase any programs that are stored in the calculator memory.

3. Your batteries may be dead.

If possible, check the voltage across each battery using a voltmeter. It should read 1.5 volts or higher. When replacing the batteries, remove and replace one battery at a time. **Do not replace the small flat backup battery**. This battery keeps your programs intact.

4. If you are still unable to turn the calculator on, call Texas Instrument customer support at 1-800-TI-CARES (800-842-2737).

3.2 Incorrect Units Displayed

Problem: *The calculator is stuck in metric or English mode.*

Solution:

Run the Reset Variables function, and then select option 7 under the main menu to choose desired units.

3.3 DMA Error

Problem: *I get a pop-up with the title 'DMA Error' when I try to run the functions.*

.
Solution:

If you encounter a DMA (dynamic memory allocation) error, you will need to free up memory by deleting programs other than the CleanAir program from the calculator memory.

To delete programs, follow these steps:

1. From the home screen, press the second [2nd] key followed by the minus [-] key (same as VAR-LINK}.
2. Scroll down to the progam that you wish to delete and press the [F1] key.
3. Select '1:Delete' and press [Enter].
4. The program will ask you to verify the deletion. Press [Enter] to continue. To cancel the deleting process, press [ESC].

4.0 APPENDICES

4.1 Appendix A: Variables List

Variable	Type	Description
An	Real	Area of Nozzle
As	Real	Area of Stack
Bwo	Real	Moisture Content
Bsat	Real	Saturation Moisture Content
CO2	Real	Carbon Dioxide Percentage
Cp	Real	Pitot Coefficient
ΔH@	Real	Delta H@ of Meter
ΔH	Real	Average Delta H of Meter
Dn	Real	Nozzle Diameter
Fd	Real	Fuel Factor
FLAG	Real	Flag used to indicate failure during validation
GD	Real	Grains per Dry Standard
I	Real	Isokinetic Counter
IN	Real	Ideal Nozzle Size
K1	Real	Intermediate Constant
KF	Real	K Factor
LM	Real	Used - check - lbs/MBtu
Md	Real	Dry Molecular Weight
Θ	Real	Duration of Test Time
Mn	Real	Weight of Particulate Collected
Ms	Real	Wet Molecular Weight.
N2	Real	Nitrogen Percentage
NOZ[I]	Matrix	English Std. Nozzle Diameters
O2	Real	Oxygen Percentage
Pb	Real	Barometric Pressure
Pg	Real	Static Pressure
PH	Real	Pounds per Hour
Ps	Real	Absolute Stack Pressure
Qact	Real	Actual Flow Rate
Qstd	Real	Standard Flow Rate
√Δ P	Real	Square Root ΔP at Standard Conditions
SVP	Real	Saturated Vapor Pressure
T1-5	Real	Constant for Saturation Equation
Td	Real	Dry Bulb Temp
Tm	Real	Temperature of Meter
Ts	Real	Temperature of the Stack (or Sample)

4.1 Appendix A: Variables List (continued)

Tw	Real	Wet Bulb Temp
U	Real	Equals 0 for English Mode, 1 for Metric Mode
VD	Real	Volume Dry Standard
Vlc	Real	Volume of Water Collected
Vlo	Real	Volume of Water Collected Over saturation
Vm	Real	Volume Metered
Vmstd	Real	Volume Metered Corrected to Standard Conditions
VP	Real	Vapor Pressure
Vr	Real	Required Volume
Vs	Real	Velocity of Stack Gas
VW	Real	Volume Dry
Vwstd	Real	Volume of Water Vapor
Yd	Real	Meter Constant

4.2 Appendix B: Sample Calculations

K Factor Program (Module K)

Absolute stack pressure

$$P_s = P_b + \frac{St}{13.6}$$

$$English = 29.60 + \frac{-6.0}{13.6} = 29.159\ in.Hg$$

$$Metric = 751.84 + \frac{-152.4}{13.6} = 740.634\ mmHg$$

Dry molecular weight of the stack gas

$$M_d = 0.32(\%O_2) + 0.44(\%CO_2) + 0.28(\%N_2)$$
$$= 0.32(9.0) + 0.44(11.9) + 0.28(79.10) = 30.264$$

Stack gas molecular weight

$$M_s = M_d(1 - B_{wo}) + B_{wo}(18.01)$$
$$= 30.264(1 - 0.050) + 0.050(18.01) = 29.651$$

K Factor

$$KF = K_{std}Cp^2(\Delta H@)\frac{(T_m + T_{conversion})}{(T_s + T_{conversion})}\frac{P_s}{P_b}\frac{M_d}{M_s}(1 - B_{wo})^2(D_n)^4$$

$$English = 850(0.84)^2(1.8)\frac{(75 + 459.67)(29.159)(30.264)}{(180 + 459.67)(29.60)(29.651)}(1 - .0500)^2(0.187)^4 = 1.00$$

$$Metric = 8.03989x10^{-5}(0.84)^2(45.72)\frac{(23.888 + 273.15)(740.634)(30.264)}{(82.222 + 273.15)(751.84)(29.651)}(1 - .0500)^2(4.75)^4 = 1.00$$

Estimated volume metered

$$V_m = \frac{K_p 60\pi(T_m + T_{conversion})C_p\theta D_n{}^2\sqrt{\Delta P}(1 - B_{wo})}{(2\,x\,(\text{length conversion}))^2 Y_d\left(P_b + \frac{\Delta H_{ave}}{13.6}\right)}\sqrt{\frac{P_s}{M_s(T_s + T_{conversion})}}$$

$$English = \frac{(85.49)60\pi(75+459.67)0.84(60)(.187)^2\,0.95(1-0.05)}{(2(12))^2(1.000)\left(29.6+\frac{1}{13.6}\right)}\sqrt{\frac{29.159}{29.651(180+459.67)}} = 31.44\,ft^3$$

$$Metric = \frac{(34.97)60\pi(23.889+273.15)0.84(60)(4.75)^2\,4.7878(1-0.05)}{(2(1000))^2(1.000)\left(751.84+\frac{25.4}{13.6}\right)}\sqrt{\frac{740.634}{29.651(82.222+273.15)}} = 0.8906\,m^3$$

4.2 Appendix B: Sample Calculations (continued)

Estimated volume metered at standard conditions

$$V_{mstd} = D_{std} C_p (1 - B_{wo}) \theta D_n^{\ 2} \sqrt{\Delta P} \sqrt{\frac{P_s}{M_s (T_s + T_{conversion})}}$$

$$English = 493.4(0.84)(1-0.05)60(0.187)^2(0.95)\sqrt{\frac{29.159}{29.651(180+459.67)}} = 30.77 dscf$$

$$Metric = 6.3564x10^{-4}(0.84)(1-0.05)60(4.75)^2(4.7878)\sqrt{\frac{740.634}{29.651(82.222+273.15)}} = 0.8716 dscm$$

Parameter Program (Module P)

Volume metered at standard conditions

$$V_{mstd} = \frac{T_{std} V_m \left(P_b + \frac{\Delta H}{13.6}\right) Y_d}{P_{std}(T_m + T_{conversion})}$$

$$English = \frac{(527.67)(31.44)(29.60 + \frac{1}{13.6})(1.0000)}{(29.921)(75+459.67)} = 30.77 dscf$$

$$Metric = \frac{(293.15)(0.89056)\left(751.84 + \frac{25.4}{13.6}\right)(1.0000)}{(760)(23.889+273.15)} = 0.8716 dscm$$

Volume of the water vapor present

$$V_{wstd} = (0.04707)(V_{lc})$$

$$English = (0.04707)(34.4147) = 1.6199 ft^3$$

$$Metric = (0.001333)(34.4147) = 0.045875 m^3$$

Moisture fraction (between 0 and 1)

$$B_{wo} = \frac{V_{wstd}}{V_{wstd} + V_{mstd}}$$

$$English = \frac{1.6199}{1.6199 + 30.77} = 0.0500$$

$$Metric = \frac{0.045875}{0.045875 + 0.8716} = 0.0500$$

4.2 Appendix B: Sample Calculations (continued)

Velocity of the stack gas*

$$V_s = K_p(C_p)(\sqrt{\Delta P})\sqrt{\frac{(T_s + conversion)}{M_s P_s}}$$

$$English = 85.49(0.84)(0.950)\sqrt{\frac{(180+459.67)}{(29.65)(29.159)}} = 58.68\ ft/\sec$$

$$Metric = 34.97(0.84)(4.7878)\sqrt{\frac{(82.222+273.15)}{(29.65)(740.635)}} = 17.89\ m/\sec$$

Nozzle area

$$A_n = English = \frac{\pi}{4}\left(\frac{D_n}{12}\right)^2 = \frac{\pi}{4}\left(\frac{0.187}{12}\right)^2 = 1.90726\times10^{-4}\ ft^2$$

$$= Metric = \frac{\pi}{4}\left(\frac{D_n}{1000}\right)^2 = \frac{\pi}{4}\left(\frac{4.75}{1000}\right)^2 = 1.77205\times10^{-5}\ m^2$$

Percent isokinetic*

$$\%I = \frac{K_4(T_s + conversion)V_{mstd}}{P_s V_s A_n \theta(1-B_{wo})}$$

$$English = \frac{0.0945(180+459.67)30.77}{(29.159)(58.68)(1.90726\times10^{-4})(60)(1-0.0500)} = 100.0\%$$

$$Metric = \frac{4.320(82.222+273.15)0.8716}{(740.634)(17.89)(1.77205\times10^{-5})(60)(1-0.0500)} = 100.0\%$$

Flow rate at stack conditions*

$$Q_{act} =$$

$$English = (60)\tfrac{\sec}{\min}A_s V_s = (60)(10)(58.68) = 35208\,acfm$$

$$Metric = (60)\tfrac{\sec}{\min}(60)\tfrac{\min}{hour}A_s V_s = (60)(60)(0.92903)(17.8907) = 59836\,acmh$$

Flow rate*

$$Q_{std} = \frac{T_{std}Q_{act}P_s(1-B_{wo})}{P_{std}(T_s+459.67)}$$

$$English = \frac{(527.67)(35208)(29.159)(1-0.0500)}{(29.921)(180+459.67)} = 26888\,dscfm$$

$$Metric = \frac{(293.15)(59836)(740.634)(1-0.0500)}{(760)(82.222+273.15)} = 45696\ dscmh$$

4.2 Appendix B: Sample Calculations (continued)

(The following are in English units only.)

Concentration in grains per dry standard cubic feet (gr/dscf)

$$gr / dscf = \frac{\left(15.43\frac{grains}{gram}\right)M_n}{V_{mstd}}$$

$$= \frac{(15.43)0.050}{30.77} = 0.025073$$

Concentration (lb/10^6 Btu)

$$lb / 10^6\,Btu = \frac{(gr / dscf)F_d(20.9)}{(7000)(20.9 - \%O_2)}$$

$$= \frac{(0.025073)9780(20.9)}{(7000)(20.9 - 9.0)} = 0.0615$$

Emission rate (lb/hr)

$$lb / hr = \frac{(gr / dscf)(Q_{std})60\frac{\min}{hr}}{7000\frac{grains}{lb}}$$

$$= \frac{(0.025073)(26888)60\frac{\min}{hr}}{7000\frac{grains}{lb}} 5.778$$