Data Resource Systems, LLC

AGA 5.0 Gas Volume Calculator for Windows
Version 5.0.2

User’s Guide

Special note: In this document where you see Error! Bookmark not defined.
purchase of manual or software is required to view.

Written by Steven B. Hughes – President
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Notice

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Introduction

Gas Volume Calculator for calculation of AGA 1992 and NX-19 Supercompressibility formulae for Linear (EFM), Roots (L-10), and Percentage charts. Windows, DOS and Pocket PC versions available.

Features

- **Volume to Plate Calculations**
  Essentially backward calculates a new orifice plate size based upon a desired differential reading and the current gas volume.

- **Volume to Differential Calculations**
  Calculates the new differential pressure based upon the desired volume. Uses the current variables to determine the new differential pressure.

- **Meter Data Files**
  Information for individual sites is stored in dBase files for easy retrieval and recalculation.

- **Reports**
  Prints a single page report listing all variables, constants, factors and meter station name.
Installation Instructions, Hardware and Operating System

Insert DRS AGA 5.0 CD into CD-ROM. the install program should automatically run. If it does not auto-run, go to “Start”, “Run”, “Browse”, “My Computer”, choose CD-ROM drive and click on the application entitled “Setup”, then follow the instructions.

You must have a computer with a CD-ROM using Microsoft Windows 95 or a later version Microsoft Windows operating system.

Operation Instructions

Once the software is installed a screen like the one below will appear. Data must be entered on the Variable Page and on the Constants Page before a valid calculation will result. Instructions for calculating accurate gas volumes and flow rates are detailed in the following pages.
Variables

Meter Tube

<table>
<thead>
<tr>
<th>Nominal Size Inches</th>
<th>Published Inside Diameter, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.300  2.626  2.900  3.068</td>
</tr>
<tr>
<td>3</td>
<td>3.152  3.438  3.826  4.026</td>
</tr>
<tr>
<td>4</td>
<td>4.897  5.189  5.761  6.065</td>
</tr>
<tr>
<td>6</td>
<td>7.625  7.981  8.071</td>
</tr>
<tr>
<td>8</td>
<td>9.564  10.020 10.136</td>
</tr>
<tr>
<td>10</td>
<td>11.376 11.938 12.090</td>
</tr>
<tr>
<td>12</td>
<td>14.688 15.000 15.250</td>
</tr>
<tr>
<td>16</td>
<td>18.814 19.000 19.250</td>
</tr>
<tr>
<td>20</td>
<td>22.626 23.000 23.250</td>
</tr>
<tr>
<td>24</td>
<td>28.628 29.000 29.250</td>
</tr>
</tbody>
</table>


Maximum tube size entry for DRS AGA 5.0 is 50.000 inches.
Orifice Size
✓ Maximum orifice size is limited to 95% of tube size (0.95 Beta Ratio, e.g. Tube/Orifice Diameter)
✓ Minimum orifice size is limited to .010 inches.
✓ (Beta ratios above .65 will result in lower stated volumes)
✓ (Beta ratios below .12 will result in higher stated volumes)

Hours (Flow Time)
✓ All volumes are calculated in thousand cubic feet (MCF)
✓ Normally set hours to 24 for MCFD calculations
✓ For 1 hour flow rates set hours to 1 for MCFH calculations
✓ Partial hours, days or total volume for an extended period (such as weekly or monthly) can be calculated up to 32,000 hours using averages for the period.

Static Pressure
Pressure readings are taken in PSIA, PSIG+atmospheric PSI, percentage of static pressure range, or roots.

✓ Upstream Pressure Tap Solution
  Pressure readings are taken at tap on downstream side of orifice plate in PSIA. If static pressure reading is taken at the upstream tap, then a correction for the excess pressure must be made in the static pressure entry as follows:

  \[ \text{PSIA upstream} - \left( \frac{\text{Diff Pressure}}{27.6807} \right) = \text{PSIA downstream} \]

  This calculation must be performed with the actual units of measurement, not percentages or roots.

✓ Vacuum Pressure Solution
  (purchase of manual or software required to view)
Differential Pressure
Differential pressure readings are entered as inches of water column, percentage of differential pressure range or roots.

✓ Over-ranged Differential Reading Solution
(purchase of manual or software required to view)

Temperature
Temperature in degrees Fahrenheit, percentage of temperature range or roots. Accepts values from -40 degrees to full range of temperature element range

Results
Volume calculation results are stated in thousand cubic feet (MCF) and million British thermal units (MMBTU).
Constants

Components (Acquire values from a valid gas analysis)

**Carbon Dioxide (CO₂)**  
Accept values from 0 to 15 percent

**Nitrogen (N₂)**  
Accept values from 0 to 15 percent

**BTU**  
Accepts values from 500 to 2000 BTU per cubic foot

**Gravity**  
Accepts values from 0.500 to 1.000  
- Air = 1.000, Methane = .5539  

Most published tables and circular slide rule orifice computers use .600 as standard for natural gas.
Contract

Temperature Base
Accepts values from 1 to 300 degrees

Pressure Base
Accepts values from 10.0 to 17.0 PSI

Barometric Pressure
Accepts values from 10.0 to 17.0 PSI

Ranges {required for Percentage and Root (L-10) Calculations}

Differential
Enter the differential pressure range of the recorder. Accepts values greater than 1 and less than 15000.

Static
Enter the static pressure range of the recorder. Accepts values greater than 1 and greater than 5000

Temperature
Enter the temperature range of the recorder. Accepts values greater than 1 and less than 240.

Meter Tube Material
304 or 316 Stainless
Carbon Steel
Monel

Orifice Material
304 or 316 Stainless
Carbon Steel
Monel

Chart Type
Linear
Percentage
Root (L-10)

Tap Type
Flange - Taps are together at the orifice fitting.

Pipe - Taps are located upstream and downstream of the orifice by the length of several pipe diameters.

Factors (Glossary)
\[ C' = (C') \text{ Orifice flow constant (Cubic feet per hour)} \] [Dynamic factor]

\[ C' = F_b \ F_r \ Y \ F_{pb} \ F_{tb} \ F_{tr} \ F_g \ F_{pv} \ F_{m} \ F_a \ F_l \]

**1 Hour** flow coefficient [for stating thousand cubic feet per hour: use is dependent upon chart type selected; linear, roots(L-10), percentage] [Dynamic factor]

**24 Hour** flow coefficient [for stating thousand cubic feet per day: use is dependent upon chart type selected; linear, roots(L-10), percentage] [Dynamic factor]

**\( F_b \)** Basic orifice factor [Orifice factor only; i.e. \( C' \) without influence of other factors, but for cubic feet of air per hour.]
Factors (Glossary – continued)

Exercise: Examine all of the above factors including the “Volume MCF” while entering the following variables and constants into the DRS AGA 5.0 application.

Differential = 0.065 (rounds to .07)
Static = 14.73
Temperature = 60 Deg F
Tube Size = 2.067
Orifice Size = 1.000
Hours = 1.0
CO2% = 0
N2% = 0
Gravity = 1.000
Temp. Base = 60
Pressure Base = 14.73
Barometric Press = 14.73
Diff Range = 100
Static Range = 100
Temp Range = 150
Meter Tube Material = Carbon Steel
Orifice Material = 304 or 316 Stainless
Chart Type = Linear

Note results:
Volume MCF 0.214 MCF
CPrime 219.098
Fb 210.194
1 Hour .2191 × 24 = 5.2584 (24 Hour)

The results are almost all the same because they have been reduced to near base values, i.e. almost non-dynamic.

F_{pv} Supercompressibility factor: Pressure compensation for molecular interaction of a natural gas mixture as pressure increases.

β Beta Ratio = Ratio of orifice diameter to upstream pipe inside diameter .e.g. 0.500 orifice divided by 4.026 i.d. meter tube equals a 0.124 beta ratio.

F_{gr} Specific gravity factor: The Basic Orifice Factor value was determined with air flowing at 60° F. The Specific Gravity Factor adjusts for gravity deviation from the gravity of air which equals 1.000. Specific Gravity of a gas is its Relative Density as compared to air.

F_{tf} Flowing temperature factor: The Basic Orifice Factor is for air flowing at 60° F. The flowing temperature factor adjusts for temperature deviation from 60° F.
Factors (Glossary – continued)

**F<sub>r</sub>  Reynolds number factor:** Corrects for effects of viscosity and velocity

**F<sub>tb</sub>  Temperature base factor:** In the United States most gas is marketed at a temperature base of 60° F. The base is 60° F and the factor corrects for deviation from 60° F.

**Y  Expansion factor:** When a gas flows through an orifice, the change in velocity and pressure is accompanied by a change in specific weight. A factor is required to correct for effects [As stated in ANSI/API 2530].

**F<sub>pb</sub>  Pressure base factor:** In the United States most natural gas is marketed at a pressure base of 14.65 or 14.73 PSI per cubic foot. Calculation is performed using 14.73, the factor corrects for deviation from 14.73.

Factors included in C’ which are listed below are not shown on the AGA 5.0 Factor page

**F<sub>m</sub>  Manometer factor and F<sub>f</sub>  Gage location factor:** Adjustment for using recording mercury manometer for differential pressure unit. Not calculated or used in DRS AGA 5.0.

**F<sub>a</sub>  Orifice thermal expansion factor:** Introduced to correct for the error resulting from expansion or contraction of the orifice operating at temperatures appreciably different from the temperature at which the orifice was bored [As stated in ANSI/API 2530].
Special Features

Volume to Plate (Backward calculation algorithm)

Answers the question, “What plate size is needed to increase the volume to X MCF?” Holds DP as constant as possible and calculates the new plate size for a new volume limited by the DP range and other constants except plate size. Gives new plate size and corresponding DP if over range occurs.

Select the “fourth from left icon” on the toolbar. Enter desired target DP up to 80% of DP range, then perform calculation. If DP result is greater than 80%, then the next larger orifice plate size is automatically selected with the new target DP being 50% of DP range.

Volume to Differential (Backward calculation algorithm)

Answers the question, “What would the differential reading be if the flow rate was increased to X MCF? Allows you to calculate the new “what if?” differential pressure upon change of volume, limited by the existing meter tube and orifice size. Holds orifice plate at existing diameter and calculates new DP for entered volume (Calculates resulting DP in inches of water but not in percent or roots. Does not consider DP range.)

Select the “fifth from left” icon on the toolbar. Enter desired target volume to calculate the resulting DP reading.
Data Files

- Default File Name. **The last file used automatically becomes the Default start up file.**

- After creating a Standard Default file, the file can be created from the File menu:
  Open a Record to choose a standard company default file.

- File Name length maximum is 25 characters, extra characters are truncated. A record for each meter or instance can be stored if careful file naming is used.

- Individual records are stored in a dBase format file. No calculated results are stored.

Printing of Data Sheet Report

**Report Print View:**
Zoom in and out by pressing left and right mouse buttons.

**Printer Setup:**
Prints to the Windows default printer without choice.
Application Notes

Electronic Flow Computers
EFM’s have the ability to turn off factors in calculations. Use Linear for the Chart Type on the Constants page. Ranges must be set to the actual range or greater.

Chart Recorders
Chart recorders may have different chart types. Chart Type settings are found on the Constants page.

*(purchase of manual or software required to view)*
Volume Statements

Volume statements sometimes roll several factors together or show very little information to help audit the transaction. Sometimes it is uncertain which factors have been used to produce a particular value. Tests must be performed upon empirical values by backing out factors to uncover remaining values to discover how the end result was calculated. Trial and error must be undertaken in order to solve for these unknown values. Then it is necessary to determine what factors the remaining unknown values represent. The Factors page is helpful in determining if certain legal and contractual factors were included in the stated volume or energy value.

Sometimes a call to the company who published the “Gas Volume Statement” is necessary to find out what has been rolled into a combined factor.

Orifice Well Tester – see page 6
Over-ranged Differential Pressures – see page 6
Vacuum Systems – see page 5
Field Volume Calculation Methods for Linear, Roots (L-10), Percentage

(purchase of manual or software required to view)
Calculating Coefficients for Field Spot Readings with a Calculator

There have been many misunderstandings between purchaser and seller due to the lack of understanding of what a field coefficient actually represents when used in the field with a regular hand calculator, this can be a real source of confusion. Developing a consistent way of calculating a field coefficient for use in field calculations should remedy the situation at least, in part.

Coefficients may need to be as generic as possible or generally adapted to a company’s normal operations in order to give a fairly accurate but generic coefficient. There is really no way to calculate a coefficient that is dynamic and always accurate as opposed to a virtually non-dynamic generic coefficient which would not be accurate in most cases.

Example of how to develop a “Standard Default” coefficient for general operations:
“Standard Default”: i.e. A setup which takes minimum changes to arrive at an accurate volume, as indicated in bold type below.

- **Differential** = 5 Roots
- **Static** = 5 Roots
- Temperature = 6.32 (60°F)
- **Tube Size** = 2.067
- **Orifice Size** = 1.000
- Hours = 24
- CO2% = 0
- N2% = 0
- Gravity = 0.6
- Temp. Base = 60
- Pressure Base = 14.65
- Barometric Press = 14.4
- **Diff Range** = 100
- **Static Range** = 100
- **Temp Range** = 150
- Meter Tube Material = Carbon Steel
- Orifice Material = 304 or 316 Stainless
- Chart Type = Roots(L-10)
Noted Errors in Report Printing

Constants:
BTU, units are expressed in /Cubic Feet, should be /Cubic Foot.

Factors:
The term "Beta Factor" should read "Fb Factor" or "Basic Orifice Factor".

References


ANSI/API 2530 First Edition, 1978 -
American Gas Association, Report #3
American National Standard Institute ANSI/API 2530
American Petroleum Institute API 2530

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