

# COMPARISON ANALYSIS OF Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids

A.G.A. Report No. 3/ANSI/API 2530  
1985 Edition vs. 1978 Edition

Transmission Measurement Committee  
Report No. 3-A



OPERATING SECTION  
AMERICAN GAS ASSOCIATION  
1515 WILSON BOULEVARD  
ARLINGTON, VIRGINIA 22209

### Part Three Flow Calculation Example

Example calculations are provided using the equations and tables in ANSI/API 2530-1985 (Second Edition). In order to assist the user in interpreting the methodology, the data set "given" below is for a single flow measurement example. It is used consistently throughout this example. Initially the quantity rate of flow is computed under the assumption that the measurements are absolute and without error. This is followed with a section on possible calibration and correction factors, which may be applied depending upon the type of instrumentation used and the calibration methods employed.

Given:

Orifice meter equipped with flange taps, with the static pressure from the downstream tap.

L = 35° latitude, meter location  
H = 500 feet elevation above sea level, meter location  
D = meter size = 8.071 in. mean meter tube internal diameter  
d = orifice size = 4.000 in. (316 S.S. Plate) mean orifice bore diameter at 70°F  
T<sub>a</sub> = ambient temperature = 70°F + 459.67 = 529.67°R  
T<sub>f</sub> = flowing temperature = 65°F + 459.67 = 524.67°R  
P<sub>f</sub> = contract pressure base = 14.65 psia  
T<sub>b</sub> = temperature base = 50°F + 459.67 = 509.67°R  
G<sub>b</sub> = specific gravity 0.570  
M<sub>r</sub> = mol percent nitrogen content = 1.10%  
M<sub>n</sub> = mol percent carbon dioxide content = 0.00%  
h<sub>c</sub> = average differential pressure = 50 in. water  
C<sub>p</sub>/C<sub>w</sub> = 1.3  
μ = 0.0000069 lb/ft sec  
mol percent methane content = 96.70%  
mol percent ethane content = 2.20%  
average downstream gage static pressure = 370 psig

NOTE - See Section 2 of ANSI/API 2530-1985 (Second Edition) for symbols used in the equations.

Use Equation E5 to calculate the average atmospheric pressure

$$P_{\text{atm}} = \frac{55096 - (\text{Elevation, ft} - 361)}{55096 + (\text{Elevation, ft} - 361)} \times 14.54 \text{ psia} \quad (\text{Eq E5})$$

### TEMPERATURE BASE FACTOR

Use Equation 67 to calculate  $F_{tb}$

$$F_{tb} = \frac{T_b}{519.67} = \frac{509.67}{519.67} = 0.98076$$

From Table D2

$$F_{tb} = 0.9808$$

### FLOWING TEMPERATURE FACTOR

Use Equation 68 to calculate  $F_{tf}$

$$F_{tf} = \left[ \frac{519.67}{T_f} \right]^{0.5} = \left[ \frac{519.67}{524.67} \right]^{0.5} = 0.99522$$

From Table D3

$$F_{tf} = 0.9952$$

### REAL GAS RELATIVE DENSITY (SPECIFIC GRAVITY) FACTOR

Use Equation 69 to calculate  $F_{gr}$

$$F_{gr} = \left[ \frac{1}{G_r} \right]^{0.5} = \left[ \frac{1}{0.570} \right]^{0.5} = 1.32453$$

From Table D4

$$F_{gr} = 1.3245$$

### SUPERCOMPRESSIBILITY FACTOR

Use Equation 73 to calculate the

Adjusted Pressure for use with the NX-19 equations and Table D5

$$P_{adj} = \frac{156.47 P_{f1}}{160.8 - 7.22 G_r + (M_c - 0.392 M_n)} \quad (\text{Eq 73})$$

Substituting the static pressure (gage), specific gravity,

mol-percent carbon dioxide and mol-percent nitrogen

$$P_{adj} = \frac{156.47 \times 370}{160.8 - 7.22 \times 0.570 + (0.00 - 0.392 \times 1.1)} = 370.5$$

Use Equation 74 to calculate the

Adjusted Temperature for use with the NX-19 equations and Table D5

$$T_{adj} = \left[ \frac{226.29 T_f}{99.15 + 211.9 G_r - (M_c + 1.681 M_n)} \right] - 460 \quad (\text{Eq 74})$$

Substituting the flowing temperature, specific gravity, mol-percent carbon dioxide and mol-percent nitrogen

$$T_{adj} = \frac{226.29 \times (65 + 460)}{99.15 + 211.9 \times 0.570 - (0.00 + 1.681 \times 1.1)} - 460$$

$$T_{adj} = 84.8^\circ\text{F}$$

Use equations presented in PAR RESEARCH PROJECT NX-19 MANUAL to calculate the Supercompressibility Factor  $F_{pv}$ . Substitute the intermediate values in the successive equations as follows

$$\pi = \frac{P_{adj} + 14.7}{1000} = \frac{370.5 + 14.7}{1000} = 0.3852$$

$$\tau = \frac{T_{adj} + 460}{500} = \frac{84.8 + 460}{500} = 1.0896$$

$$m = \frac{0.0330378}{\tau^2} - \frac{0.0221323}{\tau^3} + \frac{0.0161353}{\tau^5}$$

$$m = \frac{0.0330378}{1.0896^2} - \frac{0.0221323}{1.0896^3} + \frac{0.0161353}{1.0896^5} = 0.021224751$$

$$n = \frac{\frac{0.265827}{\tau^2} + \frac{0.0457697}{\tau^4} - \frac{0.133185}{\tau^1}}{m}$$