Annex J (normative)
Gas meters and input calculation

Note: *This Annex is a mandatory part of this Standard.*

J.1 General

Gas meters shall have an accuracy of ±1% over the range of measurement. Gas meters with internal compensation for either or both pressure and temperature shall be calibrated over the gas supply temperatures and pressures to which they are subjected during use. Gas meters shall be used within its upper and lower boundaries of accuracy. No correction for meter accuracy shall be applied to the input calculations.

It shall be determined if the reported laboratory heating value (HV) of the gas is a dry or saturated value.* The following formulas shall be used to convert between H_{dry} and HV_{sat} at STP conditions of 30 in Hg (101.59 kPa) and 60 °F (15.56 °C):

$$HV_{sat} = \frac{HV_{dry}}{1.0177} \text{ or } HV_{dry} = 1.0177 \times HV_{sat}$$ **Equation J.1**

* *The gas delivered to the test lab should have no significant water moisture. The saturated or dry gas heating value should be a result of how the measurement of the heating value is performed and whether the HV of the calibration gas was reported as a dry or saturated value.*

If using a dry test meter, the HV of the gas entered into Equation J.2 should be the dry HV. If using a wet test meter, the HV used in Equation J.4 should be the saturated value even though the gas might actually be dry as it enters the meter because saturation will occur within the meter.

J.2 Dry gas meters:

The equation for gas input measurement shall be as follows:

$$Input = V \times HV_{dry} \times CF_{dry} \times \left(\frac{3600}{t}\right)$$ **Equation J.2**

where

Input = BTU/h (MJ/h)

V = volume of gas measured, ft^3 (m^3)

HV_{dry} = gross, real heating value based upon a dry gas (no water saturation), Btu/ft^3 (MJ/m^3)

CF_{dry} = correction for standard temperature and pressure deviation (see Equations J.3 and J.4) as measured in the gas meter, dimensionless

3600 = conversion of seconds to hour

t = time recorded for the measurement of V, seconds

Conversion from MJ/h to kW is: 1 MJ/h = 0.2778 kW.

CF_{dry} for a dry test meter without any internal temperature or pressure compensation is given as follows:

a) for US customary units of measurement:

$$CF_{dry} = \left[\frac{459.67 + 60}{459.67 + G.T.}\right] \times \left[\frac{B.P. + (M.P./13.56)}{30}\right]$$ **Equation J.3**

where

459.67 = conversion of °F to °R

60 = standard temperature, °F

G.T. = gas temperature in the gas meter, °F

B.P. = barometric pressure, in Hg

M.P. = meter pressure, in inches water column

13.56 = conversion of inches water column to in Hg

30 = standard pressure, in Hg

b) for SI units of measurement:

$$CF_{dry} = \left[\frac{273.15 + 15.56}{273.15 + G.T.}\right] \times \left[\frac{B.P. + M.P.}{101.59}\right]$$ **Equation J.4**

where

237.15 = conversion of °C to °K

15.56 = standard temperature, °C

G.T. = gas temperature in the gas meter, °C

B.P. = barometric pressure, kPa

M.P. = meter pressure, kPa

101.59 = standard pressure, kPa

For a volumetric gas meter incorporating an acceptable compensation device, the appropriate elements of Equations J.3 and J.4 would not be used. For example, if a temperature compensator is included, the temperature portion of Equation J.3 and J.4 would be unity or 1.00. If the meter contains both temperature and pressure compensation, CF_{dry} would be 1.00.

J.3 Wet gas meters

For a water based, volumetric displacement gas meter (commonly referred to as a “wet meter”), the input formula is as follows and assumes a nearly complete saturation of the gas with water vapour as the gas flows through the wet meter:

$$Input = V \times HV_{sat} \times CF_{sat} \times \left(\frac{3600}{t}\right)$$ **Equation J.5**

where

Input = Btu/h (MJ/h)

V = volume of gas measured, ft^3 (m^3)

HV_{sat} = gross, real heating value based upon a wet gas which assumes 100% saturation with water vapour, Btu/ft^3 (MJ/m^3)

CF_{sat} = correction factor for standard temperature and pressure (see Equations 6 and 7) as measure in the gas meter with water saturated gas, dimensionless

3600 = conversion of seconds in 1 h

t = time recorded for the measurement of V, seconds

Conversion from MJ/h to kW is as follows: 1 MJ/h = 0.2778 kW.

CF_{sat} for a wet test meter without any internal temperature or pressure compensation is given as follows:

a) for US customary units of measurement:

$$CF_{sat} = \left[\frac{459.67 + 60}{459.67 + G.T.}\right] \times \left[\frac{B.P. + M.P. - E}{30 - 0.52}\right]$$ **Equation J.6**

where

G.T. = gas temperature in the gas meter, °F

B.P. = barometric pressure, in Hg

M.P. = meter pressure, in Hg (or inches water column divided by 13.56)

E = vapour pressure of water at the gas meter temperature, in Hg

0.52 = vapour pressure of water at 60 °F, in Hg

b) for SI units of measurement:

$$CF_{sat} = \left[\frac{273.15 + 15.56}{273.15 + G.T.}\right] \times \left[\frac{B.P. + M.P. - E}{101.59}\right]$$ **Equation J.7**

where

237.15 = conversion of °C to °K

15.56 = standard temperature, °C

G.T. = gas temperature in the gas meter, °C

B.P. = barometric pressure, kPa

M.P. = meter pressure, kPa

E = vapour pressure of water at the gas meter temperature, kPa

101.59 = standard pressure, kPa

The vapour pressure of water at various temperatures can be found in the AGA *Gas Engineers Handbook* in Table 1-27, Properties of Air, and in numerous other handbooks.

From 35 °F (1.7 °C) to 115 °F (46.1 °C), *E* can be adequately approximated using Antoine's equations for the vapour pressure of water:

a) for US customary units of measurement:

$$E = \frac{10^{8.07131 - \frac{1730.63}{233.426 + \frac{T-32}{1.8}}}}{25.4}$$ **Equation J.8**

where

E = vapour pressure of water at the gas meter temperature, in Hg

T = temperature of the gas in the meter, °F

25.4 = conversion of mm Hg to in Hg

b) for SI units of measurement:

$$E = 0.1333 \times 10^{\left(8.07131 - \frac{1730.63}{233.426 + T}\right)}$$ **Equation J.9**

where

E = vapour pressure of water at the gas meter temperature, kPa

0.1333 = conversion of mmHg to kPa

T = temperature of the gas in the meter, °C