Mass Flow Compensation

The purpose of performing a mass flow compensation is to standardize the amount of material (usually steam or natural gas) being transferred from one location to another. Since pressure and temperature can cause variance in the density of the material, a compensation calculation must be performed (so that, for example, a customer does not purchase a volume of low-density natural gas at the same price as a higher density volume). This compensation is required by law in certain applications.

Calculation

The mass flow computer accepts 3 inputs:

Flow input	(pulsed or 4-20mA signal from a flow meter)
Temperature input	(RTD or 4-20mA signal)
Pressure input	(4-20mA signal)

The computer uses these three inputs in combination with programming parameters to calculate and display a so-called "standard flow" (this flow can also be totalized). Programming parameters include standard temperature, standard pressure, gas compressibility, and gas molecular weight. The idea is that regardless of the actual volume flowing through the meter, the computer will display what *would* be flowing if the pressure and temperature were the standards mentioned above. The calculation to perform this adjustment is as follows:

SV = (AD/BD) * AV

Where

SV is Standard Volume
AD is Actual Density
BD is Base Density
AV is Actual Volume

AD is calculated by the computer from the pressure input, the temperature input, and the programming parameters. BD is a constant – it derives from the standard pressure and temperature in conjunction with the programming parameters. AV is derived from the input of the flow meter and corresponds to the actual volume of gas flowing through the meter. All of these quantities are used to calculate SV, which is our end result and can be totalized, rate-measured, et cetera. Note that if AD > BD, the gas is denser than the standard and so SV > AV. Conversely, if AD < BD, the gas is less dense than standard and so SV < AV.

<u>K-factor and the linearization feature</u>

A flow meter can fall into one of two categories: those with a *linear* response and those with a *nonlinear* response. A meter with a 4-20mA output will typically fall into the linear category. For pulsed output meters, a linear response implies that the number of pulses per unit volume stays constant, regardless of flow rate. In this instance, the meter manufacturer will provide a single *K-factor* which is then programmed into the mass flow computer (you can think of this K-factor as being similar to a count scaler). The user will also need to input a single value for F (frequency), and this can be any nonzero value (1 is standard).

A pulsing meter with a nonlinear characteristic will not give a steady change in pulse frequency with a steady change in actual flow. In order to correct this, the mass flow computer is able to perform a *linearization* of the incoming data. To enable the linearization feature, the user must enter (up to 20) pairs of K and F values. The frequency values signify flow rates, typically in units of volume per second.

For example, if the pairs entered are (K1, F1), (K2, F2), and (K3, F3), you are telling the computer:

- "At flow rate F1, the meter produces K1 pulses per unit volume."
- "At flow rate F2, the meter produces K2 pulses per unit volume."
- "At flow rate F3, the meter produces K3 pulses per unit volume."

and so on. This instructs the computer to compensate for the nonlinearity of the meter, allowing it to produce valid data.