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TECHNICAL NOTES

TEMPERATURE AND PRESSURE COMPENSATION FOR GAS

INTRODUCTION

Turbine flowmeters may be utilized to provide an accurate measurement of flow rate and total flow of various gases over wide flow ranges.

Where the desired measurement units are volumetric, for example, in actual cubic feet per minute, standard Digital Flow Rate Indicators and Totalizers may be used.

For most applications, however, the user wishes to know the flow rate or total flow at some reference condition (70°F, 4.7 PSIA). For these latter applications, temperature and/or pressure compensation may be performed electronically to provide the user with an indication or output in the desired units, at the desired reference condition.

The basic equation which the temperature and pressure compensated flow measurement system implements is:

$$Q_{REF} = \frac{S.F. \times Q_{FLOWING} \times \frac{PF_{ABS}}{P_{REF}} \times \frac{T_{REF}}{T_{ABS}}}{TF}$$

Where

Q REF	Flow at reference condition
Q FLOWING	Volumetric flow measured at flowing temperature and pressure
S.F.	Scaling Factor
PF ABS	Flowing Pressure (absolute)
P REF	Pressure at reference condition (absolute scale)
T REF	Temperature at reference condition (absolute scale)
T ABS	Flowing temperature (absolute)

APPLICATION

The accuracy of a Temperature/Pressure Compensated Measurement System is largely dependent on the accuracies of the flowmeter, temperature transmitter and pressure transmitter. Also, it is required that the transmitters be correctly installed.

The turbine flowmeter should be chosen so that it is operated within its linear range. Suitable installation requires straight runs of pipe into and out of the meter of the same nominal bore. See user manual on the turbine flowmeter for details.

The temperature transmitter is chosen to provide in range measurement for all anticipated ambient environmental conditions. Good thermal contact with the media should be provided. The temperature transmitter should be located in the downstream straight pipe run. The output signal may be any of the standard process current or voltage signals (i.e. 4-20-mA, 10-50 mA, 0-5V, 0-10V). Factory wired options are equipped for the users desired signal range. +15 VDC and +24 VDC are provided for driving external transmitters.

For this system it is necessary to select a suitable pressure transmitter such that the maximum flowing pressure not exceed 75% of the calibrated output span. For example, if the maximum anticipated pressure is 150 PSI, choose a pressure transmitter with a calibrated output span of 0-200 PSI. The pressure tap should be located in the downstream pipe run. Comments as to the available signals which may be accepted by the Temperature and Pressure Compensator also apply to the Pressure Transmitter input channel.

Scaling of the various signals is performed within the Temperature and Pressure Compensator and by other signal processing circuitry within the unit to provide output indication in the units of measurement desired by the user. The user's manual explains the simple calculation involved, as well as, means to incorporate a mean super compressibility factor into the scaling.

PRINCIPLE OF OPERATION

The basic operation of the system is described in the following dialogue:

The output signal from the turbine flowmeter is a digital pulse train whose frequency is proportional to the actual volumetric flow rate and where each pulse represents a discrete volume of gas that has passed through the flowmeter.

This signal is amplified and shaped into a train of pulses suitable for further processing by the digital circuitry within the measuring system.

The output signal from the pressure and temperature probe are conditioned into voltage signal proportional to absolute temperature and absolute pressure.

The flow, temperature and pressure information are then combined digitally according to the following relationship:

$$Q = \frac{F}{T} \times \frac{P}{FABS} \times FABS$$

The output signal is then passed to a digital scaling network that scales the calibration data on the flowmeter, the proportioning constants for the temperature and pressure transmitters and provides a signal in the user desired measurement units of flow.

This resulting signal then is passed to the drive circuitry and finally to the panel meter for display.