ELECTRONIC VOLUME CORRECTOR BASICS AND INSTALLATION EXAMPLES

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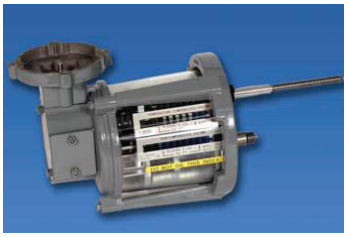
Introduction

Over the past 20+ years, the capability, footprint and mounting styles of the electronic gas volume corrector have evolved significantly. The use of electronic measurement equipment has increased tremendously over the past several years as cost has decreased at the same time that reliability and connectivity options have increased. The intent of this presentation is a discussion of basic gas volume pressure and/or temperature correcting equipment.

In the old days…

Historically, gas volume correcting and compensating equipment was primarily mechanical in nature. Instrument drive mounted mechanical pressure recording devices, such as chart recorders, were the industry standard used to chart variations in pressure at a particular metering site. In some cases this technology is still used, but with the advent of electronic technology, this is becoming less the case. For basic temperature compensation on rotary type gas meters, the industry standard for many years has been the mechanical TC accessory unit. With the introduction of electro-mechanical temperature compensating devices two decades ago, this also has prompted the evolution to the electronic temperature compensating accessory units for rotary meters.

Mechanically Temp Compensated ID



Typical Pressure Chart Recorder

What prompted the movement to electronics?

Deregulation in the Gas Industry:

For many years, the gas distribution industry has used mechanical accessory units. They work properly, are accurate and give them the billing information they require from the meter. There are many factors that have precipitated the move to electronic forms of correction/compensation.

The advent of deregulation in the natural gas industry – e.g. FERC 636 – which created the need for more and better information, in a timely manner. In some cases, information that was formerly gathered at best monthly, was now required daily, or, in the case of larger installations, hourly. Customers now had the ability to nominate from whom they would buy their gas, and how much. Transportation customers such as these increase the need for accurate and timely information on much more than just volumetric information, but also for

information such as temperature and pressure, etc.

Automated Meter Reading and Advances in Modem Technology:

AMR has been around in some form for several decades and has integrated well with mechanical accessory units for the collection of volumetric pulse data. The requirement for more than volumetric data in a timely manner, along with advanced AMR/AMI systems capability has been instrumental in utilities making the switch to electronics.

Advances in Electronics Technology:

A couple of decades ago, the general concept of an electronic volume corrector was the following:

- Volumes, pressure, temperature were displayed on the LCD only – no logging.
- Later on, the requirement was for corrector to provide at least one month of hourly logged data.
- Changes to configurations were either made on a resident keypad, via a proprietary hand held device, or were introduced by physically moving jumpers on circuit boards. Programming was generally stored in RAM. When the battery lost power, the configuration was gone and had to be reloaded.
- Field power to the corrector was provided by either alkaline or lithium bricks and one year of service was considered the norm.
- And…finally…electronic volume correctors always had a mechanical backup "just in case"!

Instrument Drive Version Corrector with Mechanical Base

Solid state electronics, advances in battery technology and faster microprocessors have all contributed to wider acceptance of electronics, including rotary meter integral designs now offered by many manufacturers. Lithium battery packs can now extend the time required between meter site visits to 10+ years. Certain integral gas volume correctors have the expanded capability of monitoring the health of the meter by sensing differential pressure, displaying it and logging it. In states that allow differential testing as an inference of meter health, this is not only a significant savings in the Operation/Maintenance budget, but also helps to assure compliance with state differential testing requirements.

Integral Volume Corrector with Differential Pressure Capability

How do they work?

Electronic gas volume correctors, at a minimum, sense actual line pressure, temperature and actual volume and convert this information to standard conditions. Gas meters measure the volume of gas at existing line conditions of pressure and temperature. This volume is usually referred to as displaced volume or actual volume (VA). The value of the gas (i.e., heat content) is referred to in gas measurement as the standard volume (VS) or volume at standard conditions of pressure and temperature.

Since gases are compressible fluids, a positive displacement meter that is measuring gas at two (2) atmospheres will have twice the capacity that it would have if the gas is being measured at one (1) atmosphere. This fact is referred to as Boyle's Law which states, "Under constant temperature conditions, the volume of gas is inversely proportional to the ratio of the change in absolute pressures". This can be expressed mathematically as:

P1 V1 = P2 V2 or
P1/P2 = V2/V1

Charles' Law states that, "Under constant pressure conditions, the volume of gas is directly proportional to the ratio of the change in absolute temperature".

V1/T1 = V2/T2 or
V1 T2 = V2 T1

The electronic corrector automatically performs the function of the application of pressure and/or temperature correction factors, and the output is standard cubic feet for the time period in question – generally per hour or per day. The mathematical representation is:

Vs = Va x Fp x Ft

Where Vs equals standard or corrected volume; Va represents actual gas volume and Fp and Ft are the appropriate pressure and temperature correcting factors. In years past, these calculations were done manually with pressure and temperature factor tables.

Installation safety considerations – hazardous area definitions.

There are certain criteria that must be considered in the installation of electronic measurement equipment. Guidelines for the design and installation of electronic correctors are provided by various technical and approval organizations. The National Electrical Code designates the Class which defines the nature of the hazardous material that is present in the atmosphere. For example, a Class 1 installation would indicate that the material present in the atmosphere is in the form of gas or vapor and it is possible for these materials to be present in quantities that can result in ignition or explosion. In the natural gas industry, we typically deal with Class 1 locations.

The Division designation defines the probability that such a hazard would even be present. A Division 1 area is defined as an area in which ignitable concentrations of flammable gases or vapors could exist under normal operating conditions. A Division 2 area could also have such gases or vapors present, however, these materials would only exist under abnormal operating conditions and therefore, the probability of this existing is considered low. In

the natural gas industry, we deal with both Division 1 and Division 2 area designations. The Group designation of the area more specifically defines the materials that can be present in the hazardous area.

- Group A – Acetylene
- Group B – Hydrogen
- Group C – Ethylene
- Group D – Methane, Butane, Propane and Pentane

In the natural gas industry, we typically deal with Group D hazardous locations. For example, a typical hazardous area classification in North America for a gas measurement installation would be *Class 1, Division 1, Group D.* It is up to the individual gas company to classify their installations according to AGA guidelines and company best practices.

Suitability of equipment for installation in hazardous areas – Intrinsic Safety

The suitability of electronic gas measurement equipment for installation in the hazardous area is tested by one of several organizations. These organizations are nationally recognized testing laboratories. The most prominent organizations for this type of testing and approval in North America are:

- UL – Underwriters Laboratory
- CSA – Canadian Standards Institute
- FM – Factory Mutual
- ETL – Intertek

The electronic gas measurement equipment that you are using will have at least one, if not several, approval numbers from these organizations listed in their product literature. In Europe, Asia and other parts of the world, approvals from organizations such as ATEX and IECEX will be required and some countries also have country specific requirements for IS approvals. Manufacturers and resellers of electronic gas measurement equipment must be fully aware of these specific country requirements.

Intrinsically Safe Installations

Using equipment designed and designated to be intrinsically safe provides the most installation flexibility, for a number of reasons:

1. There is no need to disconnect the power source (i.e. battery) to the equipment during site visit for instrument verification or troubleshooting.
2. You can physically open the equipment enclosure and gain access to circuit boards to wire pulse outputs, for example.
3. If the equipment is certified to be intrinsically safe, there is generally no need for the user to further test the product for mounting in the hazardous area, as long as the equipment is rated to be adequate for the area classification it is being mounted in. If equipment that does not have an IS rating is attached to this equipment – an example would be an external modem cabled to the equipment – then the modem should be mounted outside the hazardous area. If such equipment is mounted inside or adjacent to the electronic corrector, then the area would most likely be rated as a Division 2 rather than a Division 1 area.
4. Energy limiting barriers are used to transmit from a hazardous area to a non-hazardous area. There are various types of barriers that limit the voltage and/or the current. Generally, if a third party barrier is required to be used, the

equipment manufacturer will specify the barrier model and rating.

5. When installing externally mounted peripherals such as modems, consideration should be given to grounding the modem installation. Grounds provide the path of least resistance to a zero potential. A reference voltage of zero volts is referred to as a ground. Local electrical codes should be consulted for grounding requirements prior to setting these types of installations.

Most, if not all, electronic volume correctors available for purchase today have an intrinsic safety (IS) rating. Consult the manufacturer for specific details.

Electronic Volume Corrector Mounting Styles

Instrument Drive Version Volume Correctors:
Typically, electronic volume correctors used in North America have been instrument drive mount models. This type of installation would require that the meter (*diaphragm, turbine, rotary*) have an ID drive accessory unit, with or without an odometer, and a drive dog (sometimes referred to as a "wiggler"…very technical term!). The electronic instrument would also have an ID base, generally with a mechanical odometer, and a drive dog that mates with the drive dog on the meter. Through a series of mechanical gear assemblies, the volumetric information from the meter to the corrector where the circuitry does the job of converting this information to corrected volume. The volumetric input to the corrector in this type of installation would be considered a low frequency output – i.e. 10 cf, 100 cf, 1000 cf.

The pressure transducer would need to be piped, generally upstream of the meter, or in the case of the rotary – at the inlet differential tap, and the temperature probe mounted in the gas stream, generally downstream of the meter. A proper installation will require, at the very least:

- A thermowell appropriately sized for the diameter of the gas line and rated for the MAOP of the line as well, required for insertion of the temperature probe into the gas line.
- A pressure/valve piping kit that includes all the required bushings, fittings, valves and appropriate length of stainless steel tubing.

If the type of meter in the installation is either a diaphragm or turbine type meter, the instrument drive version corrector would likely be the preferred model.

Integral Gas Volume Correctors designed for Rotary Meters:
While the ID version corrector over time has been widely used in rotary meter installations, the rotary meter design does offer the advantage of the gas volume corrector to be integrally mounted.

This model allows the actual volume, temperature, and, in the case of some newer rotary meters the pressure, to be sensed internal to the installation. Magnetic pickups using reed switch or Weigand sensor technology gather and transmit volumetric information from the meter to the corrector. The volumetric input from the meter to the corrector in this type of installation would generally be considered to be high frequency. This allows the corrector to perform many more functions than it could in the past, such as the ability to display uncorrected instantaneous flow rate on the LCD of the

volume corrector. This is an aid in clocking the meter when performing a differential test. HF input allows the corrector to perform some diagnostics such as meter overspeed due to high flow rate.

Integral installation of the gas volume corrector also contributes to installation cost savings and security.

- If the temperature and pressure can be sensed internally, there is no need for additional thermowells, pressure piping valves, tubing, etc.
- Integral volume sensing via high frequency input to the corrector allows the meter size to be programmed via the user terminal software. This is a significant reduction in inventory requirements for meter accessory units.
- Integral connections to the meter are a deterrent to vandalism and theft.
- Integral correctors that have the option to sense and record differential pressure can reduce the number of site visits required to obtain this information

In summary, the electronic gas volume corrector has evolved throughout the years and today, there are correctors available in various mounting styles and with differing capabilities. The slide show associated with this paper will hopefully illustrate this as well.