Electronic Volume Correctors

Ben Manson
Agenda

- Customer Types and suitable equipment
- Volume corrector standards / regulations
- Basics of volume correction
- Gauge v Absolute pressure sensors
- New product technologies
Customer Types

Take or Pay Transmission

Contracts / Hourly Basis Special Contract customer

Contracts / Daily Basis Special Contract Customer

Residential Customer

Stations
- Flow Computer
  - Meter Reading once per Day / online

Industrial Customer
- Volume corrector
  - Meter Reading once per Day

Commercial Customer
- Data Logger
  - Meter Reading once per Month

Residential Customer
- Meter Reading
  - Every 2-3 Months
# Volume Correctors – Flow Computers

<table>
<thead>
<tr>
<th>EVC</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>![EVC Image]</td>
<td>![FC Image]</td>
</tr>
</tbody>
</table>

**Installation**

- Mounted on the meter / pipe
- Mounted in the control room
- Fixed connected sensors
- Sensors separated (changeable) HART protocol
# Volume Correctors – Flow Computers

<table>
<thead>
<tr>
<th>Feature</th>
<th>Power Supply</th>
<th>Mains powered (115 / 230VAC / 24VDC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery powered device</td>
<td>Power Supply</td>
<td>Mains powered (115 / 230VAC / 24VDC)</td>
</tr>
<tr>
<td>(Option: mains powered)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal housing; IP65</td>
<td>Housing</td>
<td>19” racket</td>
</tr>
<tr>
<td>Outdoor installation</td>
<td></td>
<td>IP20; Indoor</td>
</tr>
<tr>
<td>Also possible in battery</td>
<td>Data Communication</td>
<td>Only with mains power supply</td>
</tr>
<tr>
<td>operated mode</td>
<td></td>
<td>Remote Control</td>
</tr>
<tr>
<td>Stand-alone device</td>
<td>Additional Features</td>
<td>More than 1-Stream supported</td>
</tr>
<tr>
<td>Easy installation</td>
<td></td>
<td>Current outputs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fixed connection to GC possible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Error curve correction of the gas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>meter</td>
</tr>
</tbody>
</table>
## Standards

<table>
<thead>
<tr>
<th></th>
<th>New Zealand</th>
<th>North America</th>
<th>Europe</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type Testing / Pattern Approval</strong></td>
<td>None</td>
<td>None</td>
<td>MID (Measurement Instrument Directive)</td>
<td>None</td>
</tr>
<tr>
<td><strong>Industry Standards</strong></td>
<td>NZ5259</td>
<td>AGA XQ9901:1999</td>
<td>EN12405</td>
<td>None</td>
</tr>
<tr>
<td><strong>Compressibility Calculation</strong></td>
<td>AGA-NX19, AGA8, or ISO12213</td>
<td>AGA 8</td>
<td>S-GERG-88</td>
<td>AGA-NX19</td>
</tr>
<tr>
<td><strong>Pressure Measurement</strong></td>
<td>Gauge</td>
<td>Gauge</td>
<td>Absolute</td>
<td>Both</td>
</tr>
<tr>
<td><strong>Intrinsic Safety</strong></td>
<td>IECEx, UL, ATEX</td>
<td>UL</td>
<td>ATEX</td>
<td>IECEx</td>
</tr>
</tbody>
</table>
Global Market Trends

- The volume corrector market is very conservative, new technologies generally take 2-3 years to be accepted

Some market trends:
- IECEx becoming the standard in more countries, expect Europe, USA, Canada
- Due to developments in pressure sensors absolute is becoming accepted in more countries
- Countries that have no local standards are adopting OIML for pattern approval / type testing
Basic Function of a Volume Corrector

1. Volume Correctors take the actual volume passing through the gas meter and compensate for pressure and temperature variations and calculates gas compressibility providing standard volume measurement.

2. Typically gas correctors are installed in applications where large volumes of gas are being consumed and pressure fluctuates.

3. Depending on the application, there are different features available such as data logging, super-compressibility, digital pulse outputs etc. Most products can be installed inside hazardous areas and read out via telephone networks.
Dependence on Pressure (Boyles Law)

- Increasing Pressure
  - Decreases Volume
- Constant Temperature
- If the temperature remains constant, the volume of a given mass or weight of gas is inversely proportional to the pressure.
- Pressure must be in Absolute Units

\[ P_1 \times V_1 = P_2 \times V_2 \]
Dependence on Temperature (Charles Law)

- Increasing Temperature
  - Increases Volume (1% per 3°C)
- If the pressure remains constant, the volume of a given mass or weight of gas varies directly with the absolute temperature.
- Temperature must be in absolute units

\[ \frac{V_1}{T_1} = \frac{V_2}{T_2} \]
Ideal Gas Law

- Combines Boyle’s and Charles’ Laws together.
- The volume of a given mass or weight of gas is directly proportional to the absolute temperature and inversely proportional to the absolute pressure.
- \( \frac{V_1 \times P_1}{T_1} = \frac{V_2 \times P_2}{T_2} \)

Where

- \( T \) = Absolute Temperature
- \( P \) = Absolute Pressure
Real Gas Law – Compressibility (Z)

- Colder temperatures and higher pressures decrease Kinetic Energy and allow forces of attraction to pull molecules together.
- Final net result depends on
  - Pressure
  - Temperature
  - Composition of the gas
- With large volumes of gas used it has a significant impact on the metering accuracy, revenue collection.
Gas Measurement Law

\[ V_b = V_m \times \left( \frac{P_m}{P_b} \right) \times \left( \frac{T_b}{T_m} \right) \times Z \]

- \( V_m \) = Metered Volume (Actual)
- \( P_m \) = Absolute Metering Pressure
- \( P_b \) = Base Pressure
- \( T_b \) = Absolute Base Temperature
- \( T_m \) = Absolute Metering Temperature
- \( Alt \) = Altitude correction factor (only if gauge pressure measurement)
- \( Z \) = Compressibility Factor

\[ T(\text{base}) = 15 \, ^\circ\text{C} \]
\[ P(\text{base}) = 101.325 \, \text{kPa (abs)} \]

Standard Conditions

Depends on location
The distinction between Gauge Pressure and Absolute Pressure should be understood. Absolute Pressure is the pressure that exists above zero pressure (a perfect vacuum). Countries with type testing do not accept gauge pressure due to the additional error.
Auckland Barometric Pressure

Auckland Barometric pressure (kPa)
Impact on PCF

- As an example for 100kPa gauge metering pressure the PCF is 1.987
- If we use an absolute pressure sensor the max PCF would be 2.007 & the min 1.964
- If we compare this to the PCF of 1.987 this could produce an error up to 1%
- The revenue or UAFG impact will depend on amount of volume passing through the meter
Conversion standard to energy

- Use of absolute pressure sensors simplifies the energy equation for billing
- Reference to NZS5259:2015
  - $F_A$ not required
  - $F_P$ is simplified

\[
FP = \frac{P_g + 101.325}{101.325}
\]

Can still be validated outside the EVC
EVC Innovations
Inputs Flexible than ever

- Up to six (counting / status) inputs
- HF sensors from the meter can be connected if the device is mains supplied
- Automatic switch over to LF in case of power failure without lost of volume
- Automatic detection of the Encoder, no settings necessary

* not possible for the input signal Vm

<table>
<thead>
<tr>
<th>Input</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Encoder, LF, HF</td>
</tr>
<tr>
<td>2</td>
<td>LF, HF, Status</td>
</tr>
<tr>
<td>3</td>
<td>LF, Status</td>
</tr>
<tr>
<td>4</td>
<td>LF, Status</td>
</tr>
<tr>
<td>5</td>
<td>LF*, Status</td>
</tr>
<tr>
<td>6</td>
<td>LF*, Status</td>
</tr>
</tbody>
</table>

Electronic Volume Corrector
Station Monitoring

- 2nd p-sensor (Option)
- 2nd T-sensor (Option)
- Inlet pressure
- Filter
- Differential pressure switch
- Regulator SSV
- Up to 5 status inputs

Electronic Volume Corrector
- \( V_m \)
- LF/
- HF/
- Encoder
- \( p \)
- \( T \)

Billing
- e.g. via
- GSM modem or
- GPRS (TCP/IP)

Monitoring
- e.g. via
- RS232/485/422
- and Modbus to SCADA system
Internal Modem – Battery lifetime

- **Lifetime of the Modem battery depends on:**
  - Ambient temperature (!)
  - Reception level (!!!)
  - Call window (!)
  - Communication time (!!!)

<table>
<thead>
<tr>
<th>Mode</th>
<th>Device-initiated PUSH-mode / ComFTP (PUSH)</th>
<th>Read Out from Head End System (PULL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Call Window</td>
<td>3 Minutes (daily)</td>
<td>60 Minutes (daily)</td>
</tr>
<tr>
<td>Service Window (monthly)</td>
<td>0 Minutes</td>
<td>-</td>
</tr>
<tr>
<td>Communication-Time</td>
<td>2 Minutes</td>
<td>2 Minutes</td>
</tr>
<tr>
<td>Lifetime of Modem battery</td>
<td>62 Month = 5.2 Years</td>
<td>32 Month = 2.7 Years</td>
</tr>
</tbody>
</table>

- 62 Month = 5.2 Years
- 32 Month = 2.7 Years
- 60 Month = 5.0 Years
- 17 Month = 1.4 Years
- 140 Month = 11.6 Years
## Technical Differences

<table>
<thead>
<tr>
<th>Feature</th>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A / D Converter Accuracy (Resolution)</td>
<td>19 bits (524288:1)</td>
<td>10 bits (1024:1)</td>
<td>12 bits (4096:1)</td>
</tr>
<tr>
<td>50 Hz / 60 Hz filter</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Onboard coefficients</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Onboard calibration traceability data</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Onboard temperature measurement</td>
<td>✔</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Noise immunity</td>
<td>Ultra-High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>(the A/D converter is at the other side of a 30 cm cable)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term analog component protection</td>
<td>All components are potted, including connectors, keeps water off.</td>
<td>Board coating with open connector pins</td>
<td>Board coating with open connector pins</td>
</tr>
<tr>
<td>Accuracy (over the entire range)</td>
<td>0.1% of Full Scale</td>
<td>0.6% of Full Scale</td>
<td>0.3% of Full Scale</td>
</tr>
<tr>
<td>Accuracy (@ ref conditions)</td>
<td>0.04% of Full Scale</td>
<td>0.4% of Full Scale</td>
<td>0.2% of Full Scale</td>
</tr>
<tr>
<td>Long term drift</td>
<td>0.4% of FS over 10yrs</td>
<td>0.5% of FS at 1st year</td>
<td>0.3 of FS at 1st year</td>
</tr>
<tr>
<td>Recommended calibration time</td>
<td>10 years</td>
<td>2 years</td>
<td>2 years</td>
</tr>
</tbody>
</table>
Internal Cellular Modems

Generally supports several modem technologies:

- Multi-band UMTS/HSPA,
- 2G, 3G
- Upgradeable to 4G (LTE)

Enables Over the air configuration or firmware upgrade.

Lowers your TCO:

- Save on installation, configuration and operation costs.
- Provides lowest cost communications available today.
Thank you for your attention