

Medidores de Caudal por Presión Diferencial



invensys[®]

Process Systems

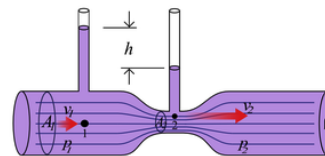
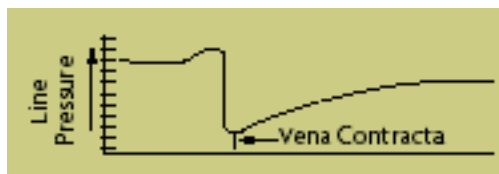
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Avantis • Foxboro • SimSci-Esscor • Triconex

Principio de Bernoulli

El principio de Bernoulli constata que siempre que circula un fluido por una tubería, frente a un incremento de velocidad existe simultáneamente una caída de presión.

Este principio es una simplificación de la ecuación de Bernoulli la cual constata que la suma de todas las energías de un fluido que circula por una tubería, es la misma en cualquiera de los puntos de la misma.



$$\begin{aligned}
 V &= k (h/D)^{0.5} \\
 \text{or } Q &= kA (h/D)^{0.5} \\
 \text{or } W &= kA (hD)^{0.5}
 \end{aligned}$$

Elementos Primarios

Venturi

Tobera

Placa de Orificio, Orificio Compacto e Integral

Tubo Pitot (Annubar)

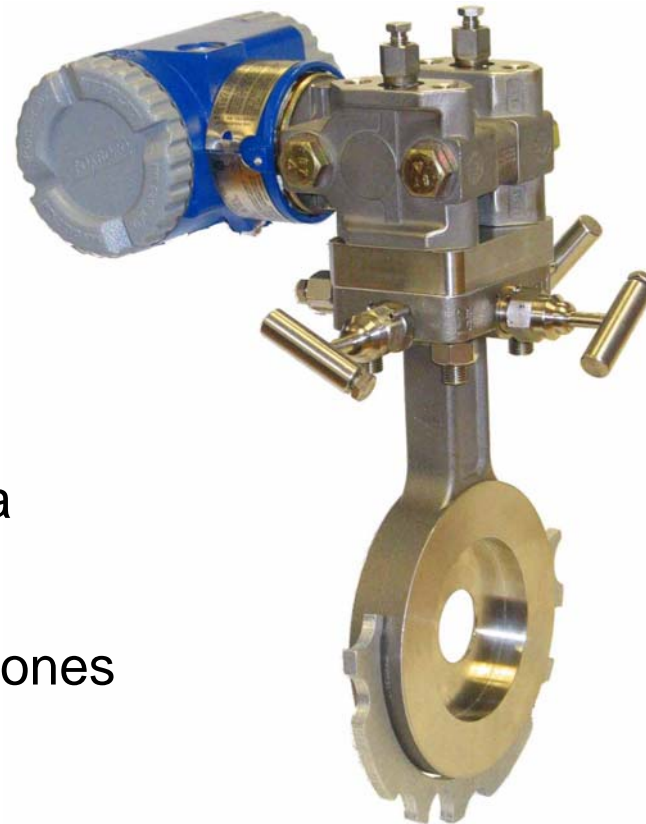
Accelabar

V – Cone

Segmento

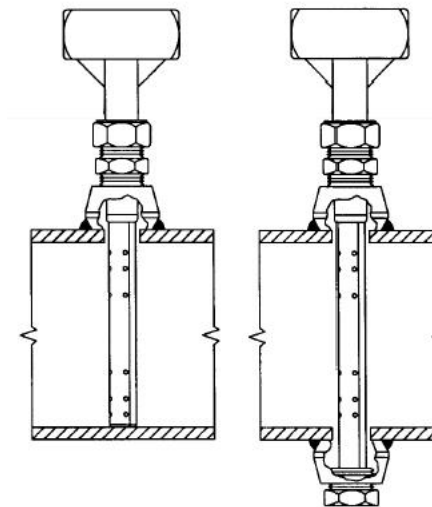
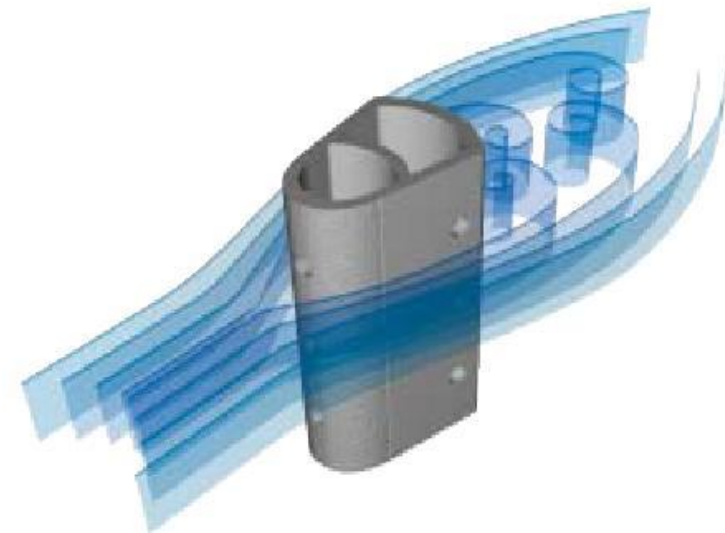
Orificio Compacto

- ▶ Medidor de caudal compacto
- ▶ Caudal másico o volumétrico
- ▶ Tamaños desde ½" hasta 4"
- ▶ Conexión bi-planar para purga
- ▶ Manifold Integral para aislamiento
- ▶ Anillo para alineamiento en la tubería
- ▶ Placa de 1" de espesor
- ▶ Ideal para sustituciones o actualizaciones



Tubo Pitot Veris Inc. Verabar™

- Diseñado sobre tecnología espacial.
- Tubo Pitot con inigualable precisión.
- Construido en una sola pieza.



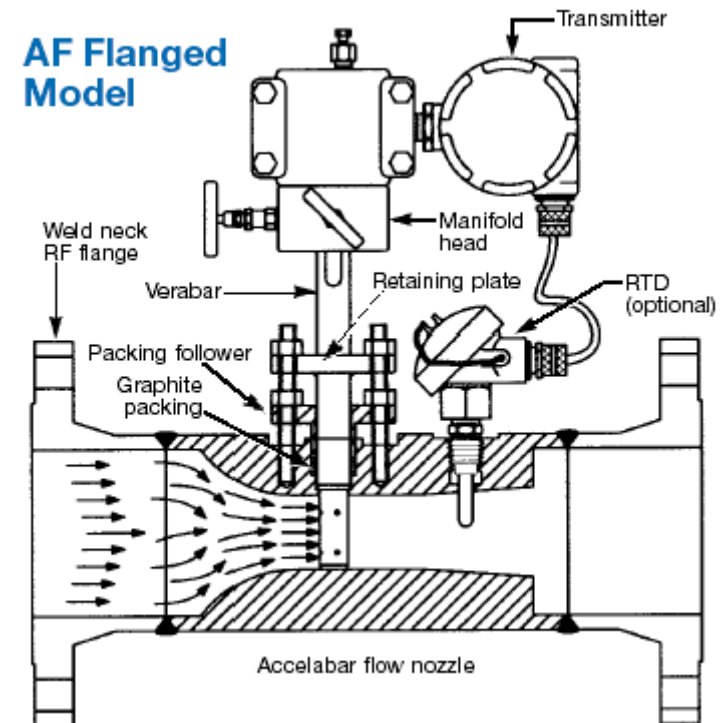
Tubo Pitot -Veris Inc. Verabar TM

Características y Montaje

- **Especificaciones en caudal másico**
- **Precisión:**
 - $\pm 1.0\%$ @ constant T&P
 - $\pm 1.3\%$ @ variable T&P
- **Rating de Presión: ANSI 600# (max)**
- **Temperatura:**
 - **Montaje Remoto:** 427 °C (max)
 - **Montaje Directo:** 120°C (Limitado por el transmisor de presión diferencial)



- El Accelabar es un nuevo elemento de medida, que combina dos tecnologías para medir en rangos de caudal, nunca antes alcanzables, con un sólo elemento.
- Es capaz de generar una alta presión diferencial para poder medir gas, líquidos y vapor con una rangeabilidad de hasta 65:1 sin tramos rectos de tubería.



Accelabar de Veris Inc. TM

- **Especificaciones de Ingeniería**

- Low velocity flow rates
- High accuracy to $\pm 0.75\%$
- Repeatability: $\pm 0.075\%$
- Verified flow coefficients
- No calibration required
- Extended turndown: up to 65:1
- No straight run requirements
- Low permanent pressure loss
- Mass or volumetric flow



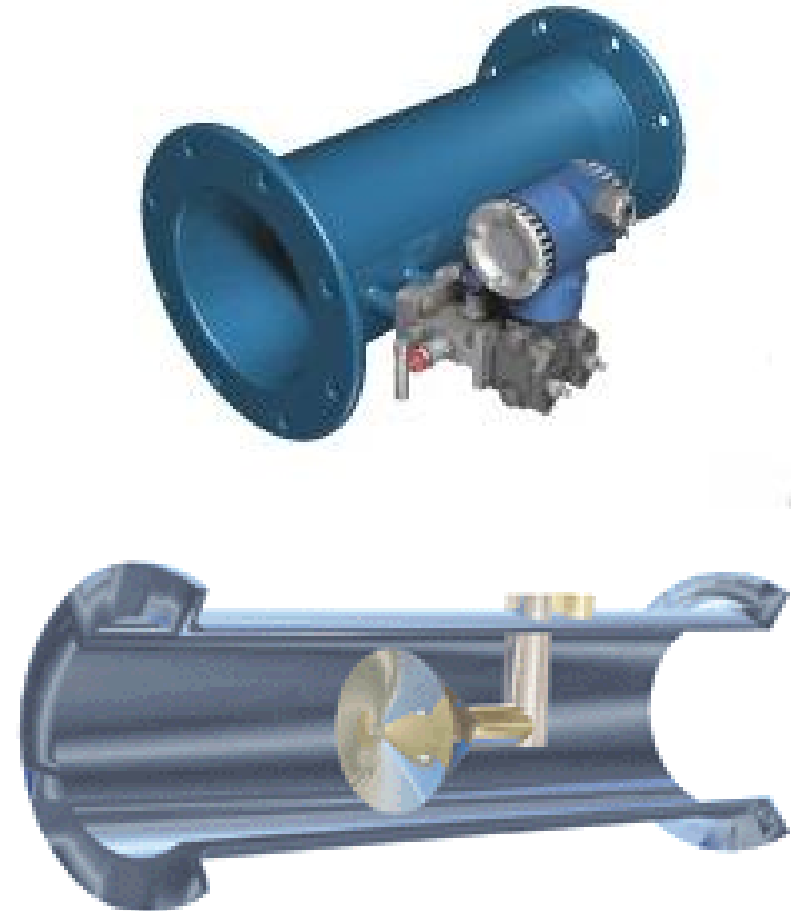
- **Actual Application**

- **Application:** 3" Sch 40 Natural Gas
- **Operating Pressure/**
- **Temperature:** 80 PSIG/70° F (5,4 bar g / 21 °C)
- **Max/Min Flow Rate:** 60,000 SCFH / 1,000 SCFH
1700 nm³h / 28,3 nm³h
- **Flow Turndown:** 60:1



V-Cone™ de McCrometer

- El V-Cone es un elemento deprimógeno con un diseño único que acondiciona el fluido antes de efectuar la medición
- La presión diferencial es por el cono situado en el centro de la tubería.
- El cono está redondeado, para aplanar el perfil de velocidad del fluido y crear una señal más estable a lo largo de todo el rango de medida.
- El caudal es calculado, midiendo la diferencia de presión entre la parte anterior al cono y la posterior en el centro del cono.



V-Cone™ de McCrometer

- **Especificaciones de Ingeniería**
- **Standard Accuracy:** From +/-0.5% of actual flow (certain fluids and Reynolds number applications require specific calibrations to achieve this value).
- **Repeatability:** +/-0.1% or better.
- **Flow Ranges:** 10:1 and greater.
- **Standard Beta Ratios:** 0.45 to 0.80, special betas available.
- **Head Loss:** Varies with beta ratio and DP.
- **Installation Piping Requirements:** Typically 0-3 diameters upstream and 0-1 diameters downstream of the cone are required, depending on fittings or valves in the adjacent pipeline.
- **Materials of Construction Include:** Duplex 2205, 304, or 316 stainless steel, Hastelloy C-276, 254, SMO, carbon steels. Special materials on request.
- **Line sizes:** 0.5" to 120" or larger.
- **End Fittings:** Flanged, threaded, hub or weld-end standard. Others on request.
- **Configurations:** Precision flow tube and wafer-type
- **Calibrated for customer application.**
- **ASME B31.3 construction available.**



Orificio Integral y Transmisor Multivariable FOXBORO para Medición de Caudal

Múltiples Mediciones

- Presión Diferencial
- Presión Absoluta
- Temperatura del Proceso – RTD externa-
- Temperatura del Sensor
- Temperatura de la Electrónica

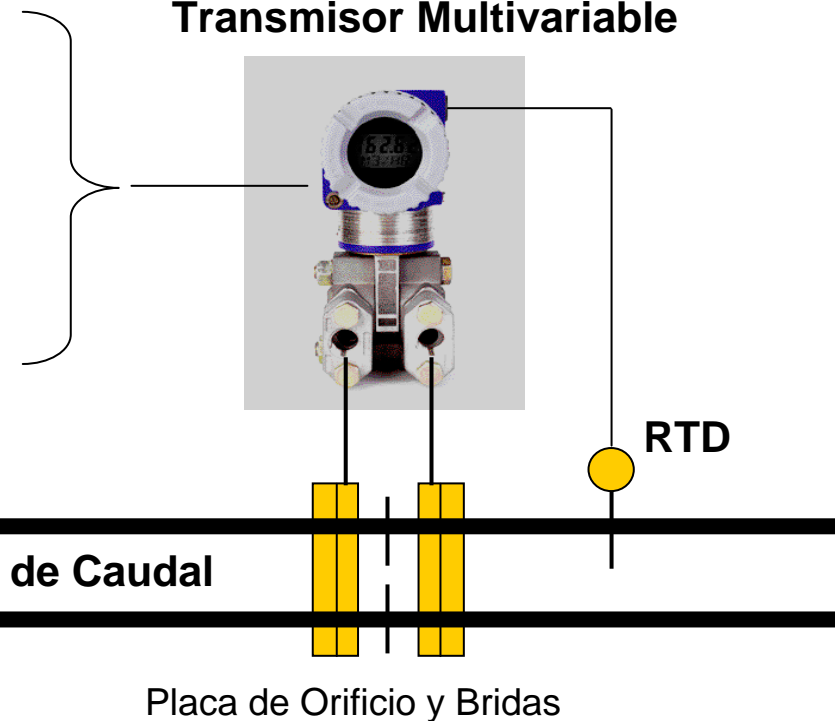
Cálculos Internos

- Densidad del Fluido
- Según Standards (ASME, AGA, API, ISO, ...)
- Caudal (Másico, Volumen Standard y Actual)



Conjunto Integral para Bajos Caudales

Transmisor Multivariable



Para una gran variedad de elementos primarios:
Venturis, Flow Nozzles, Averaging Pitot, V-Cone, etc.

Programa de Configuración PCMCV Transmisor Multivariable

PCMVa - [User Data]

File Show User Data Window Help

CompanyID Device Tag

Inputs	Current Calibration		Enter Flow Equation Limits			
Input Variables	Cal LRV	Cal URV	Equation LRL	Equation URL	Units	Test Values
M1 = DP	-0,0000842	100,001	<input type="text" value="-0,4972821"/>	<input type="text" value="200"/>	kPa	<input type="text" value="100"/>
M2 = AP	0,0000134	9,999964	<input type="text" value="0,0689476"/>	<input type="text" value="10"/>	MPaa	<input type="text" value="7,5"/>
M5 = RTD	-200,	850,	<input type="text" value="4,444519"/>	<input type="text" value="800"/>	degC	<input type="text" value="460"/>

Fluid State
 Gas Vapor Liquid
 Fluid: Steam

Outputs	Calculated Limits			
Output Variables	Equation LRL	Equation URL	Units	Cal. Values
M7 = Density	0	944,3319	kg/m3	23,97802
M6 = Flow	-1924,852	1924,852	t/h	199,9825

Version 3.00.000 19/06/2006 11:43

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Main Menu - Meter Design, Materials etc.]

File Selections Help

Selections

Vapor
Flow

Venturi
Machined In (machined) 7 deg Exit Cone

ASME 3MISO 5167
Pipe Material:
Chrome-Moly Steel Grade 11
Primary Element Material:
Carbon Steel
Special Factors:

Upstream Pressure Tap

Tag Number: 281FT001

Celbi

Differential Producers

Next Close

Sized Bore and Standardized Devices

- Orifice
- Venturi
- Nozzle
- Fixed Geometry: Multiport Averaging Pitot (MAP), Compact Orifice
- V-Cone (McCrometer Div Ketema)

Note: Refer to Std or Miller "Flow Measurement Engineering Handbook"

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Main Menu - Meter Design, Materials etc.]

File Selections Help

Selections

Vapor Flow

Venturi
Machined In (machined) 7 deg Exit Cone

ASME 3MISO 5167

Pipe Material:
Chrome-Moly Steel Grade 11

Primary Element Material:
Carbon Steel

Special Factors:

Upstream Pressure Tap

Tag Number: 281FT001

Celbi

Venturi

Next Back

Enter Coefficient On Flow Coefficients Screen

Machined Inlet
(Machined) 7 Degree Exit Cone

Rough Cast Inlet
(Cast) 7 Degree Exit Cone

Rough Welded Sheet Iron Inlet
(Fabricated) 7 Degree Exit Cone

Machined Inlet
(Machined) 15 Degree Exit Cone

Rough Cast Inlet
(Cast) 15 Degree Exit Cone

Rough Welded Sheet Iron Inlet
(Fabricated) 15 Degree Exit Cone

Note: Refer to Std or Miller "Flow Measurement Engineering Handbook"

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Main Menu - Meter Design, Materials etc.]

File Selections Help

Selections

Vapor
Flow

Venturi
Machined In (machined) 7 deg Exit Cone

ASME 3M/ISO 5167

Pipe Material:
Chrome-Moly Steel Grade 11

Primary Element Material:
Carbon Steel

Special Factors:

Upstream Pressure Tap

Tag Number: 281FT001

Celbi

Venturi Cylindrical Throat

Next Back

- Carbon Steel
- 5-9% Chrome-Moly Steel
- Chrome-Moly Steel Grade 11
- Chrome-Moly Steel Grade 22
- 300 Stainless Steel
- 400 Stainless Steel
- Hastelloy B
- Hastelloy C
- Inconel X, annealed
- Haynes Stellite 25 (L605)
- Yellow Brass (ASTM B36, B134, B135)
- Beryllium Copper 25 (ASTM B194)
- Cupronickel 30%
- K-Monel
- Pyrex Glass
- Titanium
- Tantalum
- PVC

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Fluid Properties]

File Selections

Vapor

Water or Steam Mixtures AIChE 250+ Fluids ...

Enter Fluid Properties

Natural Gas

NX-19 S-GERG Heating Value, Gr, and CO2 inputs

AGA-8 Gr, N2 and CO2

AGA-8 Heating Value, Gr, and CO2 inputs

AGA-8 Detailed Method, Input Mole Fractions

Additional Standard Fluids

<input type="radio"/> Air	<input type="radio"/> Carbon Dioxide	<input type="radio"/> Hydrogen	<input type="radio"/> Pentane
<input type="radio"/> Ammonia	<input type="radio"/> Ethane	<input type="radio"/> Methane	<input type="radio"/> I-Pentane
<input type="radio"/> Argon	<input type="radio"/> Ethylene	<input type="radio"/> Nitrogen	<input type="radio"/> Propane
<input type="radio"/> Butane	<input type="radio"/> Heptane	<input type="radio"/> Octane	<input type="radio"/> Propylene
<input type="radio"/> I-Butane	<input type="radio"/> Hexane	<input type="radio"/> Oxygen	

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Water/Steam]

File Selections

Steam Properties Computation

Apply Next Back

Normal Pressure: MPa,abs
Normal Temperature: degC

Saturated Steam Calculation
(RTD Temperature Not Used)

Steam Calculation
(Using Measured Pressure and Temperature)

Temperature (Saturation): 290,49 degC
Flowing Density: 23,9780 kg/m³
Specific Volume: 0,0417 1/(kg/m³)
Viscosity: 0,0270 cP
Isentropic Exponent: 1,2603
Pressure Maximum: 20,6842 Minimum: 3 psia

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Flow Coefficients]

File Selections

Apply Next Back

Click Unit to Change

Normal Differential Pressure: kPa

Pipe Internal Diameter D: inches

Standard Pipe Sizes:

Bore of Primary Element d: inches

Beta Ratio d/D:

No Errors

Programa de Configuración PCMCV Transmisor Multivariable

The Foxboro Co. IMV30 by R.W.Miller & Associates, Inc. - [Flow Coefficients Machined In (machined) 7 deg Exit Cone For Vapor WATER]

File Selections

Save Back

Normal Operating Point
Pressure: 7,5000 MPa,abs
DP: 100,0000 kPa
Temperature: 460,00 degC

Primary Element
Pipe Diameter: 9,3701 inches
Bore Diameter: 6,6050 inches

Calculated Values for Normal Operating Point
Pipe RD: 10921159,
Flowing Density: 23,9780 kg/m³
Flow-Rate: 199,9824 metric ton/h

Reynolds Number Outside Standard/Equation Limit

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window. At the top, there are several tabs: 'Rtd Temp. (M5)', 'Flow (M6)', 'Density (M7)', 'A/P (M2)', 'Sensor Temp. (M3)', 'Elec. Temp. (M4)', and 'dp (M1)'. The 'Identification' tab is currently selected. Below the tabs, the 'General Device Information' section contains the following fields: 'CompanyID' (dropdown menu with 'Celbi' selected), 'Tag' (text box with '281FT001'), 'Model' (text box with 'IMV30-CE'), 'Descriptor' (text box with 'DESCRIPTOR'), and 'Message' (text box with 'MESSAGE'). An 'Advanced Info' button is located to the right of the 'Message' field. The 'Local Display Passwords' section has three radio button options: 'No Passwords' (selected), 'Cfg Pwd Enabled', and 'Cfg & Cal Pwd Enabled'. To the right of these options are two password input fields: 'CfgPwd (6 char max)' and 'CalPwd (6 char max)', both containing 'xxxxxxx'. At the bottom of the window, there are four buttons: 'Back Tab', 'Next Tab' (highlighted in green), 'OK', and 'Cancel'.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window. The 'General Configuration' tab is active, showing the following settings:

- Protocol Settings:** Preambles: 5, Polling Address: 0
- mA Output Fail Safe:** Down Scale, Up Scale
- Dynamic Variable Assignment:**
 - PV: M6: FLOW
 - SV: M2: A/P
 - TV: M5: RTD
 - 4th Variable: M1: D/P

At the bottom of the window, there are buttons for 'Back Tab', 'Next Tab', 'OK', and 'Cancel'.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window with the 'A/P (M2)' tab selected. The interface includes several configuration sections:

- Standard Configurable Data:**
 - Units: Absolute (dropdown), MPaa (dropdown)
 - Upper Range Value: 10,0
 - Lower Range Value: 0,0
 - Damping (seconds): 0 (dropdown)
- Measurement Limit Information:**
 - Upper Range Limit: 10,3421
 - Lower Range Limit: 0,0
- Absolute Reference ATM Pressure:**
 - Value: 0,1013529
 - Unit: MPaa

Navigation buttons at the bottom include 'Back Tab', 'Next Tab' (highlighted in green), 'OK', and 'Cancel'.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window with the 'Rtd Temp. (M5)' tab selected. The interface is organized into several sections:

- Standard Configurable Data:**
 - Rtd Temp.:** Linear Units are set to 'degC'. The 'Meas On' checkbox is checked.
 - Upper Range Value: 850,0
 - Lower Range Value: 0,0
- Measurement Limit Information:**
 - Upper Range Limit: 850,0
 - Lower Range Limit: -200,0
- RTD Strategy for Flow and Density:**
 - Radio buttons: 'Use Default on Failure' is selected; 'Never Use Default (Fail when bad)', 'Use SatSteam', and 'Always use Default' are unselected.
 - Default Value: 460,0 degC

At the bottom of the window, there are four buttons: 'Back Tab', 'Next Tab' (highlighted in green), 'OK', and 'Cancel'.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot shows the 'Hart Device Configuration' window for a 'dp (M1)' transmitter. The window has a tabbed interface with the following tabs: Rtd Temp. (M5), Flow (M6), Density (M7), A/P (M2), Sensor Temp. (M3), Elec. Temp. (M4), Identification, General Configuration, and dp (M1). The 'dp (M1)' tab is active, showing the following configuration options:

- Standard Configurable Data:**
 - Linear Units: kPa (dropdown menu), Custom... (button)
 - EGU is Standard (checkbox)
 - Upper Range Value: 200,0 (text input)
 - Lower Range Value: 0,0 (text input)
 - Damping (seconds): 0 (dropdown menu)
- Measurement Limit Information:**
 - Upper Range Limit: 208,856 (text input)
 - Lower Range Limit: -208,856 (text input)
- SquareRoot/Linear Options:**
 - Linear
 - Square Root (Active @0)
 - Square Root (10%of Flow Cut Off)

At the bottom of the window, there are four buttons: 'Back Tab', 'Next Tab' (highlighted in green), 'OK', and 'Cancel'.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window with the 'Flow (M6)' tab selected. The interface includes several sections for configuring flow measurement parameters:

- Standard Configurable Data:**
 - Flow:** A dropdown menu is set to 'MassFlow' and a unit dropdown is set to 't/h'. A 'Custom...' button is available.
 - Meas On** (Measurement On) is checked. The text 'EGU is Standard' is displayed.
 - Upper Range Value:** 200,0
 - Lower Range Value:** 0,0
- Measurement Limit Information:**
 - Upper Range Limit:** 2022,586
 - Lower Range Limit:** -2022,586
- dp Input Noise Reduction for Flow:** **Noise Reduction** is checked.
- Flow Cutoff (M6):** 0=None, with a text input field containing '0'.

At the bottom of the window, there are buttons for 'Back Tab', 'Next Tab' (highlighted in green), 'OK', and 'Cancel'. A 'Display Flow Data' button is also present in the upper right area of the configuration panel.

Programa de Configuración PCMCV Transmisor Multivariable

The screenshot displays the 'Hart Device Configuration' window with the 'Density (M7)' tab selected. The interface includes several tabs at the top: A/P (M2), Sensor Temp. (M3), Elec. Temp. (M4), Identification, General Configuration, dp (M1), Rtd Temp. (M5), Flow (M6), and Density (M7). The 'Density (M7)' tab contains the following configuration options:

- Standard Configurable Data**
 - Density**
 - Linear Units: Custom...
 - Meas On EGU is Standard
 - Upper Range Value:
 - Lower Range Value:
- Measurement Limit Information**
 - Upper Range Limit:
 - Lower Range Limit:

At the bottom of the window, there are buttons for 'Back Tab', 'Next Tab', 'OK', and 'Cancel'. A 'Display Flow Data' button is also present in the upper right area of the configuration panel.