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Thank You for Attending Today's Webinar:

Accurate Flow Measurements in Changing Process Conditions

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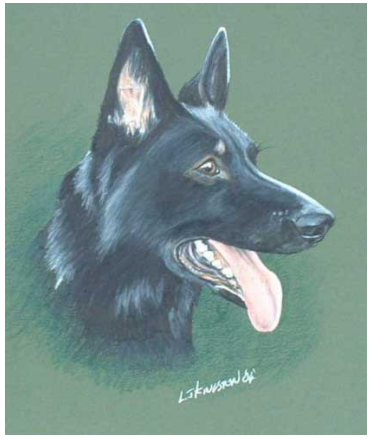
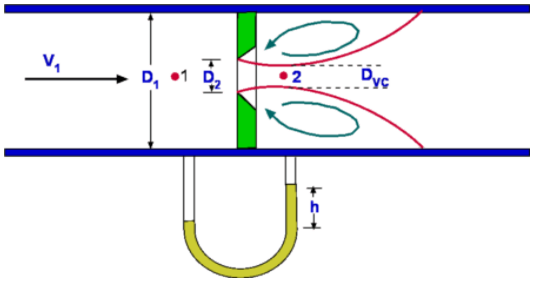
Accurate DP Flow Measurements in Changing Process Conditions



Review - DP Flow



DP (**D**ifferential **P**ressure) flow measurement

- It's been around for ages

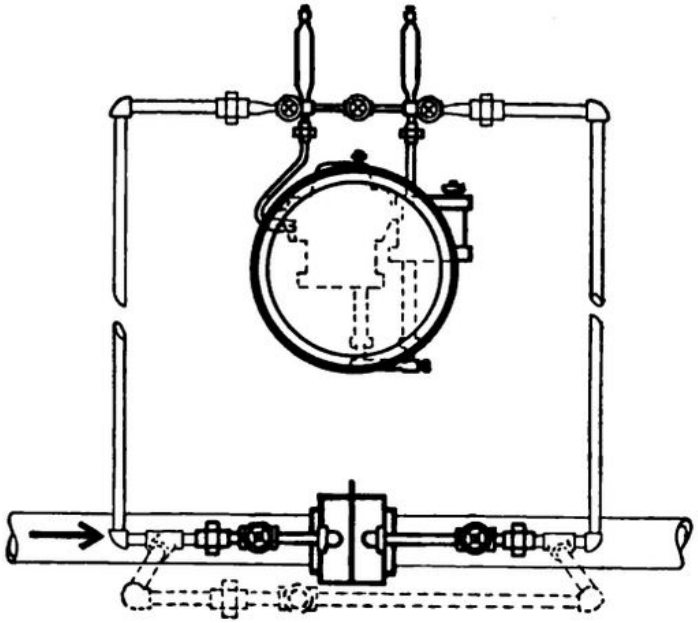
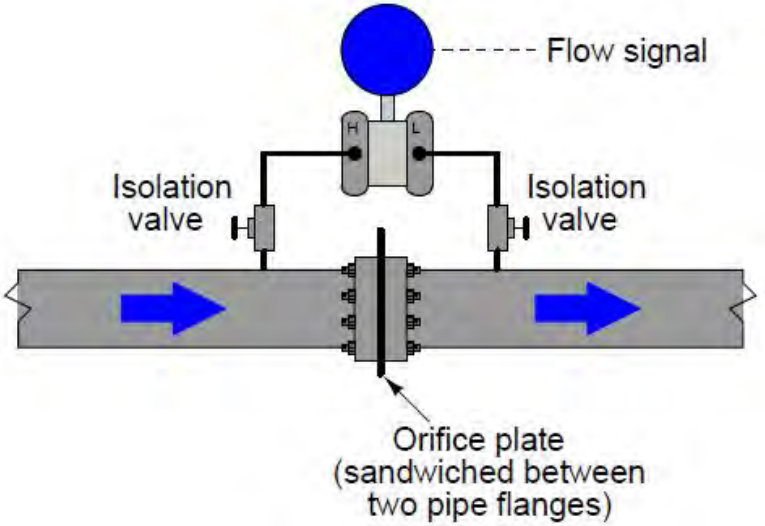
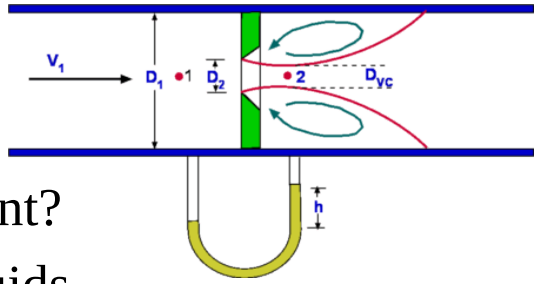


Fig. 10630 Liquid Flow. Meter mounted above the line

1940's illustration



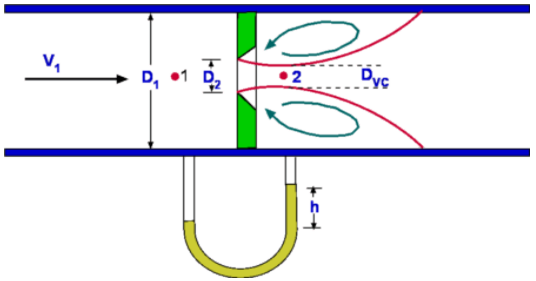
Review - DP Flow



What is DP (**D**ifferential **P**ressure) flow measurement?

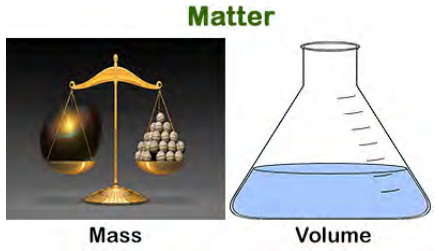
- ***Volumetric*** flow measurement for gases and liquids
- By definition, ***primary flow element*** creates a pressure drop
  - Half dozen common, commercial, in-line primary flow elements, several hi-tech
  - Orifice plates, Venturi, pitot tube, V-cone, Fluidic's HHR, Accelabar
- The flow meter, a DP (Differential Pressure) or Multivariable ***transmitter***
  - reads the pressure drop
  - Can convert from non-linear pressure to a linear flow rate by square root extraction function (optional, by choice)
  - Transmits raw DP or linear 0-100% flow rate signal as 4-20mA, optional local display
- Receiver interprets 4-20mA transmitter output as volumetric flow
  - If the transmitter does not square root, the receiver square roots
- Volumetric flow measurement used for control loops
  - Very prominent technology in oil & gas, large pipes, steam, gas flow
- Mr. Bernoulli did the math

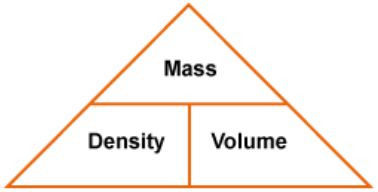
Volumetric vs Mass



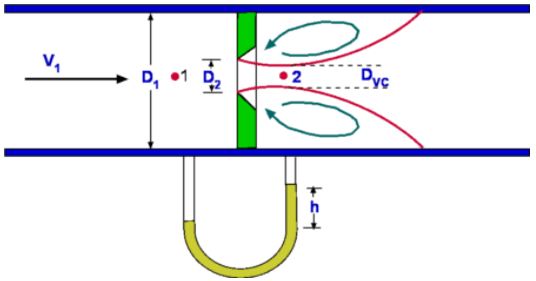
What is wrong with volumetric flow?

- Volumetric is great for retail
  - Gallon of milk, 2 liter bottle of Coke, pint of ice cream
    - How many glasses will X amount fill?
    - 1/2L or 16.9 oz water bottle
- The process world deals with chemistry or heat
- Chemical processing uses ***mass*** or ***BTU***
- Mass accounts for density, volumetric does not
- Mass is important in the process industries.
- A mass measurement reports how many moles (# of molecules) are involved.
  - Too many moles, wasted product and energy
  - Too few moles, probably bad product or process

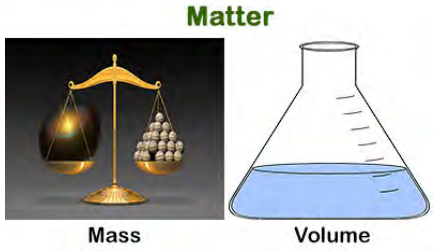


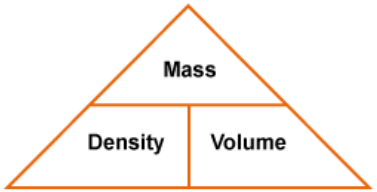


Volumetric vs Mass



- Heat in steam is carried by the water molecules
  - Heat transfer is a function of the mass of steam flow
- Density of water molecules in a closed volume changes with pressure
  - Wrong number of molecules, the wrong amount of heat (BTU)
- Same thing with gases – density varies with pressure (P) and temperature (T)



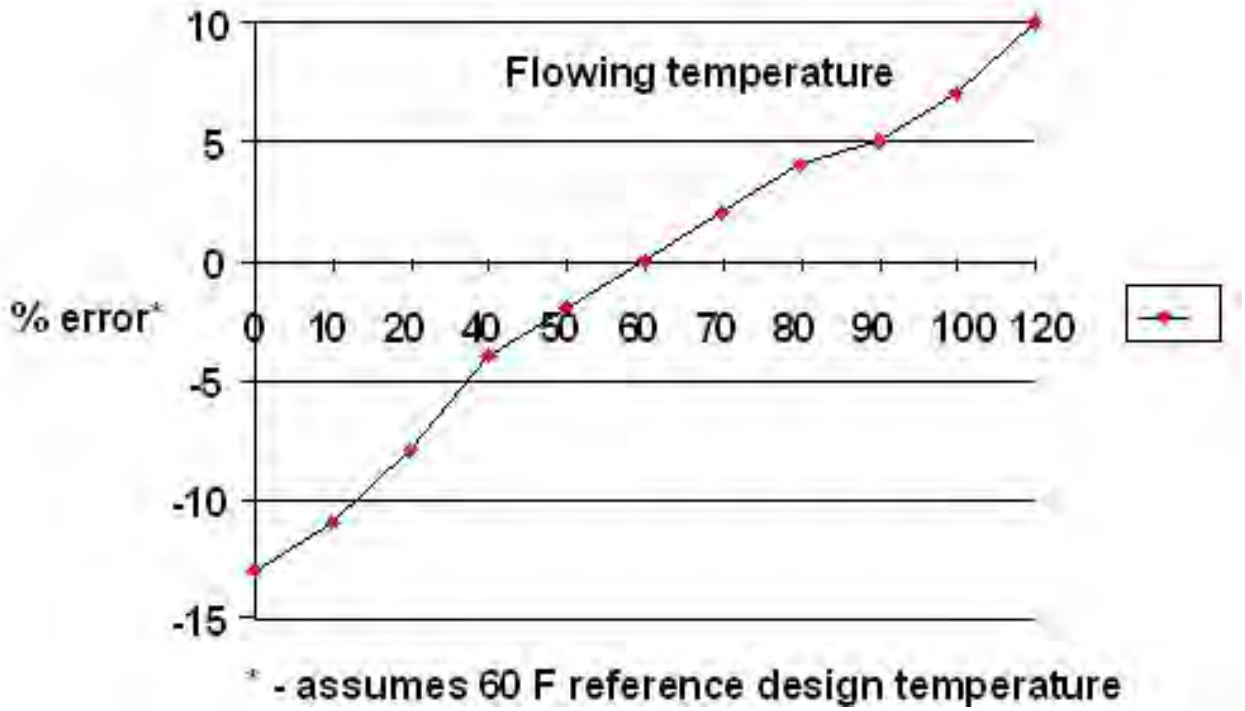


Issue with Gas Flow – Design conditions

- Gas is compressible, whereas liquids (for practical purposes) are not
  - Density varies with temperature and pressure
- DP flow measurement is dependent upon “design conditions”
- Design conditions are used in ‘sizing’ the flow element
  - operating temperature
  - operating pressure
  - Operating density
  - Operating viscosity
- The end result of sizing calculation is
  - a flow rate at a DP ***for those design conditions (and only those design conditions)***:
  - 2000CFM @ 100”wc
- ***Any deviation from the design operating conditions*** produces an error because the reported DP is measuring a flow that is more or less dense than specified in the design conditions

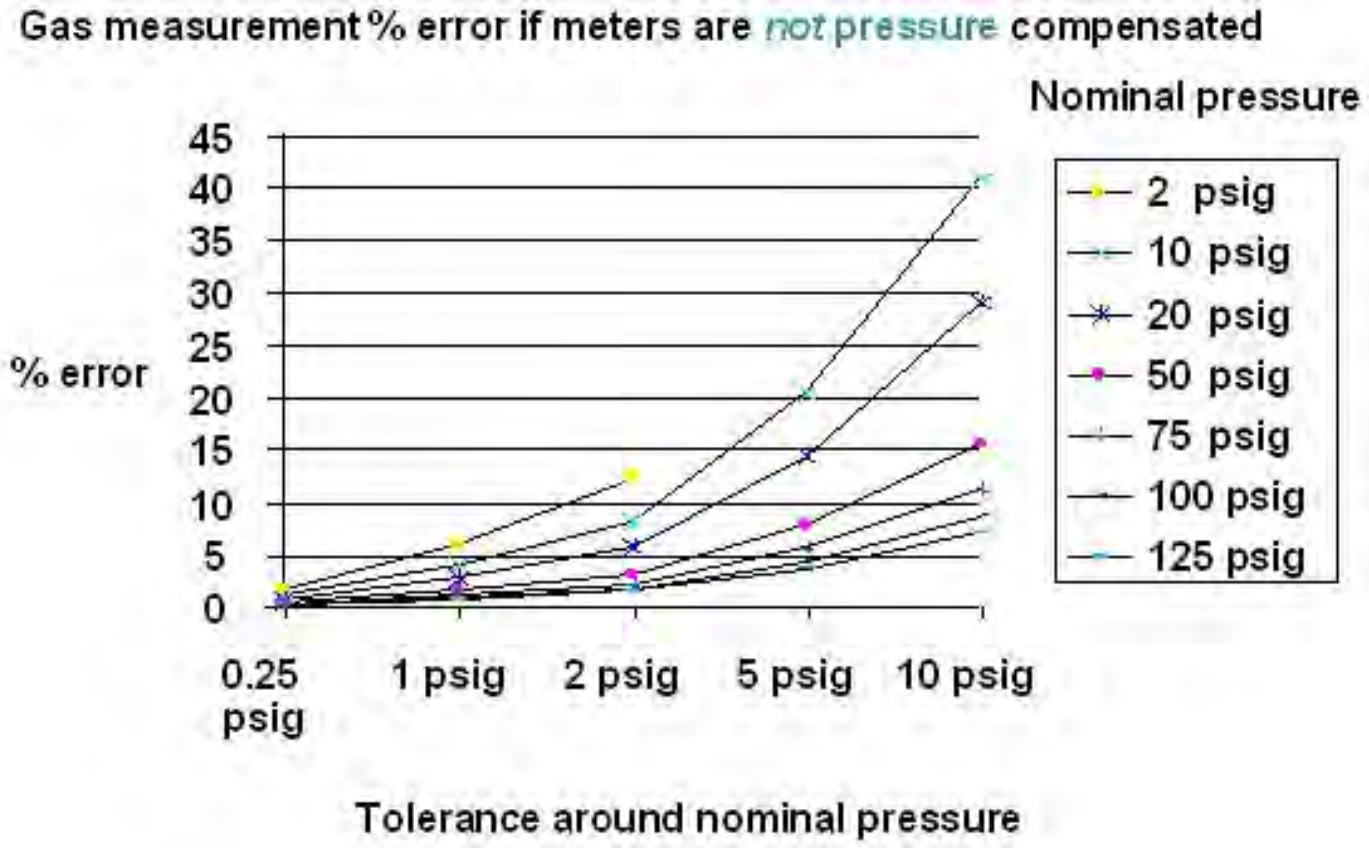
What happens when temp deviates from design cond?

- Flow error due to temperature deviation from design conditions (gas/steam)

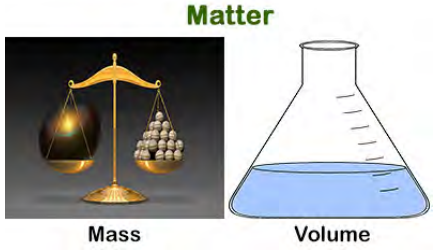


What happens when pressure deviates from design cond?

- Flow error due to static (line) pressure deviation from design conditions (gas)



Compensating for deviation



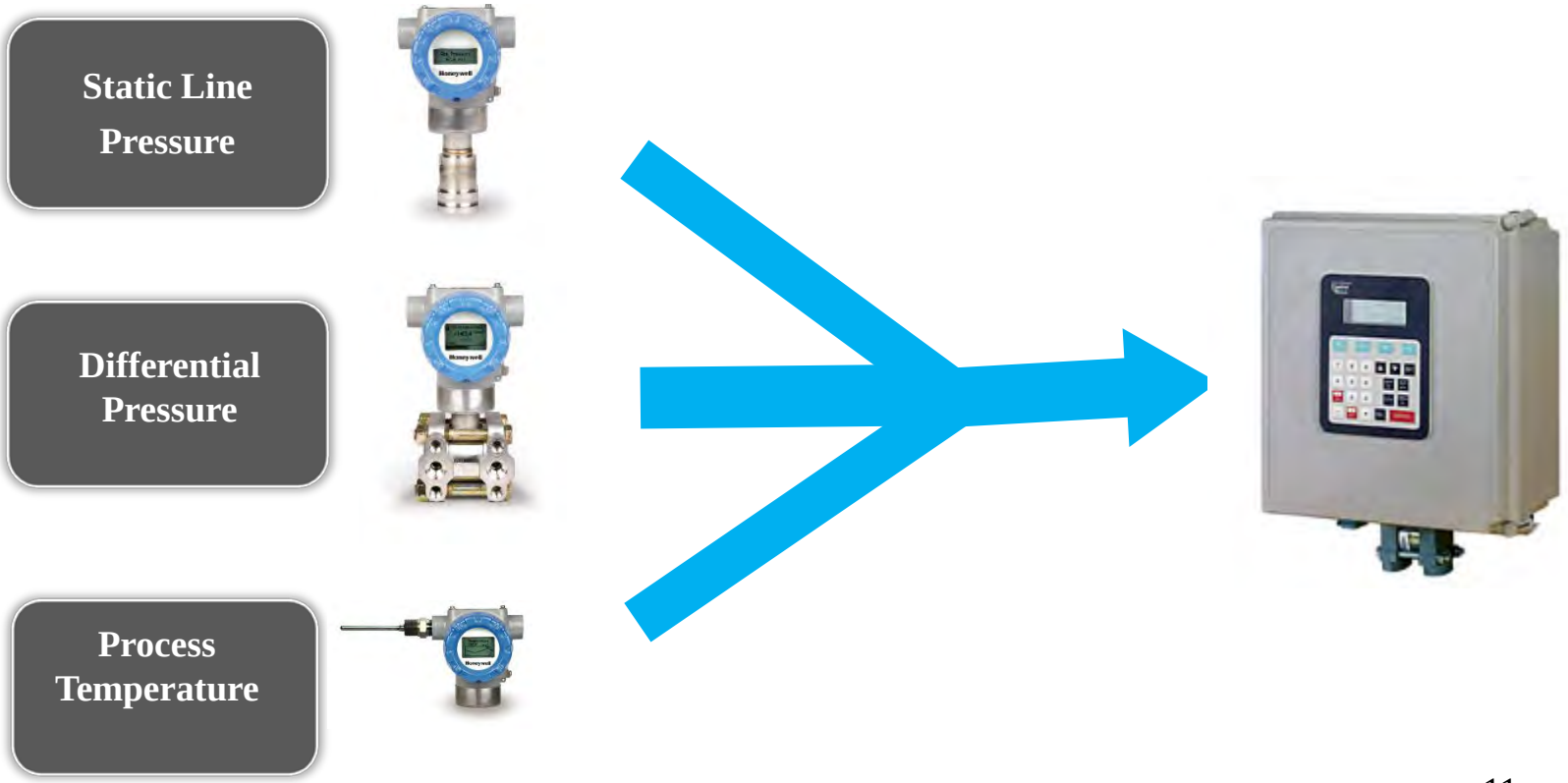
- It is more the rule than the exception that the operating conditions are not the same as the design conditions
  - Means volumetric measurement lives with “error”
- Compensating for static (working line) pressure and fluid temperature eliminates the *non-design condition operating* error
- The pressure compensation is absolute pressure, AP, (references absolute zero) because Bernoulli’s calculations use absolute units.
- Whereas flow measurement with DP technology is a volumetric measurement
- Compensating for temperature and pressure produces an inferred mass flow measurement, not volumetric
  - Mass is typically the measurement needed for chemical processes

Flow computer – mass flow

- A flow computer
  - Measures DP (differential)
  - Measures static line pressure (AP)
  - Measures fluid temperature
  - Calculates the mass flow
- Whereas DP gas flow is a volumetric measurement
  - Units: LPM, CFM
  - Subject to density changes with temperature and pressure changes
- Flow computer (with T & P compensation) measures Standardized Flow
  - SCFM (Standard CFM), corrected to STP
- Flow computer (with T & P compensation) measures inferred mass flow
  - pounds per hour (steam, liquid), Kg/min
- T and P compensation accounts for steam's superheat
  - Not available in volumetric DP flow

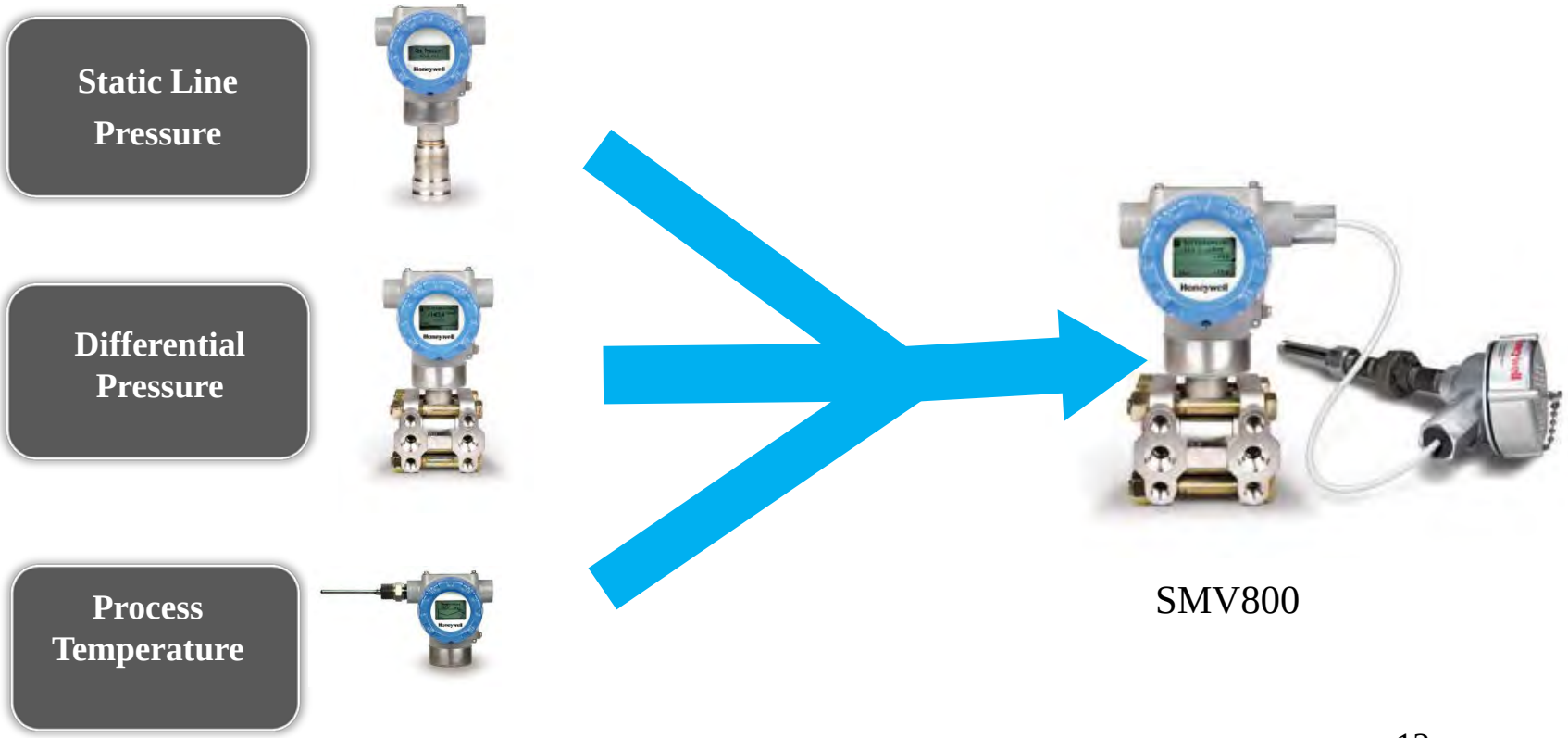
Flow Computer – mass flow

- Historically gas/steam mass flow measurement has been done with three separate transmitters (DP, T, AP) and a *flow computer*



Multivariable - Mass Flow

- The multivariable does the work of a flow computer

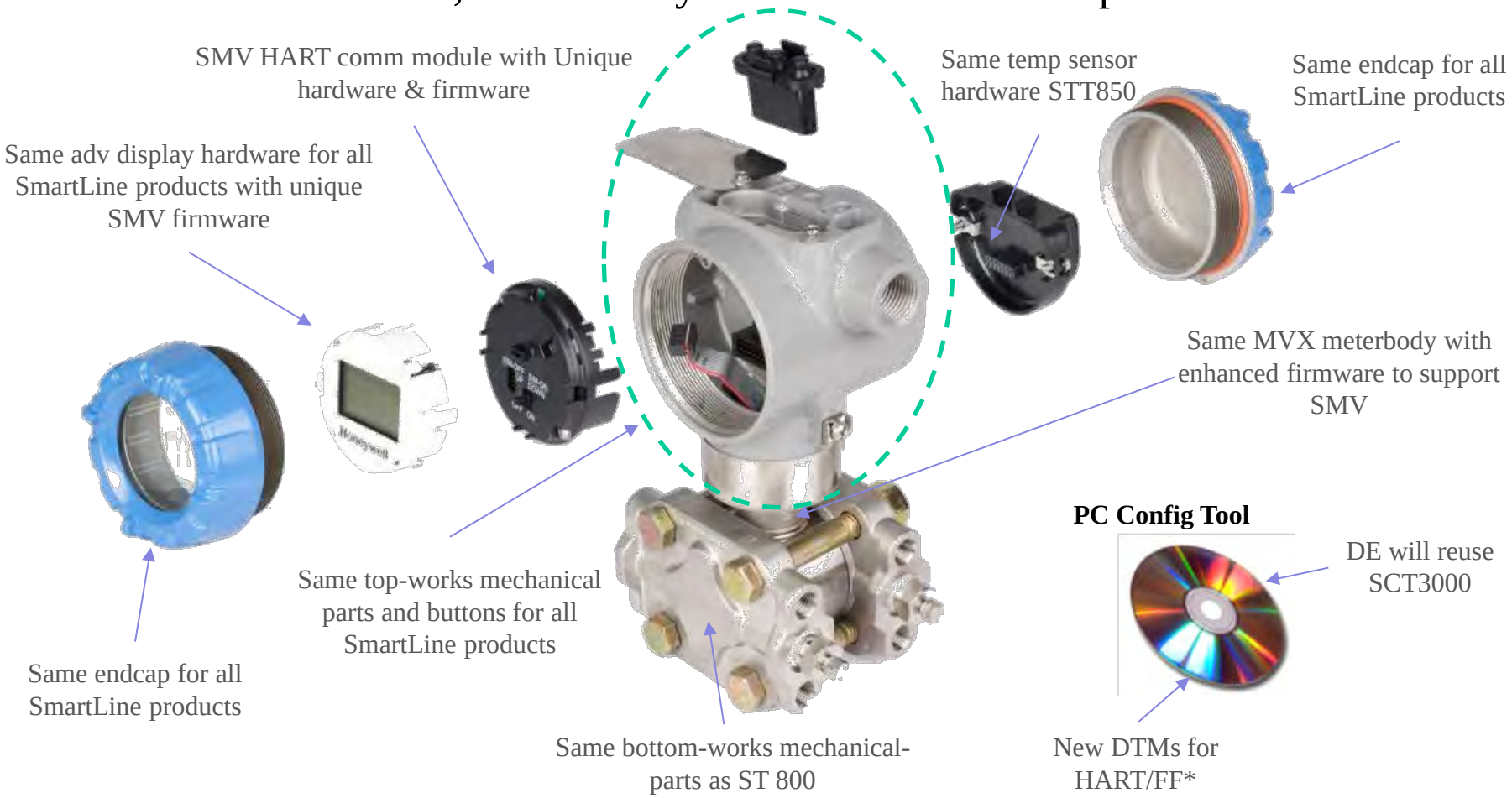


Honeywell SMV 800

- What's commercially available?
- Honeywell's 2nd generation multivariable SMV800
- Thermocouple or RTD for temperature measurement
  - Not a transmitter, just the sensor
- Digital display of mass flow value and units
- Embedded absolute pressure (AP) (aka: static pressure) sensor
- An internal data base with viscosity and density data for 108 fluids
- Calculates mass flow using AP, T, viscosity and density data
- Output is mass flow rate

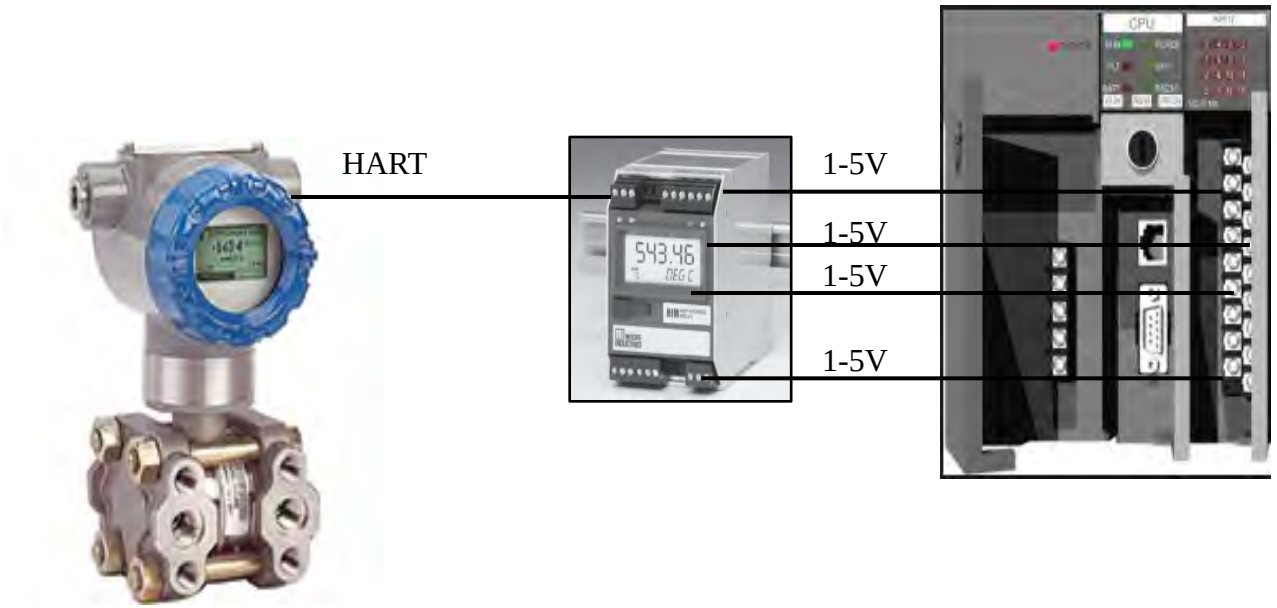
Honeywell's 2nd Generation SMV800

Looks like an ST800 DP, shares many of the ST800 DP components



HART break-out box

- What if I need all three measured variables?
- The SMV800 connect to a HART HIM break-out box
  - Provides all three measured variables, DP, AP, T, and the calculated mass flow rate



Why Multivariable ? (flow computer in a transmitter body)

Three measurements DP, AP, T & flow computer all-in- 1

Inferred mass flow value: lbs Kg

Minimizes Process Intrusions

No separate Flow Computer

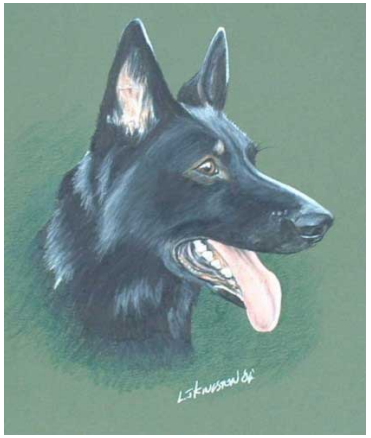
Who benefits from mass flow measurement?

- Steam Flow
- Gas Flow
- High temperatures; when other technologies can't take the heat in the kitchen
  - Steam
  - When it's a hot process, impulse tubing keeps the DP transmitter within operating limits
- High pressures, up to xmtr body ratings (4,500psig @ 260°F, derated above)
- Large line sizes
  - Ever hear of a 24" Coriolis meter?
  - DP primary flow elements are cost effective
- When the process needs a mass measurement (pounds, Kg)

Classic example

- Title: Accurate DP flow measurement in changing process conditions
- Prime Example of where mass measurement made a difference
  - Gas flows were ratioed
  - 20 year old control scheme using DP flow to do ratio control of gases
  - The process needed constant flow adjustment due to temperature and pressure deviations from design conditions
    - Unheated buildings, uninsulated gas piping from outside to inside
    - Hour to hour, day to day, season to season temperature changes
    - Load changes on a shared supply regulator change upstream supply pressure
  - Issue
    - Process needs a certain blended mass flow to operate properly
    - Volumetric flow measurement did not account for varying gas densities
    - Continually manually tweaking the control based on after-the-fact analyzer output
  - Solution – measure supply gas as mass flow, not volumetric
    - Ratio of the correct masses produces the correct blend/mixture

Questions ? ?



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North American Director of Sales
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