In-line meter pressure drop

Thermal anemometers can have a low installed pressure drop as they use convective heat flow to infer the mass flow rate. In contrast, classic pressure drop technologies, like the orifice plate or venture, use the pressure drop as the flow measurement method.

No mater if the pressure drop is deliberate or due to the flow conditioners used in the meter, they all tend to flow the classic $dP \sim cQ^2$ scaling rules which have been generalized for predicting the pressure drop on any flow meter at any flow, temperature, pressure or gas type. The exception to this rule applies to laminar flow elements, LFE where the pressure drop is almost linear with the flow rate and scales with the gas viscosity and molecular weight (MW).

Meter Pressure drop equation

The dp or pressure drop is based on $hm_wg = ½\, m_gV^2$ where potential energy, height of water pressure is equal to the kinetic energy of impact of the gas. The density terms are rolled into the mass and the flow rate is the velocity. We get the following expression:

$$Dp = dP_{maxstd}(Ps/Pa)(Ta/Ts)(Q/Q_{max})^2\ (MW/28.96)$$

Where

dP_{maxstd} = the pressure drop at max. flow for the standard conditions and air.
Ps = Standard pressure, absolute units, not gage
Pa = Actual pressure, absolute units, not gage
Ta = Actual temperature in absolute units (deg K or R), not C or F
Ts = Standard temperature in absolute units (deg K or R), not C or F
Q = flow rate, mass rate or velocity
Q_{max} = maximum flow rate which matches the dP_{maxstd} constant in Air
MW = gas molecular weight

The dP equation shows that most parameters linearly scale the dP. This includes the gas molecular weight, gas pressure or absolute temperature.

The gas flow rate, scales with a square though. So at ½ the flow rate, the pressure drop is ¼. At 1/10 the flow rate, the pressure drop is 1/100. Also note at the actual pressure goes up, so does the pressure drop. This is because the gas density goes down, the actual velocity is higher and the

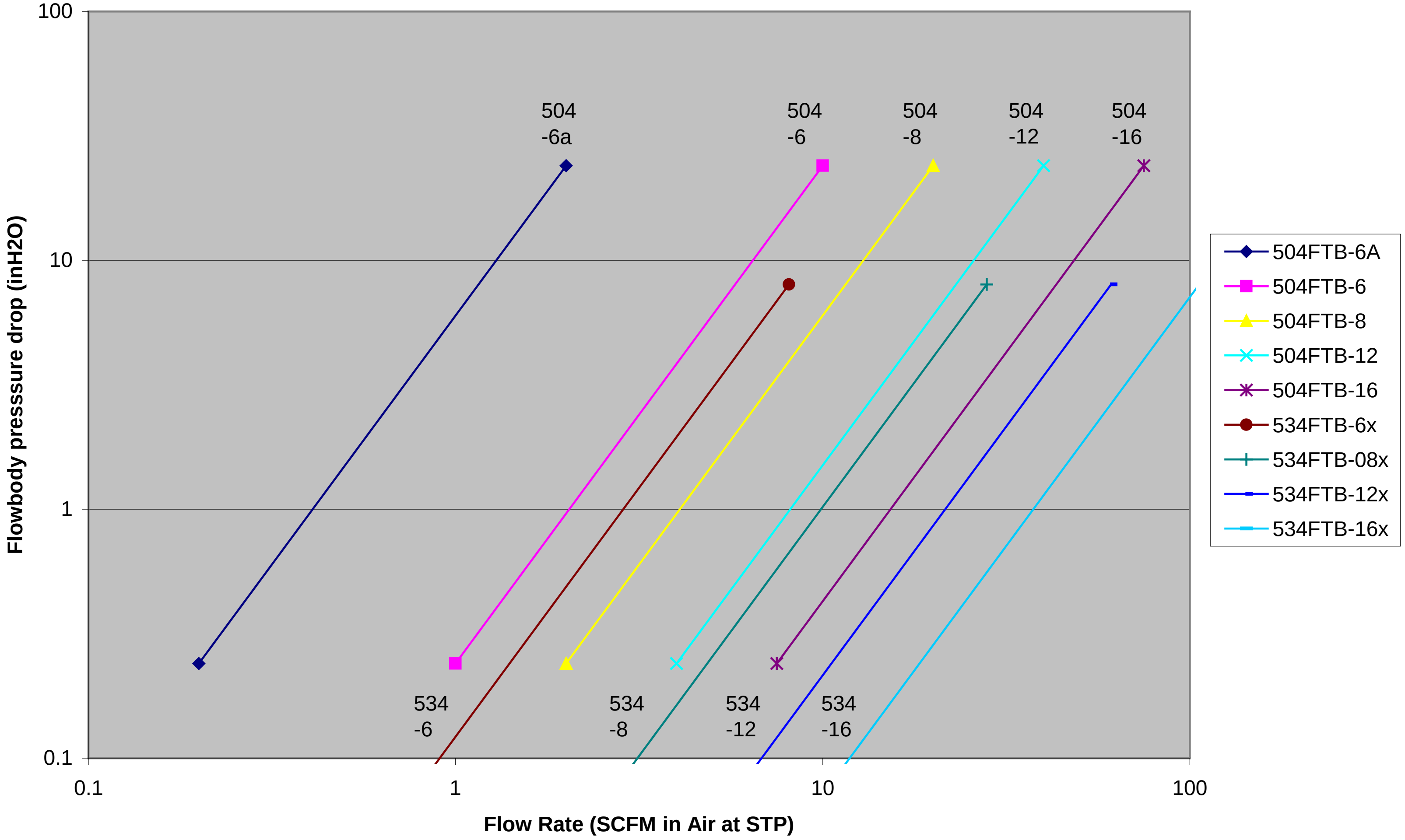
Looking at an example.

> *Gas is methane, 50 SCFM in a Kurz 504FT-16 meter, 30 pisg and 40 °C. Looking at the brochure on the 504FT-16, we read it has 24 inches of water dp at the 75 SCFM full scale in Air. Methane MW = 16.*
>
> $Dp = 24 \{(14.69/(14.69+30)\} (273+40)/(273+25) (50/75)^2 (16/28.96) = 2.03\ inH2O$
>
> *This example is substantially lower pressure drop than the full scale Air number for several reas*ons: higher than ambient pressure, less than FS flow, lower gas MW.

In-line flow meter, pressure drop curves

If we graph the results of this equation at STP (25 °C, 0.1013 MPa, 760 mmHg) for the 504FTB and 534FTB product lines, we get the family of curves shown in the two graphs below: The fist graph is the -16 or 1" line size and smaller where the second graph is the larger sizes. See the brochures of the 504FTB and 534FTB for more details on what these models are.

504FTB & 534FTB



504FTB & 534FTB