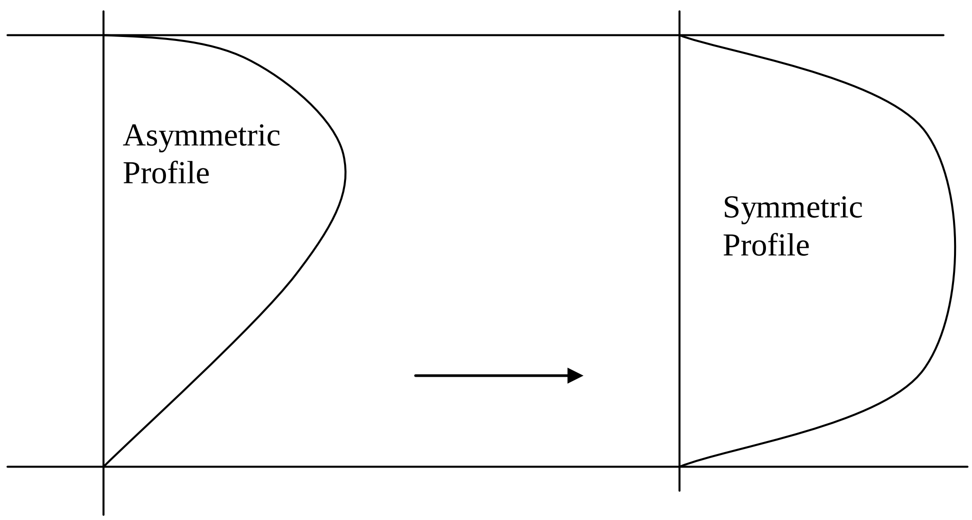
Why use a flow conditioner for a Thermal Anemometer?

Flow conditioners can be used with all flow measurement technologies to improve their installed accuracy and repeatability. Just about every book on flow measurements has a chapter for flow conditioners which illustrates the importance of this issue. The confusing part is that some measurement technologies are more sensitive than others to non-ideal flow conditions found in process applications.

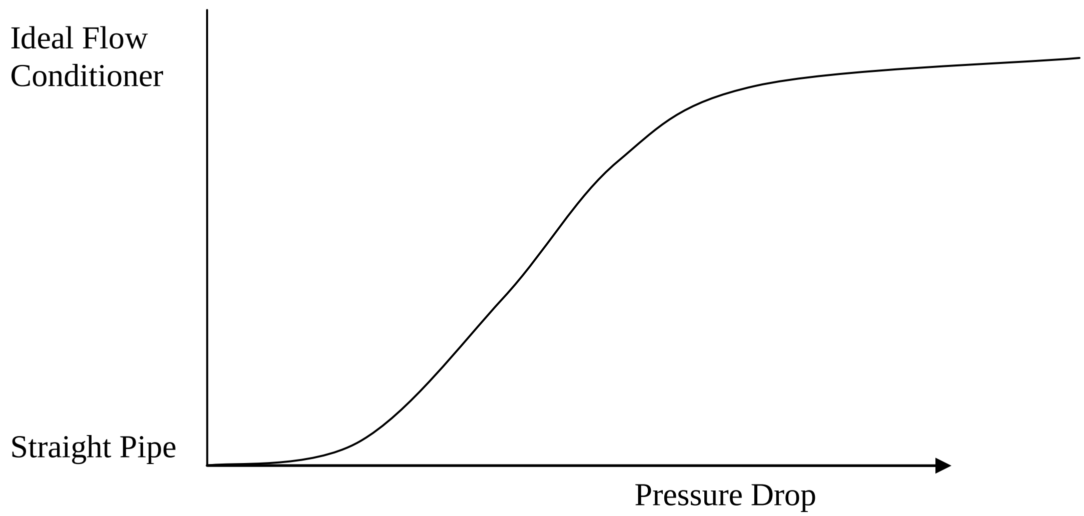
Non Ideal Flow Conditions

- Non-symmetric flow profiles (elbows, line size changes, tee, partly open valve)
- Flow profiles that change with flow rate
- Changing Flow profiles from upstream disturbances (branching Y, valves etc.)
- Swirling flow
- Temperature stratified profiles



For large process piping or ducts, insertion flow elements that measure the localized or point velocity are very popular (cost effective solutions) but lack flow conditioning. For smaller process piping, an in-line meter or volumetric or mass rate meter are popular which often include some kind of flow conditioning. For that reason, the smaller meters as a group tend to have a higher installed accuracy.

The techniques used to make flow conditioners to deal with the flow conditions vary widely so does their effectiveness depending on how much process pressure drop is used.



Flow Conditioner Examples

- Long length of pipe
- Perforated plates
- Laminar Flow Elements (LFE)
- Honeycomb
- Venturi piping
- Flow nozzles
- Partial honeycomb and partial nozzles (like the "Vortab")

Small flow semiconductor gas flow meters are a good example of inline devices which have nearly ideal flow conditioners yet they consume large pressure drops in the process. While a long pipe run will eventually through drag, establish a stable flow profile, the space and cost of such a method is often not practical unless you already have such a "metering" run available because the gas is being transported from one location to another. Venturi flow sections are a very good compromise in size, cost and performance due to their pressure recovery sections or diffusers which tend to defy the basic performance /pressure drop curve (Kurz 534FTB for example). The partial honeycomb/nozzle flow conditioners (FCI or Kurz Vortab device) have similar immunity to profile disruptions as the ventrui type conditioners with a higher pressure drop. In compressed gas applications, the pressure drop is often of no concern whereas in blower applications the pressure drop can be a significant factor in peak system flow rates.

CPA vs. CTA Thermal Anemometer

When a thermal anemometer is used as the primary velocity sensing device, the temperature profiles in the process may be a source of error. The CPA or constant power anemometer flow meters tend to use only a fraction of a watt of power which only heats the velocity sensor slightly (~ 10 °C) above the ambient temperature for a typical sensor and this temperature rise falls with increasing velocity. If there is a small temperature difference with position in the duct (thermal gradient) this will superimpose with the flow measurement causing the meter to read high or low depending on the gradient direction (hot pipe center, cold walls or cold pipe center and hot walls). The CPA devices use a small amount of measurement power so they do not overheat at zero flow but this limits their accuracy at high flow rates because the signal is so week.

The CTA or constant temperature anemometer regulates the internal sensor temperature say 55 °C above the ambient, no mater what the gas flow rate. This results in a higher temperature difference between the velocity sensor and ambient and thus is less affected by thermal gradients in the process. This can also looked as a signal to noise ratio (SNR). The temperature difference is the signal and the background thermal gradients are the noise. This is why the CTA devices have a more stable signal in heated gas applications.

The flow conditioners not only mix the flow to stabilize the flow profile, they also have the side effect of mixing the temperature profile and thus reducing the thermal gradient in the pipe. This thermal mixing is the primary reason flow conditioners are very popular with CPA meters even when there is no profile disruption before the meters.

Summary

Flow conditioners are used to improve the installed repeatability and accuracy of a flow meter. For thermal anemometers, especially the constant power anemometer (CPA) they also mix the gas temperature to reduce the flow errors duce to thermal gradients. The constant temperature anemometer (CTA) can be used without the flow conditioner in many applications where the flow profile is stable due to is higher thermal signal to noise ratio (SNR). For many applications, the cost of both the CPA flow meter and flow conditioner is substantially higher than the high performance CTA flow meter which can often be used with good results without a flow conditioner.