AN07 Application Note –
Gas corrections factors

Introduction

The VPFlowScope M, VPFlowScope Probe and VPFlowScope In-line flow meters use a thermal mass flow principle. This is great, because you do not need an external pressure or temperature sensor to compensate the output signal. But it also means that the output depends on the density, the thermal conductivity of the gas, the heat capacity and the viscosity. For common technical gases, VPInstruments has verified the conversion factors experimentally. This application note provides more background information on how conversion factors can be used.

Real gas calibration vs theoretical factor

VPInstruments offers real gas calibration for a selected group of safe, non-corrosive, non-oxidizing, non-combustible and non-toxic gases. Due to safety regulations of the calibration lab, it is not possible to calibrate with toxic gases or strong oxidizing gases.
The validation of the gas correction factors in the calibration lab shows an average error of 5% of reading.
Real gas calibration results in a higher accuracy of the instrument compared to conversion factors, as this eliminates any non-linear effects. Real gas calibrations meet the calibration accuracy according to the product specifications.

Correction factors table

The correction factor table for VPFlowScope M, VPFlowScope Probe and VPFlowScope In-line is shown below. The standard calibration gas is compressed air, which has a reference factor of 1.0. When subjected to another gas, the flow meter output needs to be multiplied with a conversion factor to show the correct measurement value. The factor is applied over the full range of the instrument and does not cancel out any non-linear effect.

Gas		Factor
Air		1,00
Argon	Ar	1,60
Carbon dioxide*	CO2	0,90
Nitrogen	N2	1,00
Protegon 18	82% Ar, 18% CO2	1,45

* Because of its density, the maximum calibrated flow range for CO2 is limited.

Oxygen

As oxygen is a strong oxidizing gas, it is not possible to calibrate with pure oxygen in the calibration lab. Therefore, the conversion factor is a calculated value. Oxygen and compressed air have similar thermal properties, resulting in a theoretical correction factor of 1.0.

Helium

When the gas properties differ significantly, the conversion factor will also differ significantly. The most dramatic effect is seen with helium gas. This gas has a very low density and a high thermal conductivity. This results in a non-linear conversion factor, so VPInstruments always offers a real gas calibration for this gas.

VPFlowScope DP

For differential pressure based instruments, the conversion factor cannot be applied in the same way. Therefore, the VPFlowScope DP has a different correction factor which is directly related to the square root of the density of the special gas. The table below shows the examples for argon (Ar), carbon dioxide (CO2) and nitrogen (N2).

Gas	Density	Density factor	1/Density factor	SQRT = correction factor
Air	1.293	1	1	1
Ar	1.784	1.380	0.725	0.85
CO2	1.977	1.529	0.654	0.81
N2	1.251	0.968	1.034	1.02