Pressure Dependence of SenseAir´s NDIR sensors

Pressure affects the reading of CO_2 sensors. This is because of the physics principle used to measure CO_2 concentration. The NDIR type of sensors measure the IR radiation absorbed by CO_2 molecules, which corresponds to the mole concentration. And when pressure increases, the number of molecules in a given volume also increases linearly. Therefore, all CO_2 sensors have a dependence on pressure.

How atmosphere affects the reading of CO_2 sensors?

The composition of air is unchanged until an elevation of approximately 10.000 m, but the atmospheric pressure of air varies with altitude, that at high altitudes there's lower pressure than at sea level. This means also that the number of molecules per volume unit decreases, according to the Ideal gas law.

Since an NDIR sensor in fact measures the number of molecules per volume unit, it will show a lower reading at higher altitudes. But the unit used by the sensor to express CO_2 concentration is ppm by volume and the volume fraction occupied by CO_2 is the same regardless of pressure, which means that the choice of ppm by volume as unit of measurement for CO_2 sensors introduces a deviation that can be compensated for, if needed. According to the US Standard Atmosphere, 1976, we know that as we increase altitude in the atmosphere, the pressure decreases (figure 1).

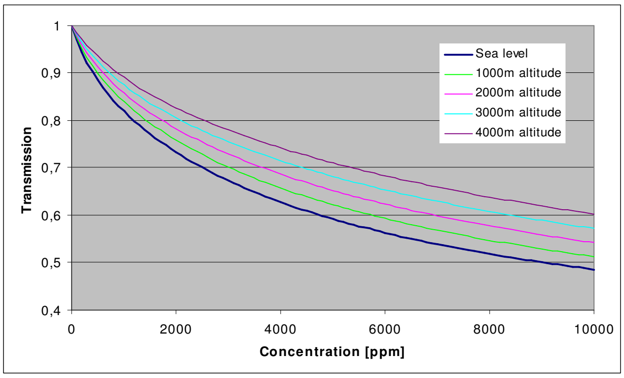

Figure 1 sensor reading depending on different altitude.

Regulation by using ABC function

SenseAir sensors make use of the ABC algorithm to compensate for any long-term drift due to e.g. aging of components and initial inaccuracy due to e.g. transportation. If we located a CO_2 at 2000 m, as figure 2 shows, using Senseair's ABC function can effectively adjust the reading close to true reading which minimizes the difference generated by pressure sensitivity.

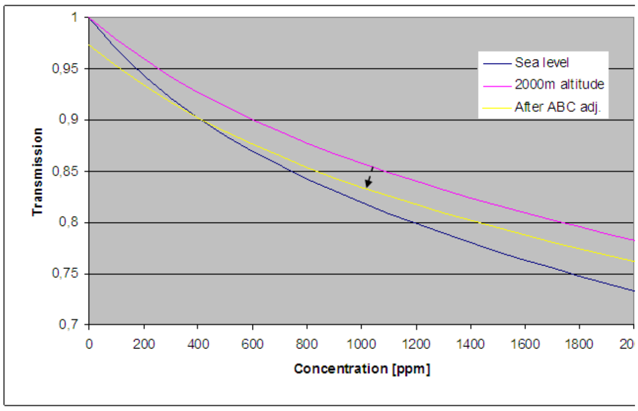

Figure 2.

True reading calculation

The pressure sensitivity of SenseAir CO_2 sensors is given in the sensor's datasheet as: "+1.58% reading per kPa deviation from normal pressure, 100kPa". This is an approximation that is valid around mean sea level pressure, 101.3kPa, at which the SenseAir sensors are factory calibrated. A more exact approximation is give below where P = pressure in kP.

$$\text{True reading} = \frac{\text{Reading}}{4.026\times10^{-3}\times P + 5.780\times10^{-5}\times P^2}$$

*Note 1

V.T.E	Pascal	Bar	Technical atmosphere	Standard atmosphere	Torr	Pound per square inch
	Pa	bar	at	atm	Torr	psi
1 Pa	≡ 1 N/m^2	10^{-5}	$1{,}0197\times10^{-5}$	$9{,}8692\times10^{-6}$	$7{,}5006\times10^{-3}$	$145{,}04\times10^{-6}$
1 bar	100 000	≡ 10^6 dyn/cm^2	1,0197	0,98692	750,06	14,5037744
1 at	98 066,5	0,980665	≡ 1 kgf/cm^2	0,96784	735,56	14,223
1 atm	101 325	1,01325	1,0332	≡ 1 atm	760	14,696
1 torr	133,322	$1{,}3332\times10^{-3}$	$1{,}3595\times10^{-3}$	$1{,}3158\times10^{-3}$	≡ 1 Torr; ≈ 1 mmHg	$19{,}337\times10^{-3}$
1 psi	$6{,}894\times10^3$	$70{,}307\times10^{-3}$	$68{,}046\times10^{-3}$	$68{,}046\times10^{-3}$	51,715	≡ 1 lbf/tum^2

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