ANNEX A (BACKGROUND)

METHANE VOC TVA 2020 PPM READING CONVERSION TO MASS LEAK RATE

Nomenclature:

- G_{OD}: Gasket winding outside diameter
- L_{rm}: Mass leak rate in mg (lb) per second per meter (inch)
- MW: Gas molecular weight
- T: Test temperature in Kelvin
- TVA Flow Rate = 1 liter/minute
- mg: milligram
- s: second
- m: meter
- in: inch

In air literature ppm applied to a gas generally means parts per million by volume.

$$ppm\ [=] \frac{mL}{m^3}$$

To convert a ppm unit to $\frac{mg}{s.m}$ it is necessary the corresponding gas density. At 1bar and considering 1mole of the gas, the density is calculated by the following expression:

$$\text{density} = \frac{MW}{0.082057x\ T} [=] \frac{g}{L}$$

In this case:

$$\text{CH4 density} = \frac{16.04}{0.082057\ x\ T(K)} = \frac{195.47}{T\ (K)}\ g/L$$

Considering the TVA 2020 flow rate and the unit conversion, the expression of the leak rate is:

$$\frac{ppm\ reading\ X\ density\ X\ flow\ rate}{1000\ x\ 60\ x\ \pi\ x\ G_{OD}\ x\ T(K)} [=] \frac{mg}{s.m}$$

Simplifying these equations:

$$L_{Rm} = \frac{0.00326\ x\ ppm\ reading}{\pi\ x\ G_{OD}\ x\ T(K)}\ \frac{mg}{s.m}$$

Considering laboratory conditions, 21^{0}C (69,8^{0}F or 294K):

$$L_{Rm} = \frac{1.11E{-}5\ x\ ppm\ reading}{\pi\ x\ G_{OD}}\ \frac{mg}{s.m}$$

According to API 622 for a Stem of 1 inch diameter the concentration should be less or equal to 100 ppm. Then,

$$L_{Rm} = \frac{1.11\text{E} - 5 \text{ x } 100}{\pi \ x \ 0.0254} \frac{mg}{s.m}$$

$$\boldsymbol{L_{Rm} = 0.0139 \frac{mg}{s.m}}$$ or $$\boldsymbol{L_{Rm} = 7.78\text{E} - 10 \ \frac{lb}{s.in}}$$