EASTERN INSTRUMENTS

Technical Application Bulletin
For All VAP's

TAB-VAP-102

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Objective:

To determine the molecular weight of a gas mixture so that density may be calculated

Gas ---Air The following example is for air but any other mixture may be substituted

Molecular Weight Calculation of Mixtures

Nitrogen, N_2

$mF_1 := .7806$ $M_1 := 2 \cdot 14.0067$

Oxygen, O_2

$mF_2 := .21$ $M_2 := 2 \cdot 15.9994$

Argon, Ar

$mF_3 := .0094$ $M_3 := 39.948$

Gas Component 4

$mF_4 := 0$ $M_4 := 0$

Air mol or volume fraction from CRC Handbook of Chemistry and Physics

$mF_1 + mF_2 + mF_3 + mF_4 = 1$

$$M_{wt} := \frac{mF_1 \cdot M_1 + mF_2 \cdot M_2 + mF_3 \cdot M_3 + mF_4 \cdot M_4}{mF_1 + mF_2 + mF_3 + mF_4} \qquad M_{wt} = 28.963$$

molecular weight calculation for standard air

Density Calculations

$$R_{universal\_gas\_constant} := 8314.32 \cdot \frac{m \cdot N}{kg \cdot K} \qquad in\_wc := \frac{psi}{27.68}$$

EI definition of in_wc

$p := 101325 \cdot Pa$ $p = 14.696\,psi$ $p = 760\,torr$ $p = 406.784\,in\_wc$ (760 mm_Hg Std Atm)

$T_{gas} := (15 + 273.15) \cdot K$

[(15°C Std Atm)--note this is dry air--ASHRAE Std is saturated at 60°F which is about the same as 69°F dry ~ .075 lb/ft^3]

$$\rho_{gas} := \frac{M_{wt} \cdot p}{R_{universal\_gas\_constant} \cdot T_{gas}}$$

equation of state is used to calculate density of a gas if molecular weight is known

$\rho_{gas} = 0.076469 \frac{lb}{ft^3}$ $\rho_{gas} = 1.225 \frac{kg}{m^3}$

this fits definition of international standard atmosphere Ower and Pankhurst at indicated conditions

To solve for density at conditions other than the given conditions, then calculate by:

$$Unit\_Constant := \frac{\frac{\rho_{gas}}{\frac{lb}{ft^3}} \cdot \frac{T_{gas}}{R}}{\frac{p}{in\_wc}} \qquad Unit\_Constant = 0.0975$$

This will be for the above calculated gas only

$T_{air} := 69$ $p_{static} := 406.78$ $density := \frac{Unit\_Constant \cdot p_{static}}{T_{air} + 459.67}$ $density = 0.07502$

Restate the temperature to see if the calculation results in the standard calculation as ASHRAE as stated above-- this shows both method and calculation.

RECOMMENDATIONS: Use the **DPS** reciever to calculate the density from a given molecular weight gas. Use of the **DPU** reciever will require calculation of both the molecular weight and density and entering this value into the **DPU**

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