Field Calibration using Process Stoichiometry

A very popular method used to evaluate the accuracy of an installed flow meter is compare its readings against the theoretical flow based on the process chemistry. In some cases, this method is the basis of the filed calibration (establishment of correction factors between the peak velocity and the average on and insertion probe).

Ia + nIb > yIc + zId

Where Ia is reactant a and Ib is reactant b resulting in lc and ld with n, y and z being molar factions.

So this method uses the know chemistry of the process to estimate the relative flow of reactants or results if the efficiency of the process is known.

A balanced chemical reaction (stoichiometric sto/key/o/metric) predicts the mount of reactants and product.

CH4 + 2O2 > CO2 + 2H2O

In this example, the Oxygen flow rate would be twice the Methane when a clean burn was occurring. If we knew one reactant, we know the other and the product or exhaust flow too (provided the H2O was gas or vapor still). For ideal gases, the molar fraction and volume fraction are the same. The mass rate fraction must include the molecular weight of each gas molecule multiplied by its molar fraction.

In the case of a simple combustion process of burning Natural Gas in Air we have the following relationships:

Applied to Air we have

100 moles of Air = 78N_2 + 21O_2 +Trace

So the O2 + other = 100/21Air ~ 4.76 Air

Combining the two relationships

CH_4 + 2(4.76 Air) > CO_2 + 2H_2O + (78N2 + Trace)*2*4.76/100

So the process input is by volume 9.52/1 Air/fuel ratio for a complete burn, no excess air or 0% O2 in the flue gas. If there was 2% O2, this ratio would increase about 10% to ~10.5/1.

In summary, knowing the process chemistry you can estimate an unknown reactant or the result gas flow if you know part of the flow.