Reply to Demetris Koutsoyiannis

I agree with the assertion regarding the benefits of signing reviewer comments, and applaud the attitude of getting involved with the outlook of a student. I want to think that I use the same outlook, although I am aware that my writing can sometimes be taken as overly authoritative and even offensive to some readers. I assure that it is not my intent to offend, but rather to learn the truth, and to defend the truth when I believe that I have found it.

With that in mind, I cannot agree with Professor Koutsoyiannis in his assertion that "the mass description is precisely equivalent to the molar description", because I believe his derivation contains two incorrect assumptions. If I follow correctly the Appendix, just prior to the word "Hence", Professor Koutsoyiannis's version of Fick's law could be written, via substitution, as:

$$J = -\mathrm{D}\frac{\mathrm{d}}{\mathrm{dz}}\left[\frac{\mathrm{m}_v}{\mathrm{m}_{TOT}}x\rho\right]$$

So that simplification to the version just following the word "Hence" requires two invalid assumptions:

1. that m_{TOT} is constant (and so can be extracted from the derivative), but molar mass varies with humidity and so $\frac{\mathrm{d}}{\mathrm{dz}}[\mathrm{m}_{TOT}] \neq 0$; and
2. that ρ is constant (and so can be extracted from the derivative), but ρ varies according to various factors*, principally the temperature (T), and so $\frac{\mathrm{d}\rho}{\mathrm{dz}} \neq 0$. Given that the issue at hand is the role of T gradients in modifying Fickian diffusion, or Soret effect, such an assumption is particularly inappropriate.

It is my contention, based on applying Newton's laws to the mixing *and inertia* of fluids with different molar masses, that the correct version of Fick's law must be

$$J = -\rho\mathrm{D}\frac{\mathrm{df}_v}{\mathrm{dz}}$$

where f_v is the mass fraction, also known as the specific humidity (q).

*The other factors influencing gradients in ρ are the pressure (via the ideal gas law) and the humidity.