4.0 MOISTURE MIGRATION AND ISOTHERM IN BIO-MATERIALS

The concepts of moisture migration and moisture isotherm are very essential in bio-material handling because they affect the behavior, storage and dying if bio-materials. Moisture can migrate both within and on the surface of bio-material in response to the fluctuations in relative humidity and temperature. The interaction between EMC, relative humidity and temperature is known as moisture isotherm.

Henderson equation shows the relationship between the EMC, Temperature and RH as stated below:

$$1 - a = e^{-kT(Me)n} \quad \text{..........................(5)}$$

$$In\,(1-a) = -kT(Me)^{n} \quad \text{.......................(6)}$$

$$\log\left[-In\,(1-a)\right] = n\log Me + \log K \quad \text{...............(7)}$$

If temperature is constant, $K = kT$ .... (8)

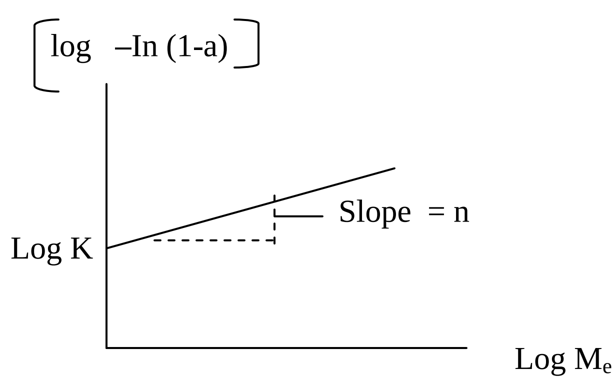
Where, Me = EMC in decimal

a = RH or water activity in decimal

T = absolute temperature

k & n are constant depending on product characteristics.

The values of K (kT) and n are obtained by plotting a graph of log (-In (1-a)) vs log Me. The slope of the graph gives the value of n and the intercept gives the value of log K. To obtain K find the antilog of the intercept.



Where,

$$n = \frac{\triangle \log [-\ln (1-a)]}{\log Me}$$

Henderson equation is graphically represented on the isotherm curve. This curve is sigmodial (See Fig 1). On the isotherm plot, we could either draw the sorption curve or the desorption curve (See Fig. 2). The sorption curve shows the isotherm plot for product absorbing moisture while desorption curve shows the isotherm plot when water is withdrawn (during drying) from product. It should be noted that the two curves do not follow the same path, but both have sigmodial shape. The desorption curve is always above the sorption curve. There is hysteresis between the two phenomena. This is because more energy is required to withdraw moisture from stored grains.

Further research showed that the moisture isotherm is not a perfect sigmoid. Rockland, 1957, discovered that a typical isotherm is made up of series of straight line. And, he identified 3-basis "local isotherms" (See Fig. 3). Each local isotherm corresponds to the degree of wetness of the product. He therefore, partition the isotherm into three local isotherm (or water binding layer) namely:

1. Monolayer water binging: This is a very dry region.
2. Multi-molecular binding: This is the most stable region.
3. Kelvin Moisture layer or Saturation layer: This is the most unstable layer.

Deterioration is very high in the saturation layer (3). For safe storage, we select storage conditions using the stable local isotherm (2). It should be noted that each of the local isotherms has its own values of k & n.