SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE - 641035

TAMIL NADU

19FTT101& FUNDAMENTALS OF FOOD PROCESSING

UNIT I PROCESSING OPERATIONS

Models, Importance and hysteresis effect

EMC models

For determination of EMC of agricultural products many theoretical, semi-theoretical and experimental models have been proposed. But, none of the theoretical EMC equation is found to predict or to provide the EMC values correctly in the entire range of temperature and relative humidity values. Some of EMC models are described below.

Kelvin equation:

Kelvin in 1871 has given the model of moisture adsorption by solid material. For evolving the model, the phenomenon of capillary condensation in pores of solid materials was considered. The relationship between the vapour of water present in capillaries and saturated vapour pressure at same temperature is the basis of capillary condensation theory. The kelvin equation is as under

$$ln\ (P_V/P_{VS}) = 2\sigma\ V\ cos\alpha/rRT_a$$

P_v = vapour pressure of grain
P_{vs}= saturated vapour pressure at temperature in equilibrium with the system
σ = moisture surface tension
α-angle between moisture and capillary wall
V=Volume of moisture
r= radius of cylindrical capillary
R= universal gas constant
T_a-absolute temperature

The utility of above equation for grain EMC determination is limited in conditions of relative humidities above 95% when the action of capillary condensation takes place.

Harkins-Jura equation:

This model is based on the theory of existence of a potential field above surfaces of solid materials. In this concept, the work required to adsorb or desorb a water molecule is the sum of work required to overcome vapour molecule to come on surface and the work necessary for condensation. Considering the above potential field theory, Harkins-Jura have proposed in 1944 the following equation

$$\ln (P_v/P_{vs})=d-e/V2$$

where, d and e = product constant depend on temperature The Harkins-Jura equation does not predict satisfactorily accurate EMC values when the relative humidity is more than 30%.

Chung-Pfost equation:
Chung-Pfost has proposed an equation for determination of EMC on the basis of potential field theory. The equation is given below

$$\ln(P_v/P_{vs}) = -\frac{A}{RT} \exp(-BM)$$

R= universal gas constant
T-absolute temperature, "K
A and B constant dependent upon grain temperature
M = moisture content, % (db)

The above equation provides fairly accurate EMC values of grains between 20 to 90% relative humidity values.

Henderson equation:
Handerson in 1952 has proposed an equation for EMC determination. This EMC equation is very much popular and based on the Gibbs' adsorption equation. The following equation for the EMC curves has been derived by Henderson.

$$1-rh = e^{-CTMe''}$$

rh = relative humidity, decimal
T= absolute temperature, "K
M = EMC, % (db)
Cand n = constant, dependent on crop type and temperature.
Out of the above described theoretical, semi-theoretical or empirical equation, no single relationship can predict grain's EMC values in the full range of relative humidities and temperatures generally encountered.

Importance of EMC

EMC is of particular importance for drying and storage of food materials. The usefulness of EMC are:

i) EMC gives an idea whether the food material will gain or lose moisture

under a particular atmospheric condition.

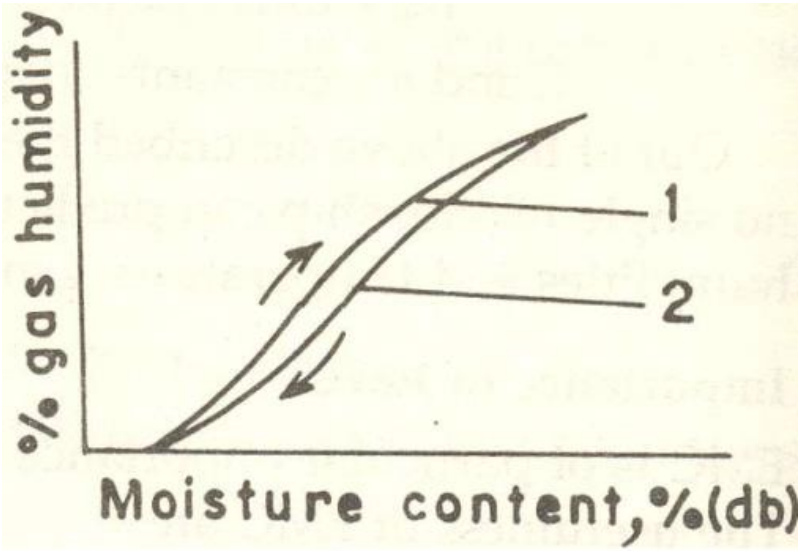
ii) It gives an idea about rate of moisture removal.

iii) EMC helps to determine drying characteristics.

iv) With the knowledge of EMC, it can be predicted as to what final moisture level a product can be dried with the heated air.

Hysteresis Effect

When food products in the process of loosing moisture attains equilibrium moisture content with the surroundings, the EMC is known as desorption EMC. But when a dry product gains moisture from the surroundings and attains EMC, that value of EMC is said to be adsorption EMC. At some relative humidity and temperature level there is a meaningful difference between the desorption and adsorption EMC values. The desorption EMC values are higher than the adsorption EMC values. The differences between desorption and an adsorption curve is known as hysteresis effect. As seen from the figure, the differences between the adsorption and desorption values are more significant for the intermediate range of moisture contents.



1) Adsorption EMC curve, 2) Desorption EMC curve