Document Title: Description, AN, AW Definition		Part # and Rev. 13418-00	
		Release Date:	
Rev.	Description	Revision By	Date

Production Filename: 13418 (In Product Library)

Path to Working Files: DecaDoc\Application Notes\Master

Dimensions: 8.5 inch wide, 11 inch tall

Material: Paper, 92 Bright White or better, 75g/m² or heavier

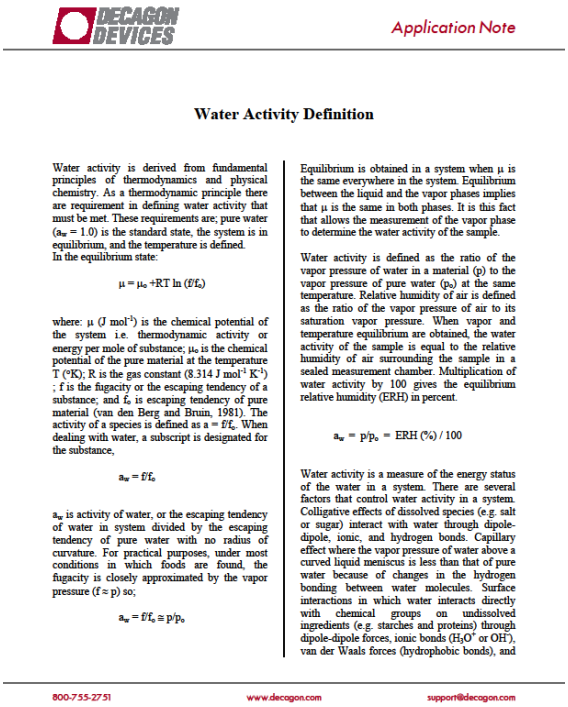
Colors: Color Print on White

Printer: HP Color LaserJet 8550-PS

Finish: None

Adhesive: None

Special Notes: Illustrations are Ref Only ** Not to Scale ** (Shown page 1 of 2)



DECAGON DEVICES Application Note

Water Activity Definition

Water activity is derived from fundamental principles of thermodynamics and physical chemistry. As a thermodynamic principle there are requirement in defining water activity that must be met. These requirements are; pure water (a_w = 1.0) is the standard state, the system is in equilibrium, and the temperature is defined. In the equilibrium state:

$$\mu = \mu_o + RT \ln (f/f_o)$$

where: μ (J mol^{-1}) is the chemical potential of the system i.e. thermodynamic activity or energy per mole of substance; μ_o is the chemical potential of the pure material at the temperature T (°K); R is the gas constant (8.314 J mol^{-1} K^{-1}) ; f is the fugacity or the escaping tendency of a substance; and f_o is escaping tendency of pure material (van den Berg and Bruin, 1981). The activity of a species is defined as $a = f/f_o$. When dealing with water, a subscript is designated for the substance,

$$a_w = f/f_o$$

a_w is activity of water, or the escaping tendency of water in system divided by the escaping tendency of pure water with no radius of curvature. For practical purposes, under most conditions in which foods are found, the fugacity is closely approximated by the vapor pressure ($f \approx p$) so;

$$a_w = f/f_o \cong p/p_o$$

Equilibrium is obtained in a system when μ is the same everywhere in the system. Equilibrium between the liquid and the vapor phases implies that μ is the same in both phases. It is this fact that allows the measurement of the vapor phase to determine the water activity of the sample.

Water activity is defined as the ratio of the vapor pressure of water in a material (p) to the vapor pressure of pure water (p_o) at the same temperature. Relative humidity of air is defined as the ratio of the vapor pressure of air to its saturation vapor pressure. When vapor and temperature equilibrium are obtained, the water activity of the sample is equal to the relative humidity of air surrounding the sample in a sealed measurement chamber. Multiplication of water activity by 100 gives the equilibrium relative humidity (ERH) in percent.

$$a_w = p/p_o = ERH\ (\%) / 100$$

Water activity is a measure of the energy status of the water in a system. There are several factors that control water activity in a system. Colligative effects of dissolved species (e.g. salt or sugar) interact with water through dipole-dipole, ionic, and hydrogen bonds. Capillary effect where the vapor pressure of water above a curved liquid meniscus is less than that of pure water because of changes in the hydrogen bonding between water molecules. Surface interactions in which water interacts directly with chemical groups on undissolved ingredients (e.g. starches and proteins) through dipole-dipole forces, ionic bonds (H_3O^+ or OH^-), van der Waals forces (hydrophobic bonds), and