

UNDERSTANDING MOISTURE AND SELECTING THE RIGHT INSTRUMENTATION

The primary consideration in selecting the right type of moisture analyzer for a given application is the samples characteristics.

But before we even start testing for moisture, we need to draw a distinction between the different types of moisture present in most materials. A simple but effective distinction between the different types of moisture, is provided in, 'Lipid Technologies and Applications', By F. D. Gunstone, Fred B. Padley', in reference to drying mechanisms for droplets.

"The moisture in a spray droplet can be present in two forms: bound and unbound. The nature of the solid and accompanying moisture determines the drying characteristics. The bound moisture in the solid exerts an equilibrium vapor pressure lower than that of pure water at the same temperature. Water retained in small capillaries in the solid absorbed at solid surfaces as solutions in cells or fibers, falls in to the category of bound moisture.

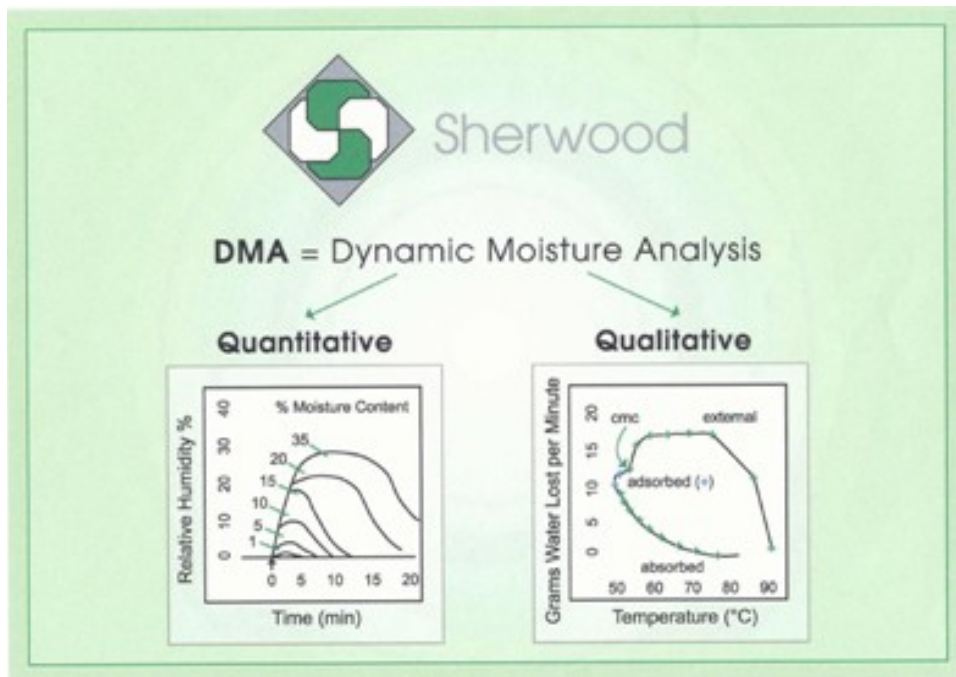
The unbound moisture in a hygroscopic material is that moisture in excess of the bound moisture. All water in a nonhygroscopic material is unbound water, that exerts an equilibrium vapor pressure equal to that of pure water at the same temperature. The equilibrium moisture is the moisture content of a product when it is at equilibrium with the partial pressure of the water vapor of the surroundings. The free moisture is the moisture in excess of the equilibrium moisture, and consists of unbound and some bound moisture. Free moisture is evaporated during spray drying."

They go on to say,

"As long as unbound moisture exists, drying proceeds at a constant rate, and will continue while the rate of moisture diffusion within the droplet is fast enough to maintain saturated surface conditions."

"When diffusion and capillary flows can no longer maintain these conditions, the critical point is reached, and the drying rate will decline until equilibrium moisture content is attained."

The same principles apply to fluidized solids in a fluid bed dryer. The below chart generated from data provided by a Sherwood Scientific M 501 Laboratory Fluid Bed Dryer, graphically shows the critical moisture point of a substance during drying, where the rate of drying changes. Because it is the free moisture in a substance that causes many of the problems, sometimes simple alterations in the product, like adding a desiccant in packaging, provide solutions.



Therefore water activity has to do with the escaping tendency of water in a material, or what the water is doing, as opposed to moisture content, which is concerned with the total amount of water present in a material.

Free moisture in hygroscopic materials like food, grains, seeds, and even pharmaceuticals, is also the moisture that allows microbial growth in a product and reduces shelf life. In powder like substances, free moisture causes clumping. In food products it is also possible, yet generally undesirable, to have two or more ingredients with different water activity values. The free moisture from the ingredient with the higher water activity value will tend to migrate to the material with the lower value.

So the way to approach moisture in a product, is first to establish if the material exhibits hygroscopic properties. If it is a non hygroscopic material, there is a direct correlation between free moisture and total moisture, so it becomes a matter of practicality as to what type of instrumentation will work the best. In a hygroscopic material it has to do with practicality as well, but also has to do with what type of moisture is of concern relative to processing.

Relative humidity measurements generally take at least five minutes per test because the sample has to be enclosed and needs to equilibrate. Moisture sensing equipment is generally more versatile, with more technological choices available, as well as quicker, often able to give instant readings. These are not mutually exclusive technologies though, and should be combined to provide a practical but informed approach to moisture determination.

Loss on drying methods (gravimetrics) of moisture determination, such as ovens, moisture balances, and the M501 Fluid Bed Dryer, are designed to measure free moisture. In an oven test, the sample is dried and weighed repeatedly until the weight loss rate slows down, and the critical moisture point is reached. Moisture balances operate the same way by weighing and drying the sample simultaneously, until the rate of weight loss changes, and the critical moisture point is reached.

Understanding how moisture leaves during drying, helps us understand the need for sample preparation to ensure uniform drying. Grinding a sample first may be necessary to facilitate proper drying, or to achieve more uniform water distribution for indirect sensing methods like capacitance, where the electrical properties of water provide quantitative information.

Newer technologies like the Sherwood Scientific M 501, which is actually a hybrid, are capable of determining moisture as well as relative humidity data, achieving uniform drying of materials, by blowing air from underneath the sample with enough force to enable the material to fluidize.

The presence of water in liquids, such as oil, is often best achieved by indirect methods, like Karl Fischer Titration Methods. Lastly, moisture can be determined inline (Real time during processing), or by sampling, and testing in a lab, or a combination of both. At this point, the materials characteristics, the cost of equipment versus manpower, and the practicality of effective sampling, become important considerations.

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