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GenRH Application Note 503

Investigating Dried Milk Powders Using Optical Microscopy at Different Humidity Conditions

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This application note demonstrates how variations between three similar dried milk samples can be compared directly using optical microscopy as a function of humidity.

Introduction

Humidity can have a profound effect on the formulation, processing behaviour, stability and shelf-life of a wide range of materials. In particular, food materials are especially sensitive to water vapour. This application note demonstrations how variations between three similar dried milk samples can be compared directly using optical microscopy as a function of relative humidity. Also, this note will address the advantages that direct comparison between different samples can bring.

Method

The GenRH-A consists of; a programmable digital controller with full time closed-loop control, temperature monitoring display, temperature and humidity probe, and a rotameter to control flow volume. A picture of the GenRH-A shown in Figure 1.

Figure 1. Surface Measurement Systems GenRH-A humidity generator.

To use the GenRH-A efficiently with a microscope, Surface Measurement Systems has developed the Mcell. The sample is mounted into the Mcell, which is fixed to the microscope stage as shown in Figure 2. This stage has double-glazed top and bottom windows, allowing both transmission and reflection illumination of the sample while minimising heat loss through the windows when being used under non-ambient conditions.

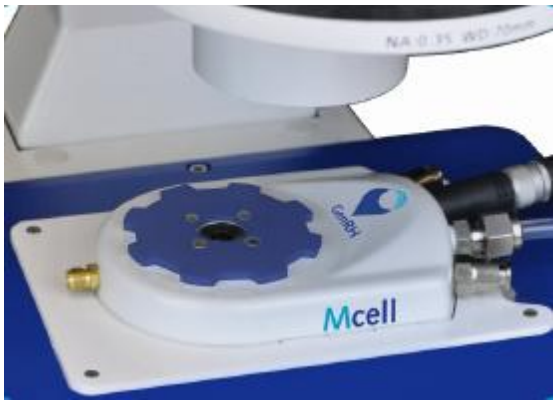


Figure 2. SMS Mcell microscope accessory for the GenRH line of products.

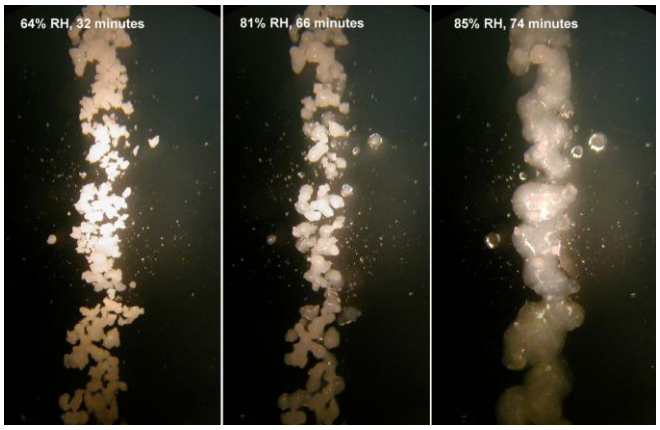


Figure 3. Photographs of the Coffeemate powder at 64%, 81% and 85% RH, taken at 25 °C and 40X magnification.

Results

Demonstration of Humidity Generation

A narrow line of Coffeemate - Virtually Fat Free milk powder was placed on a microscope slide, perpendicular to the direction of gas flow, and exposed to a range of humidity conditions from 50% to 95% RH. Three sample photographs are shown in Figure 3, where images were collected at different humidity conditions.

Figure 3 clearly shows the onset of deliquescence begins by 81% RH and is independent of vertical position within the sample area. The particles from the top, middle and lower regions appear to deliquescence simultaneously. Careful inspection of the photographs also reveals that, as would be expected, the particle size exerts an influence over the onset of deliquescence, small particles dissolving before larger particles.

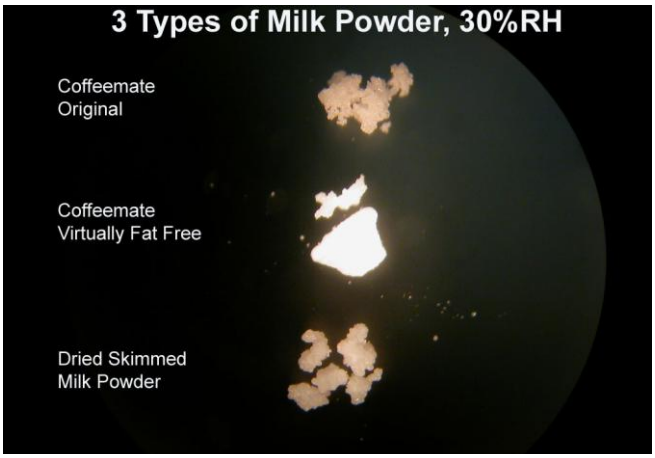
Simultaneous Measurement of Three Milk Powder Samples

A few particles of three different milk powder samples (Coffeemate Original, Coffeemate Virtually Fat Free, and freeze-dried, skimmed milk) each dried milk sample were placed on a slide perpendicular to the direction of gas flow, and exposed to various humidity conditions from 30% to 95% RH, followed by a 80 minute hold at 95% RH.

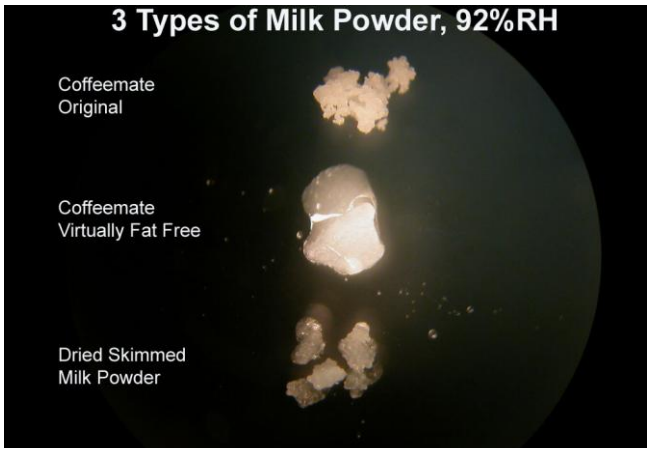
Figure 4 displays the images (40X magnification) for the three samples at 30% RH (a.), 92% RH (b.), and 95% RH (c.). The Coffeemate Virtually Fat Free sample is the first to show visible evidence of deliquescence. This sample is closely followed by the freeze-dried skimmed milk sample. The Coffeemate Original sample of the higher fat content.

Figure 4 clearly shows that it is more stable than the other two samples. Rather than deliquescing, sorbed water only causes swelling and the particles to move slightly. Smaller particles take up water faster and dissolve before the larger particles. Therefore, the precise deliquescence point of each type of milk powder is difficult to define accurately with this optical method. However, this method does allow direct visual comparison of the different samples, facilitating

detailed analysis of batch to batch variations, and enabling quick and clear determination of the effects of individual parameters such as particle size. This is difficult to do with gravimetric techniques due to the averaged nature of the data obtained.



(a.)



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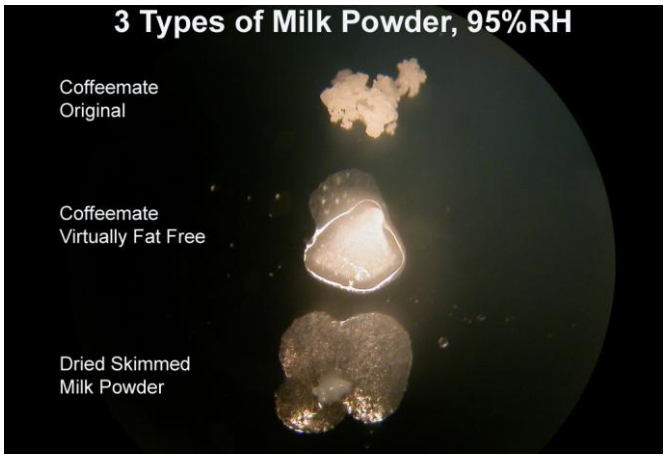

(c.)

Figure 4. Coffeemate Original, Coffemate Fat Free and spray dried skimmed milk powder at 30% RH (a.), 92% RH (b.), and 95% RH (c.). Experiments conducted at 25 °C and 40X magnification.

Conclusion

The method described above shows that multiple samples can be viewed simultaneously while controlling relative humidity. This allows the clear and quick screening of subtle differences between samples that would otherwise be difficult or time consuming to observe if monitored individually.

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