Polymer Characterization Using Vapor Sorption Analysis

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INTRODUCTION

Water affects the properties of virtually all materials (foods, pharmaceuticals, organic/inorganic chemicals, and polymers). Since water is everywhere, it is impractical to assume that the humidity seen by a material will always be within a narrow specific range. Hence, materials are generally selected, which have the best properties over a broad range of temperature and humidity. Vapor sorption (VS) provides a convenient technique for obtaining that information.

EXPERIMENTAL

VS analysis of polymers is generally a more challenging measurement than its use in the assessment of pharmaceuticals and foods. This is because the levels of water adsorption / desorption are low (requiring good instrumental baseline stability to accurately measure small weight changes), the range of temperatures of interest is broader (requiring the ability to perform humidity experiments up to 85 °C), and the sample forms are more diverse (requiring sample pan configurations compatible with thin films, fibers, and liquid samples). The following examples illustrate several of those considerations.

RESULTS and DISCUSSION

Figure 1 displays VS profiles for two polymeric packaging films, which show overlapping adsorption / desorption curves with low levels (<20 micrograms) of total water adsorbed, indicating surface adsorption behavior. The results were obtained using flat bottom platinum pans rather than the traditional hemispherical quartz boats used for evaluating pharmaceutical powders. This change allows multiple pieces of film to be stacked in the pan to improve weight change sensitivity without static electricity effects.

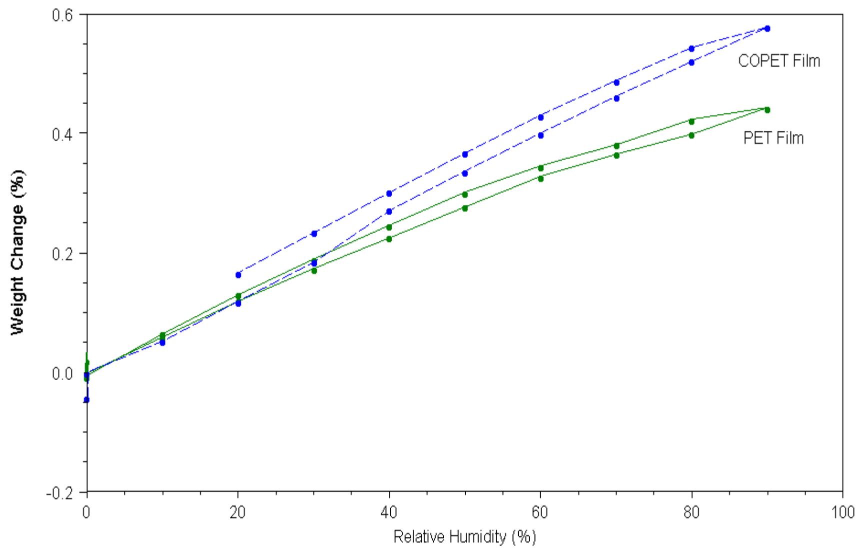

Figure 1 Comparison of Adsorption / Desorption in Polymer Films

Figure 2 shows another comparison of packaging films and features the detection of differences in drying and water adsorption rates. Film A (dashed line) adsorbs and desorbs water more rapidly than the other film. The 100% weight in this case was readjusted to the weight after initial drying at 60 °C. This approach eliminates the previous "humidity history" and makes the subsequent adsorption and drying comparisons more pertinent.

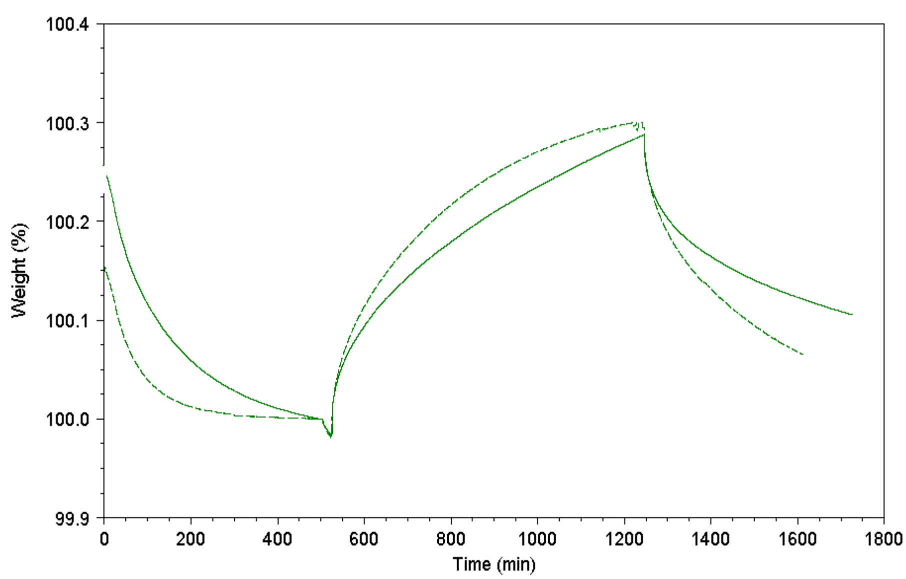

Figure 2 Packaging Film Adsorption and Drying Properties

Materials, which can change while awaiting VS analysis, are best studied by sealing them in pans, which can be opened just prior to analysis (1). This is shown for polymeric paint formulations (Figures 3 and 4). Drying of paints is a process, which is strongly affected by the temperature and humidity of the environment under which the paint is being used. Figure 3 compares the drying properties of a paint formulation at temperature / humidity combinations representative of common usage environments.

The results suggest that temperature is a more significant drying rate factor than humidity for this formulation, a conclusion that was confirmed by further testing. Figure 4 is a latex paint evaluated at a specific temperature and different humidities. As expected, the rate of drying increases as the humidity of the environment decreases.

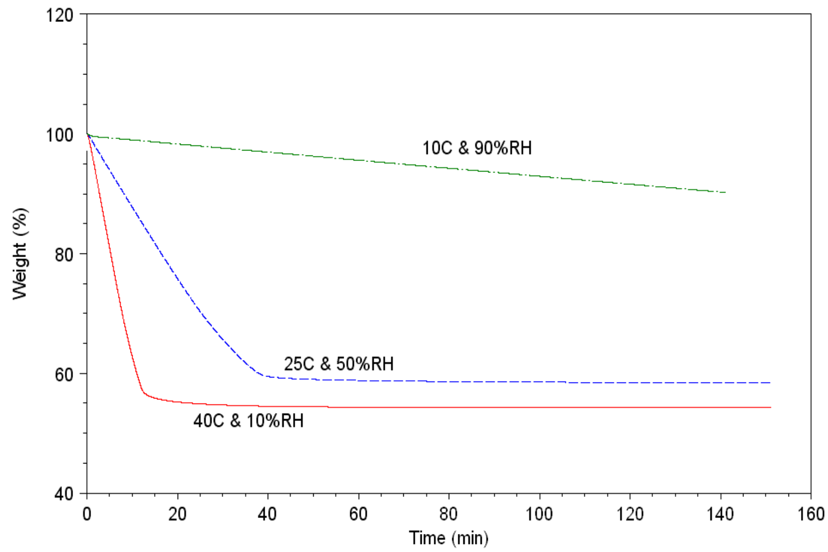

Figure 3 Paint Drying at Various Temperature / Humidity Combinations

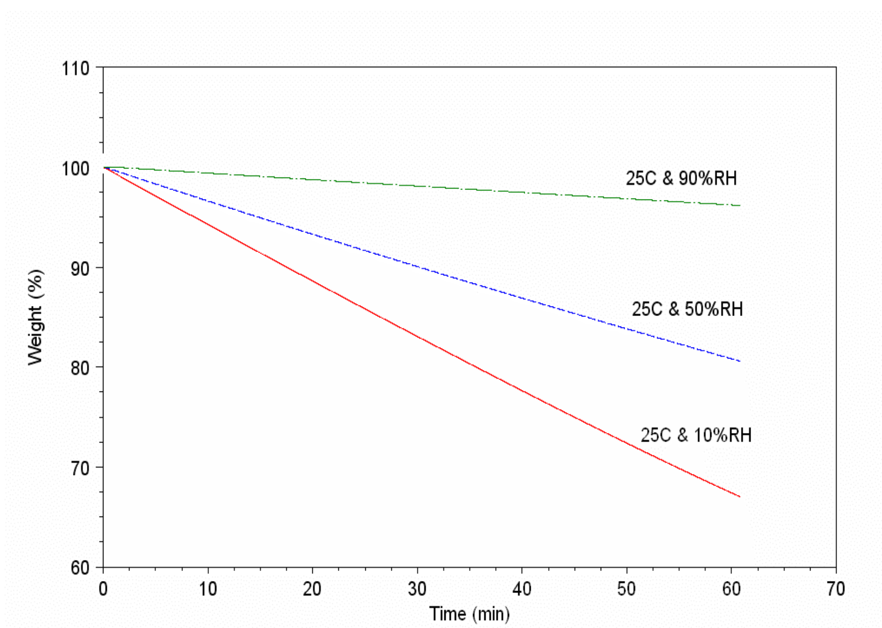

Figure 4 Humidity Effects on Paint Drying at 25C `

SUMMARY

This brief shows that the VS technique, which is widely used to characterize the effects of temperature and humidity on foods and pharmaceuticals, can also be applied to polymers such as resins, fibers, films, and paints/emulsions.

REFERENCE

1. TA Instruments Applications Brief TA333 (2007).

KEY WORDS

Polymers, Paints, VS, Vapor sorption, Adsorption, Desorption

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