

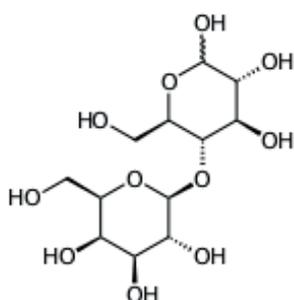
APPLICATION NOTE

Lactose – TG 209 F1 Libra®



Avoid Caking of Lactose – Apply the NETZSCH TGA

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1 Structure of lactose (C₁₂H₂₂O₁₁) [6]

Introduction

Lactose is a sugar found in the milk of mammals. It can be obtained in an amorphous or a crystalline form. α -lactose crystallizes as a monohydrate while β -lactose does not contain crystal water; therefore, it is often described as anhydrous lactose. A particular form of lactose is obtained by spray drying of a solution of finely milled α -lactose monohydrate. During this process, amorphous lactose is formed in addition to crystalline lactose. The obtained product is a matrix of lactose glass in which lactose monohydrate crystals with narrow size distribution are embedded. The presence of the amorphous structure facilitates the compression processes and leads to better tableting properties [1, 2, 3].

Lactose, Humidity and Caking

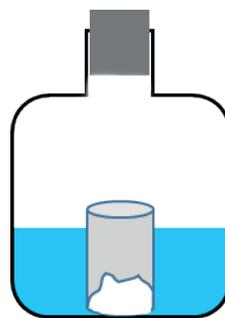
The affinity of lactose products to humid air depends on their modification. Pure α -lactose monohydrate products are very stable to humid air. In contrast, amorphous lactose is very hygroscopic: At a certain humidity, amorphous lactose is transformed into the crystalline α -lactose monohydrate form and exhibits changes in its compression properties [2].

Caking (appearance of lumps of various sizes in lactose powder) is a common problem that can occur during production, storage or transport of powders. If a powder is caked, this results in longer processing times and reduced product quality. Caking results from the formation of solid bridges between particles due to humidity, temperature fluctuations, pressure and migration of small particles [4, 5]. The ability to cake also depends on the particle size distribution. For example, small lactose crystals with a particle size of less than 300 μm can cake easily as soon as the water content is higher than 3% [4].

In the following, the influence of moisture on the storage behavior of lactose FlowLac® 90 from MEGGLE is studied by means of TGA. FlowLac® 90 is a spray-dried α -lactose monohydrate containing 8% to 12% of amorphous lactose.

Measurement Conditions

For the moisture treatment, the sample was stored in an open container placed in a closed vessel filled with water (no direct sample contact with water) for two weeks (figure 2).



2 Storage of the sample in a humid atmosphere at room temperature

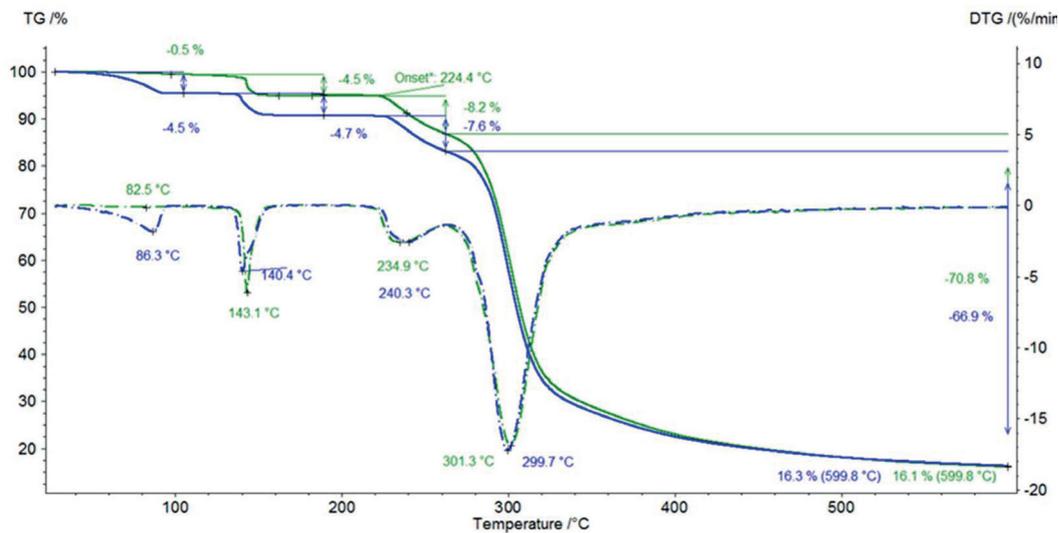
APPLICATIONNOTE Avoid Caking of Lactose – Apply the NETZSCH TGA

The measurements were carried out with the TG 209 **F1 Libra**® under a dynamic nitrogen atmosphere (40 ml/min). Two lactose specimens were prepared in closed aluminum crucibles: one as received (6.43 mg) and the other one after a two-week storage period in a humid atmosphere (7.62 mg). The lid of each sample pan was automatically pierced from the instrument just before the measurement. The samples were heated from room temperature to 600°C at 10 K/min.

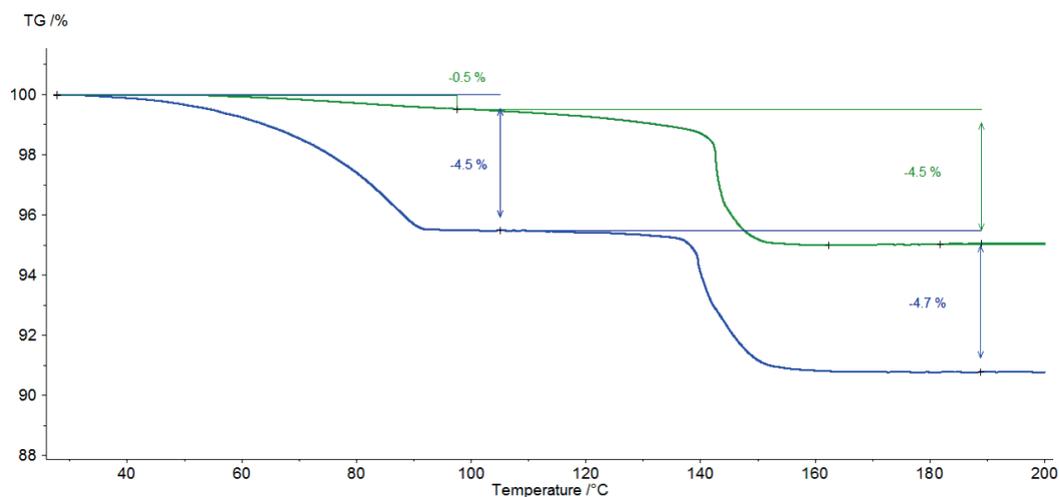
Test Results

Figure 3 depicts the mass changes in both samples during heating to 600°C. Figure 4 displays a zoom of the

temperature range from room temperature to 200°C. The two TGA curves differ significantly in the first mass-loss step resulting from the release of surface water: The two-week humidity storage yields an increase in adsorbed water from 0.5% to 4.5% (blue curves). No significant difference is detected in the second mass-loss step of 4.5% and 4.7%, respectively. This step is due to the release of crystal water present in the α -lactose monohydrate. It is followed by the decomposition at 224°C (extrapolated onset of the TGA curve) which takes place in two steps, independently of the moisture treatment. More information about the decomposition process is given in [7].



3 TGA (solid lines) and DTG (dashed-dotted lines) curves of α -lactose monohydrate with moisture storage (blue curve) and without moisture storage (green curve)



4 TGA curves of α -lactose monohydrate with (blue curve) and without moisture storage (green curve) between room temperature and 200°C, enlargement of the temperature range up to 200°C from figure 3.

Conclusion

Thermogravimetry allows for the determination of surface water and crystallization water in a single analysis. Classical methods for water determination, such as Karl Fischer, toluene distillation and conventional oven methods, require more analysis time in some cases and deliver fewer results than just a single TGA measurement [8].

Two-week storage in a humid atmosphere at room temperature results in a sharp increase in surface water in spray-dried α -lactose monohydrate. Here, the TGA method serves as a quality control tool by monitoring the amount of surface water in the product so that no powder caking occurs during the storage, transport and processing of lactose.

Literature

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- [2] Lactose, Some basic properties and characteristics, DFE Pharma <https://azdoc.pl/lactose-some-basic-properties.html>
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- [8] Thermal analysis of amorphous lactose and α -lactose monohydrate, Yuan Listiohadi, James Hourigan, Robert Walter Sleigh, Robert John Steel, Dairy Science & Technology, EDP sciences/Springer, 2009, 89 (1), pp. 43-67