

# Powder Conditioner: Moisture Equilibration of Powders

– Application Note 25-01



## Introduction

Moisture conditioning of powders is an important issue whenever moisture affects powder properties. These include changes in flowability, density (bulk, tap), compressibility, caking and consolidation behavior, and rheological properties such as yield strength or friction.

The market offers highly specialized instruments for measuring the above-mentioned powder properties such as powder rheometer, flow tester or ring shear cell. However, the influence of humidity can only be assessed if the moisture content of the product is precisely set to a specific value in advance of the analysis.

This step is often critical. For example, conditioning in climate chambers is often neither reliable nor precise. Alternative methods, such as storing in desiccators over saturated salt solutions are time-consuming, work-intensive, and require a significant amount of lab-space.

In addition, these methods do not give any indication when the equilibration process has finished, nor does it provide any information about water uptake and moisture content of the material at equilibrium.

These issues can be addressed by using the proUmid Powder Conditioner, which provides a precise, reliable, and automated method for the moisture conditioning process of powders, granules, pellets or even chunky products.

Table 1: Specifications

Powder Conditioner	
Volume	200 mL
Humidity range	2 % - 95 % RH
Humidity accuracy	±0.6% RH at 23°C ±5 °C
Min particle size	< 100 µm
Stirrer	Recommended for particle sizes < 500 µm
MHG 32	
Mass flow	0 - 500 mL/min
Gas supply	dry compressed air, 1 – 6 bar

## 2. Powder Conditioner – Benefits & Specifications

The Powder Conditioner, which comes along with the MHG32 humidity generator is best suited for moisture equilibration of particulate systems such as powders, granules or pellets. With the help of an intuitive software, settings like air mass flow and humidity can be done conveniently. The conditioning process runs fully automated and, as soon as the sample has reached the equilibrium state, this is signaled by the software. Further benefits of the software are the direct visualization of the change of water activity and calculation of water uptake and loss due to the moisture-powder interaction. Specification of the Powder conditioner as well as combination and set-up with the MHG32 are shown in Tab. 1 and Fig. 1.



Fig. 1: Set-up Powder Conditioner in combination with MHG32

### 3. Principle of Operation

Fig. 2 shows a scheme of the Powder Conditioner set-up. Conditioning is achieved using a humidity-controlled gas stream that is introduced at the bottom and then flows upwards through the powder bed. The relative humidity and temperature of the gas are measured by sensors at both the inlet and outlet. An agitator option is available and is particularly recommended for particle sizes below 500 µm. Slow, constant agitation avoids the formation of aggregates or caking that can result from the interaction of powder and moisture. A further advantage is that the formation of air channels is prevented, which is important for the even distribution of the gas flow.

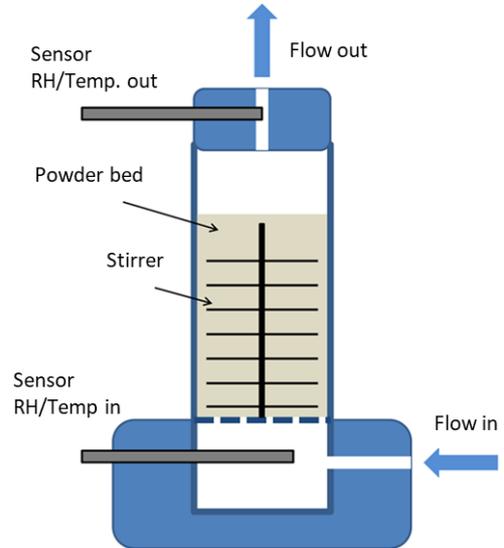


Fig. 2: Powder Conditioner scheme

### 4. Measurement procedure

Sample preparation and measurement set-up is very convenient. The cylindrical powder container can be removed from the station, and the sample is added by opening the top lid. The weight of the sample can be entered into the software to determine the change in moisture content during conditioning. Once the sample preparation is complete, the container is placed on the station, the moisture sensors are inserted into their positions and the MHG32 humidity generator is attached via a plug-in connection. All further measurement settings are done using the Powder Conditioner software which comes along with the instrument (Fig. 3).

### 5. Powder Conditioner Software

Before starting the measurement, the data storage location is defined. The relative humidity and flow rate of the conditioning gas stream can be defined and varied as required within a range of up to 500 mL/min (optional 1000 mL/min). During the measurement, the inlet and outlet humidity is recorded, and the water sorption of the powder is calculated by a software algorithm based on these values together with the gas flow and temperature. The progress of the conditioning can be directly observed through a graphical representation of the parameters. Once the sample has reached equilibrium, the software displays the message "Conditioning good" (Fig. 3).



Date	Time	Elapsed Time	F.H. IN [%]	F.H. OUT [%]	Flow [ml/min]	Temp [°C]	Water Sorption [µg]
22.03.2019	12:31:03	00:01:00	45.4	28.9	200	22.1	9.363
22.03.2019	12:32:03	00:02:00	52.2	16.3	200	22.1	1.375
22.03.2019	12:33:03	00:03:00	55.8	13.8	200	22.2	2.802
22.03.2019	12:34:03	00:04:00	56.2	10.8	200	22.2	4.716
22.03.2019	12:35:03	00:05:00	56.3	8.2	200	22.2	6.540
22.03.2019	12:36:03	00:06:00	56.6	8.1	200	22.2	8.941
22.03.2019	12:37:03	00:07:00	56.8	7.5	200	22.2	10.981
22.03.2019	12:38:03	00:08:00	56.9	6.7	200	22.2	12.772
22.03.2019	12:39:03	00:09:00	56.9	5.2	200	22.2	14.678
22.03.2019	12:40:03	00:10:00	56.9	3.8	200	22.2	17.003
22.03.2019	12:41:03	00:11:00	56.9	3.4	200	22.2	19.143
22.03.2019	12:42:03	00:12:00	56.9	3.1	200	22.2	21.296
22.03.2019	12:43:03	00:13:00	56.9	4.9	200	22.2	23.467
22.03.2019	12:44:03	00:14:00	56.9	4.6	200	22.2	25.627
22.03.2019	12:45:03	00:15:00	56.9	4.5	200	22.2	27.803
22.03.2019	12:46:03	00:16:00	56.9	4.4	200	22.2	29.987
22.03.2019	12:47:03	00:17:00	56.9	4.2	200	22.2	32.177
22.03.2019	12:48:03	00:18:00	56.9	4.1	200	22.2	34.372
22.03.2019	12:49:03	00:19:00	56.9	4.1	200	22.2	36.574
22.03.2019	12:50:03	00:20:00	56.9	4.3	200	22.2	38.774
22.03.2019	12:51:03	00:21:00	56.9	3.8	200	22.2	40.974
22.03.2019	12:52:03	00:22:00	56.9	3.8	200	22.2	43.186
22.03.2019	12:53:03	00:23:00	56.9	3.8	200	22.2	45.396
22.03.2019	12:54:03	00:24:00	56.9	3.8	200	22.2	47.606
22.03.2019	12:55:03	00:25:00	56.9	3.7	200	22.2	49.818
22.03.2019	12:56:03	00:26:00	56.9	4.0	200	22.2	52.032
22.03.2019	12:57:03	00:27:00	56.9	3.8	200	22.2	54.247
22.03.2019	12:58:03	00:28:00	56.9	3.6	200	22.2	56.463
22.03.2019	12:59:03	00:29:00	56.9	3.6	200	22.2	58.679
22.03.2019	13:00:03	00:30:00	56.9	3.6	200	22.2	60.898
22.03.2019	13:01:03	00:31:00	56.9	3.5	200	22.2	63.117
22.03.2019	13:02:03	00:32:00	56.9	4.0	200	22.2	65.338
22.03.2019	13:03:03	00:33:00	56.9	3.8	200	22.2	67.556

Fig. 3: Powder Conditioner software

## 6. Calibration routine

To prevent deviation between the in- and outlet sensor, a software-assisted calibration routine should be performed in regular time intervals.

Therefore, an adjustment plug is available where the external sensor is inserted. Afterwards, the relative humidity of the inlet air is set to defined values and compared to the measured values at the outlet-sensor.

The results are saved, and adjustment is done automatically by the software.

The set-up of the Powder Conditioner with adjustment plug and humidity generator is shown in Fig. 4.

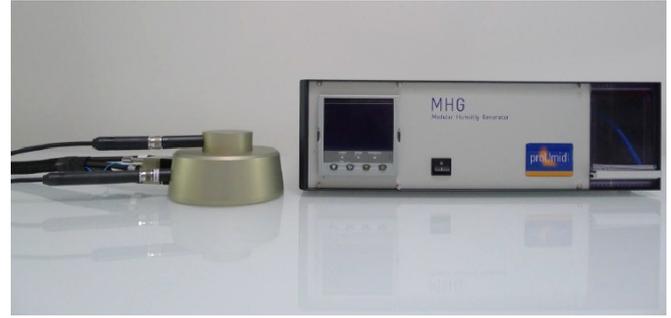


Fig. 4: Powder Conditioner set-up for calibration routine

## 7. Reliability of Conditioning

To verify the quality of the data, the results of the powder conditioning were compared with the certified data of the proUmid MCC reference material obtained from the dynamic vapor sorption analysis with the SPS instruments. Powder conditioning was performed at 22°C (room temperature) with an MCC volume of 200 mL and a gas flow rate of 200 mL/min. The results are shown in Figure 5. The colored crosses represent the Powder Conditioner data; the black dots show the sorption isotherm from the SPS measurement.

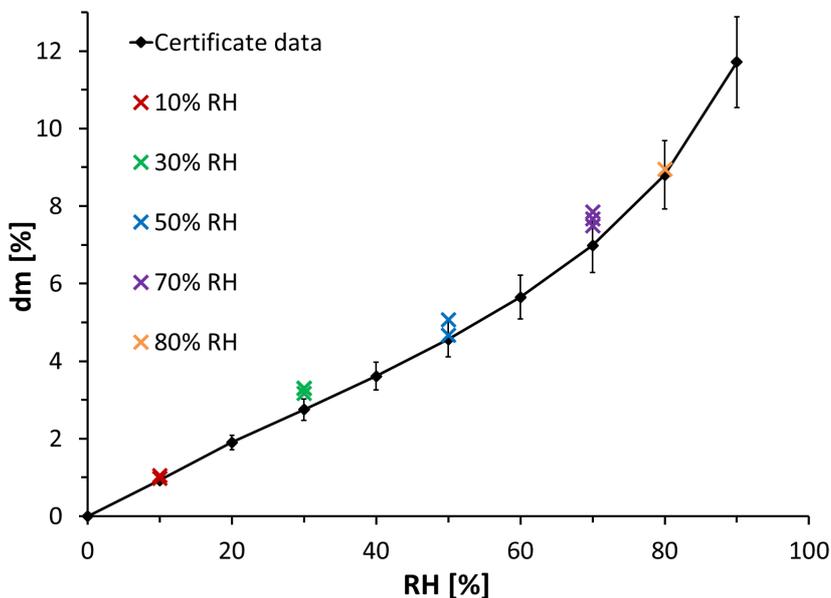


Fig. 5: Conditioning of MCC reference material and comparison with certified data from Dynamic Vapor Sorption analysis

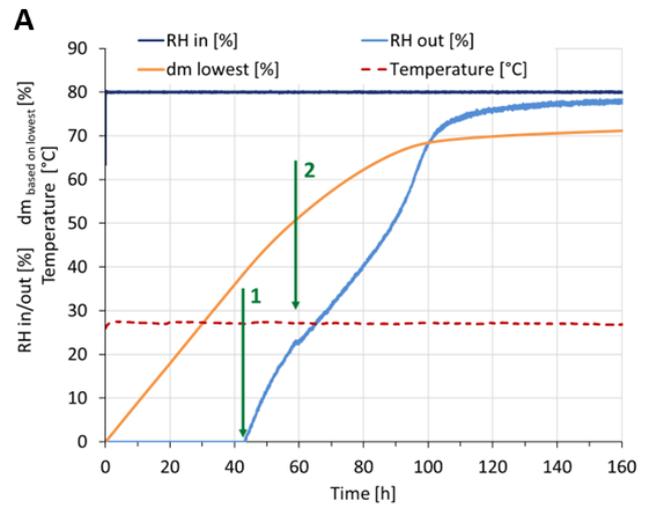
The results in Fig. 5 show a good consistency of the Powder Conditioner data with the expected results. However, a systematic error of 5-15 % must be considered.

For this reason, the Powder Conditioner is a good choice to condition a material to a certain moisture level, and the method also allows a first quick characterization of the material.

However, it is not suitable to replace a DVS analysis.

## 8. Visualization of the conditioning process

Fig. 6 shows the powder conditioning process with silica gel as an exemplary sample material. A humidity indicator shows the transition from a dry to a moist state by changing the color from orange to white. Conditioning was carried out at an inlet air humidity of 80 % RH and a gas flow rate of 1000 mL/min. The humidity of the outlet sensor was measured and the %tual change in product moisture (dm %) was calculated using a software algorithm. To document the progressive humidification, camera images were taken every 2 hours. The results are shown in Fig. 6A and B.



The sorption curve in Fig. 6A shows the constant increase of the product humidity (dm %) until in- and outlet humidity have approached the same level.

The shape of the “RH out” curve is characteristic of the behavior of silica gel. As a typical desiccant, it can adsorb large amounts of moisture. Therefore, the curve does not show an increase until the adsorbed moisture content exceeds 38 % (marker “1” in Fig. 6A). This is consistent with the product specifications, which indicate a sorption capacity of 40 % (w/w) at 80 % RH.

A second characteristic point was observed after a conditioning time of ~58 h (marker “2” in Fig. 6A). Beyond this point, the “RH out” curve appears to make a transition from a linear to an exponential increase. An explanation for this behavior could be attributed to the progressive depletion of the drying/absorptive capacity which could be confirmed by the images shown in Fig. 6B. Here, a complete discoloration of the silica gel was observed after a conditioning time of 58 h.

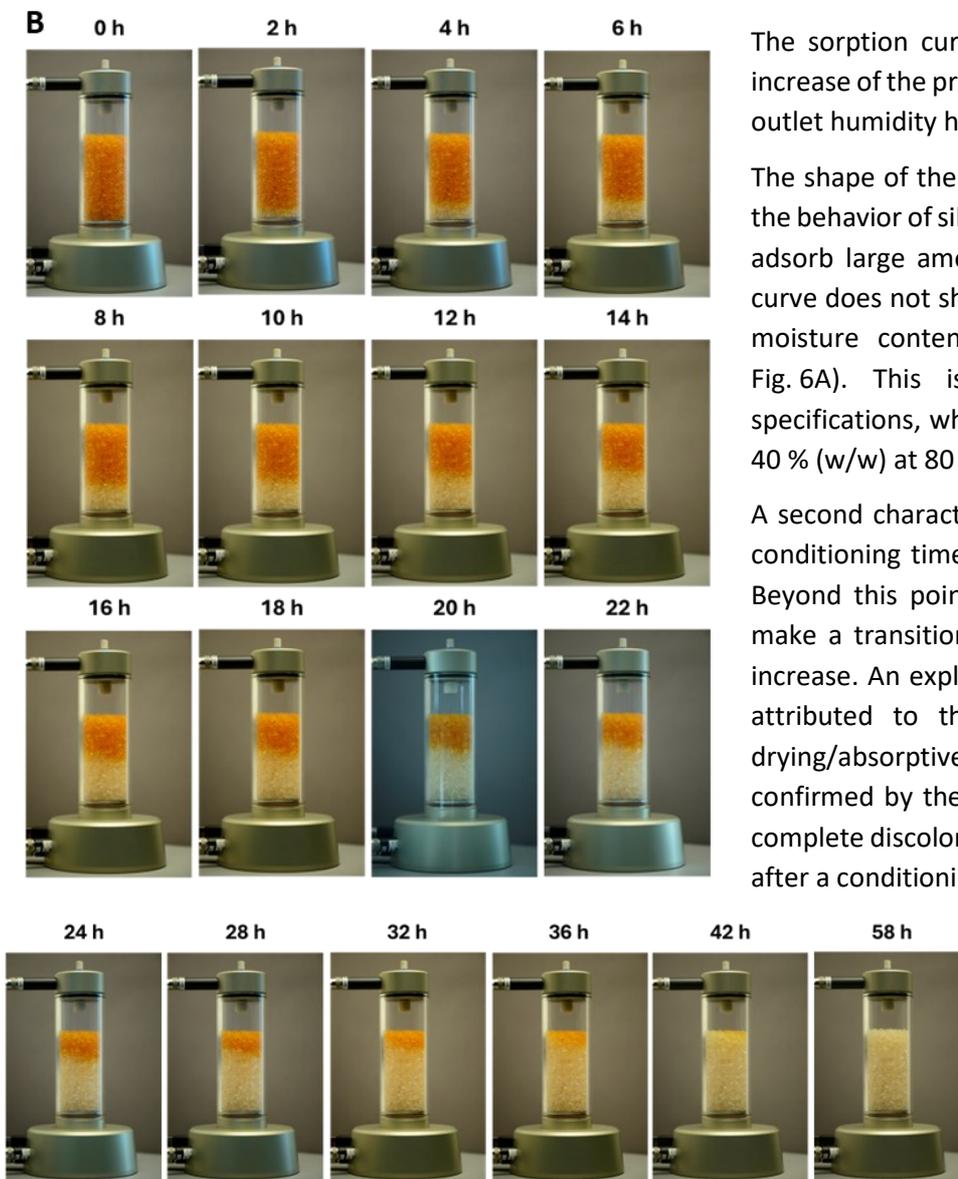


Fig. 6: Sorption curve (A) and visualization of the Conditioning process of silica gel (B)

## 9. Conclusion

This Application Note explained how the proUmid Powder Conditioner works as a method for precise and reliable moisture adjustment.

The spectrum of materials that can be used for powder conditioning is very diverse, ranging from fine to coarse powders, granules and flakes to chunky materials.

Other advantages of the Powder Conditioner include convenient handling and sample preparation, as well as a software control, which enables both automated conditioning and further data analysis.

