PCCA UniFlow™ | TECHNICAL REPORT

Characterization of the Physical Properties of the New Excipient Base Part 2: Powder Flowability

SUMMARY: Powder flowability is an important physical characteristic that influences the quality of powder mixtures and the efficiency of mixing processes. PCCA UniFlow™ was evaluated and compared to the commonly used compounding excipient MCC NF (PH-105), and it was concluded that the new excipient base demonstrates significantly superior flowability, based on the testing of six powder characteristics: angle of repose, aerated and packed bulk density, compressibility, angle of spatula and cohesion/uniformity.

Introduction:

Flowability is an important physical property of powders that influences the ability to achieve consistent and homogeneous mixtures. It refers to a powder's ability to flow smoothly and predictably, which directly impacts the quality and efficiency of mixing processes. Poor flowability can lead to uneven mixing, blockages in equipment, and difficulties in handling and packaging, ultimately affecting the integrity of the final product. The powder flowability of the new excipient base, PCCA UniFlow™, was evaluated and compared to a commonly used compounding excipient: Microcrystalline Cellulose (MCC) NF (PH-105).

Methodology:

The Hosokawa Powder Tester PT-X (Figure 1) was used to measure powder flowability. The PT-X employs the methods developed by Ralph L. Carr (Carr Indices) to determine the flowability of dry powders. In this study, six powder characteristics were analyzed: angle of repose, aerated bulk density, packed bulk density, compressibility, angle of spatula and cohesion/ uniformity. These tests assess how powders behave when transitioning from static to dynamic states. The measured values are assigned to indices on the standardized analysis of about 3,000 different bulk materials by R.L. Carr.

The two excipients, PCCA UniFlow and MCC NF (PH-105), were provided by PCCA and the study was conducted by Measurlabs (Helsinki, Finland). Before testing, samples were homogenized by rotating the containers to ensure representativeness. Approximately 300 mL of powder was used per test, which was conducted at 23–24°C and 45–48% relative humidity. Each sample was tested in duplicate, with results averaged.

Figure 1. Powder Tester PT-X (*adapted from* Hosokawa Micron B.V., 2025).

Results and Discussion:

PCCA UniFlow displayed lower angle of repose, lower compressibility and lower angle of spatula, as shown in Table 1.

The angle of repose is measured by subjecting the standard sieve (710 µm) to vibration and letting the sample pass through a funnel on a horizontal plate, forming a heap whose angle is recorded; lower angles indicate better flowability. Compressibility is the value which has the greatest effect on flowability of a powder. It is obtained by taking the ratio of the aerated bulk density (freely settled) and the packed bulk density (after tapping); higher compressibility is associated with poor flowability.

The angle of the spatula reflects a material's internal friction and is measured by the angle formed by the powder that builds up on the spatula. The greater this characteristic, the poorer the powder's flowability. Cohesion is measured by vibrating a standard sieve for a set time and force, then seeing how much powder passes through.

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The cohesion test was not conducted on PCCA UniFlow as the particle size uniformity test was deemed more appropriate. Uniformity is quantified as the ratio of the particle diameters at the 60th percentile (d60) to those at the 10th percentile (d10) within the particle size distribution of the sample.

The measured values of the six powder characteristics were used to calculate the Carr Index of Flowability. PCCA UniFlow displayed an index of 65.5, whereas MCC NF (PH-105) displayed an index of 46 (Table 1). The classification of the flowability index according to Carr states that an index of 40–59 is poor, whereas 60–69 is passable (Table 2). Despite the visual similarity between the two samples, MCC NF (PH-105) scored much lower on flowability, more specifically on compressibility. During testing of MCC NF (PH-105), static effects made the powder stick to the chutes in the angle of spatula and compressibility tests. This may have also affected the particle settling behavior during the aerated density test, resulting in higher compressibility.

In conclusion, PCCA UniFlow demonstrates significantly superior flowability compared to MCC NF (PH-105), indicating that the new excipient base may enable higher-quality powder mixtures and more efficient mixing processes.

Table 2. Classification of the flowability index according to Carr.

Carr Index	Flowability	Performance
90-100	Excellent	Aid is not needed, will not arch
80-89	Good	Aid is not needed, will not arch
70-79	Fair	Aid is not needed but vibration is sometimes required
60-69	Passable	Borderline; material may hang up
40-59	Poor	Agitation or vibration is needed
20-39	Very Poor	Agitate more positively
0-19	Very Very Poor	Special agitation, hopper or engineering

Table 1. Comparison of powder characteristics and Carr Index of PCCA UniFlow and MCC NF (PH-105).

Powder Samples	Angle of repose (deg.)	Aerated bulk density (g/cm^3)	Packed bulk density (g/cm^3)	Compressibility (%)	Angle of spatula (deg.)	Cohesion / Uniformity	Carr Index
PCCA UniFlow	44.8	0.443	0.631	29.9	54.2	5.2	**65.5**
Microcrystalline Cellulose NF (PH-105)	45.1	0.254	0.517	50.9	56.4	3.7	**46**