# Handbook of PHARMACEUTICAL EXCIPIENTS

## **Third Edition**

# *Edited by* **Arthur H. Kibbe, Ph.D.**

Professor and Chair Department of Pharmaceutical Sciences Wilkes University School of Pharmacy Wilkes-Barre, Pennsylvania



American Pharmaceutical Association Washington, D.C.



London, United Kingdom

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102 Cellulose, Microcrystalline

# Cellulose, Microcrystalline

### 1. Nonproprietary Names

BP: Microcrystalline cellulose JP: Microcrystalline cellulose PhEur: Cellulosum microcrystallinum USP: Microcrystalline cellulose

### 2. Synonyms

Avicel; cellulose gel; crystalline cellulose; E460; Emcocel; Fibrocel; Tabulose; Vivacel.

### 3. Chemical Name and CAS Registry Number

Cellulose [9004-34-6]

### 4. Empirical Formula and Molecular Weight

 $(C_6H_{10}O_5)_n \approx 36\ 000$ Where  $n \approx 220$ .

### 5. Structural Formula



### 6. Functional Category

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Adsorbent; suspending agent; tablet and capsule diluent; tablet disintegrant.

### 7. Applications in Pharmaceutical Formulation or Technology

Microcrystalline cellulose is widely used in pharmaceuticals, primarily as a binder/diluent in oral tablet and capsule formulations where it is used in both wet granulation and directcompression processes.<sup>(1-7)</sup> In addition to its use as a binder/diluent, microcrystalline cellulose also has some lubricant<sup>(8)</sup> and disintegrant properties that make it useful in tableting.

Microcrystalline cellulose is also used in cosmetics and food products.

Use	Concentration (%)		
Adsorbent	20-90		
Anti-adherent	5-20		
Capsule binder/diluent	20-90		
Tablet disintegrant	5-15		
Tablet binder/diluent	20-90		

### SEM: 1

Excipient: Microcrystalline cellulose Manufacturer: Penwest Pharmaceuticals Lot: 98662 Magnification: 100×



### 8. Description

Microcrystalline cellulose is a purified, partially depolymerized cellulose that occurs as a white, odorless, tasteless, crystalline powder composed of porous particles. It is commercially available in different particle sizes and moisture grades which have different properties and applications.

### 9. Pharmacopeial Specifications

Test	JP	PhEur	USP
Identification	+	+	+
Characters	+	+	<u> </u>
pH	5.0-7.0	5.0-7.5	5.0-7.0
Bulk density	+	-	+
Solubility	-	+	_
Loss on drying	≤ 7.0%	≤ 6.0%	≤ 7.0%
Residue on ignition	≤ 0.05%	-	≤ 0.05%
Conductivity	+	-	+
Sulfated ash	-	≤ 0.1%	<del></del>
Ether-soluble substances	≤ 0.05%	≤ 0.05%	≤ 0.05%
Water-soluble substances	≤ 0.24%	<b>≤</b> 0.25%	≤ 0. <b>24%</b>
Heavy metals	≤ 10 ppm	≤ 10 ppm	≤ 0.001%
Starch		+	<del></del>
Organic volatile impurities			+
Microbial limits	+	+	+
Assay	-	—	97.0-102.0%

#### SEM: 2 Excipient: Microcrystalline cellulose Manufacturer: Penwest Pharmaceuticals Lot: 98662 Magnification: 300×



SEM: 3
Excipient: Microcrystalline cellulos
Manufacturer: FMC Corp
Magnification: 100×



Table I: Properties of some commercially available grades of microcrystalline cellulose.

	Nominal	Particle		
	mean		Amount	Moisture
	particle size	Mesh	retained	content
Grade	(µm)	size	<b>(%)</b>	(%)
Avicel PH-101(a)	50	60	≤ 1.0	≤ 5.0
		200	≤ 30.0	
Avicel PH-102(a)	100	60	≤ 8.0	≤ 5.0
		200	≥ 45.0	
Avicel PH-103(2)	50	60	≤ 1.0	≤ 3.0
		200	≤ 30.0	
Avicel PH-105(a)	20	400	≤ 1.0	≤ 5.0
Avicel PH-112(a)	100	60	≤ 8.0	≤ 1.5
Avicel PH-113(a)	50	60	≤ 1.0	≤ 1.5
		200	≤ 30.0	
Avicel PH-200(a)	180	60	> 10.0	< 5.0
		100	> 50.0	
Avicel PH-301(1)	50	60	< 1.0	≤ 5.0
	•••	200	≤ 30.0	
Avicel PH-302(a)	100	60	<b>≤ 8.0</b>	≤ 5.0
		200	≥ 45.0	
Emcocel 50M <sup>(b)</sup>	51	60	≤ 0.25	≤ 5.0
		200	≤ 30.0	
Emcocel 90M <sup>(b)</sup>	91	60	≤ 8.0	≤ 5.0
		200	≥ 45.0	
Vivacel 101 <sup>(c)</sup>	50	50	≥ 35.0	≤ 5.0
		150	≤ 10.0	
Vivacel 102°)	100	50	≥ 50.0	≤ 5.0
		150	≤ 30.0	
Vivacel 12 <sup>(c)</sup>	180	50	≥ 70.0	≤ 5.0
		500	≤ 1.0	
Vivacel 20 <sup>(c)</sup>	20	50	≤ 2.0	≤ 5.0
		150	≤ 0.1	

Suppliers: <sup>(a)</sup> FMC Corporation; <sup>(b)</sup> Edward Mendell Co Inc; <sup>(c)</sup> J. Rettenmaier & Söhne GmbH

# 10. Typical Properties Angle of repose: $34.4^{\circ}$ for Emcocel 90M.<sup>(9)</sup> Density (bulk): 0.32 g/cm<sup>3</sup> for Avicel PH-101;<sup>(10)</sup> 0.29 g/cm<sup>3</sup> for Emcocel 90M.<sup>(9)</sup> Density (tapped): 0.45 g/cm<sup>3</sup>;<sup>(a)</sup> 0.45 g/cm<sup>3</sup> for Avicel PH-101;<sup>(10)</sup> 0.35 g/cm<sup>3</sup> for Emcocel 90M.<sup>(9)</sup> Density (true): 1.512-1.668 g/cm<sup>3(a)</sup> Compressibility: See Figs. 1, 2, and 3.<sup>(a)</sup> Mechanical properties<sup>(a)</sup> Compression pressure: 9.84 kN/cm<sup>2</sup>

Tensile strength:	0.8711 kN/cm <sup>2</sup>
Permanent deformation pressure:	15.3
Brittle fracture index:	0.0821
Bonding index:	0.0571
Reduced modulus of elasticity:	1472

Flowability: 1.41 g/s for Emcocel 90M.<sup>(9)</sup>

Melting point: chars at 260-270°C.

- Moisture content: typically, less than 5% w/w. However, different grades may contain varying amounts of water. Microcrystalline cellulose is hygroscopic.<sup>(11)</sup> See Fig. 4<sup>(a)</sup> and Table I.
- Particle size distribution: typical mean particle size is 20-200 µm. Different grades may have a different nominal mean particle size, see Table I.
- Solubility: slightly soluble in 5% w/v sodium hydroxide solution; practically insoluble in water, dilute acids, and most organic solvents. Specific surface area:

1.06-1.12 m<sup>2</sup>/g for Avicel PH-101.<sup>(a)</sup> 1.21-1.30 m<sup>2</sup>/g for Avicel PH-102.<sup>(a)</sup> 0.78-1.18 m<sup>2</sup>/g for Avicel PH-200.<sup>(a)</sup>

(a) Results of laboratory project for third edition.

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### Fig. 1: Crushing strength.

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**\blacksquare**: Microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X. Mendell) at V = 100 mm/s

▲ : Microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X. Mendell) at V = 300 mm/s



### Fig. 2: Total work of compaction.

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■ : Percentage porosity (E) vs. pressure plot for microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X. Mendell) at V = 100 mm/s ▲ : Total work of compaction (TWC) vs. pressure plot for microcrystalline cellulose, *Emcocel 90M* (Lot # 1037X, Mendell) at V = 100 mm/s



Fig. 3: Heckel plot for microcrystalline cellulose. (): In1/(1-D)

🔳 : Hardness



Fig. 4: Sorbtion-desorption isotherm for microcrystalline cellulose.

: Desorption

### 11. Stability and Storage Conditions

Microcrystalline cellulose is a stable, though hygroscopic material. The bulk material should be stored in a well-closed container in a cool, dry, place.

### 12. Incompatibilities

Incompatible with strong oxidizing agents.

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