

Performance of

Composite Filters Assembled from Multiple Layers of Basic Filtration Media

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Table S1. The comparison of various testing standards for the particle filtration efficiency of FFRs

Country	Standard	Aerosol type	Particle size	concentration	Particle charge	Aerosol detector	Flow rate	Sample size
USA	42 CFR part 84	NaCl (N-series)	0.075±0.020 µm CMD (GSD<1.86)	≤200mg/m ³	Neutralized	Forward-light-scattering photometer	85±4 L/min	Entire Respirator (including surgical N95 respirator)
		DOP (R- or P- series)	0.185±0.020 µm CMD(GSD<1.6)					
China	GB 2626-2006	NaCl (KN- series)	0.075±0.020 µm CMD(GSD<1.86)	≤200 mg/m ³	Neutralized	Testing range 0.001~200 mg/m ³ , Accuracy 1%	85±4 L/min	Entire Respirator
		DOP (KP- series)	0.185±0.020 µm CMD(GSD<1.6)	50~200 mg/m ³				
Europe	EN 149:2001+A1(EN 13274-7:2019)	NaCl	0.06 µm~0.1 µm CMD (GSD 2.0~3.0)	4~12 mg/m ³	Non-neutralized	Flame photometer	95 L/min	Entire Respirator
		Paraffin oil	0.29 µm~ 0.45 µm CMD (GSD 1.6~2.2)	15~25 mg/m ³				
Japan	JIS T 8151-2018	NaCl (RL- or DL-series)	0.06-0.1 µm CMD (GSD<1.8)	≤50 mg/m ³	Undefined	Light-scattering type particle concentration meter	85L/min	Entire respirator
		DOP (RS- or DS-series)	0.15-0.25 µm CMD (GSD<1.6)	≤100 mg/m ³				

Table S2. The comparison of testing standards for the particle filtration efficiency of face masks

Country	Test method	Standard	Aerosol type	Particle size	concentration	Particle charge	Aerosol detector	Flow rate	Sample type and size
USA	BFE	ASTM F2101-19	Staphylococcus aureus bacteria	3.0±0.3 μm (MPS)	1700-3000 viable particles per test	Unneutralized	Six-Stage Viable Particle Cascade Impactor	28.3 L/min	Medical face mask, Entire mask
	PFE	ASTM F2299/F2299M-03(2017)	latex sphere	0.1~5 μm (MPS)	<102 particles/cm ³	Neutralized	Optical particle counters	Face velocity 0.5-25 cm/sec	Medical face mask, 50–150 mm diameter circle
	PFE	FDA guidance	polystyrene latex particles	0.1 μm mono-disperse	<102 particles/cm ³	Unneutralized	Optical particle counters	Face velocity 0.5-25 cm/sec	Medical face mask, 50–150 mm diameter circle
China	BFE	YY 0469-2011 YY T 0969-2013	Staphylococcus aureus bacteria (ATCC 6538)	3.0±0.3 μm (MPS)	2200±500 CFU per test	Unneutralized	Six-Stage Viable Particle Cascade Impactor	28.3 L/min	Single use medical mask/surgical mask, Entire mask
	PFE	YY 0469-2011	NaCl	0.075±0.020 μm CMD (GSD<1.86)	≤200 mg/m ³		Undefined	30±2 L/min	Surgical mask 100cm ²
		GB 19083-2010						85±2 L/min	Medical respirator, entire respirator
Europe	BFE	EN 14683:2019	Staphylococcus aureus bacteria	3.0±0.3 μm (MPS)	2200 ± 500 CFU per test	Unneutralized	Six stage cascade impactor	28.3 L/min	Medical face mask, minimum 100 cm ²

Table S3. The summary of the particle collection efficiency for face masks and FFRs in different types

Country	Type	Standard	Collection efficiency (%)								
			≥30	≥80	≥90	≥94	≥95	≥98	≥99	≥99.9	≥99.97
USA	Particulate respirator	CFR 42-84-1995					N95 P95 R95		N99 P99 R99		N100 P100 R100
	Medical face mask	ASTM F2100-19					Level 1 (BFE, PFE)	Level 2 Level 3 (BFE, PFE)			
China	Particulate respirator	GB 2626-2006			KN90 KP90		KN95 KP95				KN100 KP100
	Medical respirator	GB 19083-2010			Level 1		Level 2				Level 3
	Surgical mask	YY 0469-2011	√(PFE)				√(BFE)				
	Single-use medical mask	YY T 0969-2013					√(BFE)				
Europe	Particulate Respirator	EN 149:2001+A1(EN 13274-7:2019)		FFP1		FFP2			FFP3		
	Medical face mask	EN 14683:2019					Type I ^a (BFE)	Type II Type IIR (BFE)			
Japan	Particulate respirator	JIS T 8151-2018		RS1 DS1 RL1 DL1			RS2 DS2 RL2 DL2			RS3 DS3 RL3 DL3	

^a Type I medical face masks should only be used for patients and other persons to reduce the risk of spread of infections particularly in epidemic or pandemic situations. Type I masks are not intended for use by healthcare professionals in an operating room or in other medical settings with similar requirement

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