

Information for Clinical Choice Matrix and Support Document

Heat and Moisture Exchange Filters

Information for Clinical Choice (ICC) has been developed to assist clinicians in the decision-making process when assessing the suitability of a product by providing a clear illustration and description of the features of a range of similar products supplied through NHS Supply Chain. The criteria provided, in the form of a Product Matrix and Support Document, is the result of a product review, conducted by DHLs Clinical Collaboration Team (CCT), with support from clinical stakeholders from across the NHS.

The aim, alongside delivering savings back into NHS frontline services, is to ensure that clinical choice remains at the forefront of any product switching decision.

Airways Management: Heat and Moisture Exchange Filters








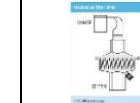
Heat Moisture Exchanger (HMEF)







These conserve heat and moisture during expiration and make this available to inspired gases during subsequent inspiration. Heat and Moisture Devices, including those that incorporate a breathing filter are tested against the international standard ISO 9360-1:2000(E).²








Why is Humidification needed?




The gases generally available for medical use lack sufficient moisture to be physiologically acceptable to the respiratory tract of patients. Heat and Moisture exchangers are used to raise the water content and the temperature of a gas delivered to the respiratory tract.²















Electrostatic Ported (Part 1)								
Supplier	Armstrong	Armstrong	Armstrong	Draeger	Draeger	Draeger	HC21	HC21
MPC	PHFT6020	PHFT6120	PHFT6130	MP01800	MP01805	MP01810	352/5877TC	352/5867TC
NPC	FDC874	FTC267	FTC273	FDC833	FTC2036	FDC834	FTC302	FDC1522
Description	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Paediatric / Adult Ported Straight	HMEF Electrostatic Paediatric / Adult Ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported with Elbow
Picture								
UOI	25	50	50	50	50	50	Each	25
Stocked	Blue Diamond	Stocked	E Direct	Blue diamond	Blue diamond	Blue Diamond	Stocked	E Direct
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	75 ml	29 ml	28 ml	90 ml	55 ml	65 ml	51 ml	93 ml
Hydrophobic filter	✓	✓	✓	✓	✗	✓	✓	✓
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	Not available	Not available	Not available	4.7	7.2	6.9	6.0	6
Mass of moisture output (mg H2O/L @Vt 500ml)	32.9	31.8 @ Vt 250ml	31.8 @ Vt 250ml	39.3	36.8	37.1	33	33
Tethered cap	✓	✓	✓	✓	✓	✓	✓	✓
Tidal volumes (VT)	15 ml – 1500ml	60ml - 900ml	60ml - 900ml	300ml - 1500ml	300ml - 1500ml	300ml - 1500ml	150ml - 1200ml	300ml - 1500ml
Latex-free	✓	✓	✓	✓	✓	✓	✓	✓
Sterile	✗	✗	✗	✗	✗	✗	✓	✓
Breathing system port 22F/15M	✓	15M (only)	15M (only)	✓	✓	✓	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	1.17 / Not available	20l/min is 1.4 / Not available	20l/min is 1.4 / Not available	1.0 / Not available	0.9 / Not available	1.1 / Not available	1.2 / 1.6	1.0 / 1.1
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	2.96 / Not available	Not Available	Not Available	3.0 / Not available	3.0 / Not available	3.0 / Not available	2.7 / 3.6	2.1 / 2.5
HEPA	✗	✗	✗	✗	✗	✗	✗	✗
Filtration performance rate as per ISO 23328-1 (salt test)	Not Available	Not Available	Not Available	> 97%	> 95%	> 97%	≥98.352%	≥98.352% ⁵⁸
Country of Manufacture	Sweden	Sweden	Sweden	China/Germany	China/Germany	China/Germany	Not available	Not available




Electrostatic Ported (Part 2)									
Supplier	Intersurgical	Intersurgical	Intersurgical	Intersurgical	Intersurgical	Intersurgical	Meditech	Meditech	Meditech
MPC	1941001	1541000	1641000	1641197	1541197	1941197	224310	222835	222832HME
NPC	FTC132	FTC166	FTC111	FDD5358	FTC285	FTC133	FSM7530	FSM7394	FSM7392
Description	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported with elbow	HMEF Electrostatic Adult Ported with elbow	HMEF Electrostatic Adult Ported with elbow	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight
Picture									
UOI	70	150	50	50	50	50	50	50	50
Stocked	Blue Diamond	Blue Diamond	Blue Diamond	Stocked	Stocked	Stocked	Blue Diamond	Blue Diamond	Blue Diamond
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	<7 Days	<7 Days	<7 Days
Internal volume	65 ml	59 ml	34 ml	34 ml	60 ml	65 ml	40 ml	32 ml	32 ml
Hydrophobic filter	✓	✓	✓	✓	✓	✓	✗	✗	✗
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	8.3	7.8	13.3	13.3	7.8	9.3	6.3	6.3	6.3
Mass of moisture output (mgH2O/L @Vt 500ml)	30.3	30.8	25.9	25.9	30.8	29.5	32	32	32
Tethered cap	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tidal volumes (VT)	>200ml	>200ml	>100ml	>100ml	200ml	>200ml	120ml - 300ml	120ml - 1200ml	120ml - 1200ml
Latex-free	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sterile	✗	✗	✗	✗	✗	✗	✗	✗	✗
Breathing system port 22F/15M	22F (only)	✓	22F (only)	22F (only)	✓	22F (only)	15M (only)	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	1.1 / 1.1	0.8 / 1.4	0.9 / 0.9	1.2 / Not available	1.2 / Not available	1.4 / Not available	1.9 / 2.0	1.4 / 1.4	1.0 / 1.0
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	2.47 / 2.3	2.1 / 2.9	2.1 / 2.0	3.1 / Not available	3.3 / Not available	3.8 / Not available	2.3 / 2.5	2.0 / 2.0	1.0 / 1.0
HEPA	✗	✗	✗	✗	✗	✗	✗	✗	✗
Filtration performance rate as per ISO 23328-1 (salt test)	99.89%	98.72%	97.17%	97.17%	98.72%	99.89%	Not available	Not available	Not available
Country of Manufacture	Lithuania	UK	UK	UK	UK	Lithuania	UK	UK	UK

Electrostatic Ported (Part 3)									
Supplier	Teleflex	Teleflex	Teleflex	Teleflex	Teleflex	Teleflex	Teleflex	Vyaire	Vyaire
MPC	18401	18402T	19502T	19401	19402T	18501	18502T	M1004132	M1010538
NPC	FDC3562	FTC344	FTC564	FDC1229	FTC347	FDC1234	FTC602	FTC297	FTC310
Description	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Angled
Picture									
UOI	25	25	50	25	25	50	50	50	50
Stocked	Blue Diamond	Blue Diamond	E Direct	Blue Diamond	E Direct	Blue Diamond	E Direct	Blue Diamond	Blue Diamond
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	38 ml	38 ml	27 ml	35 ml	38 ml	27 ml	27 ml	34 ml	34 ml
Hydrophobic filter	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mass of moisture loss of the HME (mg H ₂ O/L @Vt 500ml)	6.0	6.0	6.0	6.0	6.0	7.0	6.0	7.5	7.5
Mass of moisture output (mgH ₂ O/L @Vt 500ml)	31	31	31	31	31	31	31	30	30
Tethered cap	✗	✓	✓	✗	✓	✗	✓	✓	✓
Tidal volumes (VT)	150ml - 1000ml	150ml - 1000ml	150ml - 1000ml	150ml - 1000ml	150ml - 1000ml	150ml - 1000ml	150ml - 1000ml	120ml - 750ml	120ml - 750ml
Latex-free	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sterile	✓	✗	✗	✓	✗	✓	✗	✗	✗
Breathing system port 22F/15M	✓	✓	15M (only)	✓	✓	15M (only)	15M (only)	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH ₂ O)	0.88 / 0.91	0.88 / 0.91	1.53 / 1.56	0.88 / 0.91	0.88 / 0.91	1.53 / 1.56	1.53 / 1.56	0.9 / Not available	0.9 / not available
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH ₂ O)	2.15 / 2.20	2.15 / 2.20	3.62 / 3.69	2.15 / 2.20	2.15 / 2.20	3.62 / 3.69	3.62 / 3.69	2.2 / Not available	2.2 / Not available
HEPA	✗	✗	✗	✗	✗	✗	✗	✗	✗
Filtration performance rate as per ISO 23328-1 (salt test)	93.39%	93.39%	87.98%	93.39%	93.39%	87.98%	87.98%	Not available	Not available
Country of Manufacture	Malaysia	Malaysia	Malaysia	Malaysia	Malaysia	Malaysia	Malaysia	Not available	Not available

Electrostatic Non-Ported				
Supplier	Armstrong	Flexicare	Intersurgical	Intersurgical
MPC	PHFT6000	038-41-350	1942000	1541007
NPC	FTC280	FTC172	FTC048	FTC676
Description	HMEF Electrostatic Adult Non-Ported Straight	HMEF Electrostatic Adult Non-Ported Straight	HMEF Electrostatic Adult Non-Ported Straight	HMEF Electrostatic Adult Non-Ported Straight
Picture				
UOI	25	Each	Each	150
Stocked	Stocked	Stocked	Stocked	Stocked
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	75 ml	66 ml	66 ml	59 ml
Hydrophobic filter	✘	✘	✓	✓
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	Not available	Not Available	9.3	7.8
Mass of moisture output (mgH2O/L @Vt 500ml)	32.9	33.6	29.5	30.6
Tidal volumes (VT)	150ml - 1500ml	> 198ml	>200ml	>200ml
Latex-free	✓	✓	✓	✓
Sterile	✘	✘	✘	✘
Breathing system port 22F/15M	✓	✓	22F (only)	✓
Patient connection port 22M/15F	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	Not available / 1.2	1.4 / 1.7	1.06 / 1.1	0.8 / 1.4
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	Not available / 2.96	3.5 / 3.9	2.48 / 2.5	2.1 / 2.9
HEPA	✘	✘	✘	✘
Filtration performance rate as per ISO 23328-1 (salt test)	Not Available	98.9%	99.94%	98.72%
Country of Manufacture	Sweden	China	Lithuania	UK

Mechanical Ported (Part 1)								
Supplier	Armstrong	Draeger	Flexicare	Flexicare	HC21	Intersurgical	Intersurgical	Intersurgical
MPC	PHFT6125	MP01801	038-41-355 (LS)	038-41-356	354/5876TC	1941000	1542000	1341000s
NPC	FTC272	FTC2001	FTC562	FTC459	FTC052	FTC029	FDB1017	FDD5392
Description	HMEF Mechanical Adult / Paediatric Ported with Elbow	HMEF (HEPA) Mechanical Adult Ported Straight	HMEF Mechanical Adult Ported Straight	HMEF Mechanical Adult Ported with Elbow	HMEF Mechanical Adult Ported Straight	HMEF Mechanical Adult Ported Straight	HMEF Mechanical Adult Ported Angled	HMEF Mechanical Adult Ported Straight
Picture								
UOI	50	50	50	50	25	Each	75	50
Stocked	Stocked	Blue Diamond	Blue Diamond	Blue Diamond	Stocked	Stocked	E direct	Blue Diamond
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	29 ml	55 ml	66 ml	76 ml	96 ml	65 ml	74 ml	57 ml
Hydrophobic filter	✓	✓	✗	✗	✓	✓	✓	✓
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	Not available	9.8	Not Available	Not Available	6.0	9.3	7.4	6.0
Mass of moisture output (mgH2O/L @Vt 500ml)	32 @ Vt 250ml	34.2	33.6	33.6	34	31.5	31.1	32
Tethered cap	✓	✓	✓	✓	✓	✓	✓	✓
Tidal volumes (VT)	50ml - 900ml	300ml -1500ml	>198ml	>228ml	300ml - 1500ml	>200ml	>225ml	>180ml
Latex-free	✓	✓	✓	✓	✓	✓	✓	✓
Sterile	✗	✗	✗	✗	✓	✗	✗	✓
Breathing system port 22F/15M	15M (only)	✓	✓	✓	✓	22F (only)	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	20l/min is 1.4 cmH2O	1.3 / Not available	1.4 / 1.7	2.0 / Not available	1.0 / 1.1	1.0 / 1.1	0.9 / 1.4	1.6 / 1.3
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	Not Available	2.7 / not available	3.5 / 3.9	5.4 / Not available	2.1 / 2.5	2.4 / 2.5	2.3 / 3.2	2.7 / 2.8
HEPA	✗	✓	✗	✗	✗	✗	✗	✗
Filtration performance rate as per ISO 23328-1 (salt test)	Not Available	> 99%	98.9%	98.9%	≥99.764%	99.90%	98.75%	98.78%
Country of Manufacture	Sweden	China/Germany	China	China	Not available	Lithuania	Lithuania	Lithuania

Mechanical Ported (Part 2)						
Supplier	Meditech	Meditech	Meditech	Meditech	Teleflex	Teleflex
MPC	222835AHME	222835ELA	222835ELP	2228351577	29001T	29002T
NPC	FSM7393	FSM7397	FSM7398	FSM7395	FDC3571	FDC3572
Description	HMEF Mechanical Adult Ported Angled	HMEF Mechanical Adult Ported Elbow	HMEF Mechanical Adult Ported with elbow	HMEF Mechanical Adult Ported with elbow	HMEF (HEPA) Mechanical Adult Ported Straight	HMEF (HEPA) Mechanical Adult Ported Straight
Picture						
UOI	50	50	50	50	20	20
Stocked	Blue Diamond	Blue Diamond	Blue Diamond	Blue Diamond	Blue Diamond	Blue Diamond
Recommended max duration of use	<7 Days	<7 Days	<7 Days	<7 Days	24 Hours	24 Hours
Internal volume	32 ml	40 ml	12 ml	40 ml	81 ml	81 ml
Hydrophobic filter	✓	✓	✓	✓	✓	✓
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	6.3	6.3	6.3	6.3	6.7	6.7
Mass of moisture output (mgH2O/L @Vt 500ml)	32	32	32	32	30.3	30.3
Tethered cap	✓	✓	✓	✓	✓	✓
Tidal volumes (VT)	120ml - 1200ml	200ml - 1200ml	200ml - 1200ml	200ml - 1200ml	300ml - 1200ml	300ml - 1200ml
Latex-free	✓	✓	✓	✓	✓	✓
Sterile	✗	✗	✗	✗	✓	✗
Breathing system port 22F/15M	✓	✓	✓	✓	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	1.4 / 1.5	1.4 / 1.4	1.4 / 1.4	1.4 / 1.4	1.41 / 1.54	1.41 / 1.54
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	2.0 / 2.2	2.0 / 2.0	2.0 / 2.0	2.0 / 2.0	3.29 / 3.62	3.29 / 3.62
HEPA	✗	✗	✗	✗	✓	✓
Filtration performance rate as per ISO 23328-1 (salt test)	Not available	Not available	Not available	Not available	Not available	Not available
Country of Manufacture	UK	UK	UK	UK	Malaysia	Malaysia

Mechanical Non Ported				
Supplier	Armstrong	Armstrong	Armstrong	Intersurgical
MPC	PHFT6005	PHFT6100	PHFT6105	1341007s
NPC	FDD5293	FDD5296	FDD5294	FDB924
Description	HMEF Mechanical Adult Non -ported with Elbow	HMEF Mechanical Adult / Paediatric Non- ported Straight	HMEF Mechanical Adult / Paediatric Non-ported with elbow	HMEF Mechanical Adult Non-ported Straight
Picture				
UOI	25	50	50	50
Stocked	E Direct	E Direct	E Direct	Blue Diamond
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	81 ml	28 ml	32 ml	57 ml
Hydrophobic filter	✓	✓	✓	✓
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	Not available	Not available	Not available	6.0
Mass of moisture output (mgH2O/L @Vt 500ml)	33	31.8	32 @ Vt 250ml	32.3
Tidal volumes (VT)	150ml - 1500ml	50ml - 900ml	50ml - 900ml	>180ml
Latex-free	✓	✓	✓	✓
Sterile	✗	✗	✗	✓
Breathing system port 22F/15M	✓	15M (only)	15M (only)	✓
Patient connection port 22M/15F	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	Not Available	Not available / 20l/min is 1.4	Not Available	1.6 / 1.3
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	Not Available	Not Available	Not Available	2.7 / 2.8
HEPA	✗	✗	✗	✗
Filtration performance rate as per ISO 23328-1 (salt test)	Not Available	Not Available	Not Available	98.78%
Country of Manufacture	Sweden	Sweden	Sweden	Lithuania



Covid Products – Products added to NHS supply chain for the use in COVID ONLY

Supplier	GVS	GVS	GVS	Medecon	Medecon	Medecon	Medecon	GVS
MPC	9067/710	9064/711	4333/711	40820	40820S	40821	40821S	4244/712BRSA
NPC	FDC1511	FDC1510	FDC1487	FTC682	FTC683	FTC684	FTC685	FDC1488
Description	HMEF Electrostatic Adult Non- ported Angled	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Straight	HMEF Electrostatic Adult Ported Angled	HMEF Electrostatic Adult Ported Angled	HMEF Mechanical Adult Non -ported Straight
Picture								
UOI	50	50	50	45	45	45	45	50
Stocked	E Direct	E Direct	E Direct	Blue Diamond	Blue Diamond	Blue Diamond	Blue Diamond	E Direct
Recommended max duration of use	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours	24 Hours
Internal volume	32 ml	33 ml	53 ml	53 ml	53 ml	55 ml	55 ml	64 ml
Hydrophobic filter	x	x	x	✓	✓	✓	✓	x
Mass of moisture loss of the HME (mg H2O/L @Vt 500ml)	6.68	13.43	9.64	Not available	Not available	Not available	Not available	11.42
Mass of moisture output (mg H2O/L @Vt 500ml)	36.5 @VT 250 ml	11.7	34	37.3	37.3	37.3	37.3	30
Tethered cap	✓	✓	✓	✓	✓	✓	✓	Non-ported
Tidal volumes (VT)	90ml - 1500ml	120ml - 1500ml	150ml - 1500ml	150ml - 1500ml	150ml - 1500ml	150ml - 1500ml	150ml - 1500ml	150ml - 1500ml
Latex-free	✓	✓	✓	✓	✓	✓	✓	✓
Sterile	✓	x	x	x	✓	x	✓	x
Breathing system port 22F/15M	✓	✓	✓	✓	✓	✓	✓	✓
Patient connection port 22M/15F	✓	✓	✓	✓	✓	✓	✓	✓
Flow resistance product & pressure at 30L Pre / Post Conditioning (cmH2O)	2.7 / Not available	3.4 / Not available	1.3 / Not available	1.0 / Not available	1.0 / Not available	1.0 / Not available	1.0 / Not available	1.7 / Not available
Flow resistance product & pressure at 60L Pre / Post Conditioning (cmH2O)	6.0 / Not available	7.6 / Not available	2.6 / Not available	2.2 / Not available	2.2 / Not available	2.2 / not available	2.2 / Not available	3.5 / Not available
HEPA	x	x	x	x	x	x	x	x
Filtration performance rate as per ISO 23328-1 (salt test)	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available
Country of Manufacture	Not available	Not available	Not available	Not available	Not available	Not available	Not available	Not available

Breathing Filters

Bacterial/Viral filters are intended to help prevent the transmission of bacteria and viruses and prevent cross infection to and from the patient during anaesthesia or other types of ventilation

The British Standards defines breathing filters as, “devices intended to reduce transmission of particulates, including micro-organisms, such as bacteria and viruses to prevent cross infection to and from the patient during anaesthesia or other types of ventilation”.^{1,2}

Heat Moisture Exchangers (HME)

These conserve heat and moisture during expiration and make this available to inspired gases during subsequent inspiration. Heat and Moisture Devices, including those that incorporate a breathing filter are tested against the international standard ISO 9360-1:2000(E).^{2,9}

HME's can be used as part of a passive humidification breathing system for mechanically ventilated patients

The HME is designed to replicate the functions of the upper airway conserving the patient's own expired heat and moisture and returning these to the patient during inspiration.¹⁰

Heat and Moisture Exchange Filters (HMEF)

HMEF's are a combination of an HME and Breathing Filter to achieve both clinical outcomes of filtration and heat and moisture exchange.⁹

HEPA Filter

HEPA filtration works by mechanical means and stands for High Efficiency Particulate Air. The HEPA filter standard to remove at least 99.97% of particles from the air down to at least 0.3 microns in size.¹²

Filtration

Breathing filters are intended to reduce transmission of particulates to prevent cross infection to and from the patient during anaesthesia or other types of ventilation, however filtration performance varies.

Comparing the results from various tests is difficult because of the use of different test methods and organisms. In particular, the filtration efficiency of filter media varies with the size of the particles in the challenge to the filter.

The filtration performance rate in the matrix uses the same, national and comparable ISO 23328-1 salt test method to assess filtration performance. The salt test assists end users to make an objective comparison between filters supplied by different manufacturers, by challenging the filters with sodium chloride particles in the most penetrating particle size range.^{3,4}

- Microbial challenges provide differing results depending on their particle size.

For a similar comparison Centers for Disease Control (CDC) (2020) recommend that a respiratory protective device has a filtration efficiency level of particle penetration (NaCl – Salt) of at least 95% as an effective barrier

- FFP2 masks have a minimum of 94% filtration percentage
- FFP3 masks have a minimum filtration percentage of 99%



It could be considered breathing filter filtration rates are comparable to required respiratory protective device (FFP) filtration rates.⁶

The CDC requirement that the filtration efficiency level of particle penetration (NaCl – Salt)

- Must be at least 95%
 - This implies bacterial filtration efficiency of at least 99.9%¹¹
- All breathing filters on NHSSC framework must have a minimum efficiency of 99.9%

In line with CDC requirements on filtration efficiency level the salt test must be greater than 95%.⁷

Research suggests mechanical filters (Pleated hydrophobic) typically allow significantly fewer particles to pass through than electrostatic filters.¹¹

Filter Components

Electrostatic Filters

Electrostatic filter material has an electrostatic charge applied to attract and capture charged particles. These are tested using the most penetrating particle size (MPPS) range of 0,1 µm to 0,3 µm. For electrostatic filter material, the density of fibres is comparatively low and the electrostatic charge on the fibres.

For circle breathing systems where low fresh gas flow techniques are used, the use of electrostatic filters cannot be recommended as there is a risk of transmission of contaminated liquid from the breathing system directly into the patient's airway.⁸

Mechanical Filters

Mechanical filter has a densely packed resin-bonded, hydrophobic glass fibres, this mechanical filter physically stops and capture particles.

Mechanical filters are mainly pleated to reduce resistance to gas flow. This type of sheet is **hydrophobic** and, under normal conditions, does not absorb water. These are tested using the most penetrating particle size (MPPS) range of 0,1 µm to 0,3 µm. The efficiency of a mechanical filter is determined by its physical features, for example diameter, orientation and arrangement of fibres.²

Dead space

Heat and moisture exchangers and filters add to the dead space of the breathing system when they are connected between the patient and the breathing system, so that a greater proportion of the exhaled carbon dioxide is returned in the next breath.

This is identified through the size of the **internal volume** of the HME(F) or breathing filter. Generally, the dead space of the bacterial/viral filter should be as small as possible in order that no detriment to the work of breathing is experienced by the patient. For some patients with small lung volumes (young children or patients with severe pulmonary disease), it is even more important that the dead space is reduced to its minimum.⁵



Mass of moisture loss

The manufacturer or supplier must supply the moisture loss, in milligrams water per litre of air and expressed to the nearest milligram as tested by stated ISO test conditions. These are within the operating range of the HME as specified by the manufacturer, and at the minimum and maximum tidal volumes recommended by the manufacturer, this is to avoid the inspissation (thickening) of secretions.

Mass of moisture output

Heat and moisture output during expiration and made available / returned to inspired gases during subsequent inspiration.

Filter resistance

- Filter resistance is dependent on the flow rate used.
- Most filters were tested in adults using a flow rate of 60 litre per min, but flow rates of about 30 litre min, were used for several filters, so that comparisons are difficult.
- Filters can be tested both pre and post conditioning, this means that the filters are tested dry and unused, but then also tested saturated which simulates their performance during use.
- Most of the HMEF on the NHS Supply Chain catalogue have a reasonable low-resistance (0.8–3.6 cm H₂O for a gas-flow rate of 60 litre per min.
- Low resistance can be paramount for clinical management of certain conditions and treatments for example Non-invasive ventilation to decrease the resistance of the breathing system for patients who may already be respiratory distressed the lower the resistance the better, usually under 1.5cm H₂O.⁵



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