

3. Air Filter Performance Characteristics

3-10 General

Every air filter has four key properties:

- manufacturer's recommended air flow,
- air flow resistance characteristic,
- efficiency at removing dust and contaminants from the air stream,
- dust holding capacity at particular test conditions.

All must be considered when selecting or comparing air filters for a particular application.

3-20 Air Capacity

Air filters are rated by the manufacturer to handle a maximum quantity of air (ℓ/s), (or have a maximum face velocity (m/s)). All other performance factors are meaningless unless referred to this air flow rate, as each property is dependent on the other three.

The required size of air filter bank can be selected using the continuity equation and the recommended face velocity for the medium.

In a duct with varying cross sectional area the velocity changes along the duct as shown in Figure 3-20A.

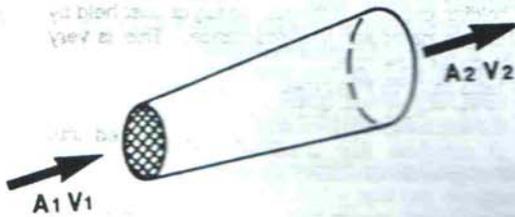


Fig. 3-20A Continuity of flow

For incompressible, steady flow:

$$A_1 \cdot V_1 = A_2 \cdot V_2 = \frac{Q}{1000} \quad \text{eqn 3-20a}$$

where :

- A_1 = Area of duct at section 1 (m^2)
- V_1 = Velocity of air at section 1 (m/s)
- A_2 = Area of duct at section 2 (m^2)
- V_2 = Velocity of air at section 2 (m/s)
- Q = Air flow rate (ℓ/s)

Example 1:

Given flat panel air filters with openings of 500 x 500mm and a recommended face velocity of 1.5 m/s, determine how many panels are required to handle 3,000 ℓ/s.

From equation 3-20a, for each panel

$$\begin{aligned} Q &= A \times V \times 1000 \\ &= 0.25 \times 1.5 \times 1000 \\ &= 375 \text{ ℓ/s (maximum air flow, one panel)} \end{aligned}$$

Thus 8 panels will be required to handle 3000 ℓ/s.

Example 2:

Given a flat media surface area of 1.2 m^2 and total air quantity of 2000 ℓ/s, determine the velocity of air through the panel.

From equation 3-20a

$$\begin{aligned} V &= \frac{Q}{A \times 1000} \\ &= \frac{2000}{1.2 \times 1000} \\ &= 1.67 \text{ m/s} \end{aligned}$$

Filter manufacturers normally select the velocity of air across the media to achieve optimum performance relative to the fibre diameter, packing density, thickness of medium and anticipated dust load. The recommended maximum air quantity for any filter or system should not be exceeded unless performance is verified by tests.

3-30 Resistance

The efficiency of a filter generally increases as the filter loads with dust. However, if the filter is loaded beyond the manufacturer's recommended final resistance, the efficiency will usually decline rapidly due to agglomerated particles being dislodged.

Filter resistance also affects fan selection, size of plant and energy consumption. Fan capacities are generally selected based on anticipated final resistance. As a result, occasionally there may be unacceptably high air flow rates when filters are clean. In such cases, automatic flow rate control may be required.

Resistance varies according to the degree of air turbulence in the media. The resistance/flow relationship varies with filter type. Most filter manufacturers publish initial resistance (clean filter) and final resistance. For some fabric and most metal filters, resistance increases as the square of the velocity. For laminar air flow through HEPA filters, the resistance is nearly proportional to velocity. For most air-conditioning filters, when velocity increases, resistance increases exponentially with a power between 1.3 and 1.8. Clean filter resistance can be easily read off graphs of filter resistance for different flows. These are in most NATA (National Association of Testing Authorities) certified test reports.

Stocked air filters drastically reduce air-conditioning performance, so they must be serviced at the proper time. Manometers should be fitted to monitor filter resistance. The manometers should be marked with the design final resistance and checked regularly.

Eurovent Ratings	CLEAN RESISTANCE			Final Resistance
	Flat Panel Up to 50 mm deep	Ext Surf Up to 300 mm deep	Ext Surf Over 300 mm deep	
EU1	25-80	25-70	20-60	100-125
EU2	30-90	30-70	25-60	100-125
EU3	35-90	35-70	30-60	100-125
EU4	35-90	35-70	30-70	100-150
EU5	50-100	40-100	30-100	100-160
EU6	70-130	50-130	35-140	100-200
EU7	70-130	50-130	35-150	150-250
EU8	70-130	50-130	35-200	200-300
HEPA/ ULPA		125-250		250-500

Table 3-30A Indicative Clean and Final Resistance of Filters. (Eurovent Rating is discussed in Clause 5-60)