超高效過濾器的容塵量比較研究

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Introduction

- A test facility of HEPA total efficiency is setup a square air duct. The filter material is glass fiber classified to the European regulations H13 category.
- Air velocity is set at 0.25, 0.4 m/s and the PAO aerosol is released from an aerosol generator by using Laskin nozzle. Both upstream and downstream aerosol concentration and penetration rate is measured by using light-scattering photometer.
- In this study, different filter surface velocity, challenge aerosol concentration and filter thickness were tested to identify the variation of dust holding capacity, filter penetration rate and filter pressure drop.

Trapping efficiency & penetration ratio

$$P = \frac{C_{N,u}}{C_{N,d}} \qquad E = 1 - P$$

- P : Penetration ratio of air filter
- $C_{N,u}$:Aerosol concentration of upstream
- $C_{N,d}$: Aerosol concentration of downstream
- E : Trapping efficiency of air filter

Specification

- Common standard :
  - EN 1822-2009
  - ISO 29463
  - ISO E、H、U:
  - EPA、HEPA、ULPA

International HEPA&ULPA grade

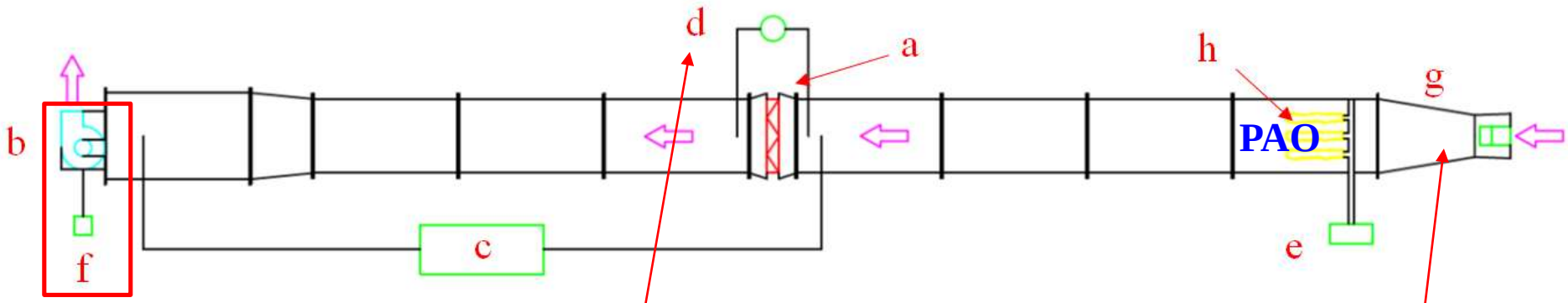
classification		eff,%
ISO 29463	EN1822	
ISO 15 E	E11	≧95
ISO 20 E	—	≧99
ISO 25 E	E12	≧99.5
ISO 30 E	—	≧99.9
ISO 35 H	H13	≧99.95
—	—	≧99.97
ISO 40 H	—	≧99.99
ISO 45 H	H14	≧99.995
ISO 50 U	—	≧99.999
ISO 55 U	U15	≧99.9995
ISO 60 U	—	≧99.9999
ISO 65 U	U16	≧99.99995
ISO 70 U	—	≧99.99999
ISO 75 U	U17	≧99.999995

Experimental Setup

Experiment system

- PAO is used in this study as challenge aerosol
- Constant air flow rate is obtained by adjusting the fan speed using VSD
- Laskin nozzle PAO generator (Cold) is used in this study
- HEPA filter penetration rate is measured by using light-scattering photometer
- The weight of HEPA filter is measured by electronic scale

Filter Duct Holding Capacity (DHC) test rig

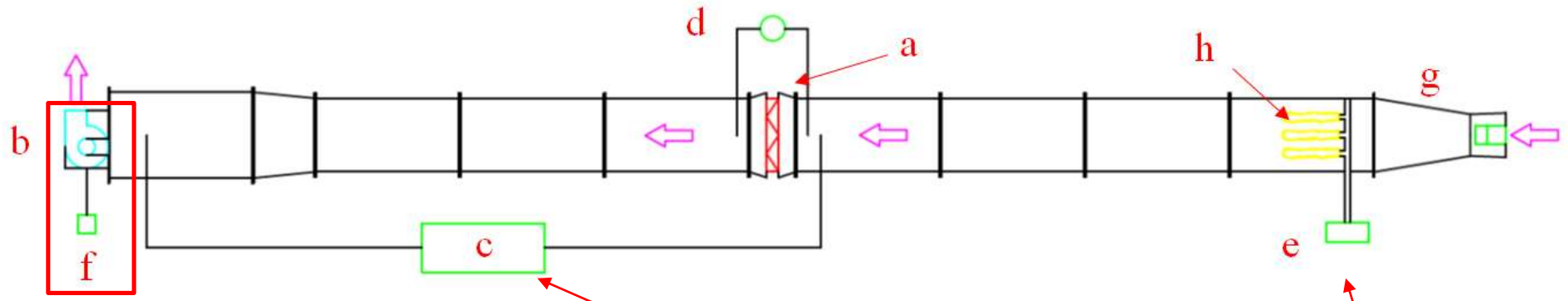


(d) pressure gauges

a	**HEPA**
b	**Centrifugal Fan**
f	**Inverter**
h	**PAO**

(g) Anemometer

Filter Duct Holding Capacity (DHC) test rig



Electronic- scale

(c) Light-scattering photometer

(e)PAO generator

Experiment parameters for Case A ~ Case J

case	Velocity (m/s)	PAO concentration (μg/L)	Final pressure drop (Pa)
A	0.4	50	600
B		25	
C	0.25	50	
D		25	
E、F、G	0.25	50	500
H、I、J	0.4		

Experiment parameters for Case K ~ Case N

case	Velocity (m/s)	PAO concentration (μg/L)	Final pressure drop Pa	Thickness (mm)
K	0.4	50	500	50
L				69
M				78
N				117

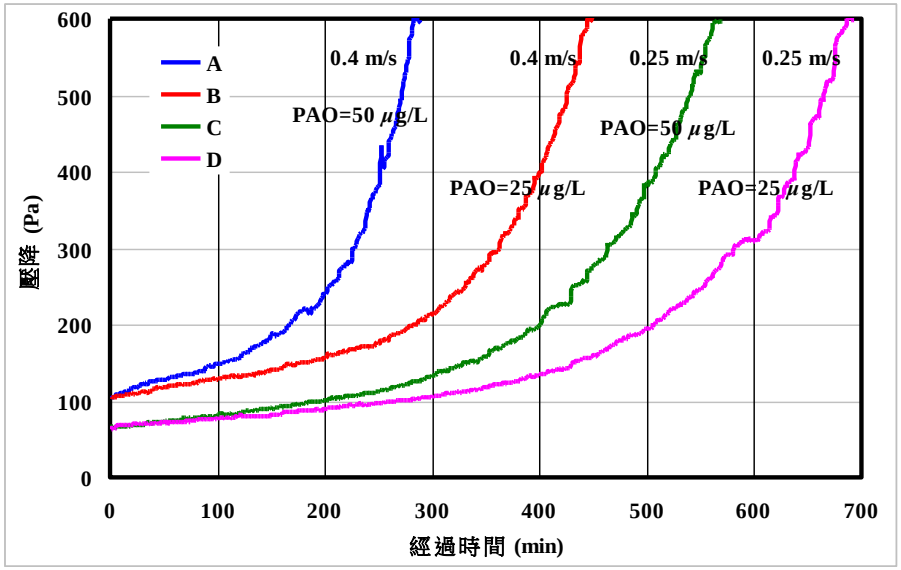
Testing procedures

- For Case A ~ Case D
  - The aerosol penetration rate was measured and recorded every hour,
  - After the pressure drop exceed twice of the initial pressure drop, the recording interval reduce to every 30mins.

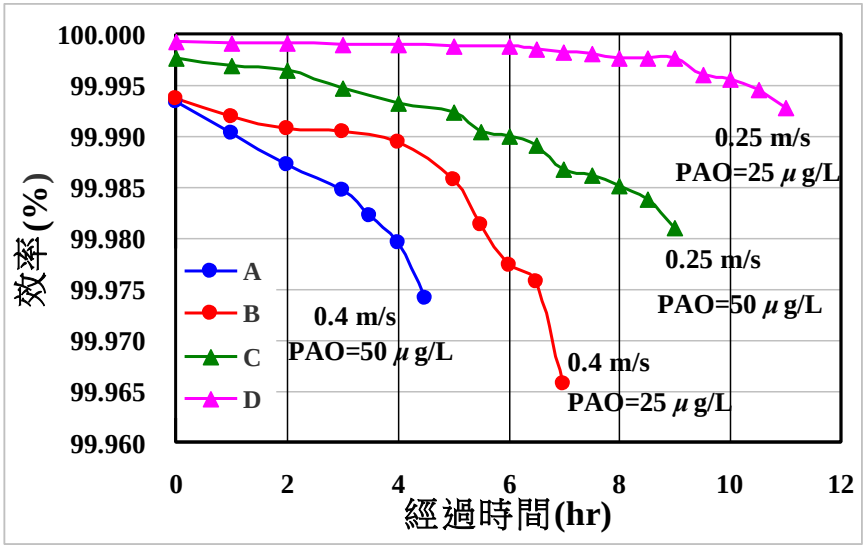
- For Case E ~ Case J
  - The aerosol penetration rate and the weight of filter was measured and recorded when the filter pressure drop reaches 100, 150, 200, 300, 400, and 500 Pa.
  - For Case E ~ Case G, Air velocity is 0.25 m/s, and PAO concentration is 50 μg/L
  - Air velocity is 0.4 m/s, and PAO concentration is 50 μg/L in case H~J

(experimental conditions)

Experimental Result for Case A ~ Case D

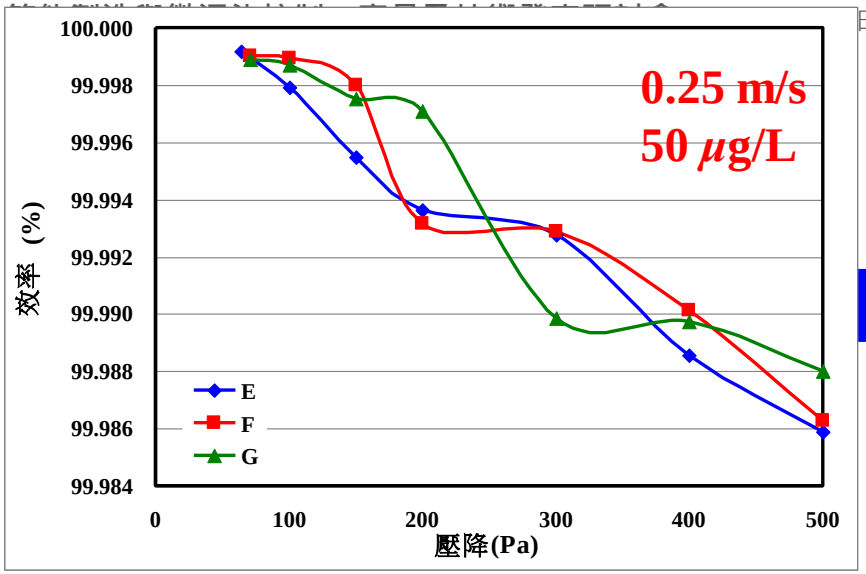


The relationship between pressure drop and time

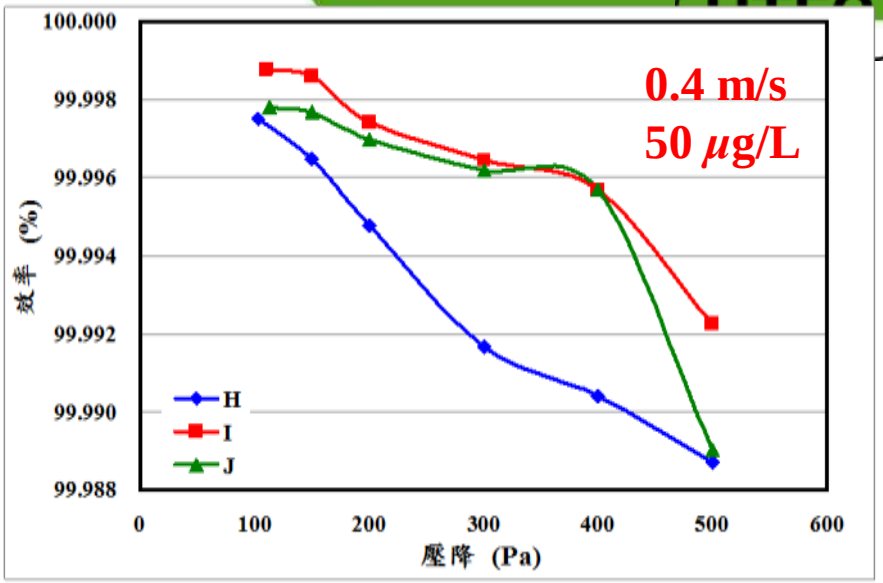


The relationship between efficiency and time

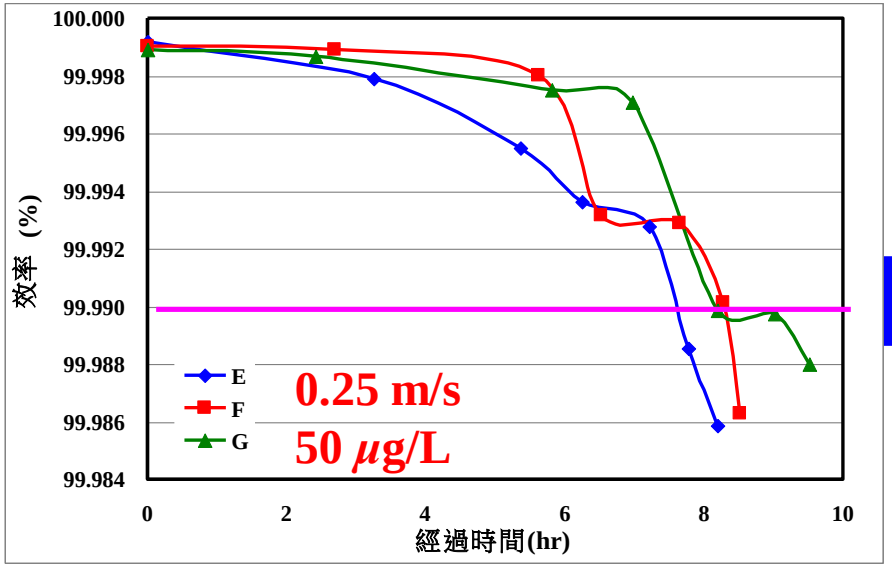
case	A	B	C	D
Dust(g)	256.5	241.5	332	287.5



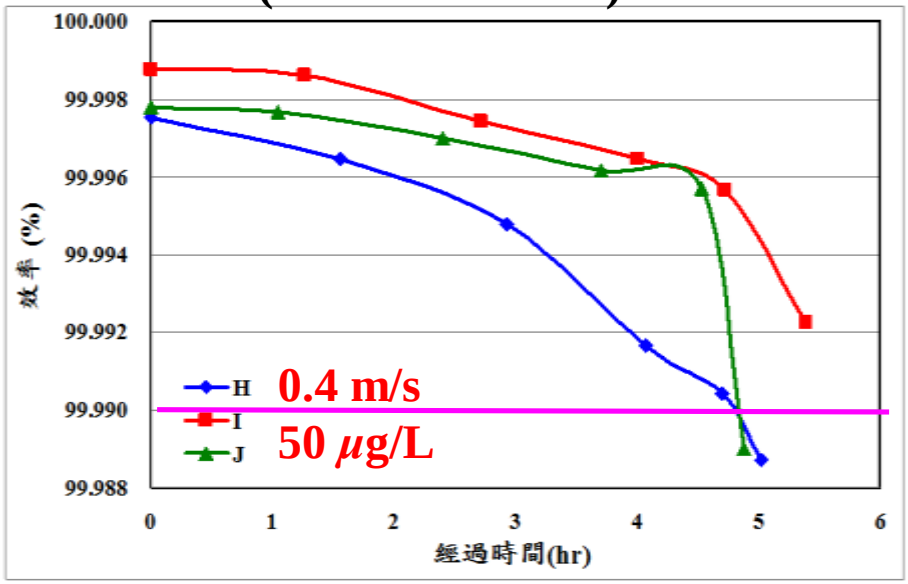
Efficiency vs. Pressure drop (Case E ~ Case G)



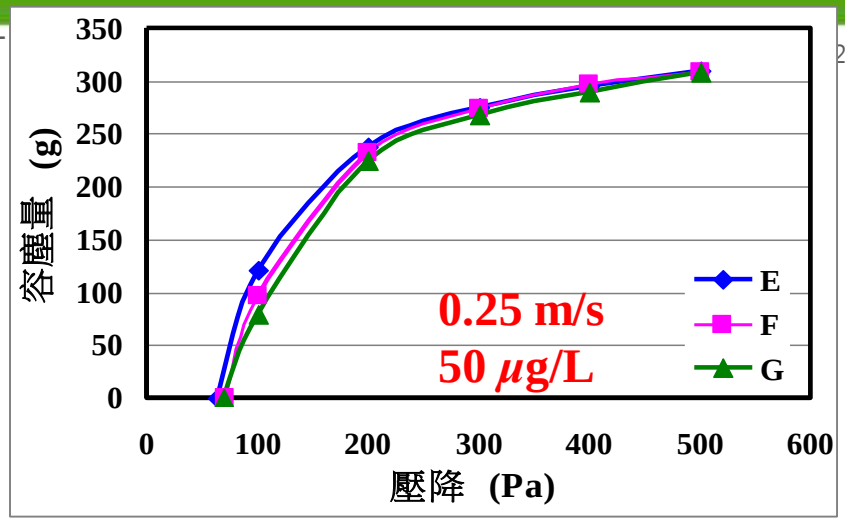
Efficiency vs. Pressure drop (Case H ~ Case J)



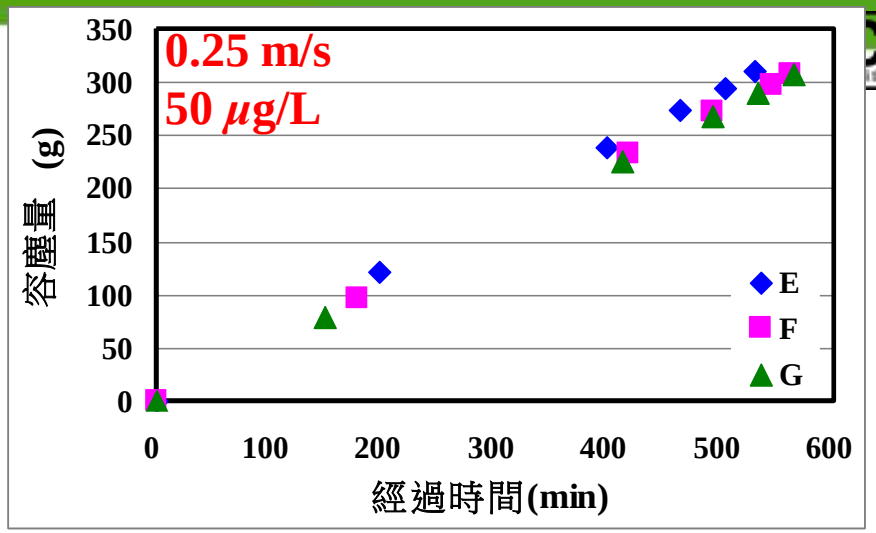
Test time vs. Pressure drop (Case E ~ Case G)



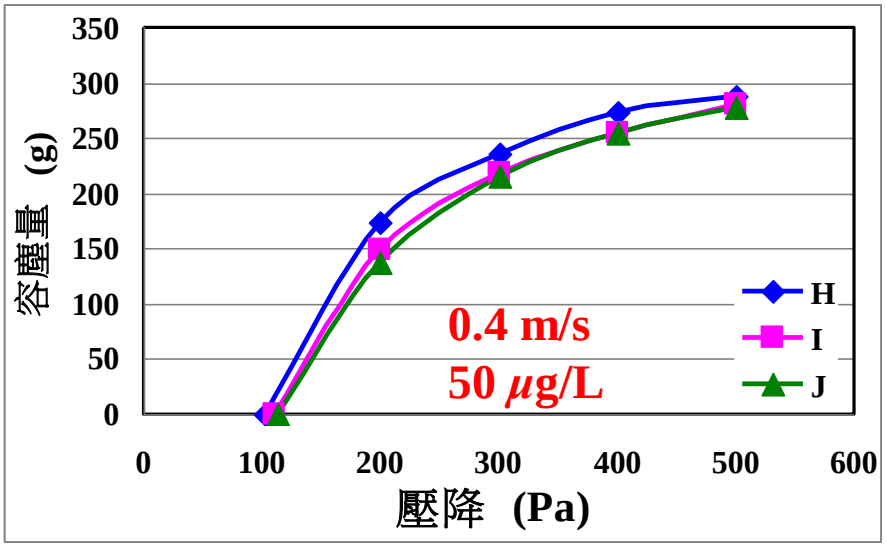
Test time vs. Pressure drop (Case H ~ Case J)



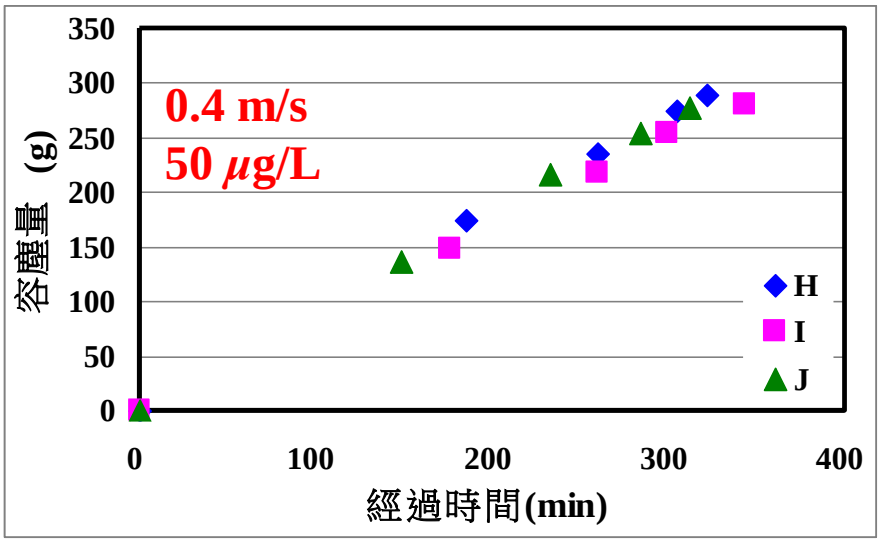
Dust holding capacity vs. Pressure drop (Case E ~ Case G)



Dust holding capacity vs. Test time (Case E ~ Case G)

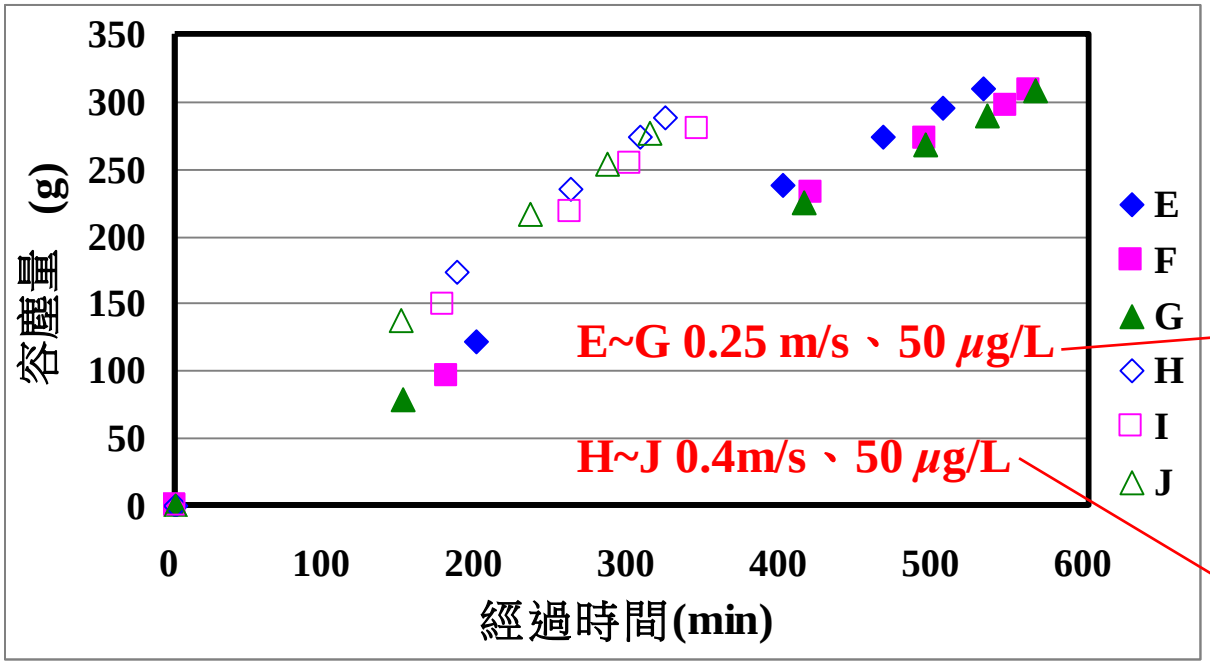


Dust holding capacity vs. Pressure drop (Case H ~ Case J)



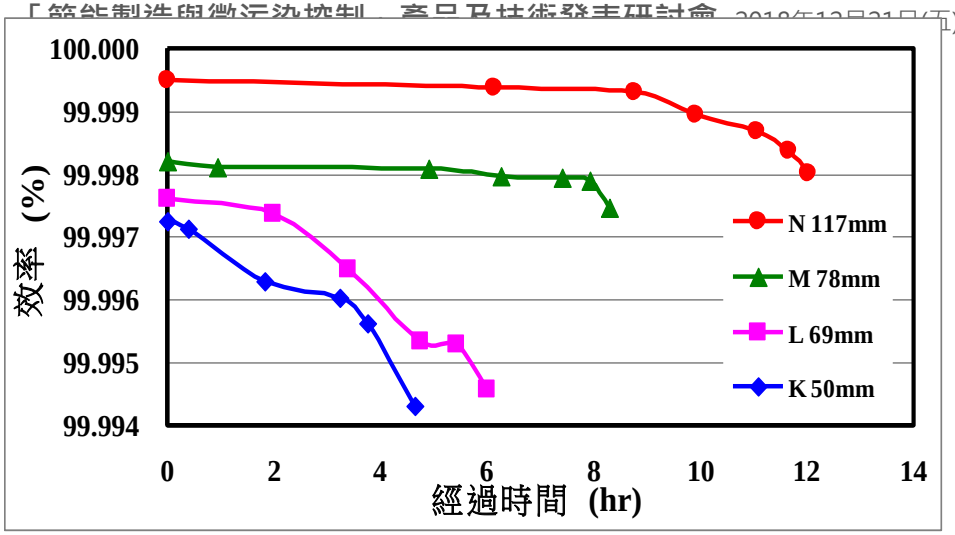
Dust holding capacity vs. Test time (Case H ~ Case J)

Dust holding capacity (Case E ~ Case J)

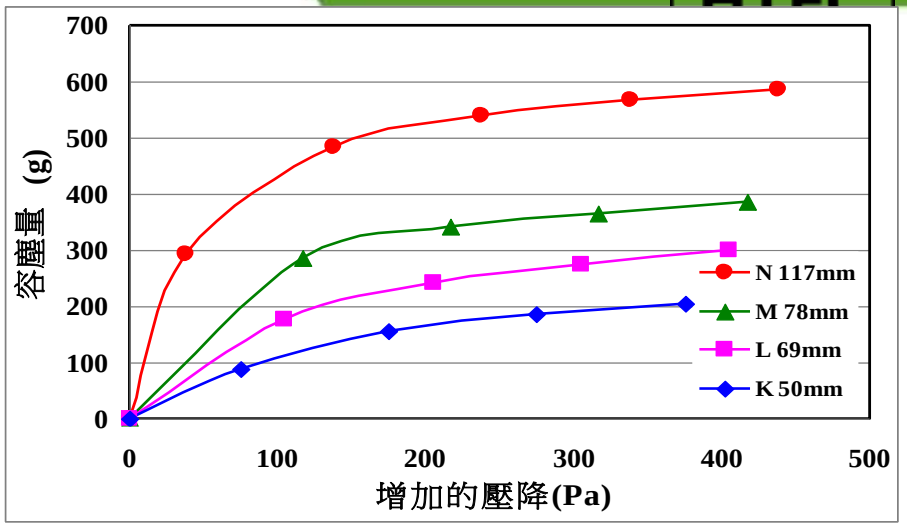


Different wind speed dust holding capacity of the time diagram

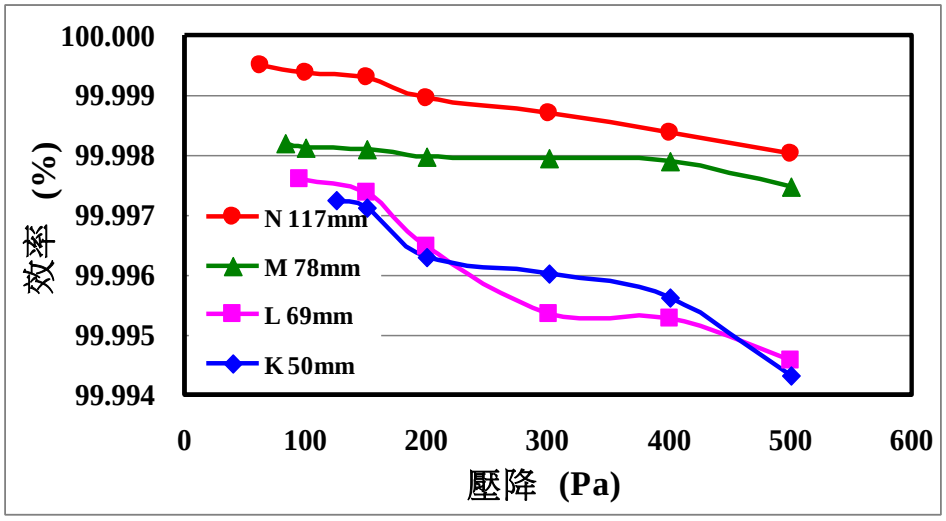
case	Dust(g)
E	310
F	308
G	308
H	288.5
I	280
J	277



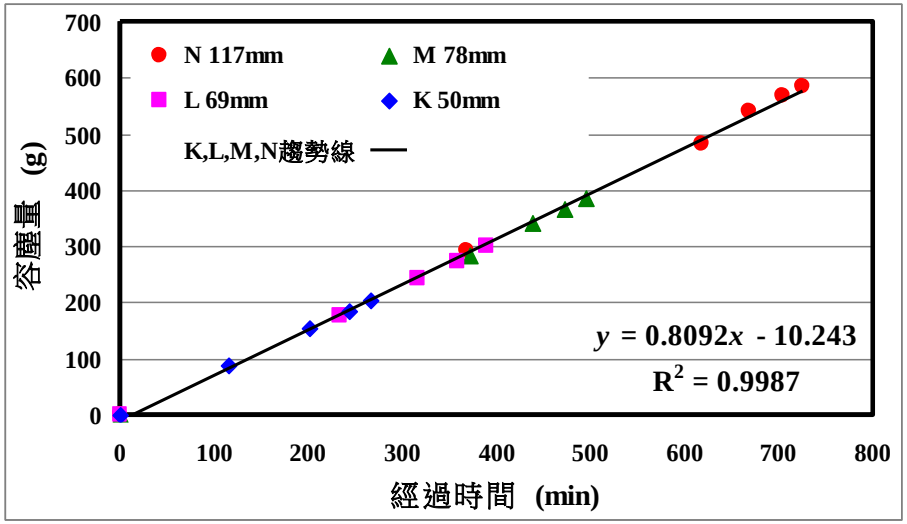
Test time vs. Filter efficiency
(Case K ~ Case N)



Pressure drop vs. Dust holding capacity
(Case K ~ Case N)



Pressure drop vs. Filter efficiency
(Case K ~ Case N)



Test time vs. Dust holding capacity
(Case K ~ Case N)

Result and discussion

- The efficiency of HEPA filter increases with lower filter surface velocity.
- Increase the thickness of filter media pack can reduce the pressure drop and increase the dust holding capacity (DHC).
- In extreme condition, the penetration rate of HEPA filter will increase due to the higher pressure drop.