Air Quality Control

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Cyclones

- ✓ can be used for 50-100 μm size particles and down to 10 μm
- ✓ simple economical unit:
  - no moving parts
  - relies on inertial effects

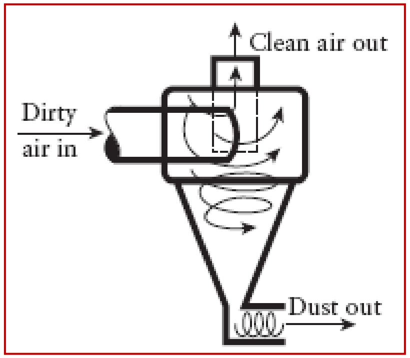
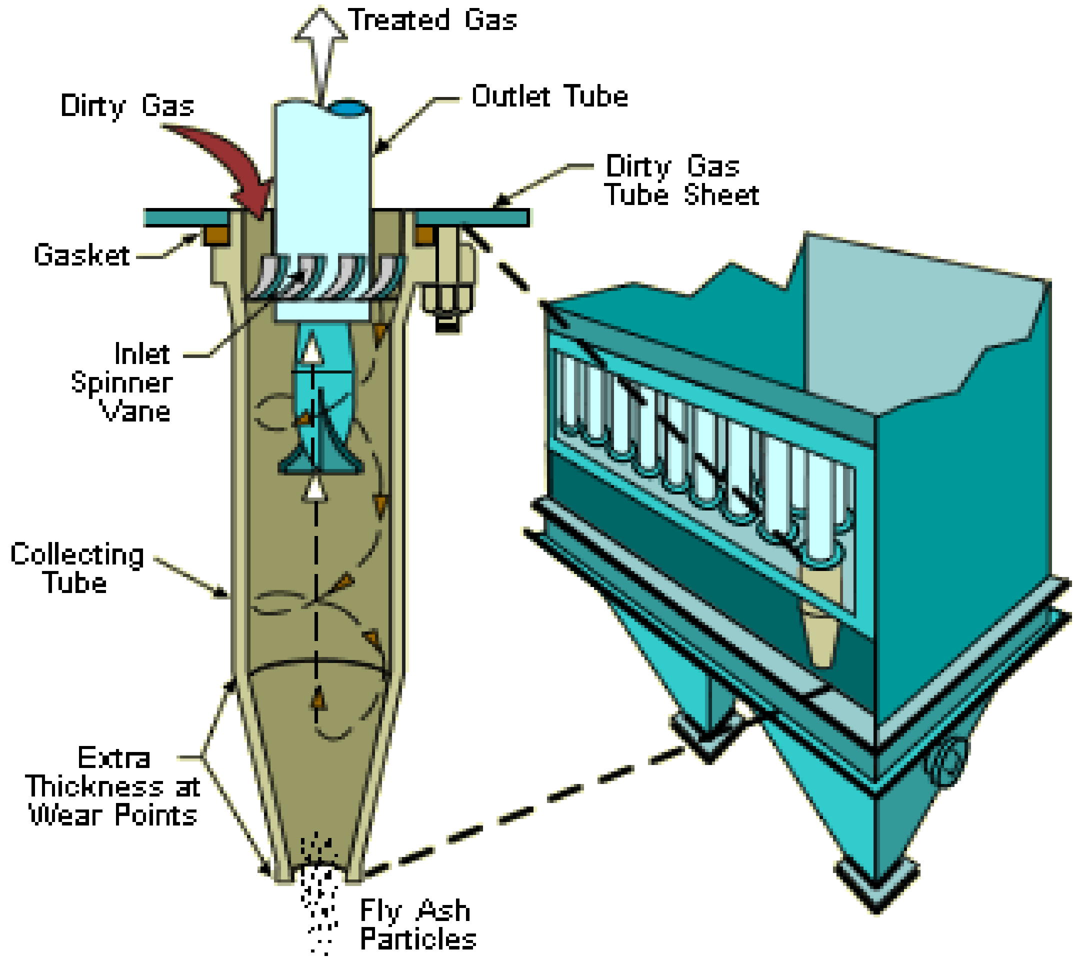
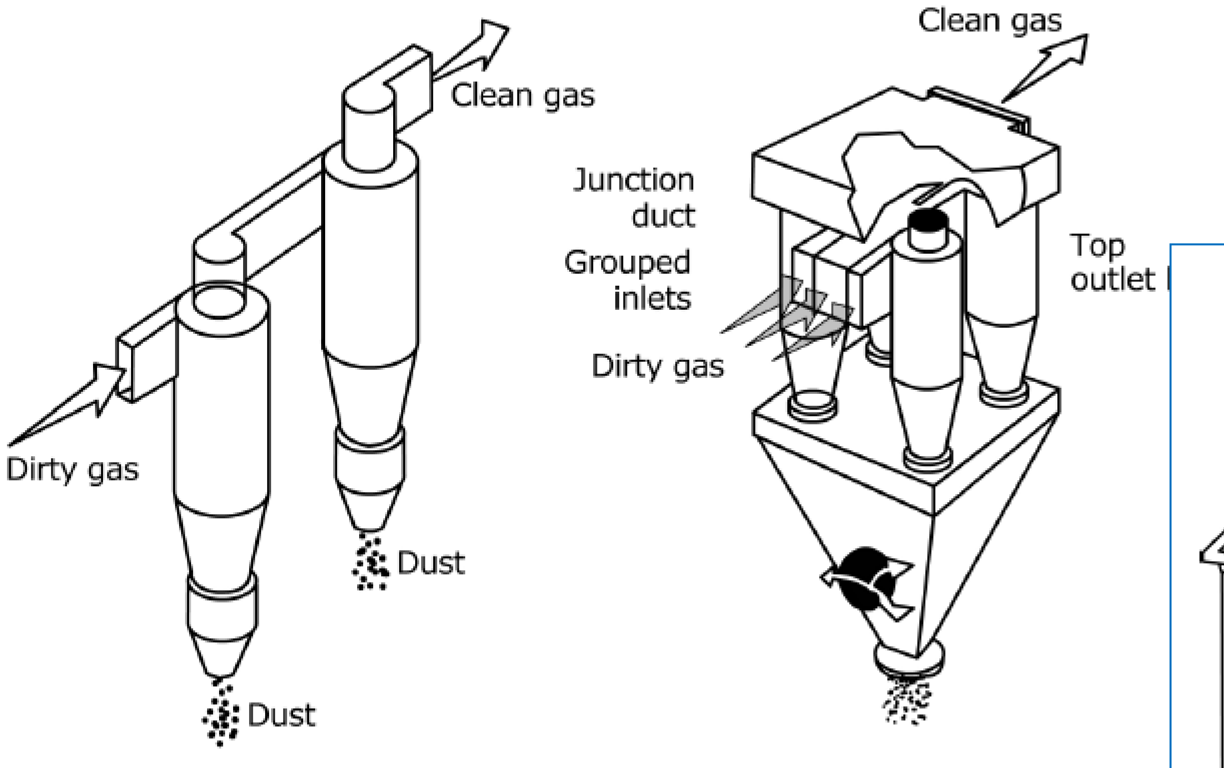


Figure 2. Small-Diameter Multi-Cyclone Collector





A. two cyclones in series

B. Four cyclones in parallel

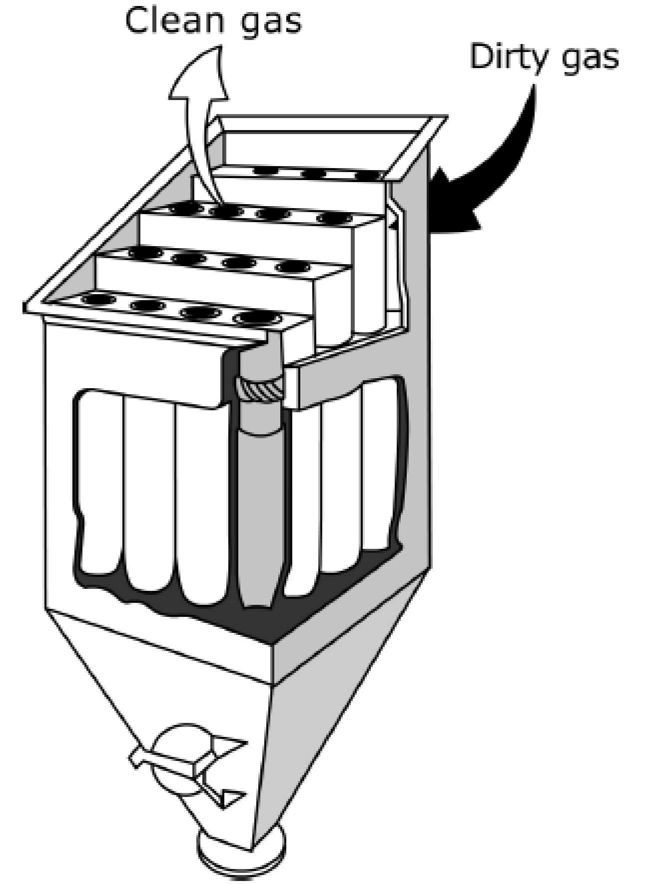


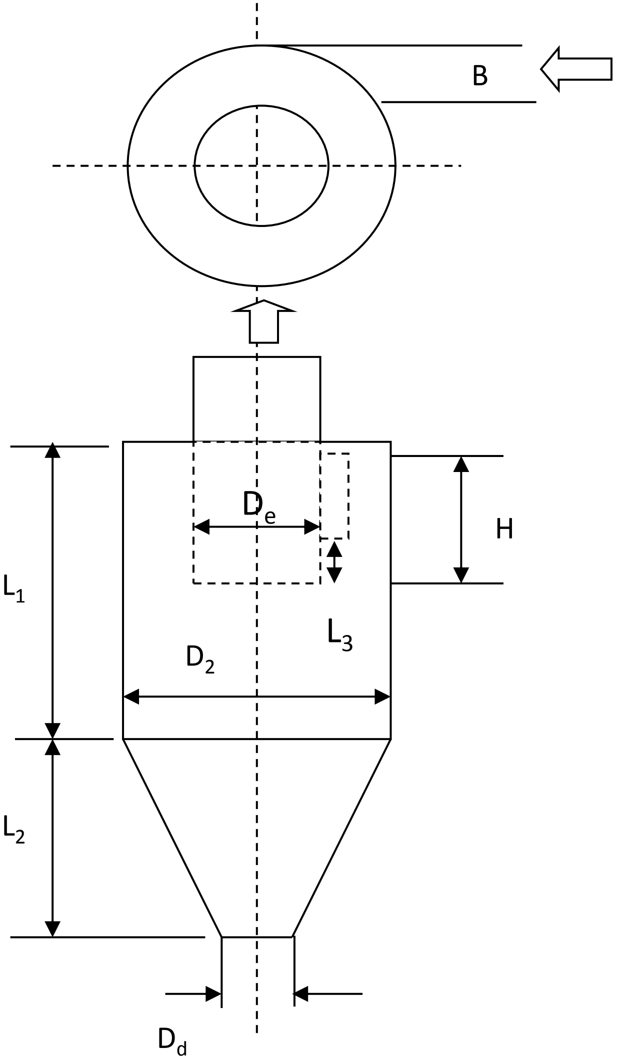
Figure 6-7. Multi-cyclone collector

For particle sizes greater than about 10 µm in diameter, the collector of choice is the cyclone

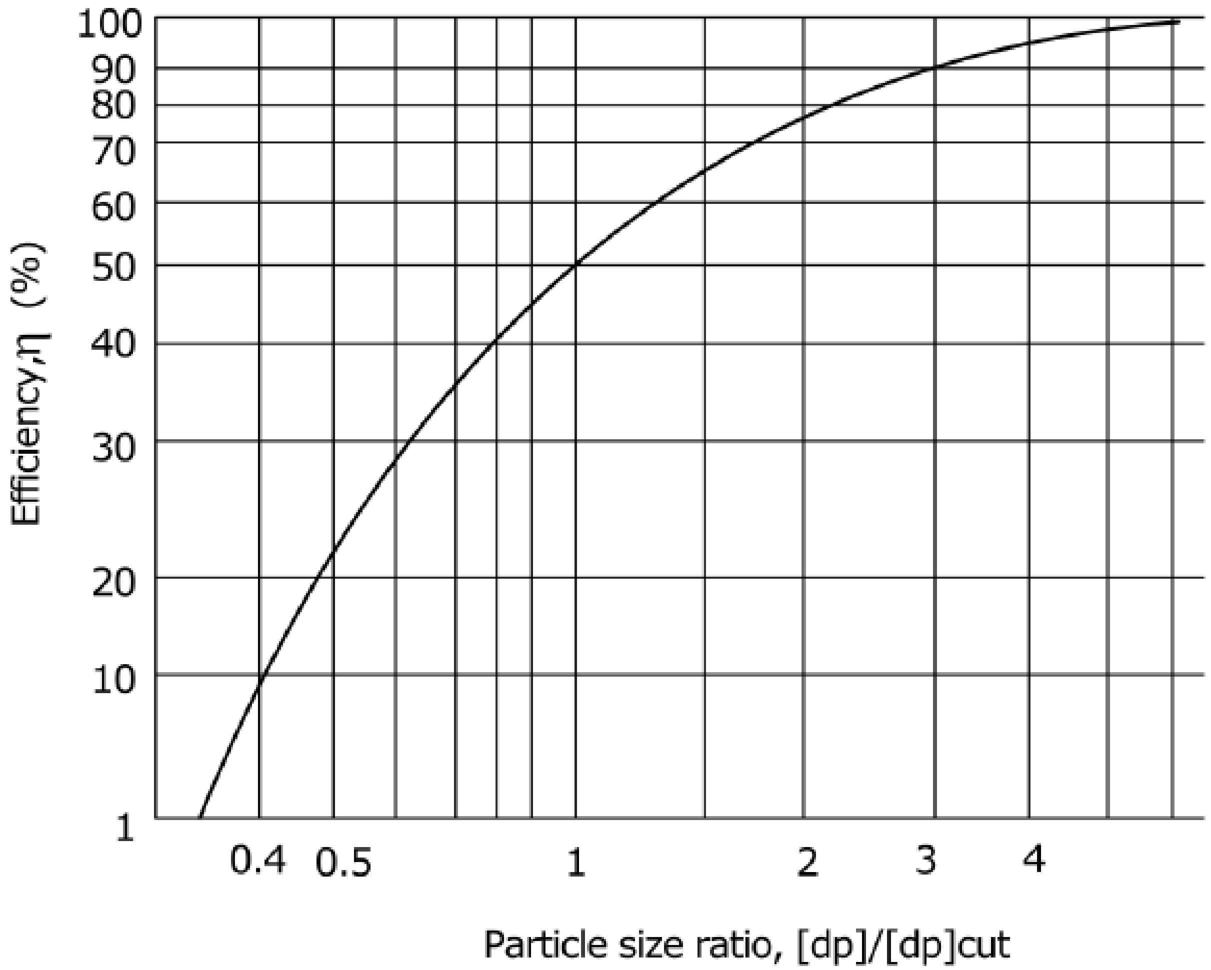
The particle size collected with 50% efficiency, termed the cut diameter:

$$d_{0.5} = \left[\frac{9 \mu B^2 H}{\rho_p Q_g \theta} \right]^{1/2}$$

$$\theta = \frac{\pi}{H}\left(2L_1 + L_2\right)$$



$d_{0.5}$ = cut diameter at 50% removal
μ = dynamic viscosity of gas, Pa-s
B = width, m
H = height, m
ρ_p = particle density, kg/m3
Q_g = gas flow rate, m3/s
θ = effective number of turns


100
90
80
70
60
50
40
30
20
10
1
Efficiency,η (%)
0.4
0.5
1
2
3
4
Particle size ratio, [dp]/[dp]cut

Example

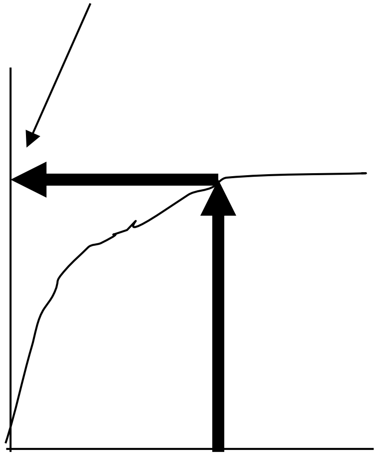
Given:
$D_2 = 0.5$ m
$Q_g = 4\ m^3/s$
T = 25 °C
$\rho_p = 800\ kg/m^3$

For standard Cyclone:
$B = 0.25\ D_2 = 0.13$ m
$H = 0.5\ D_2 = 0.25$ m
$L_1 = L_2 = 2\ D_2 = 1$ m

$$\theta = \frac{\pi}{0.25}\left(2(1)+1\right) = 37.7$$

Q = What is the removal efficiency for particles with ave diameter of 10 μm?

$\eta = 0.95$



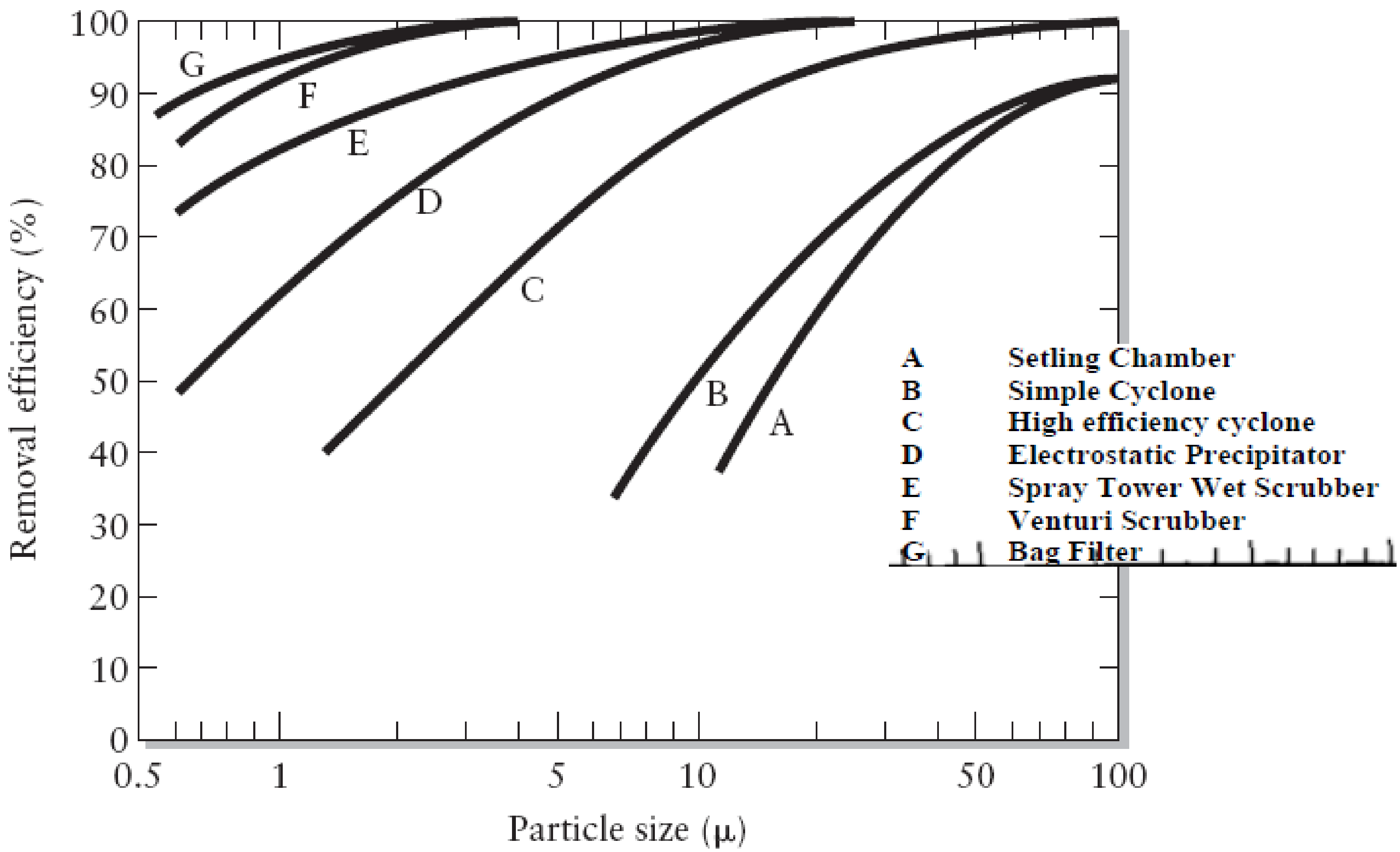
$$d_{0.5} = \left[\frac{9(18.5x10^{-6})(0.13)^2(0.25)}{(800)(4)(37.7)}\right]^{0.5} = 2.41x10^{-6}$$

$$= 2.41(\mu m)$$

@ d =10 μm

$$\frac{d}{d_{0.5}} = \frac{10}{2.41} = 4.15$$

Comparison of Air Pollution Control Devices



Effectiveness of Air Pollution Control Devices