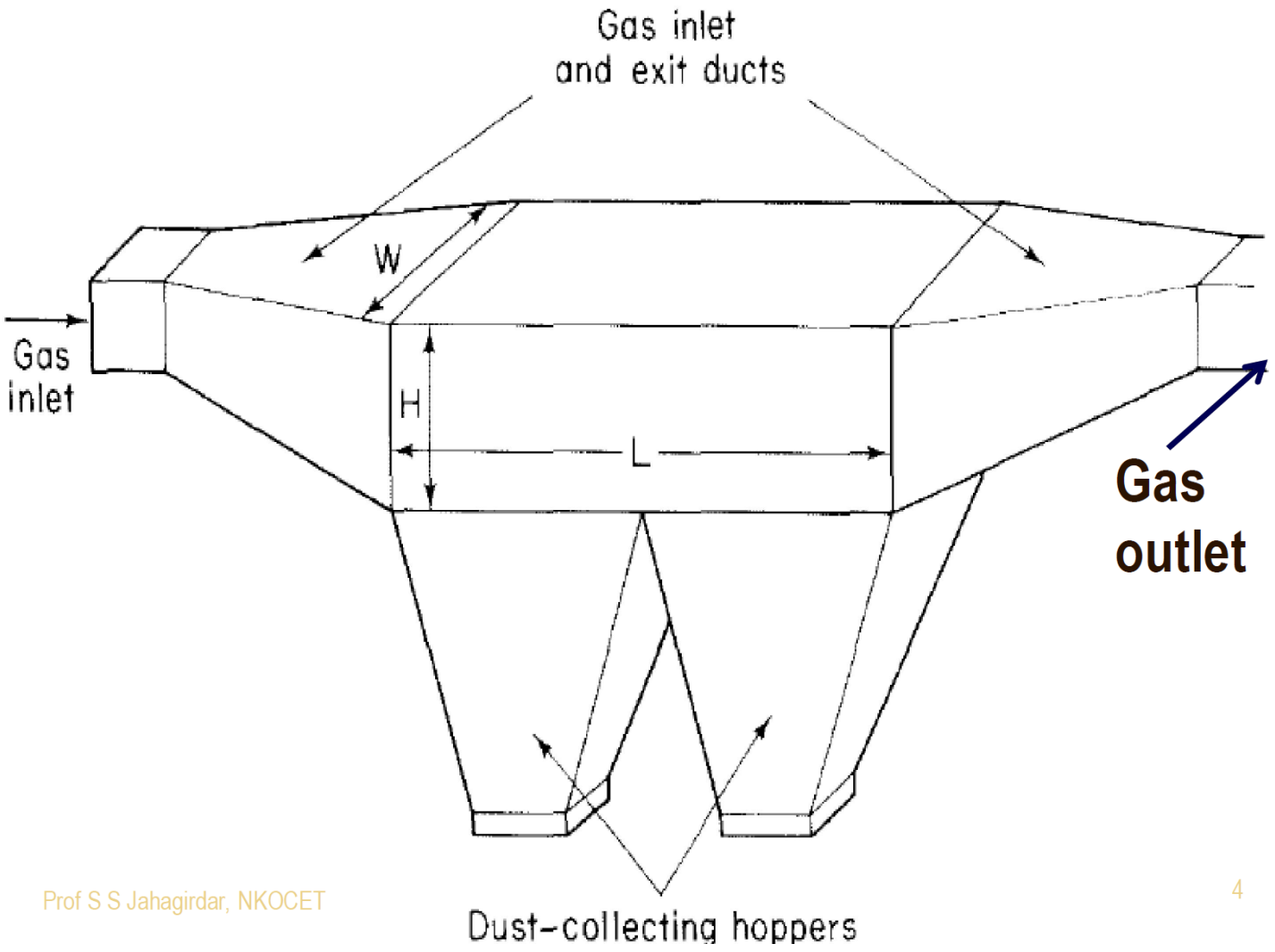
GRAVITY CHAMBER SETTLING

General concepts

- Gravity settling chamber is used to remove **large** and abrasive particles greater than 50 μm from a gas stream.
- This is a **simple particulate** collection device using the principle of gravity to settle the particulate matter in a gas stream passing through its long chamber.
- The primary requirement of such a device would be a chamber in which the carrier gas velocity is reduced so as to allow the particulate matter to settle out of the moving gas stream under the action of gravity.
- This particulate matter is then collected at the bottom of the chamber.
- The chamber is cleaned manually to dispose the waste.

Operating principles



Operating principles and design parameters

- The gas velocities in the settling chamber must be sufficiently low for the particles to settle due to gravitational force.
- Literature indicates that gas velocity less than about 3 m/s is needed to prevent re-entrainment of the settled particles. The gas velocity of less than 0.3 m/s will produce good results.

- For 100 % efficiency

$$t = \frac{H}{v_t} = \frac{L}{v_H}$$

Where,
H= height of settling chamber
L = Length of settling chamber
V_t = Velocity of settling
V_H = velocity of flow

$$v_t = \frac{Cu\, d_p^2\, \rho_p\, g}{18\mu}$$

Operating principles and design parameters

$$\frac{v_H \cdot H}{L} = \frac{g \cdot {d_p}^2 \cdot \rho_p}{18 \cdot \mu}$$

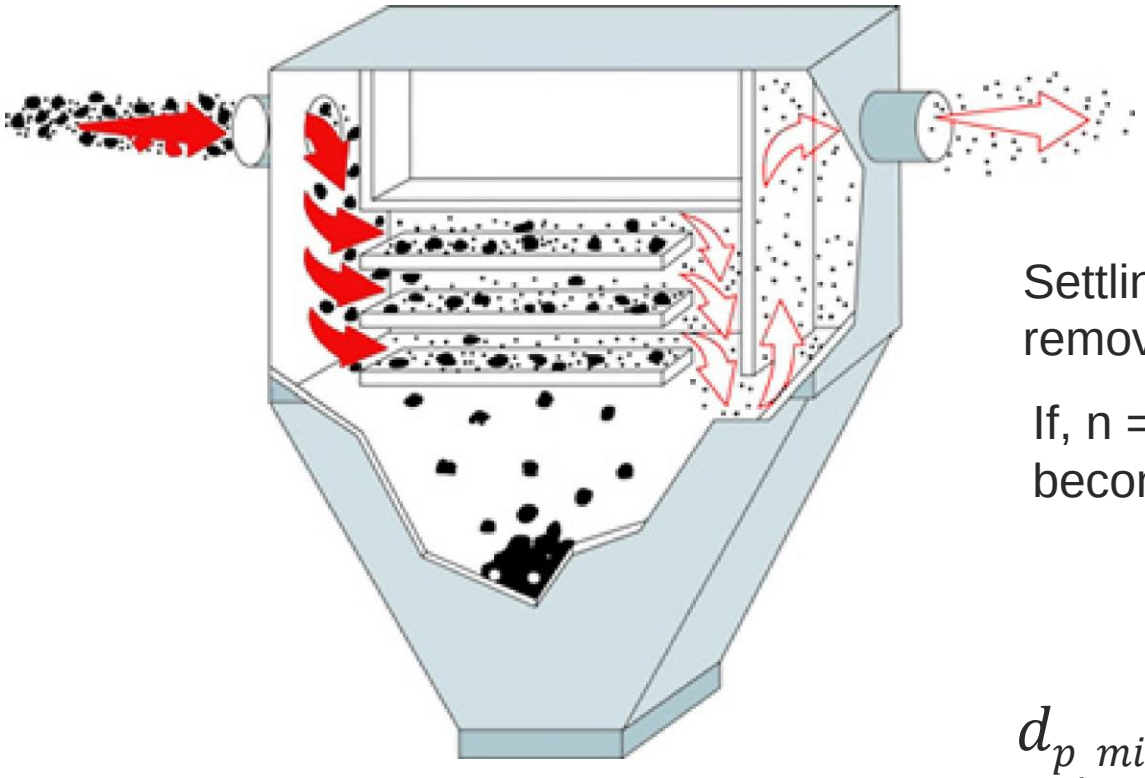
Therefore,

$$d_{p,\,min} = \sqrt{\frac{18 \cdot \mu \cdot v_H \cdot H}{g \cdot L \cdot \rho_p}}$$

$d_{p,min}$ is min size of particle that can be removed with 100 % efficiency. For better and conservative results multiplying factor 2 can be taken to define $d_{p,min}$

$$d^{*}_{p,\,min} = \sqrt{\frac{2 \cdot 18 \cdot \mu \cdot v_H \cdot H}{g \cdot L \cdot \rho_p}}$$

Gravity chamber settling with trays



Settling trays can be used to improve removal efficiency.

If, n = number of trays, then equation becomes

$$d_{p,\,min} = \sqrt{\frac{18 \cdot \mu \cdot v_H \cdot H}{n \cdot g \cdot L \cdot \rho_p}}$$

Advantages and disadvantages

ADVANTAGES

- Low initial cost
- Simple construction
- Low maintenance cost
- Low pressure drop
- Dry and continuous disposal of collected solids
- Can be constructed of any material
- Temperature and pressure limitations are imposed by type of material used

DISADVANTAGES

- Large space requirement
- Only comparatively large particles can be collected

Exercise

Calculate the minimum size of the particle that will be removed with 100 percent efficiency (theoretically) from a settling chamber under the following conditions:

- Viscosity of air is $2.1*10^{-5}$ kg/m*s
- Horizontal velocity is 0.3 m/s;
- Temperature is 77°C;
- Particulate density is 2000 kg/m^3
- Chamber: lenght is 7.5 m; height is 1.5 m.