L-27
Bag house filter (Fabric filter)

Air Pollution and Control
(Elective-I)

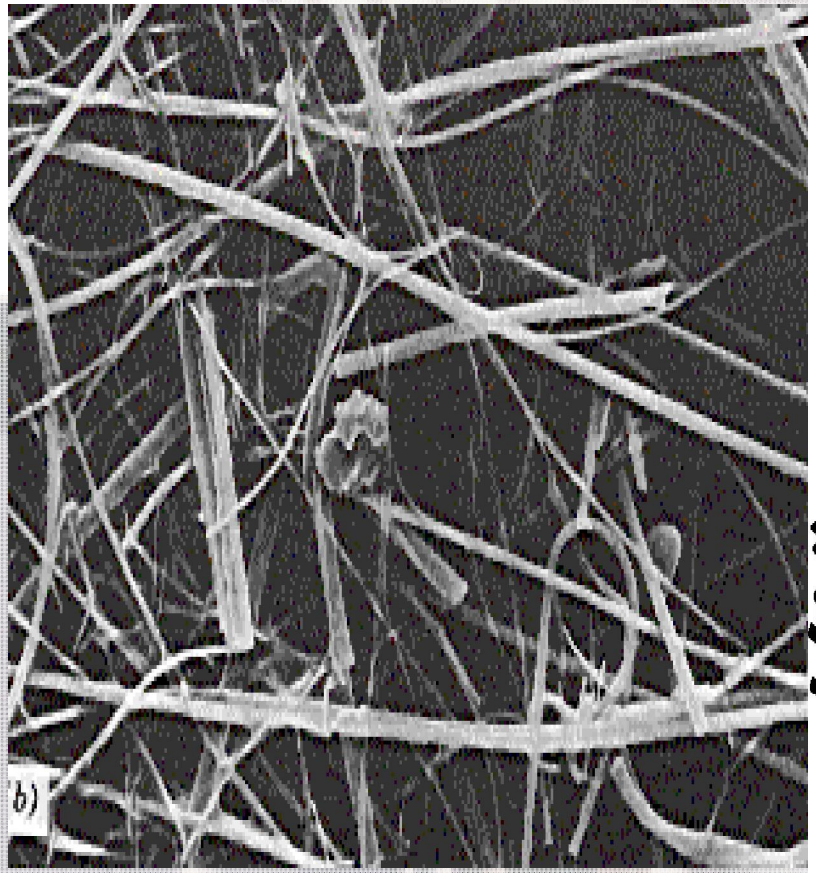
Fabric Filters (Bag house filter)

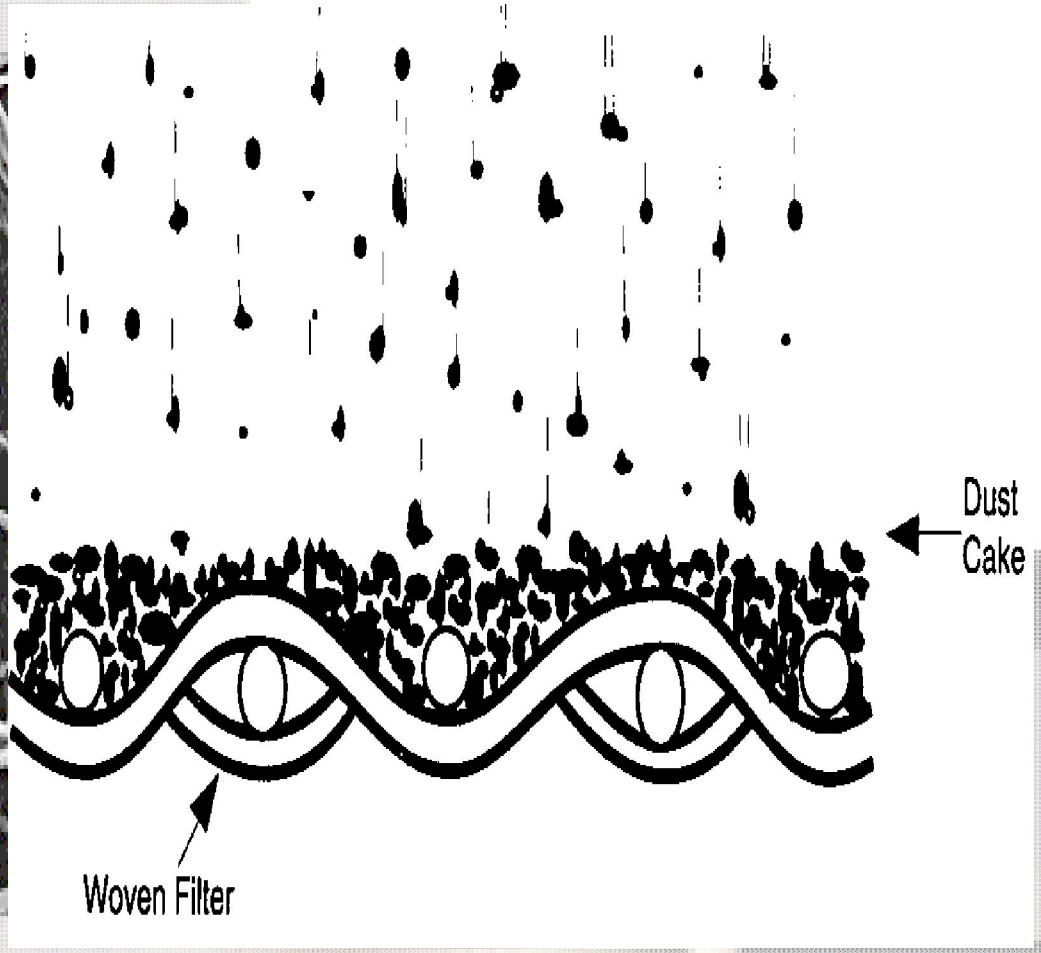
- Fabric filtration is one of the most common techniques to collect particulate matter from industrial waste gases.
- The use of fabric filters is based on the principle of filtration, which is a reliable, efficient and economic methods to remove particulate matter from the gases.
- The air pollution control equipment using fabric filters are known as **bag houses**.

- The high efficiency of these collectors is due to the dust cake formed on the surfaces of the bags.
- The fabric primarily provides a surface on which dust particulates collect through the following four mechanisms:
- **Inertial Collection** - Dust particles strike the fibers placed perpendicular to the gas-flow direction instead of changing direction with the gas stream.
- **Interception** - Particles that do not cross the fluid streamlines come in contact with fibers because of the fiber size.

FILTRATION

Fiber filter





- **Brownian Movement** - Submicron particles are diffused, increasing the probability of contact between the particles and collecting surfaces.
- **Electrostatic Forces** - The presence of an electrostatic charge on the particles and the filter can increase dust capture.
- A **combination of these mechanisms** results in formation of the dust cake on the filter, which eventually increases the resistance to gas flow.
- The filter must be cleaned periodically.

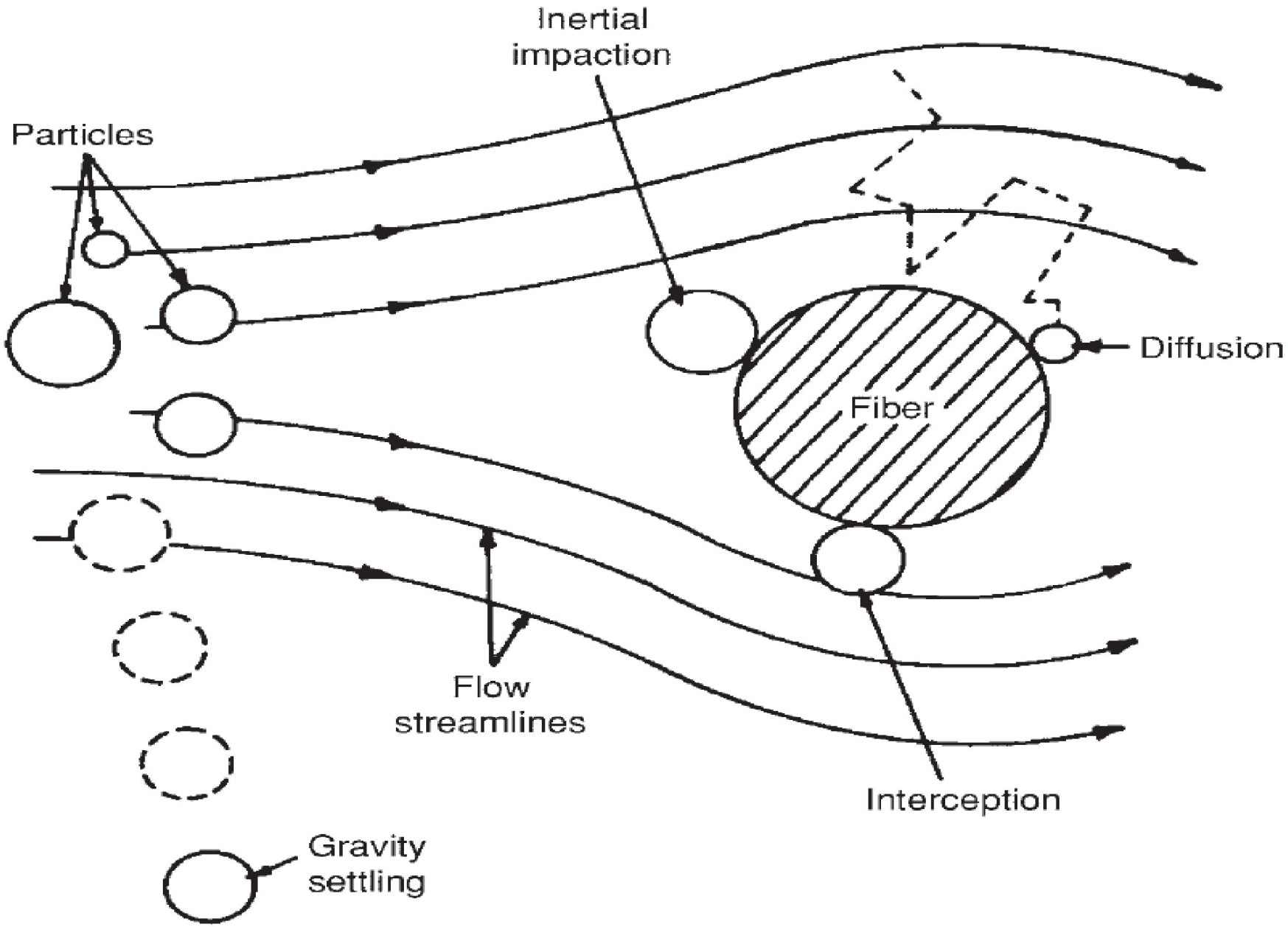
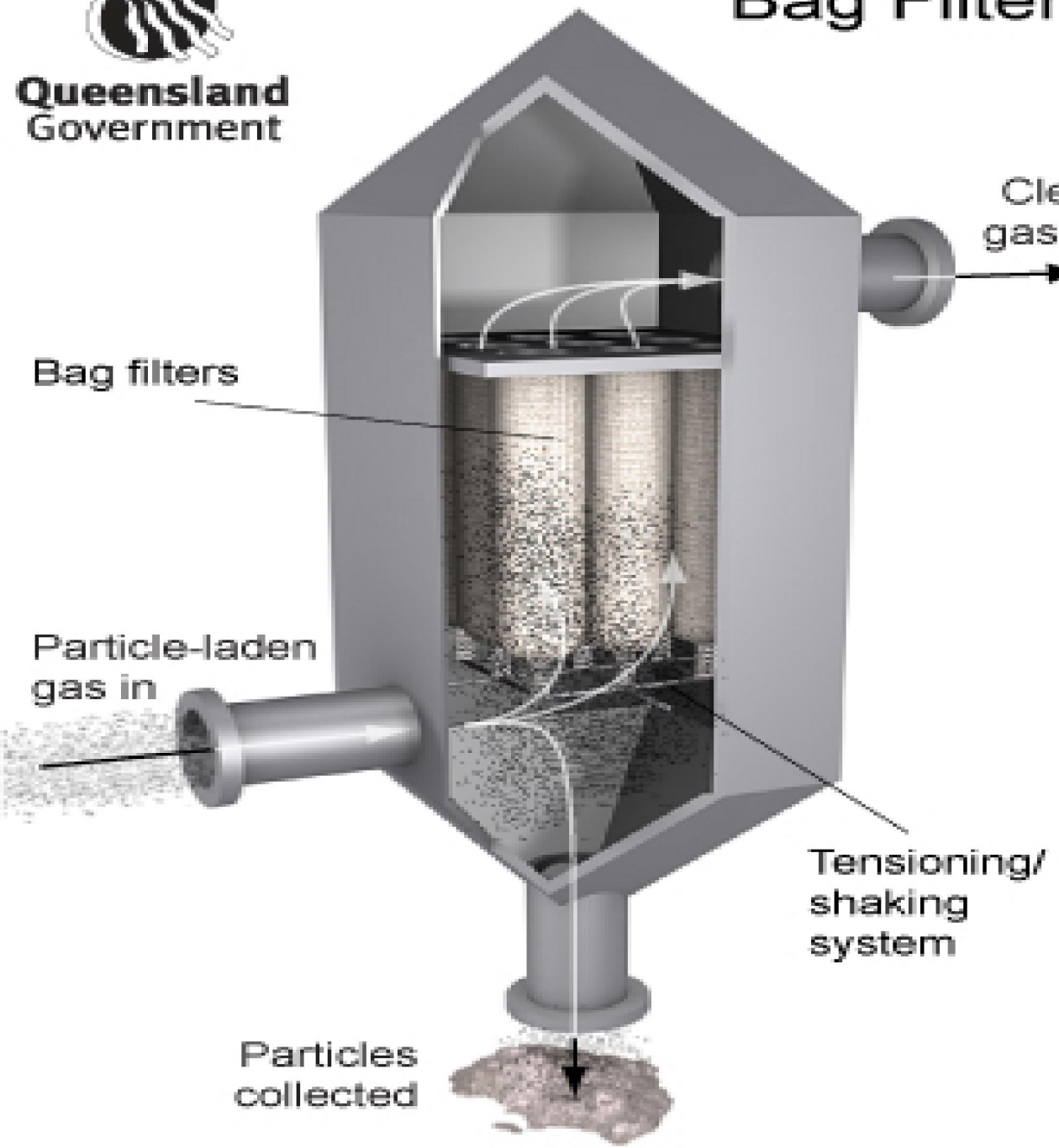
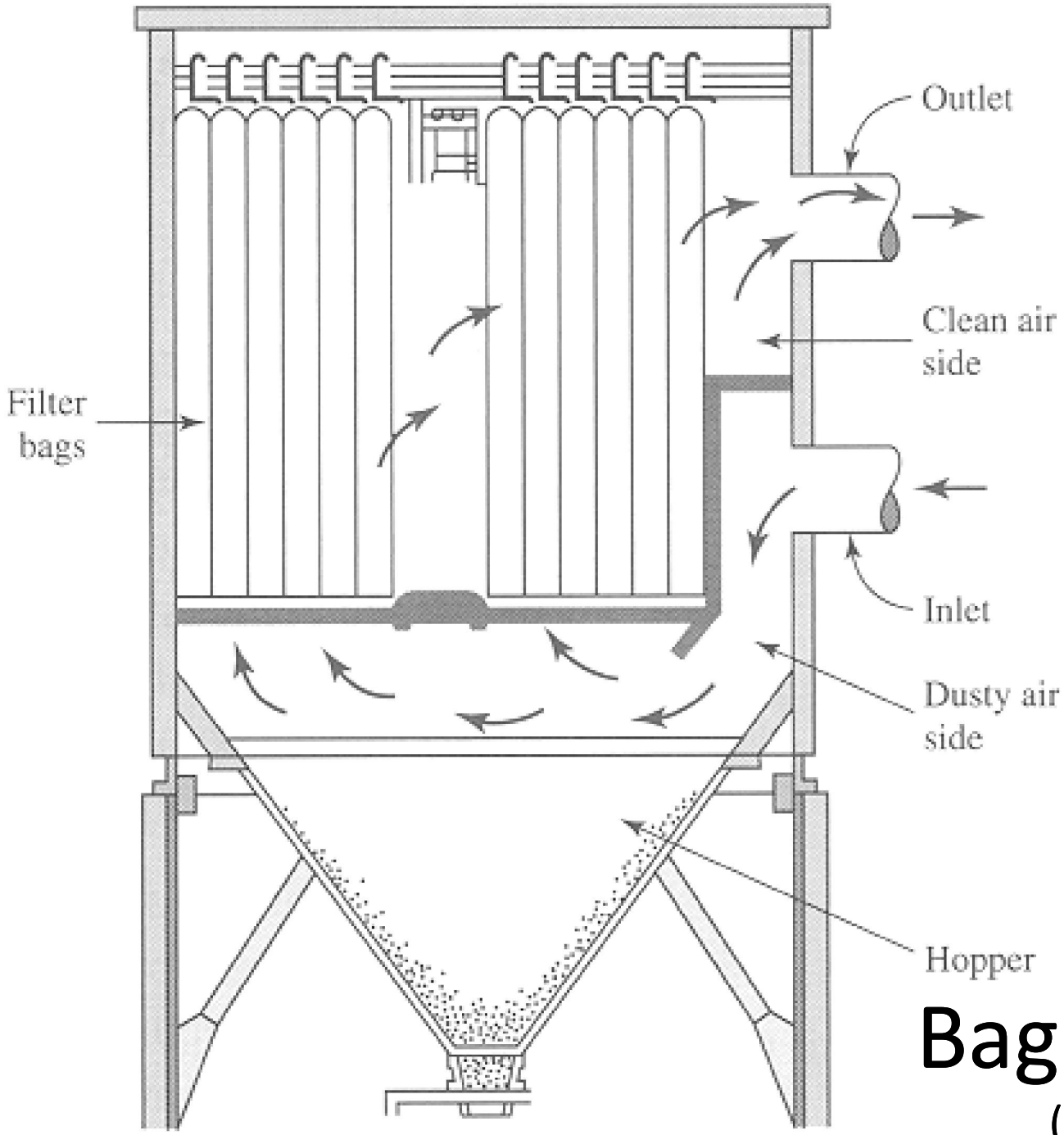


Fig. 2. Mechanisms for particle removal by a filter.

Queensland Government

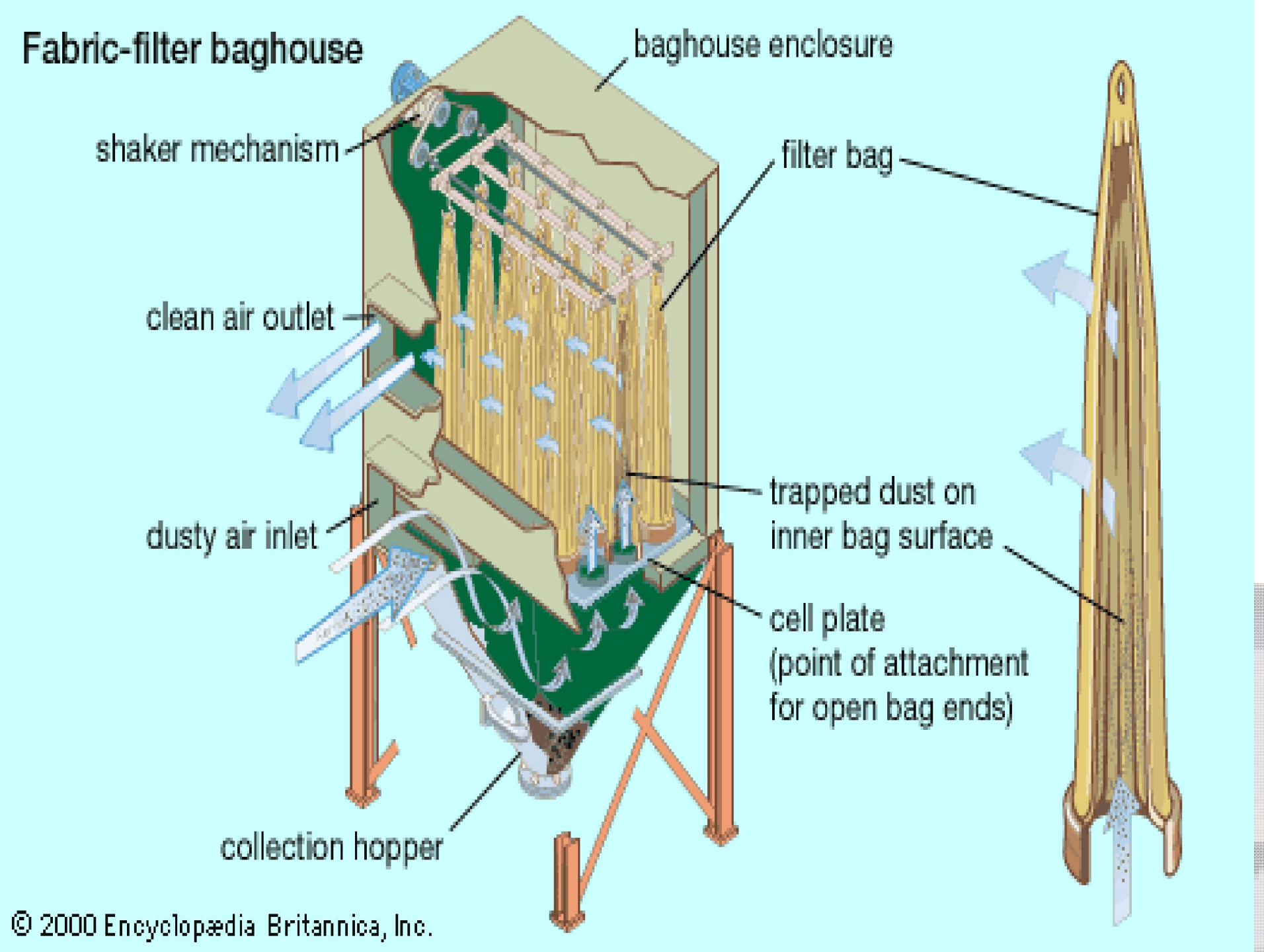
Bag Filter





Bag House Filter

(practice for exam)


Fabric-filter baghouse
baghouse enclosure
shaker mechanism
filter bag
clean air outlet
trapped dust on
inner bag surface
dusty air inlet
cell plate
(point of attachment
for open bag ends)
collection hopper
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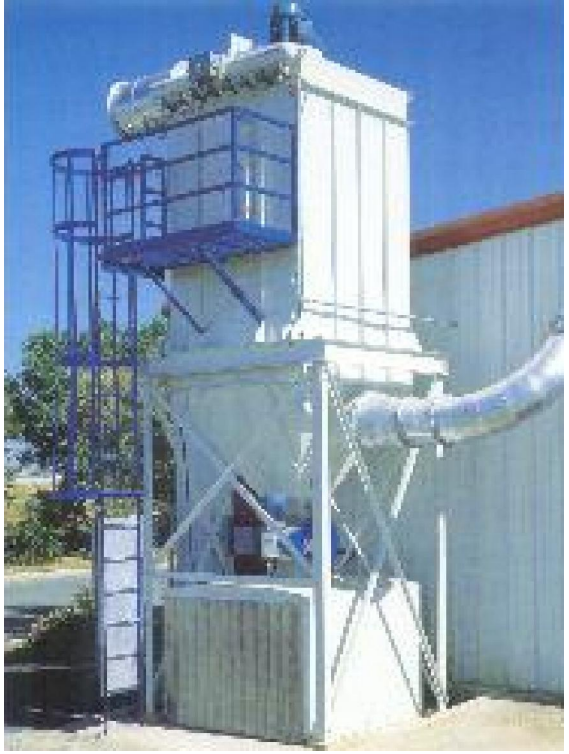
GRACE FILTER MFG



- A bag house or a bag filter consists of numerous vertically hanging, tubular bags, **12 to 40 cm in diameter and 2 to 10 m long.**
- They are suspended with their open ends attached to a manifold. The number of bags can vary from a few hundreds to a thousand or more depending upon the size of the bag house.
- Bag houses are constructed as single or compartmental units. In both cases, the bags are housed in a shell made of rigid metal material.

Filter Media

- Woven and felted materials are used to make bag filters.
- Woven filters are used with low energy cleaning methods such as shaking and reverse air.

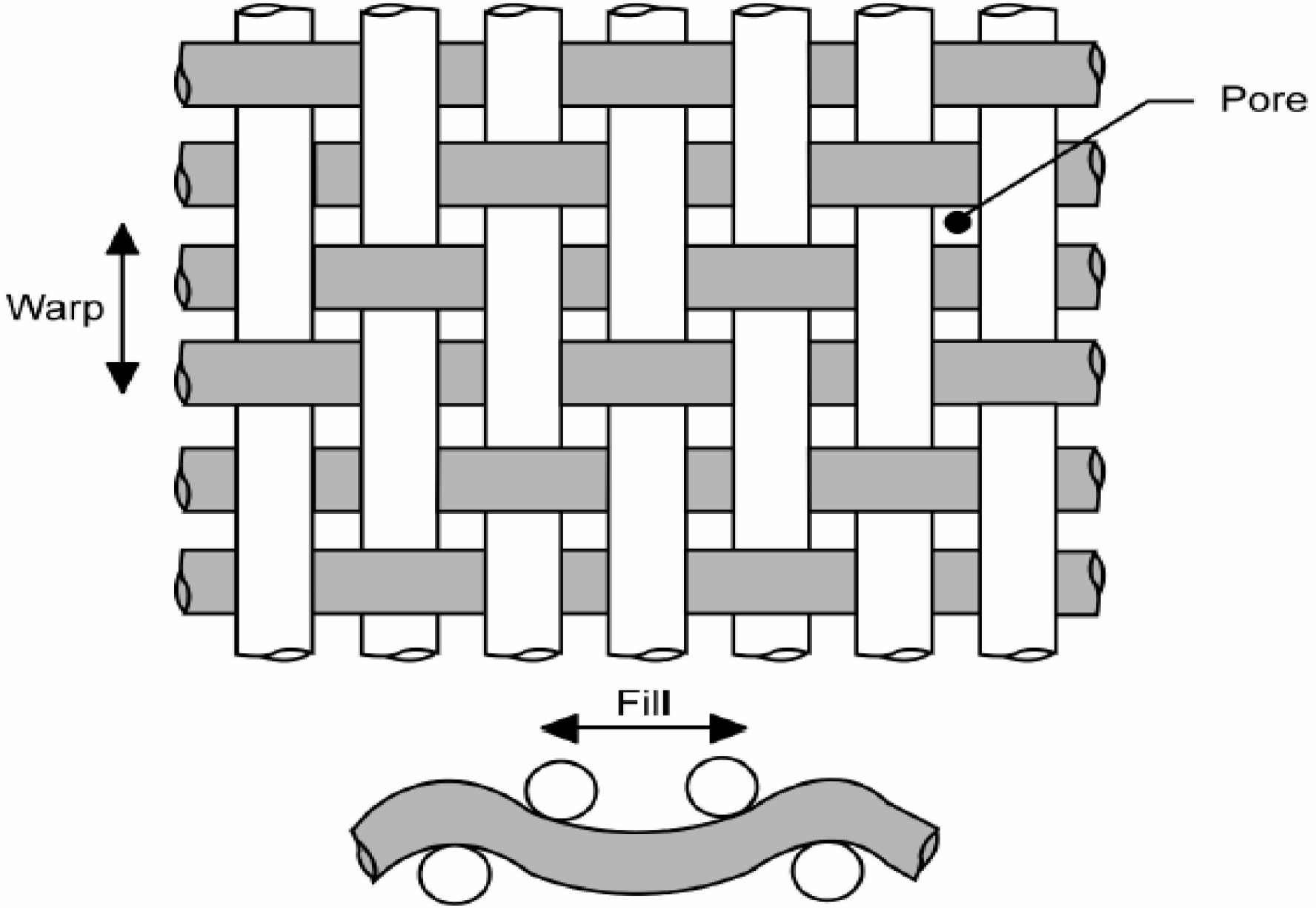


Figure 7-22. Woven fabric

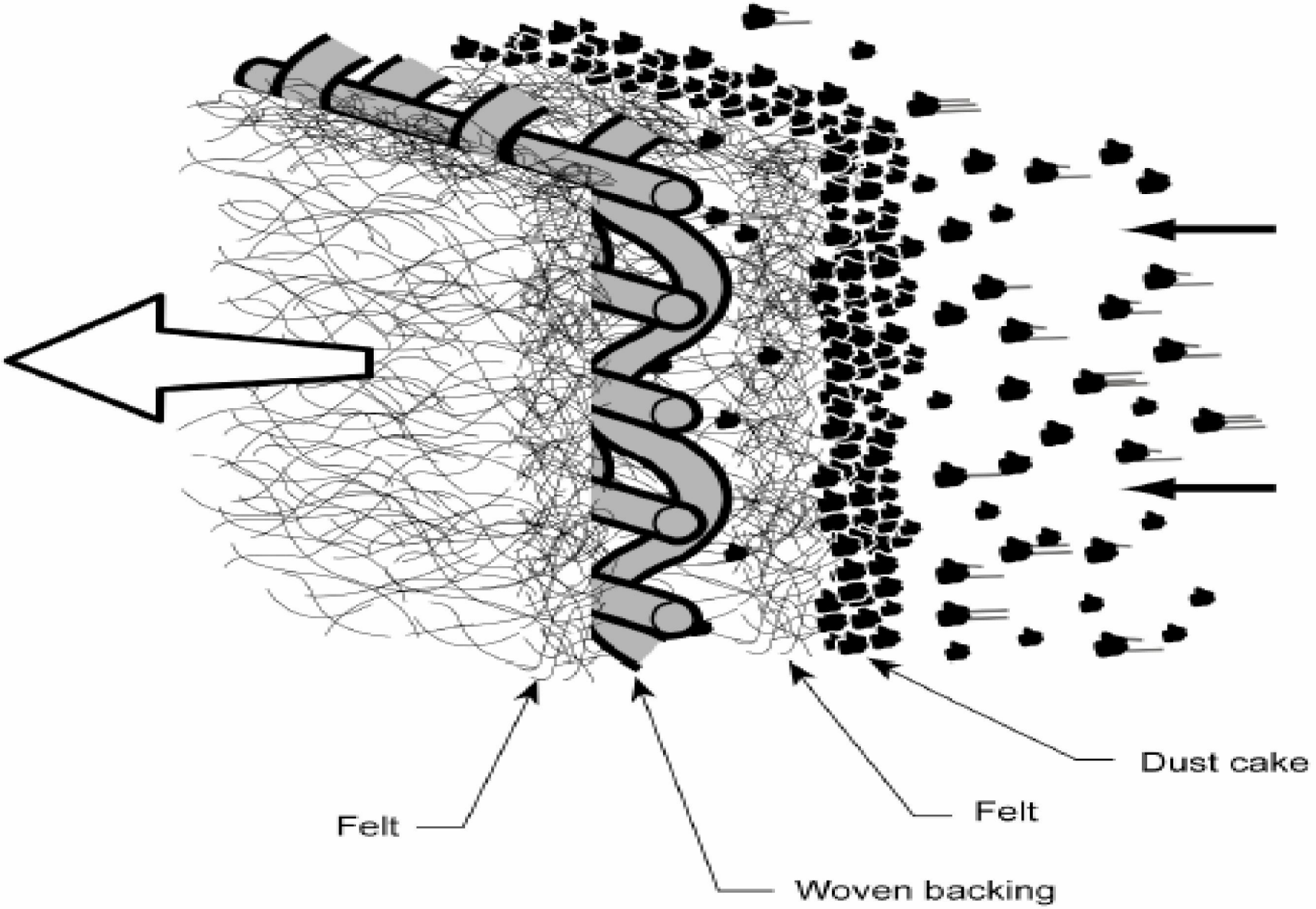


Figure 7-23. Felted fabric

- Felted fabrics are usually used with low energy cleaning systems such as pulse jet cleaning.
- While selecting the filter medium for bag houses, the characteristics and **properties of the carrier gas and dust particles** should be considered.
- *The properties to be noted include:*

  a) Carrier gas temperature

  b) Carrier gas composition

  c) Gas flow rate

  d) Size and shape of dust particles and its concentration

Properties of bag fabric

TABLE 13.2 *Physical Properties of Some Common Bag Fabrics*

Fabric	Maximum continuous operating temperature	Acid resistance	Alkali resistance	Flex abrasion resistance	Tensile strength kg/cm²
Cotton	82°C	Poor	Good	Very good	4920
Wool	93°C	Very good	Poor	Fair to good	1755
Nylon	93°C	Poor to fair	Excellent	Excellent	5625
Dacron	135°C	Good	Good	Very good	5625
Polypropylene	93°C	Excellent	Excellent	Excellent	7730
Fibre glass	290°C	Fair to good	Fair to good	Fair	14,060

Operation of a bag house

- The gas entering the inlet pipe strikes a baffle plate, which causes larger particles to fall into a hopper due to gravity.
- The carrier gas then flows upward into the tubes and outward through the fabric leaving the particulate matter as a "cake" on the insides of the bags.

Bag house design

1. Air-to-Cloth Ratio :-

The volume of gas flow passed per unit area of the bag i.e.

Air to cloth = Volume of gas flow (Q)/ Area (A) of bag ratio

(Typical value 0.010 to 0.020 m/sec-for shaker type)

2. **Net area of bags of bags = Q/Air to cloth ratio**

3. **Area of one bag = ∏ x D x L**

L=length of bag

D= Dia of bag

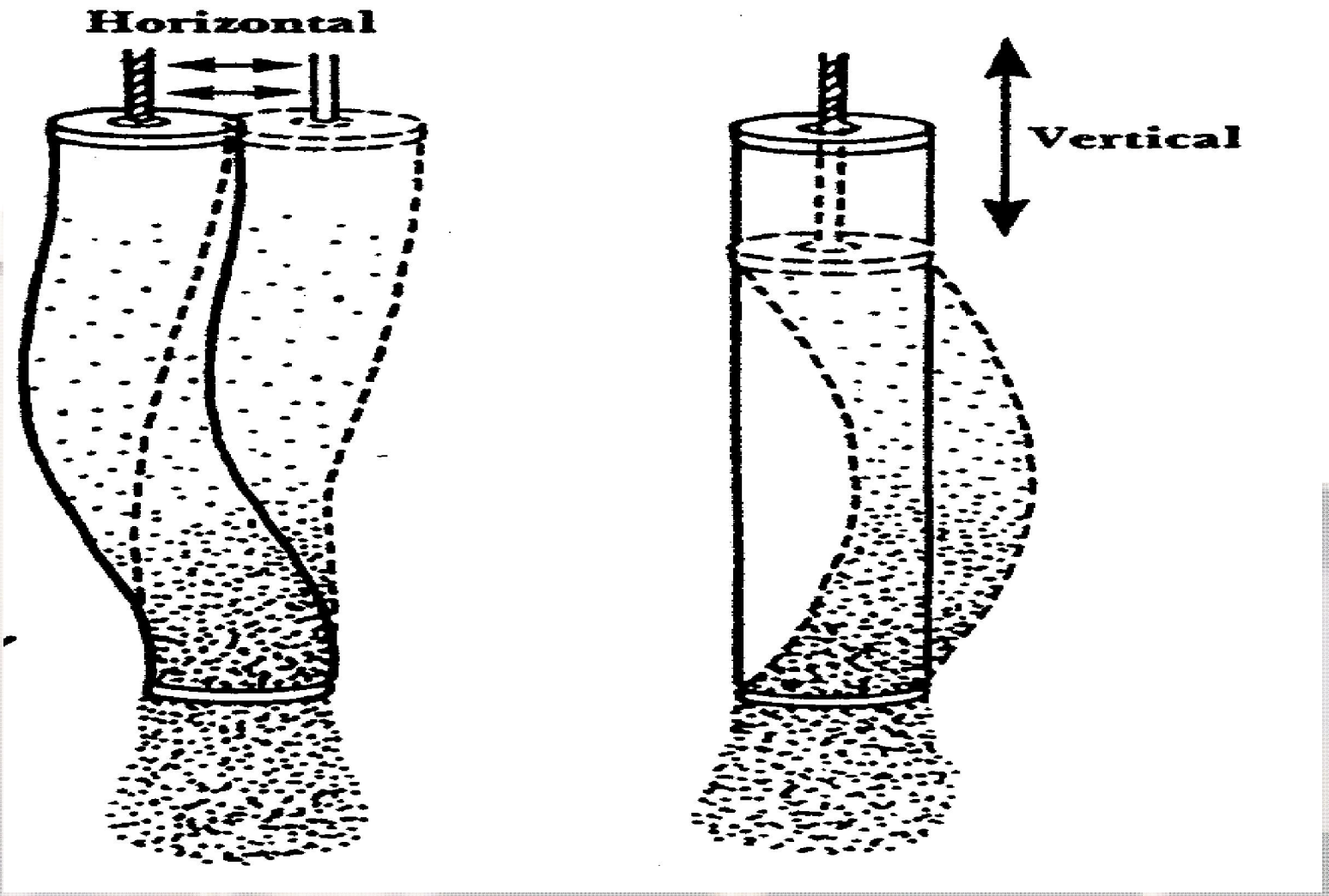
4. **No of bags = Net area / area of one bag**

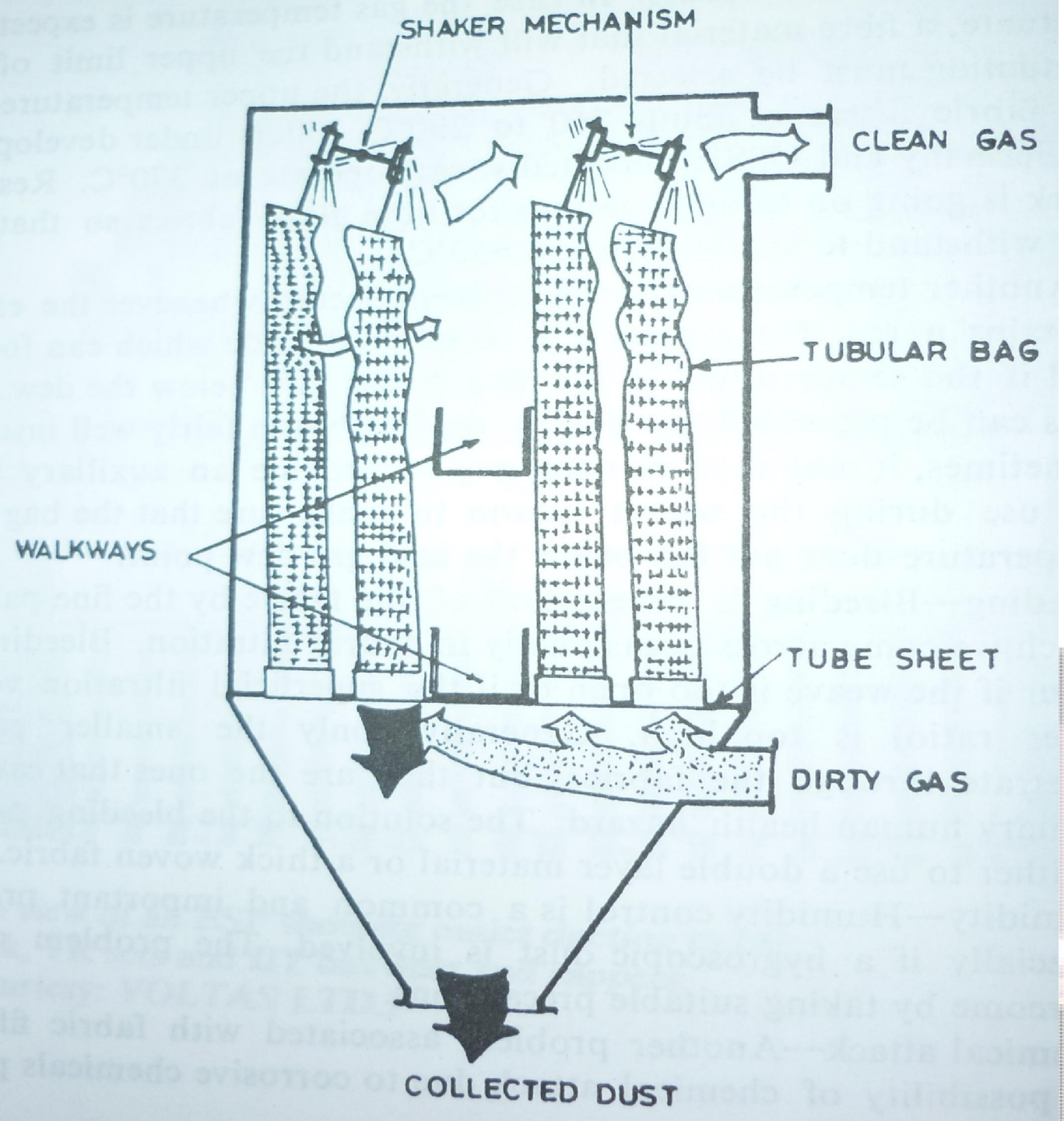
Filter cleaning mechanisms

- The following mechanisms are used for cleaning the filters in a bag house:

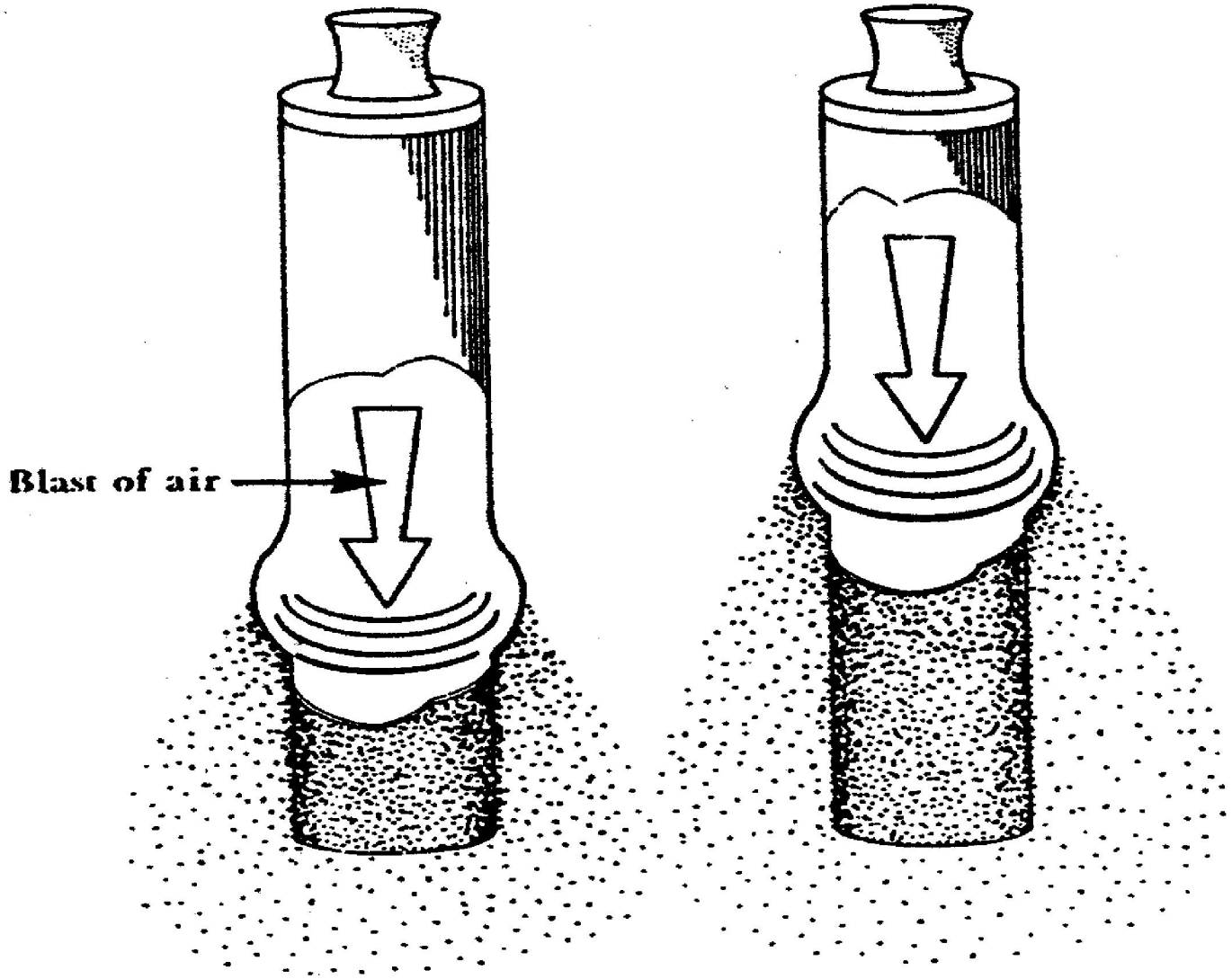
i) **Rapping**
ii) **Shaking**
iii) **Reverse air flow (back wash)**
iv) **Pulse jet**

Mechanical cleaning (Shaking)




SHAKER MECHANISM
CLEAN GAS
TUBULAR BAG
WALKWAYS
TUBE SHEET
DIRTY GAS
COLLECTED DUST

Pulse jet



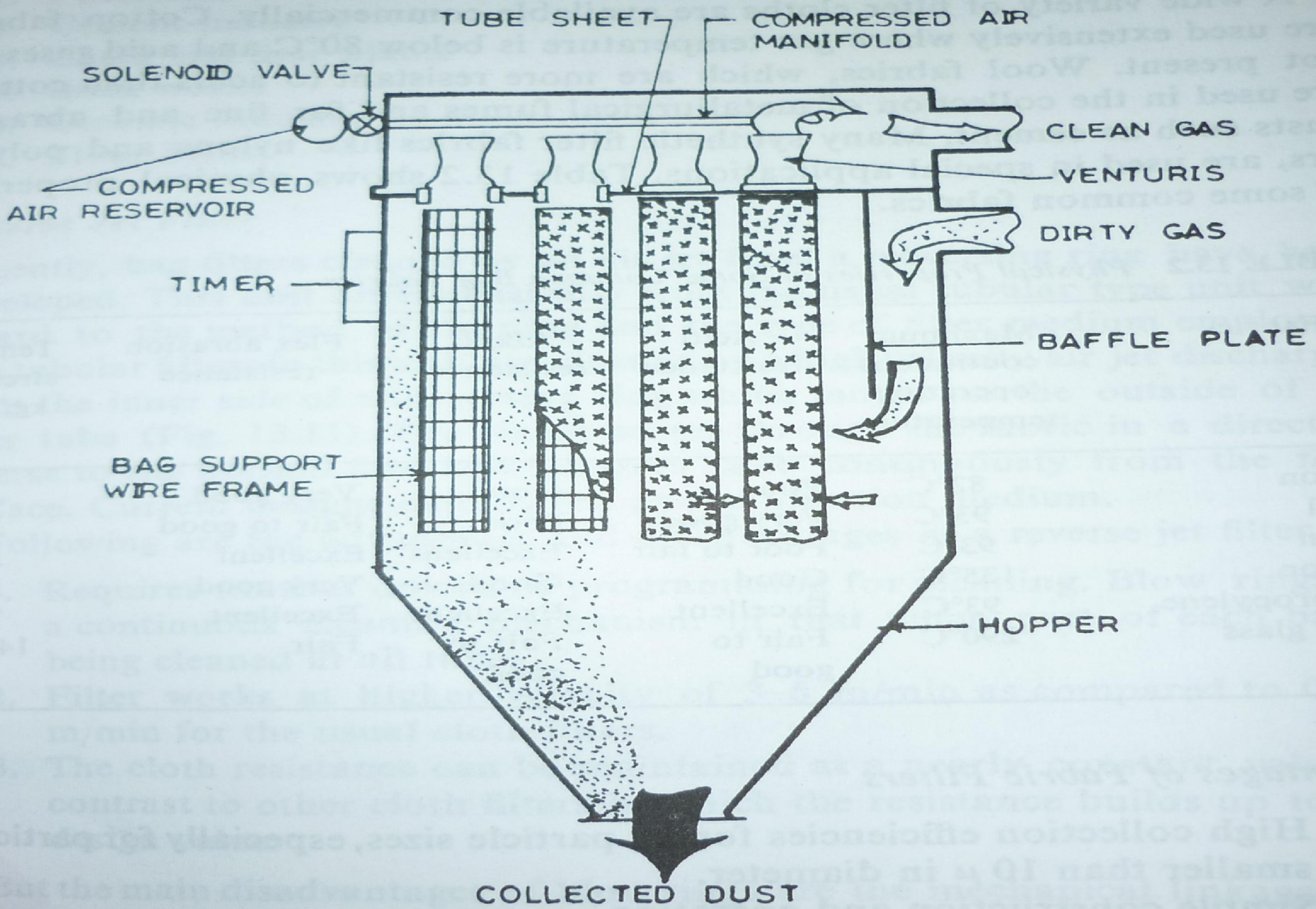


Fig. 13.10 *Filter cleaning using pulse jet*

Advantages

i) High collection efficiencies for all particle sizes, especially for particles smaller than 10 micron in diameter.

ii) Simple construction and operation.

iii) Nominal power consumption.

iv) Dry disposal of collected material.

Disadvantages

i) Operating limits are imposed by high carrier gas temperatures, high humidity and other parameters.

ii) High maintenance and fabric replacement costs. Bag houses are difficult to maintain because of the difficulty in finding and replacing even a single leaking bag. Also as general rule, about 1/4th of the bags will need replacement every year.

iii) Large size of equipment.

iv) Problems in handling dusts which may abrade, corrode, or blind the cloth.

Operating Problems

a) Cleaning -

At intervals the bags get clogged up with a covering of dust particles that the gas can no longer pass through them. At that point, the bags have to be cleaned by rapping, shaking or by reverse air flow by a pulse jet.

b) Rupture of the cloth -

The greatest problem inherent in cloth filters is the rupture of cloth, which results from shaking. It is often difficult to locate ruptures and when they're found the replacement time is often considerable.

- **c)Temperature-**

Fabric filters will not perform properly if a gross temperature overload occurs. If the gas temperature is expected to fluctuate, a fiber material that will sustain the upper temperature fluctuation must be selected.

Also, whenever the effluent contains a reactive gas like SO_2 which can form an acid whenever the temperature in the bag house falls below the dew point it can create problems.

d) Bleeding -

This is the penetration of the fabric by fine particles, which is common in fabric filtration. It can occur if the weave is too open or the filter ratio is very high. The solution is to use a double layer material or a thick woven fabric.

e) Humidity -

This is a common and important problem, especially if the dust is hygroscopic. It would therefore be advisable to maintain moisture free conditions within the bag house, as a precautionary measure.

- **f) Chemical attack -**

This is another problem associated with fabric filters. The possibility of chemical attack due to corrosive chemicals present in the effluent. A proper choice of fabric filter will avoid this problem.

Applications of a fabric filter

- Fabric filters find extensive application in the following industries and operations:

  i) Metallurgical industry
  ii) Foundries
  iii) Cement industry
  iv) Chalk and lime plants
  vi) Ceramic industry
  vii) Flour mills

Objective Questions

Q1. Bag house filters has Length and diameter in the range of _____ respectively.

Q2. Air to Cloth ration is given by _____.

Q3. While selecting the filter medium for bag houses, the characteristics and properties of the _____and _____ should be considered.

Q4. Typical values of air to cloth ratio for bag house filter are _____ to _____ m/s.

Q5. Area of each bag is given by _____.

Q6. Net area is ratio of _____ and _____.

Theory Questions

Q1. Explain working principle of bag house filter with neat sketch by giving advantages and disadvantages.

Q2. Write short notes on

1. Operating problems in bag house filter
2. Selection of fabric for bag house filter
3. Design of bag house filter