SISTEMI ETEROGENEI

Metodi di separazione

Sistema eterogeneo → separazione delle fasi

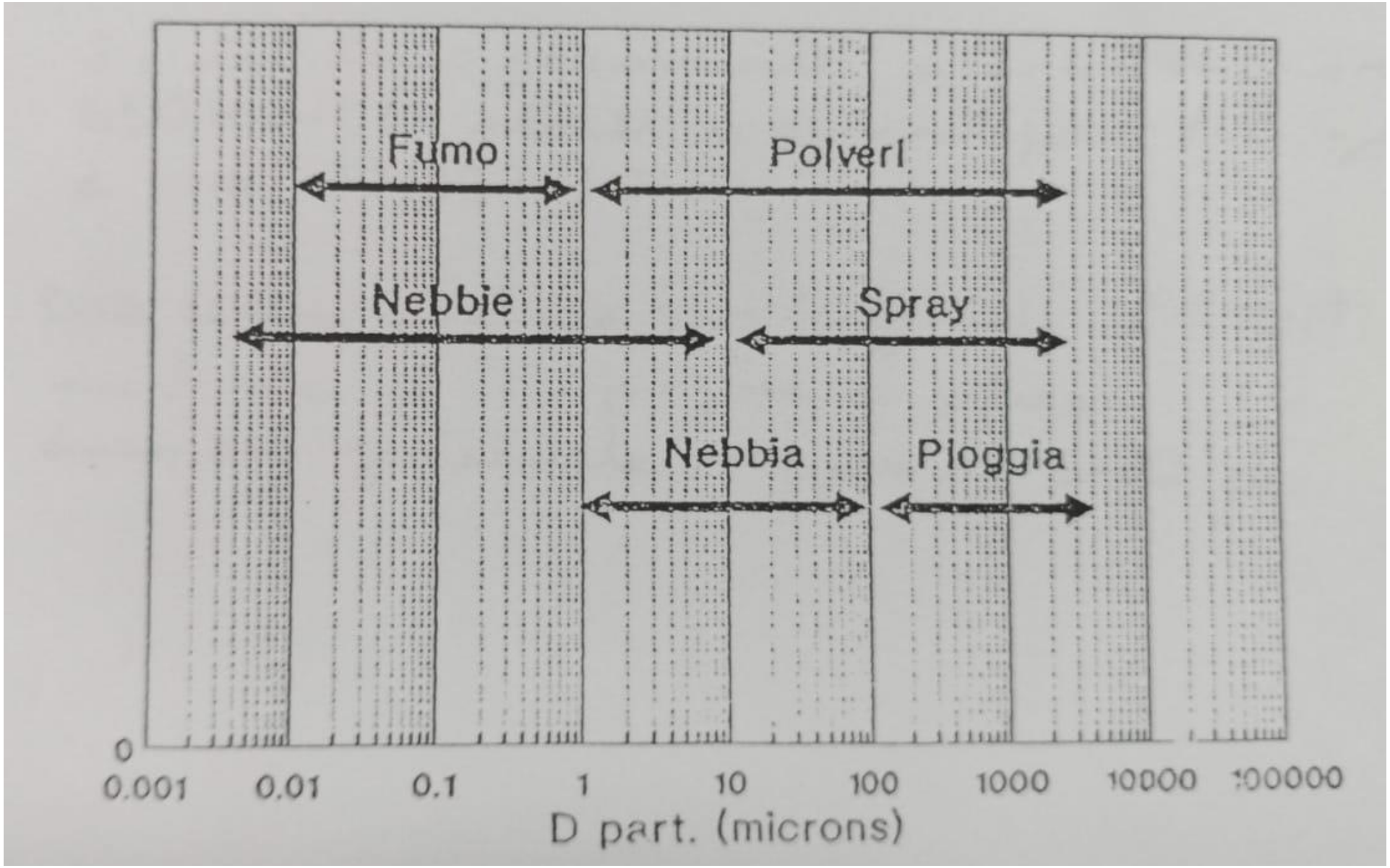
Sistema omogeneo → creazione di una seconda fase e sua separazione

Se servono entrambe, si fa prima la separazione delle parti eterogenee

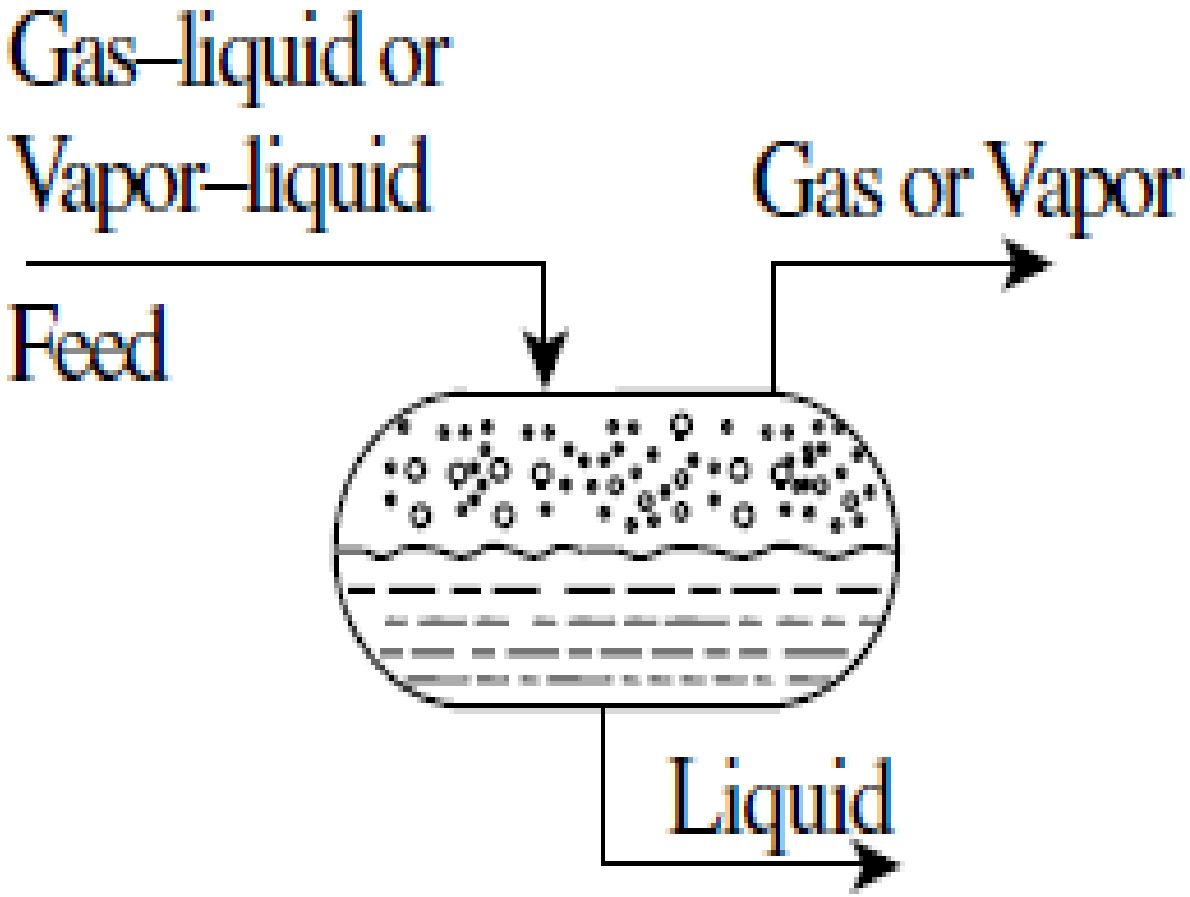
Sistema eterogeneo

- **Gas-liquido (o vapore-liquido)**
- **Gas-solido (o vapore-solido)**
- **Liquido-liquido (immiscibili)**
- **Liquido-solido**
- **Solido-solido**

Separazione da una fase gas

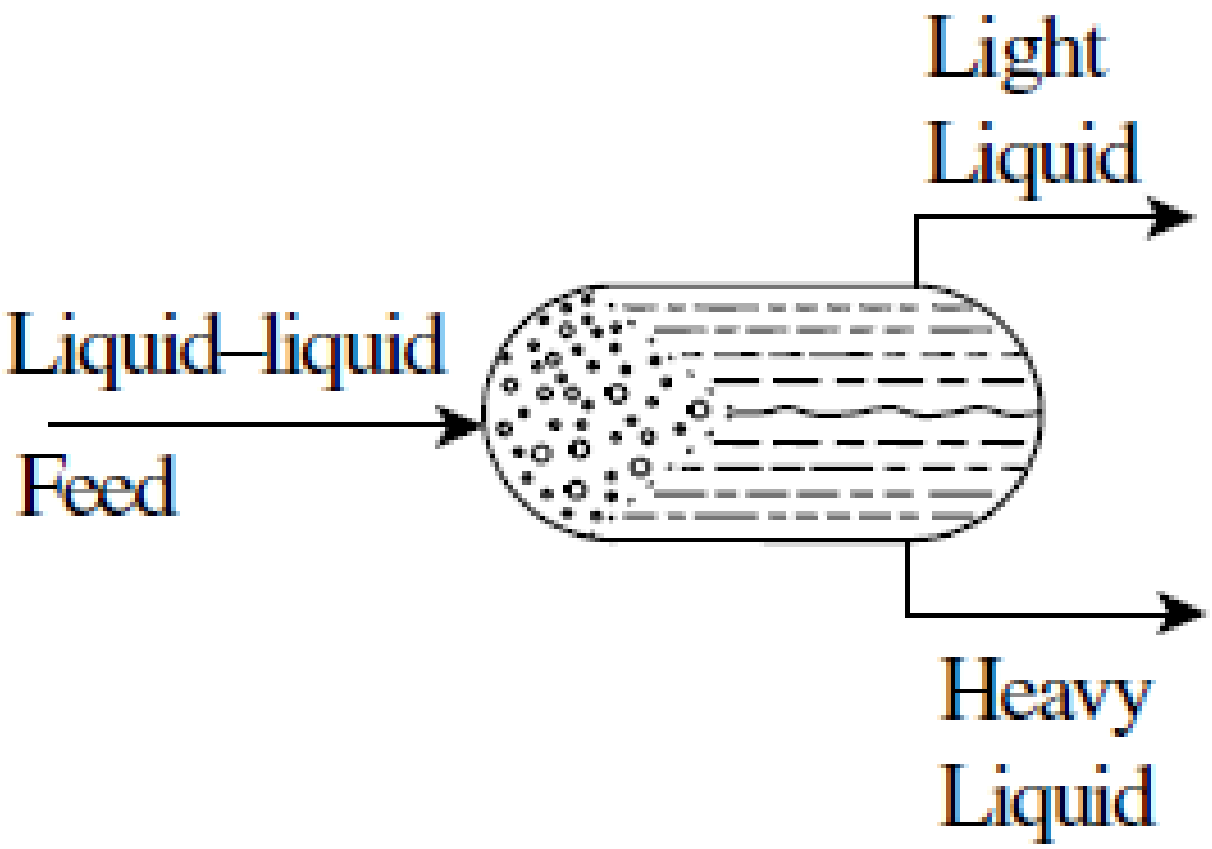


Separatori gravitazionali

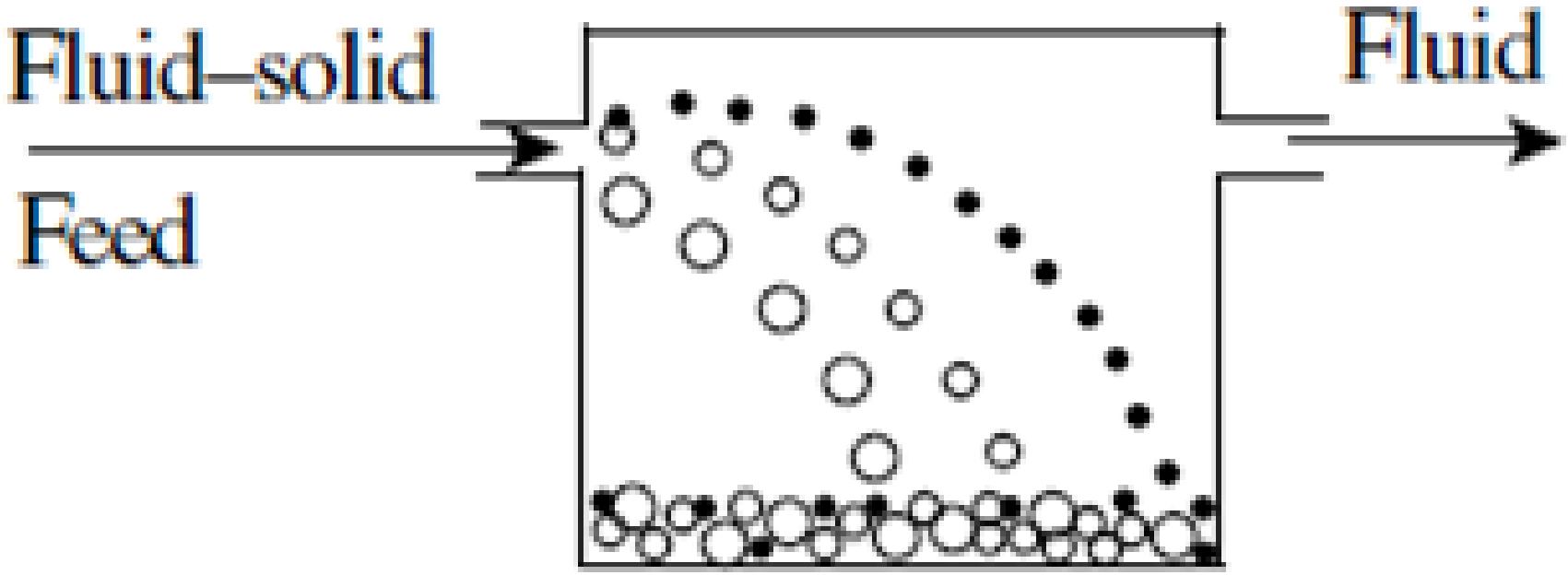


Separatore gravitazionale aeriforme-liquido

Separatore gravitazionale liquido-liquido



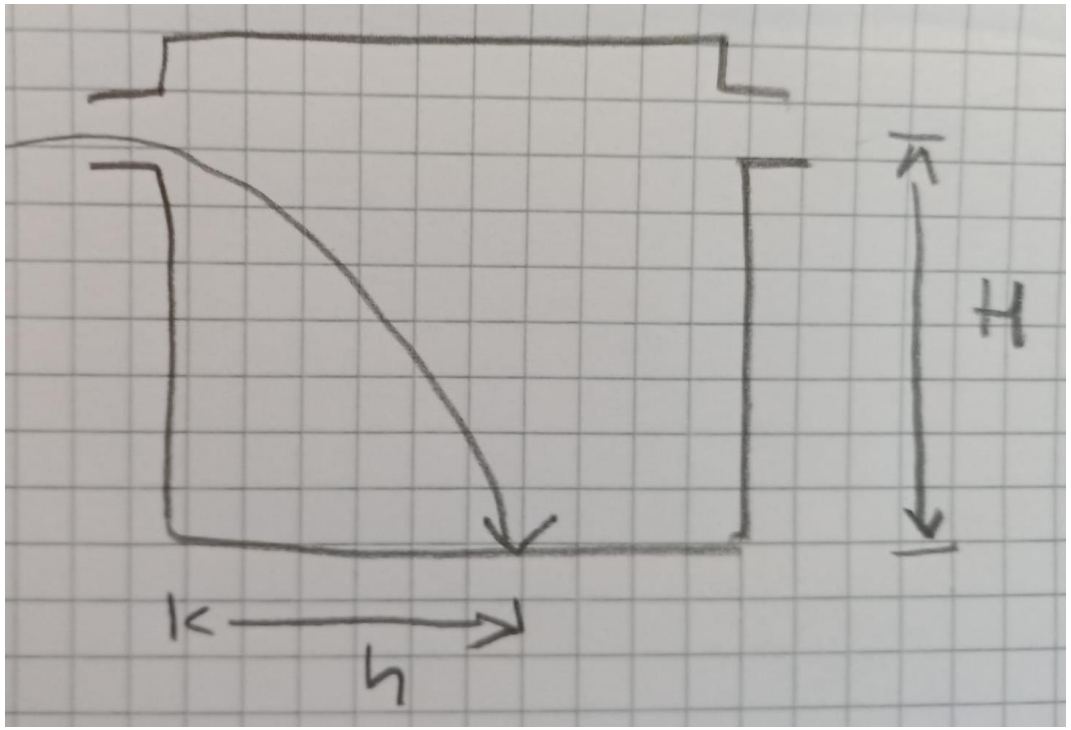
Separatore gravitazionale fluido-solido



$$\eta = \frac{h}{H}$$

LA SEPARAZIONE è PARZIALE
DIPENDE DAL DIAMETRO DELLE PARTICELLE
E DAI TEMPI DI PERMANENZA

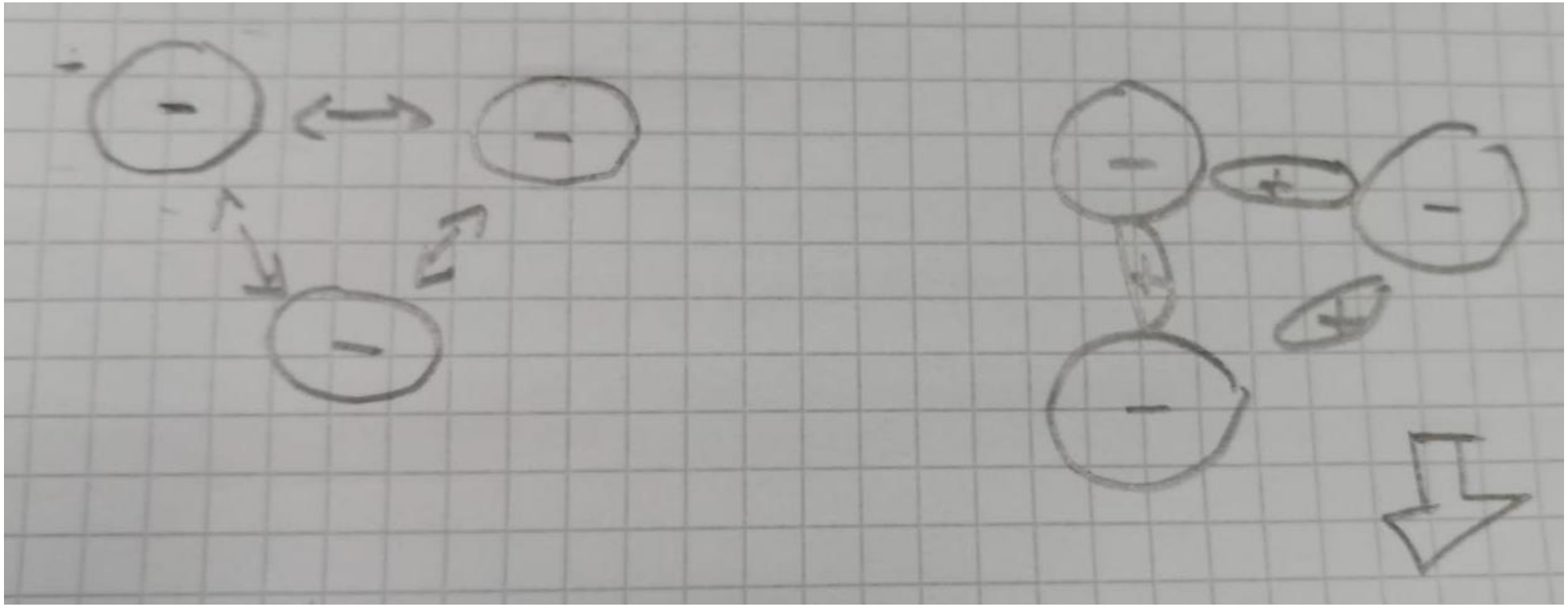
PER AUMENTARE L'EFFICIENZA SI POSSONO
PREVEDERE PERCORSI TORTUOSI



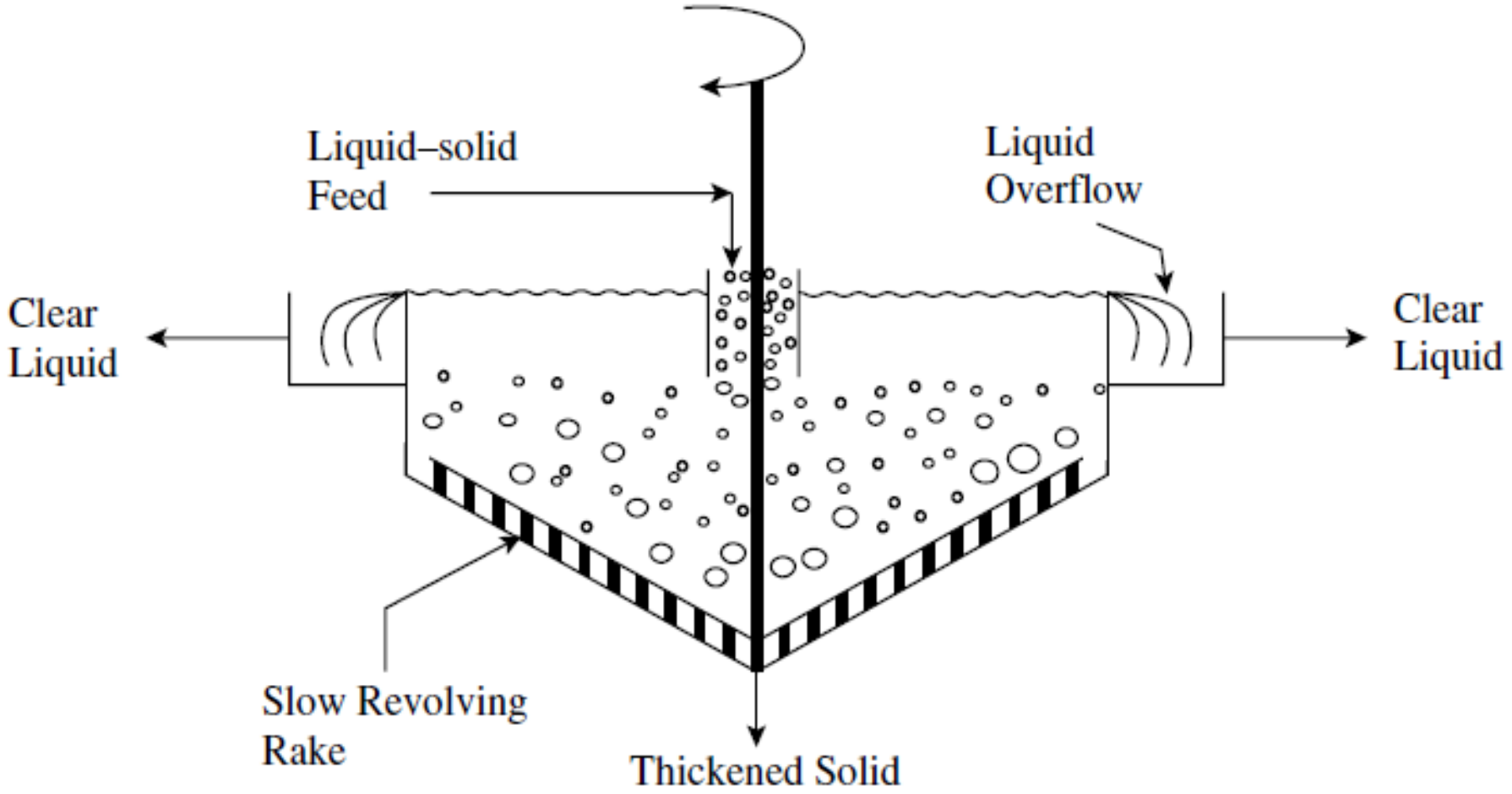
Agente flocculante

100 micron dimensione media per sep. di gravità

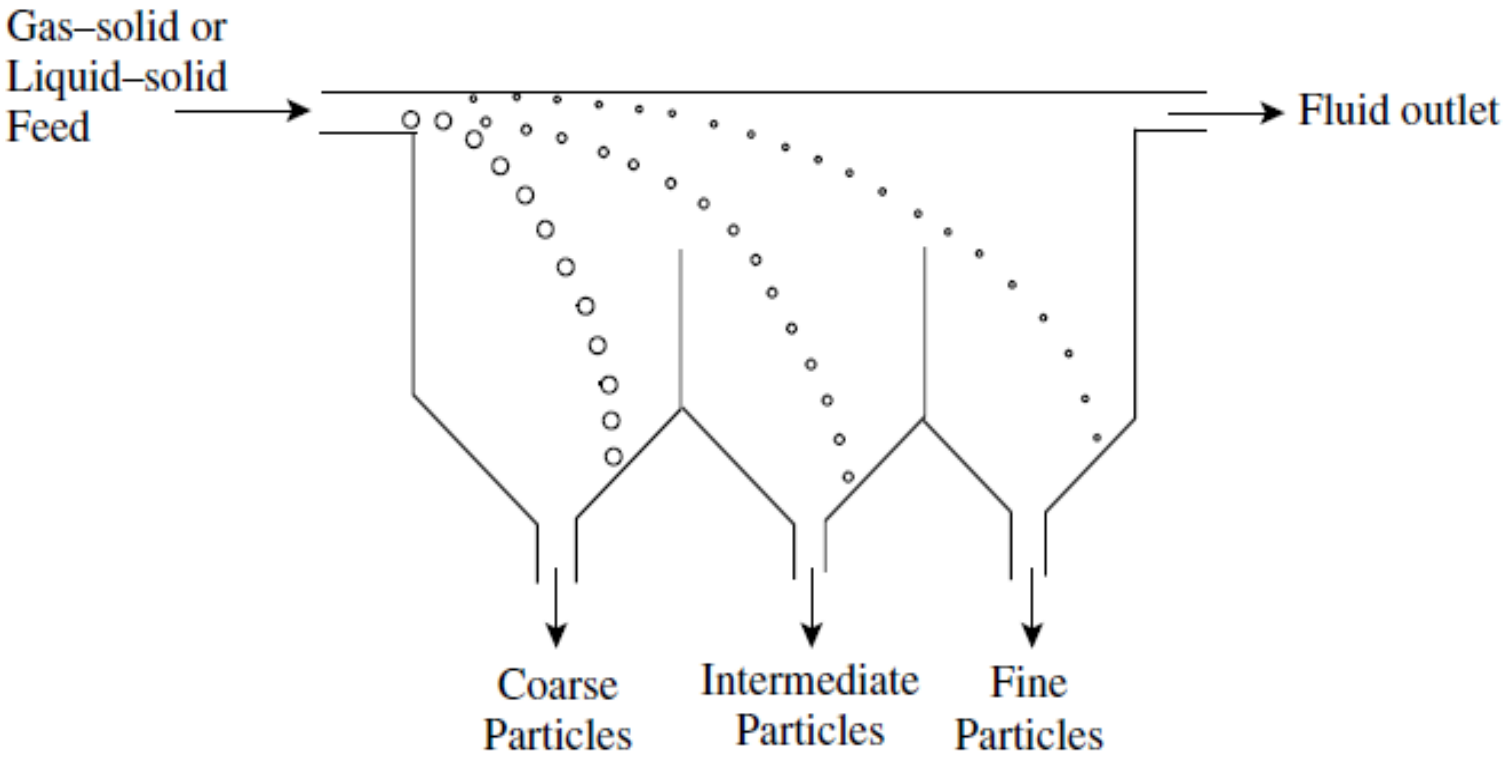
Sotto 20 micron diventa indispensabile l'uso di flocculanti



Sedimentazione (ispessimento e chiarificazione)

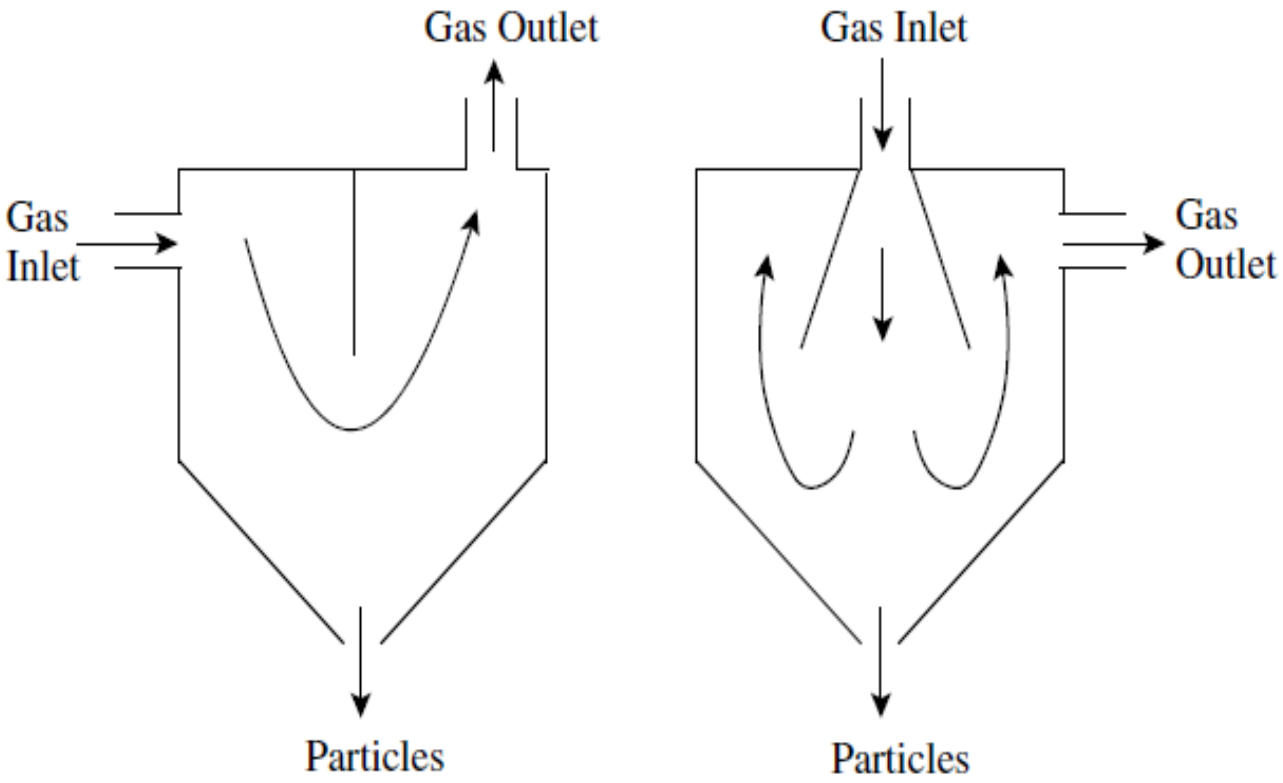


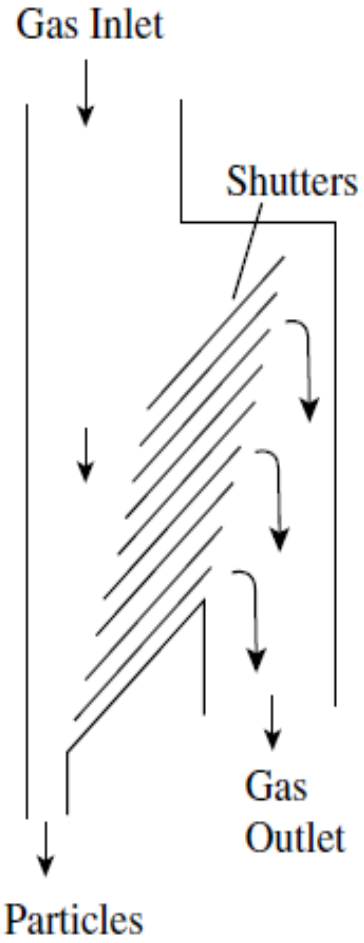
Classificatore

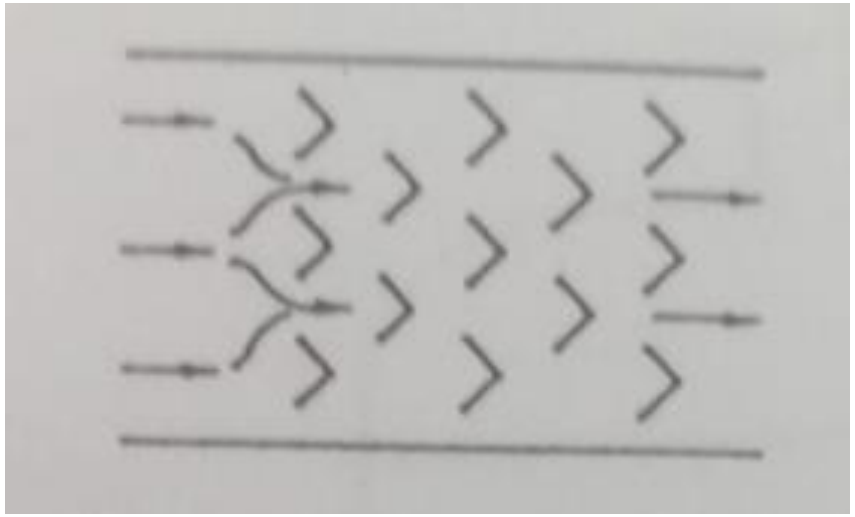


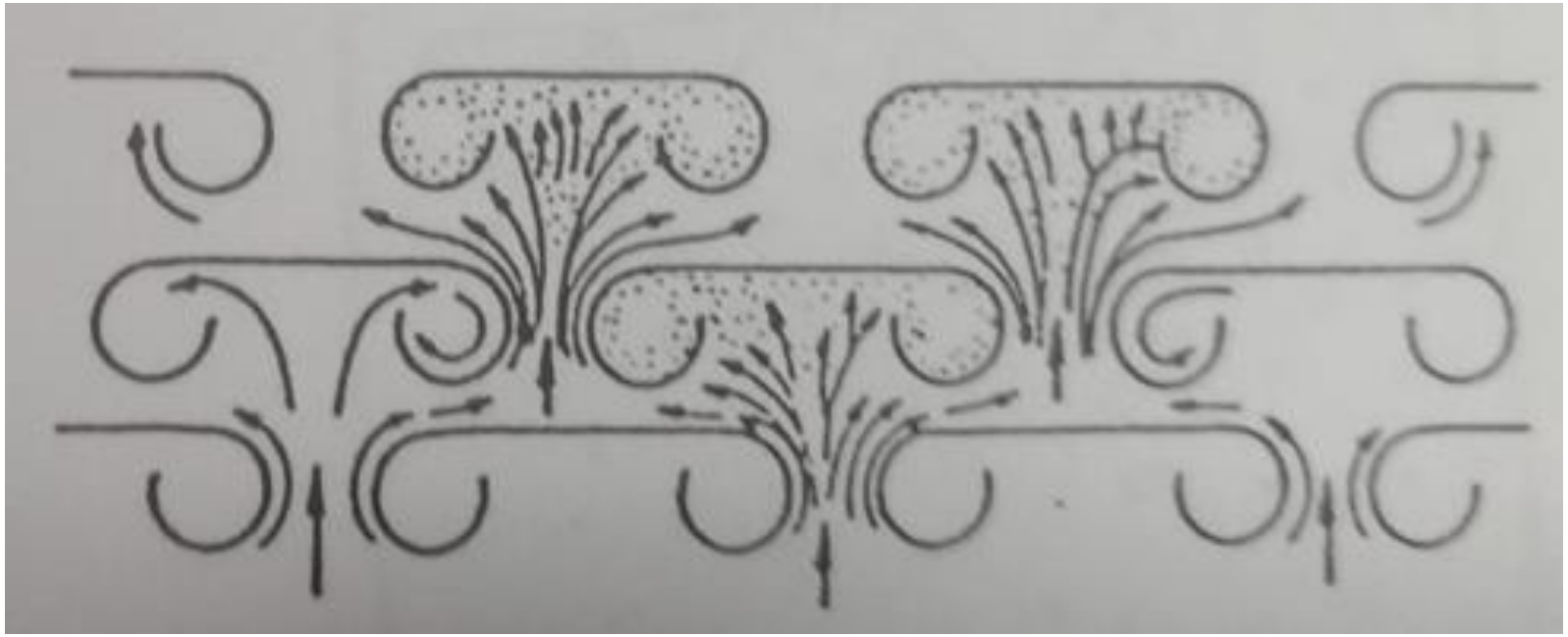
Separazione inerziale e centrifuga

Per favorire la separazione









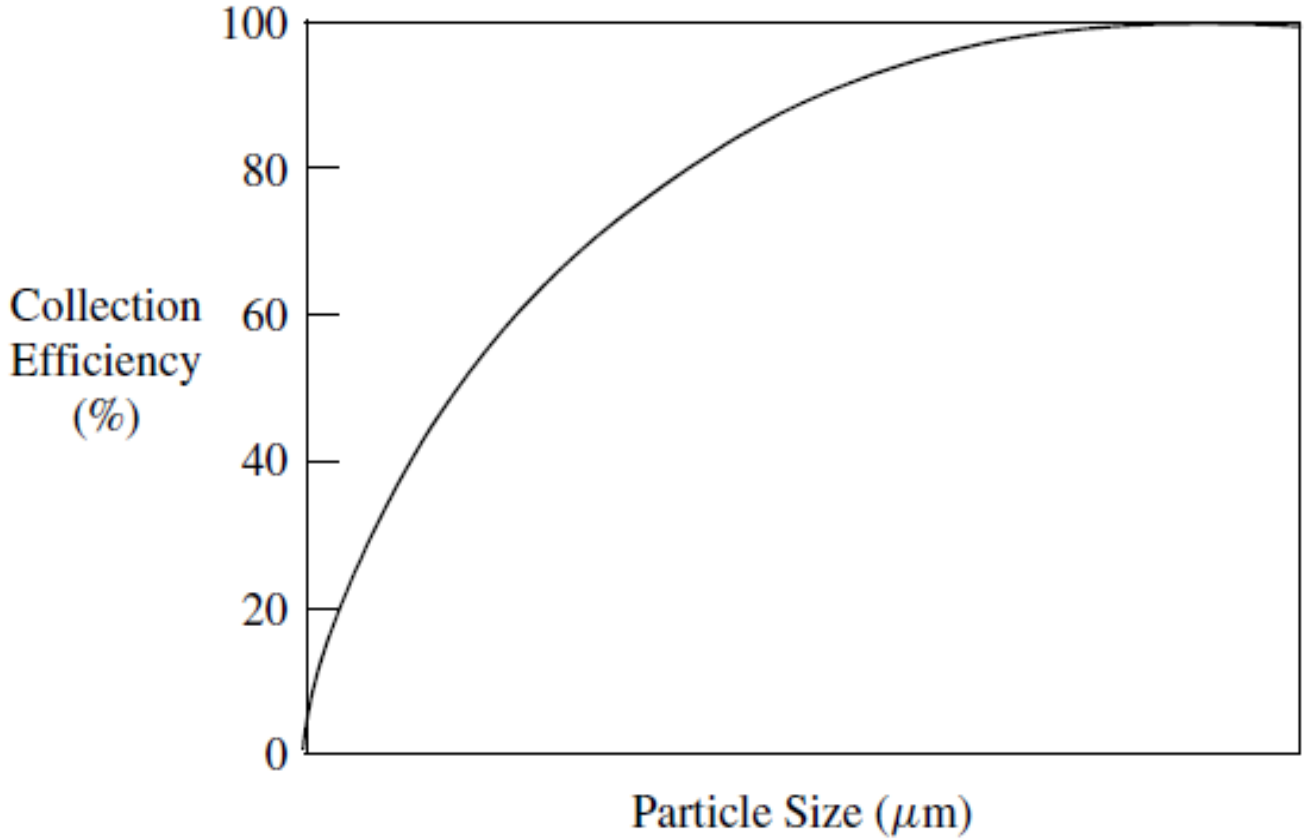


Figure 8.5 A collection efficiency curve shows the fraction of particles of a given particle size that will be collected.

Diametro max 650 mm
velocità 10-25 m/s

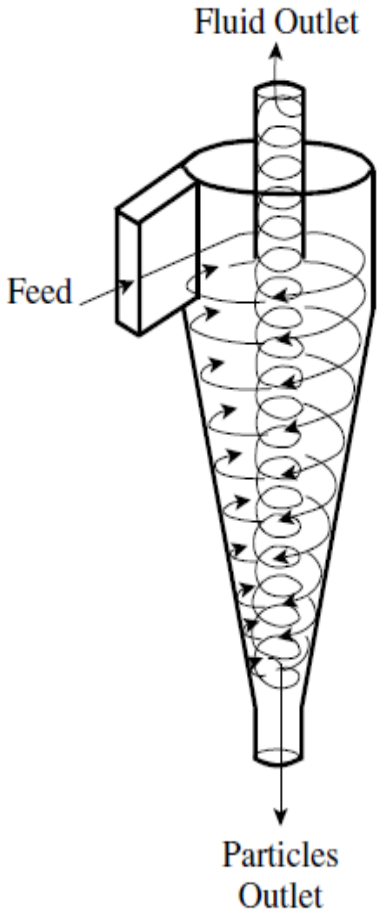
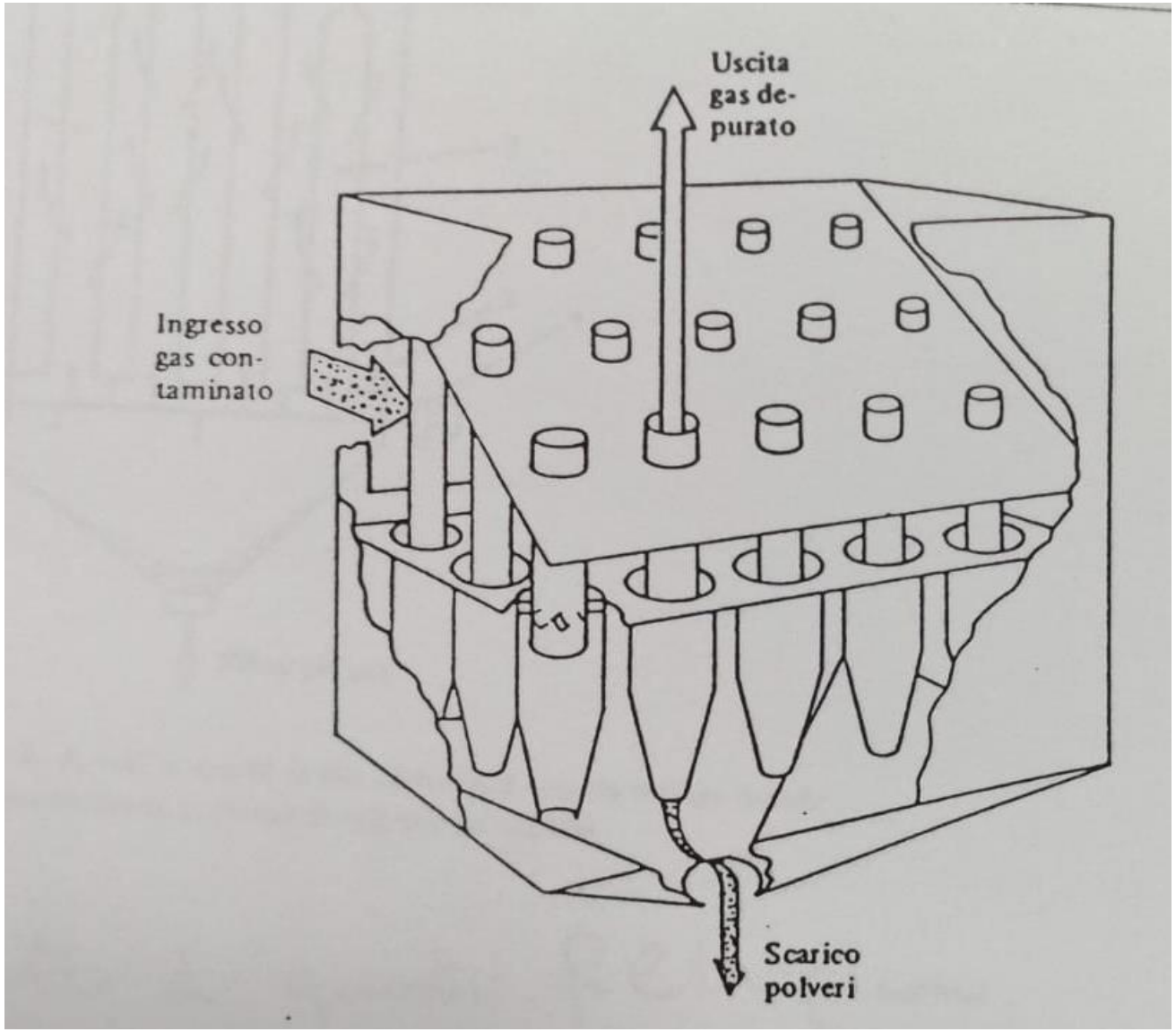
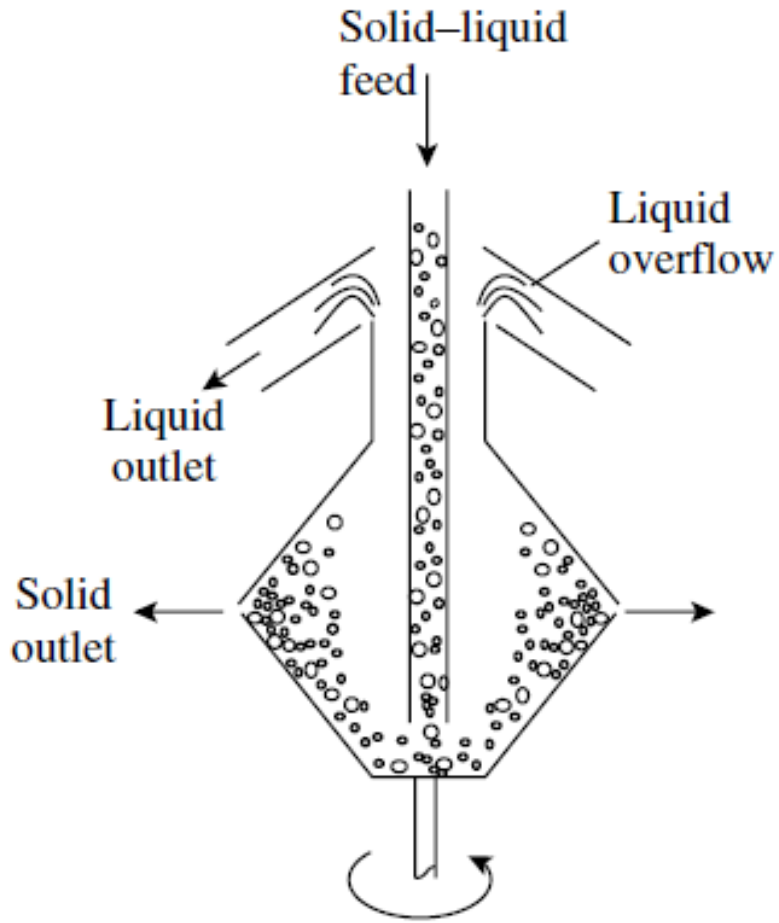


Figure 8.6 A cyclone generates centrifugal force by the fluid motion.

Multiciclone (portate elevate)

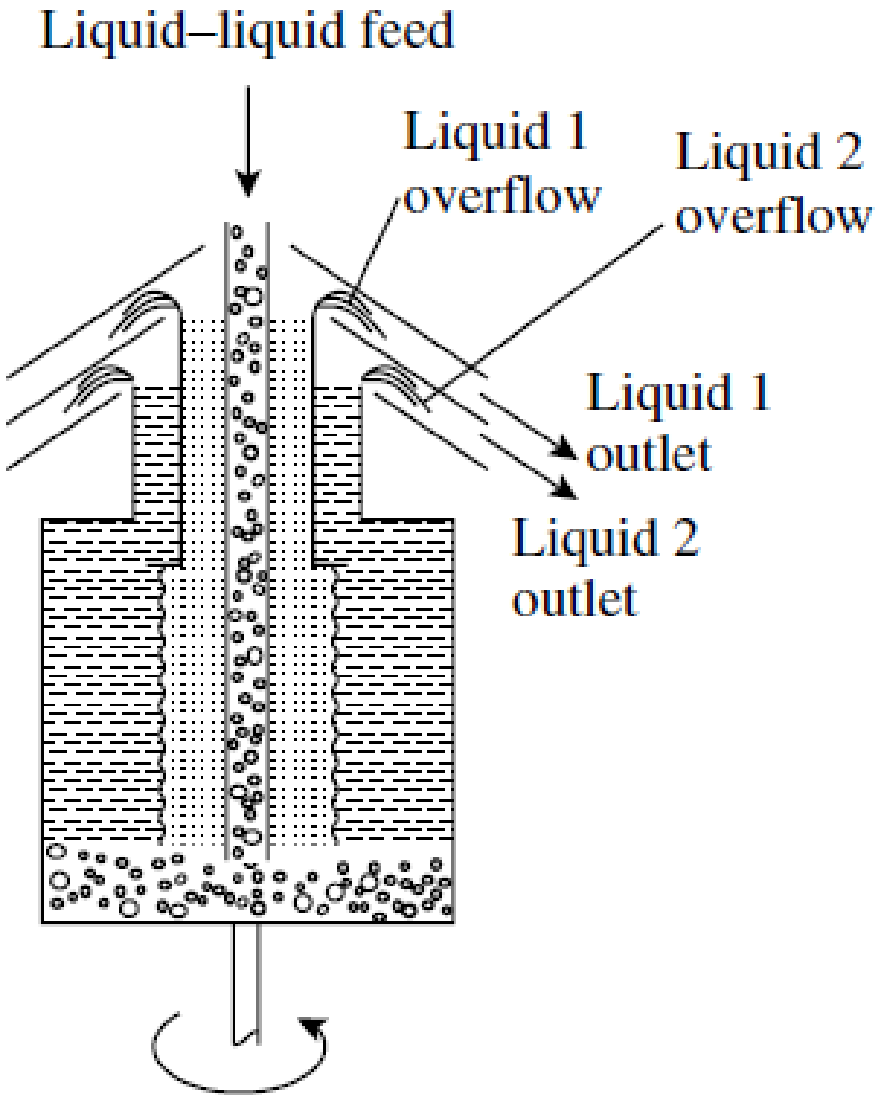
Poichè la dimesione non può aumentare





(a) Separtion of liquid–solid mixture

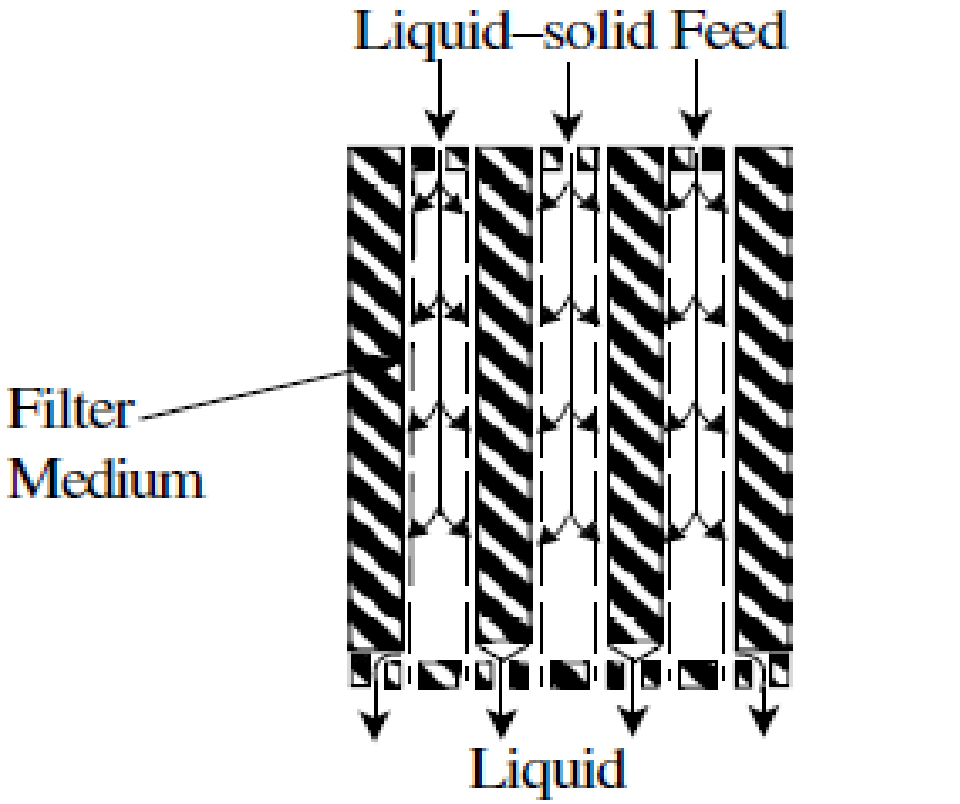
centrifuga, nella quale una tazza a simmetria cilindrica viene messa in rotazione



(b) Separtion of liquid–liquid mixture

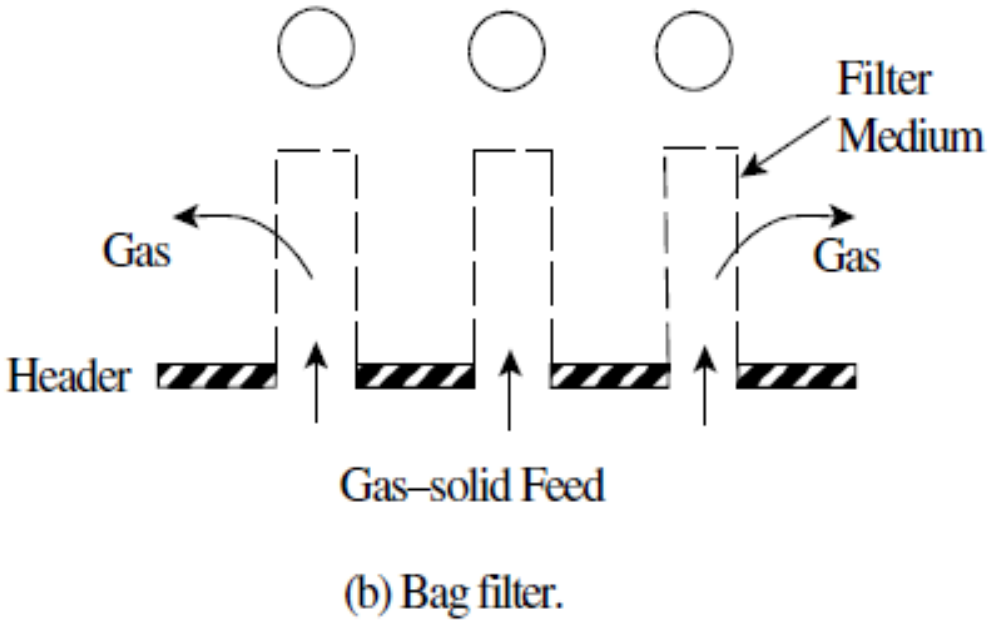
Filtrazione

Filtrazione ordinaria : diametro particelle 10 micron



(a) Plate-and-flame filter.

Filtro a piastre



(b) Bag filter.

Dal materiale del tessuto dipende la Tmax di utilizzo

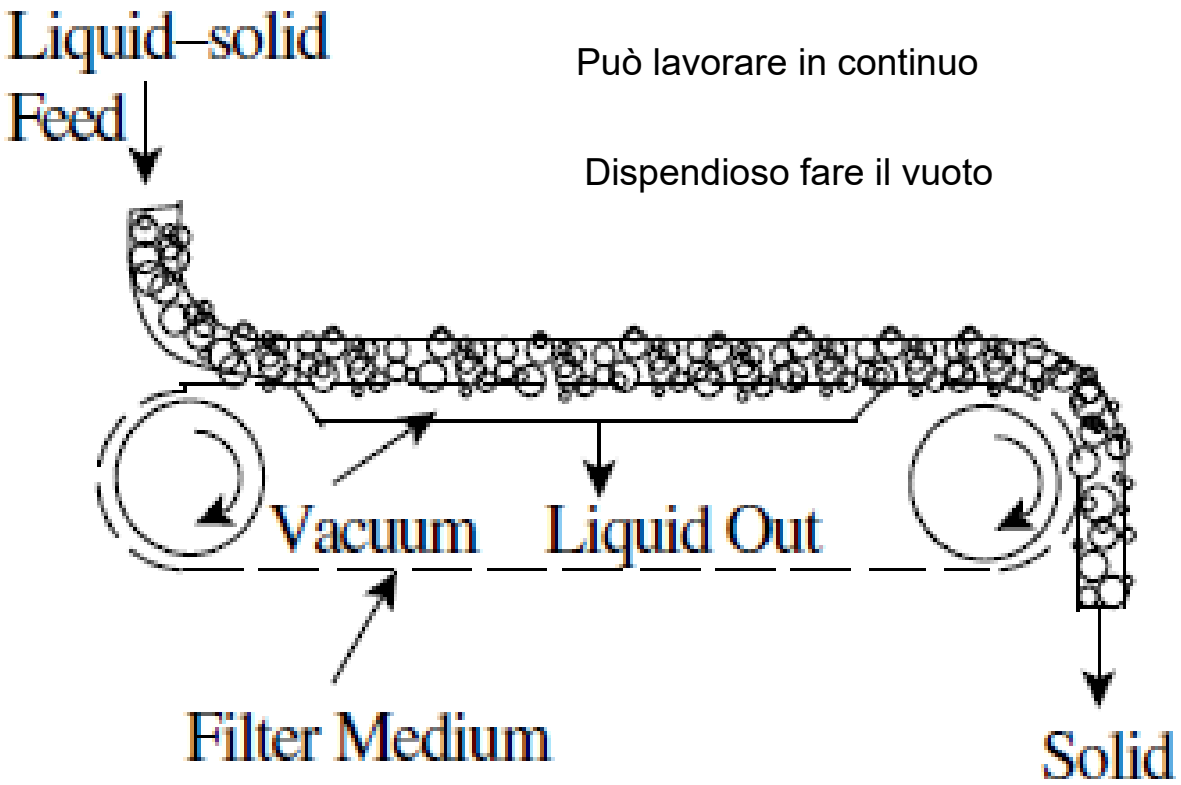
Cotone 80°C
Lana 93°C
Nylon 130°C
Teflon 290°C

Per T ancora più alte si devono sinterizzare metalli/ceramici porosi

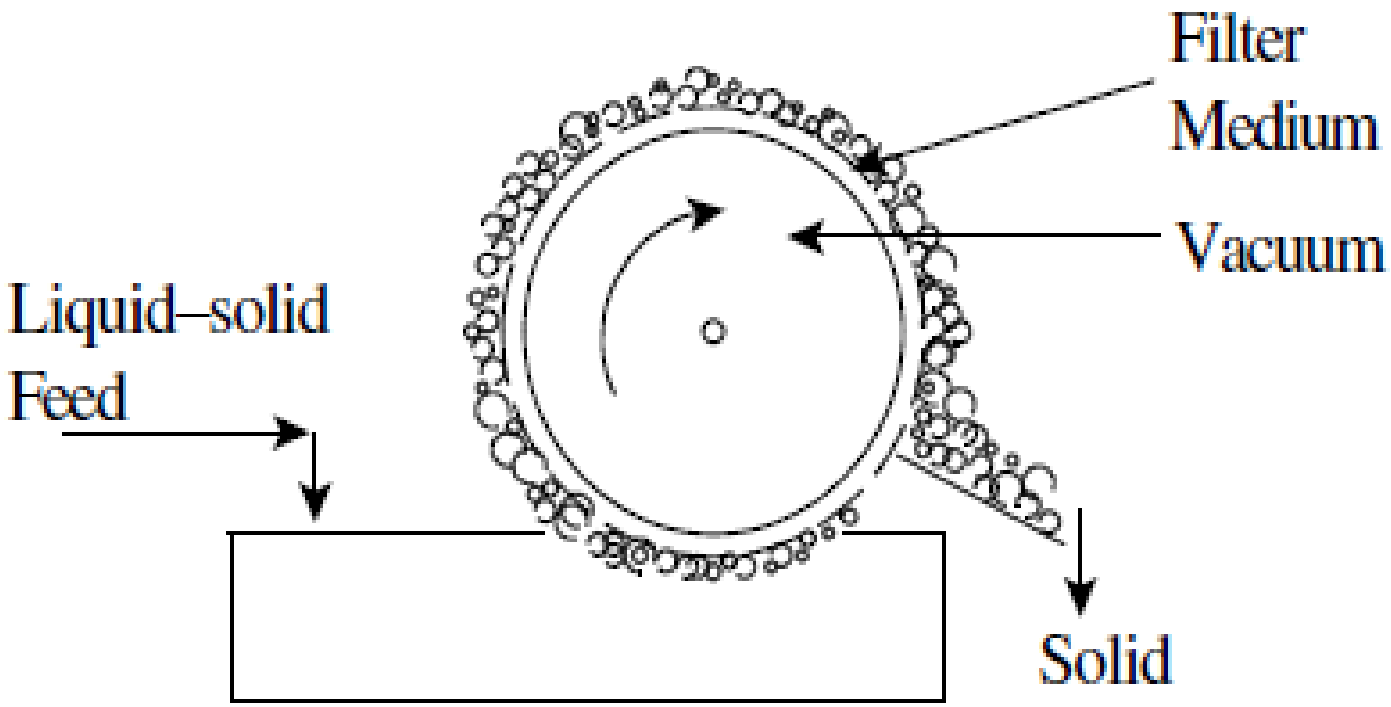
Filtro a maniche

Può lavorare in continuo

Dispendioso fare il vuoto

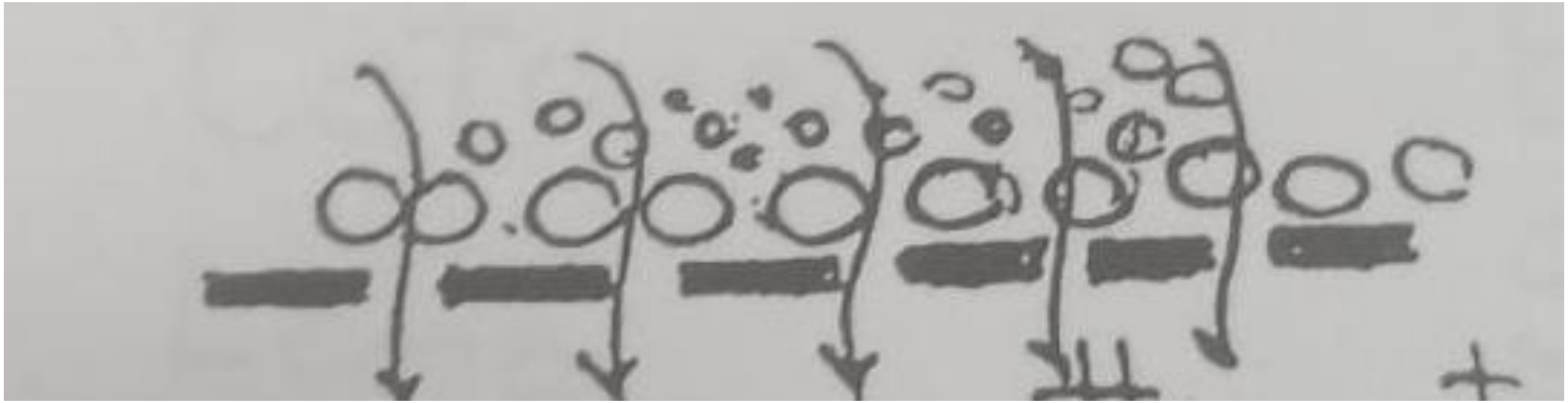


(c) Belt vacuum filter.



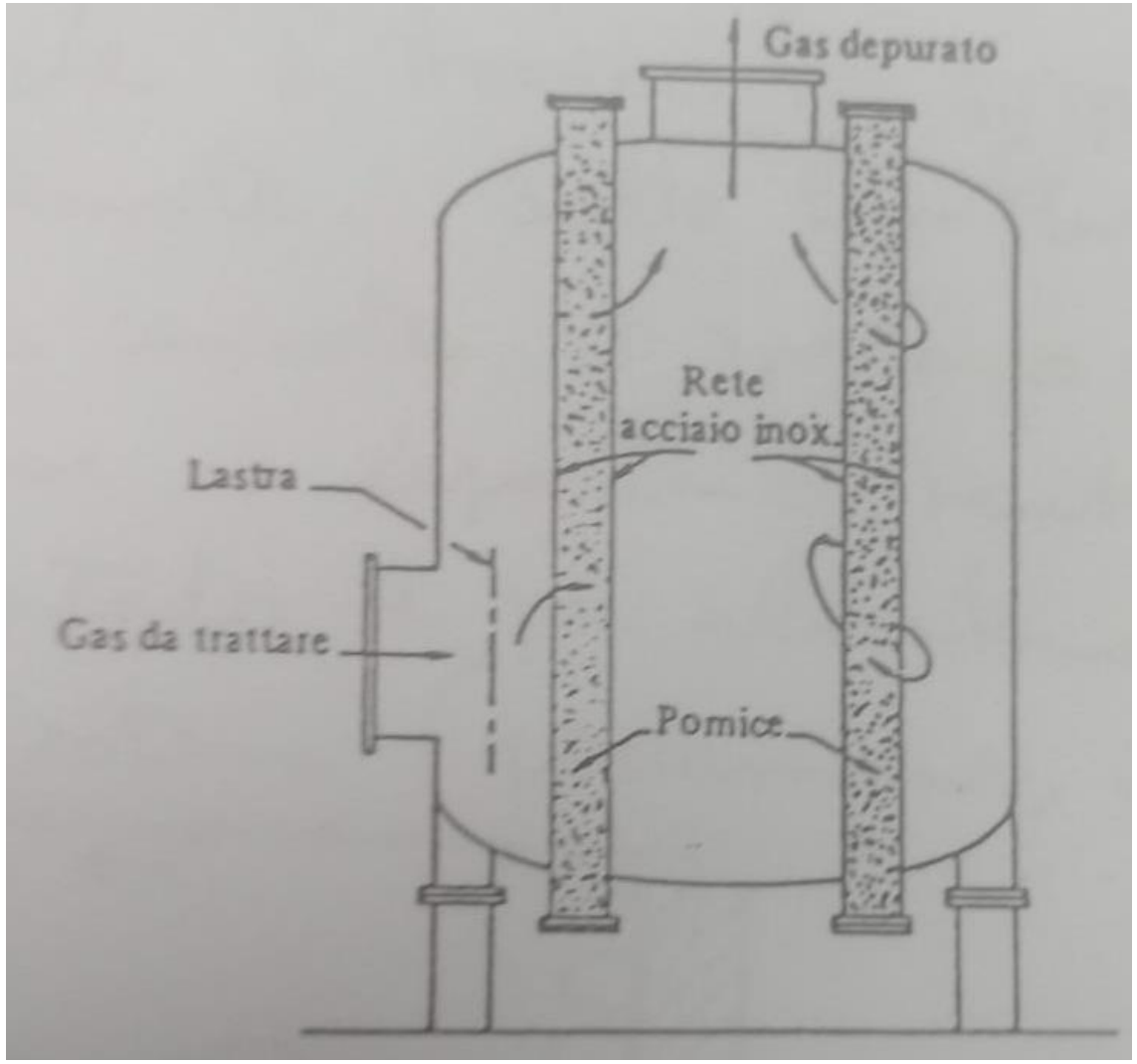
(d) Rotary vacuum filter.

Filtro a tamburo rotante



-CAKE FILTRATION (SUPERFICIE)
-DEPTH FILTRATION (PROFONDITA')

Filtro a letto fisso



Filtro a solido poroso

MICROFILTRAZIONE

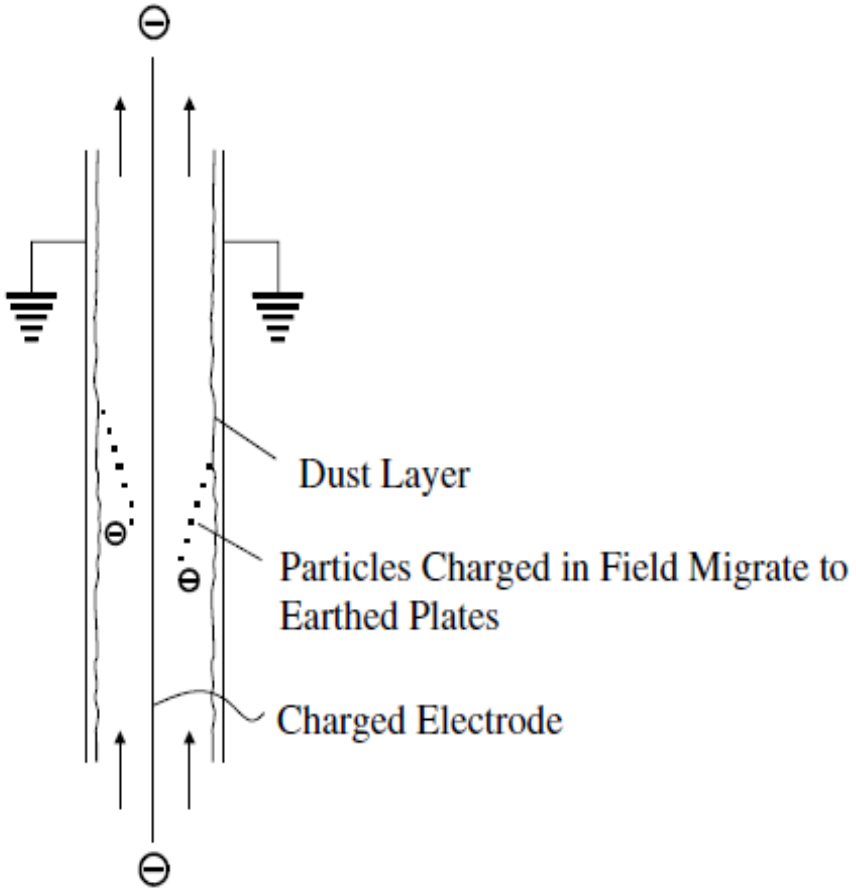
Membrane polimeriche per arrivare a 0,05 micron
Necessarie grandi superfici e contenere il volume:
-Spirale
-Fibra cava : tubo molto piccolo, flusso dall'esterno all' interno, sistemate in fascio con alimentazione tangenziale per far si che si autopulisca

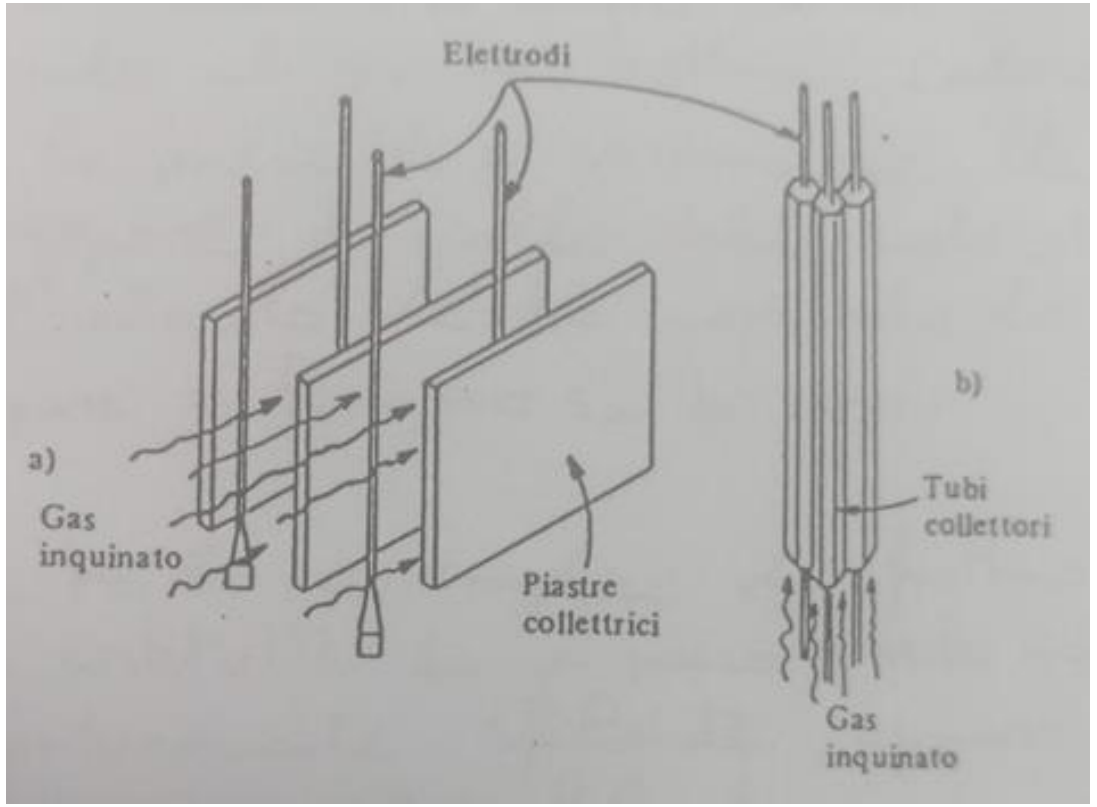
Precipitazione elettrostatica

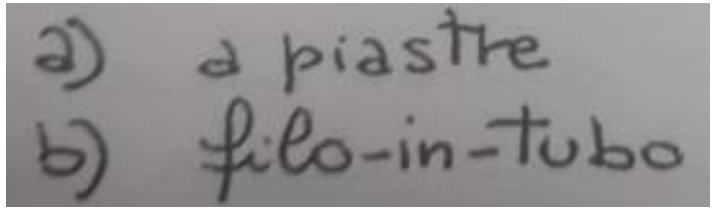
Necessario basso costo energia

Utile per alte portate e pochi solidi perchè ci sono poche perdite di carico

Utile per alte T dove si degraderebbe il filtro

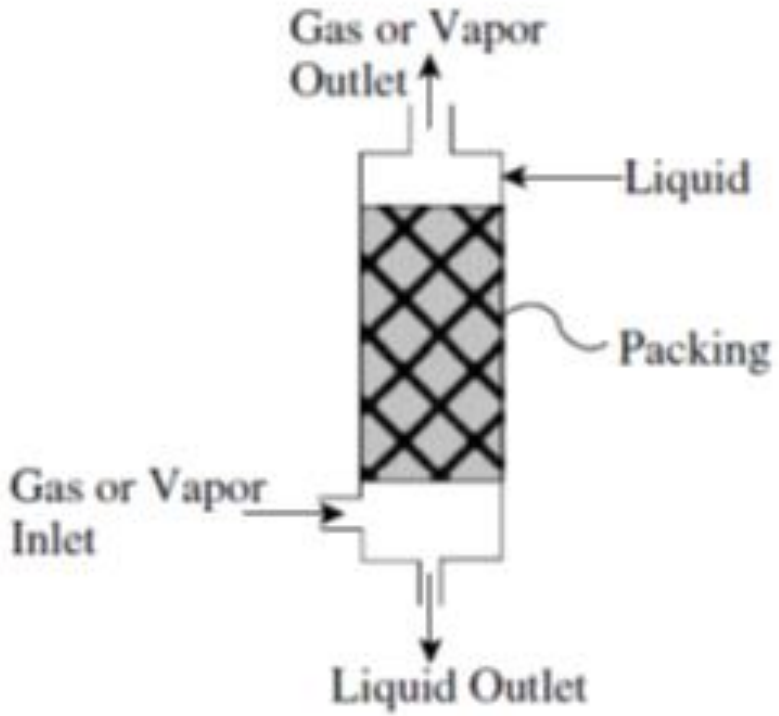




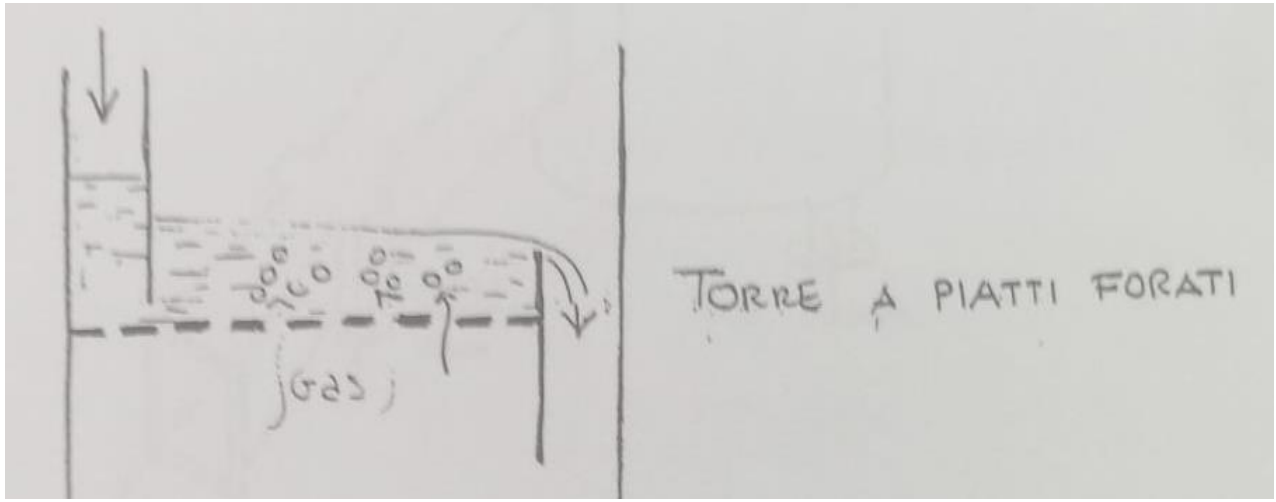


Separazione ad umido (scrubbing)

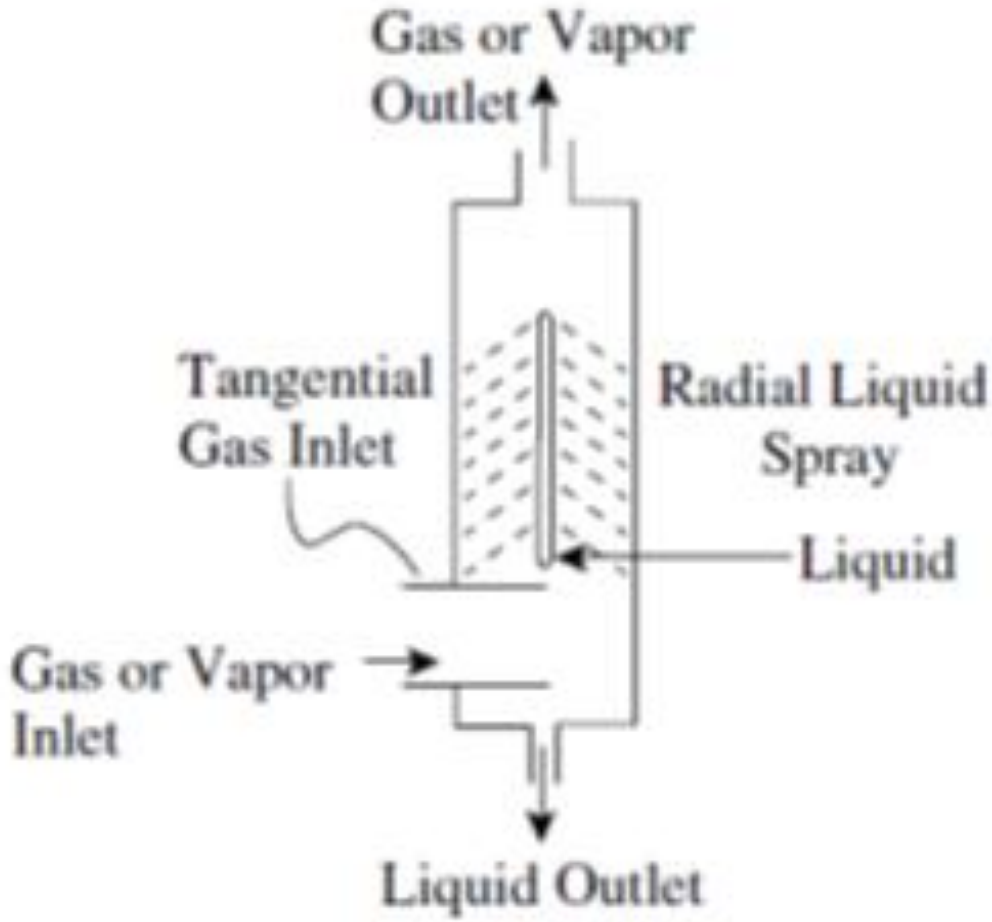
Impaccamento comporta perdite di carico



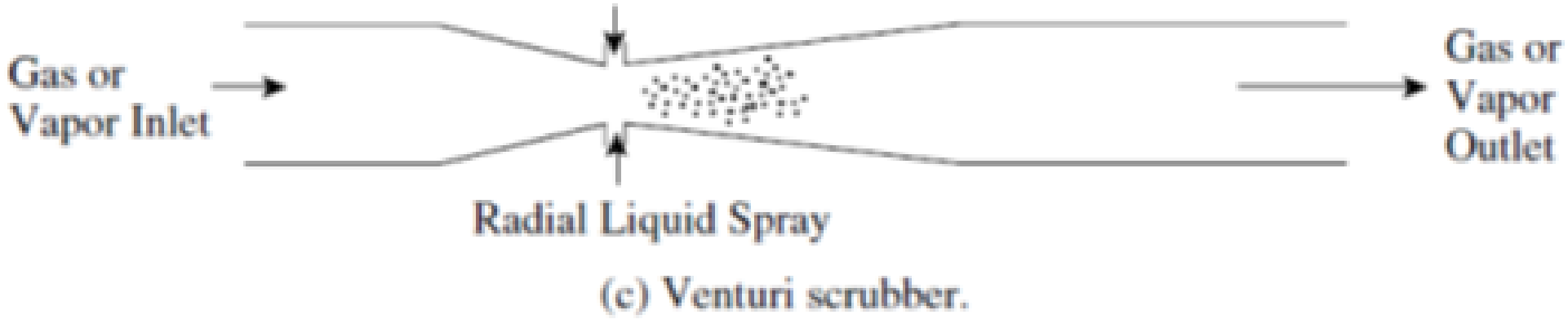
(a) Packed bed scrubber.


TORRE A PIATTI FORATI
GAS


TORRE A PIATTI
A CAMPANELLE
GAS



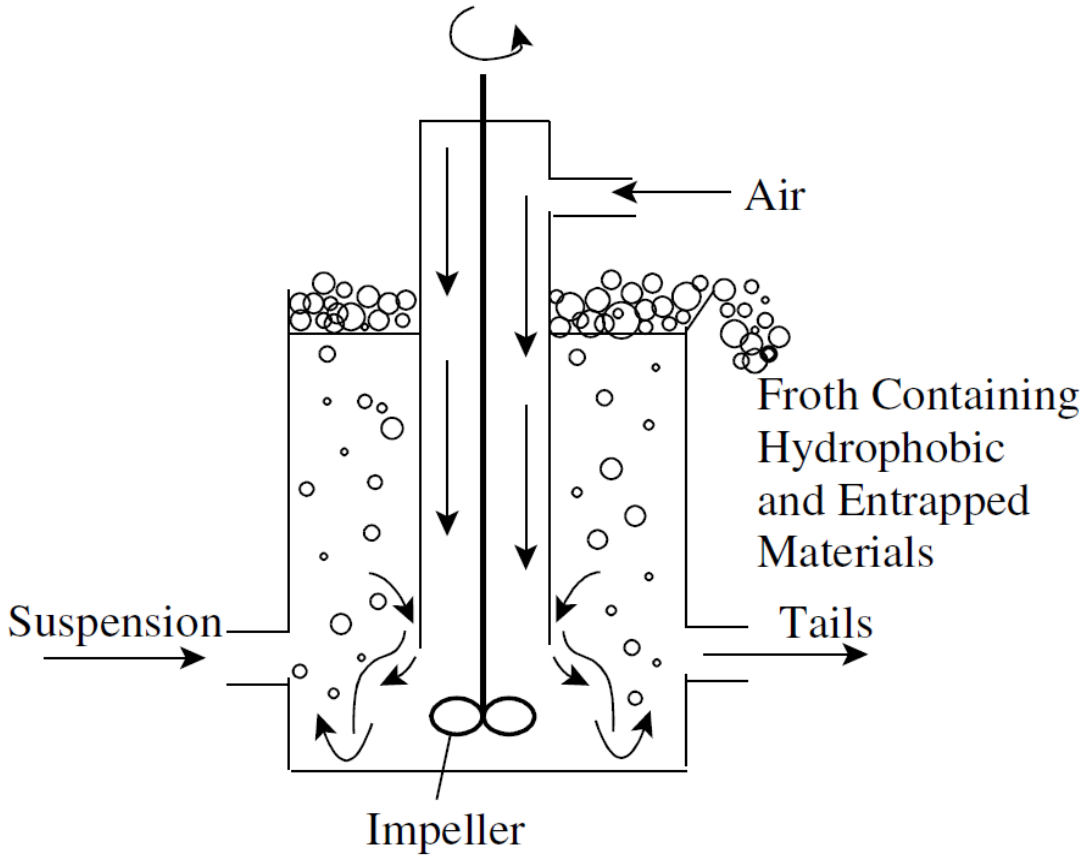
(b) Spray scrubber.



(c) Venturi scrubber.

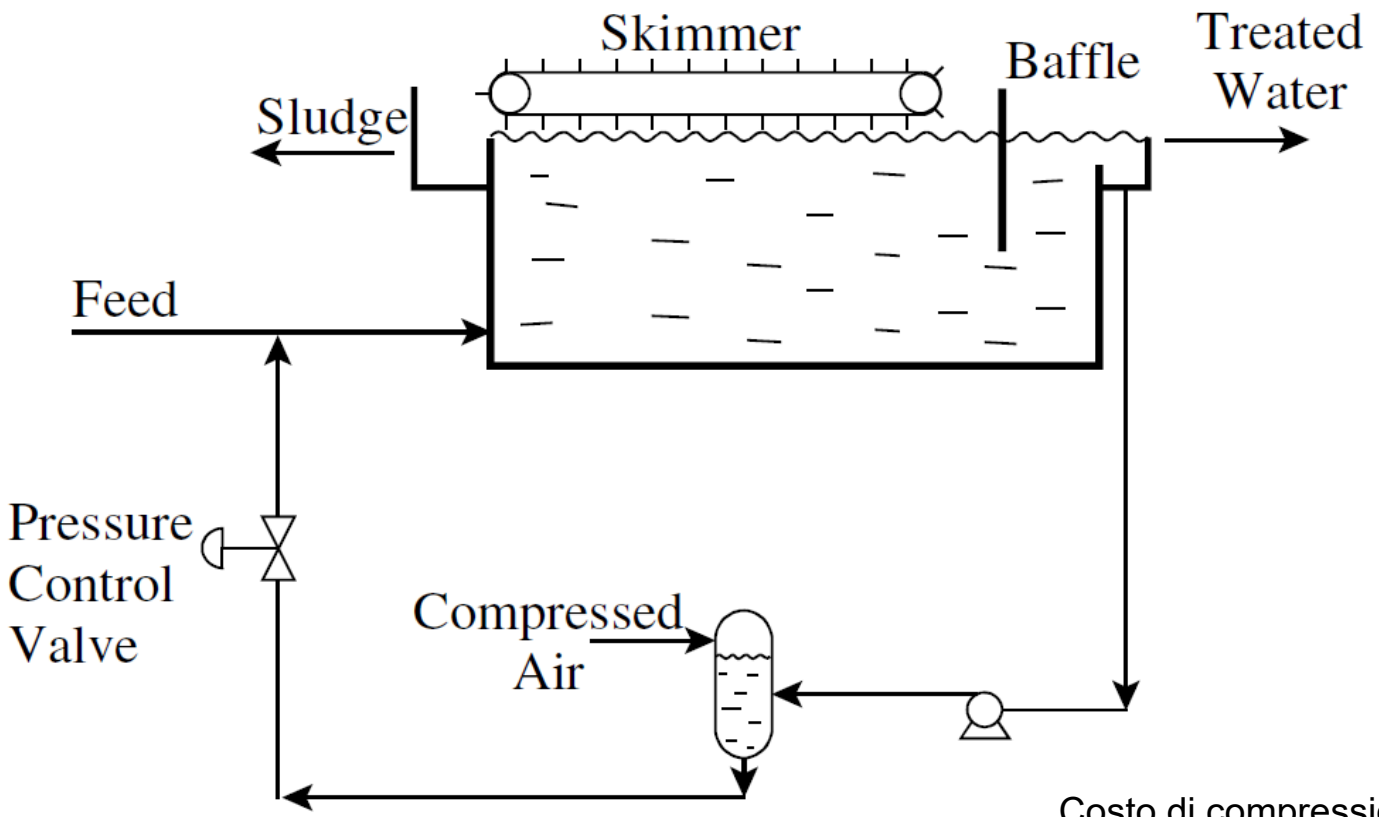
Spray e Venturi per abbassare perdite di carico

Flottazione



(a) A typical flotation cell for solid separation.

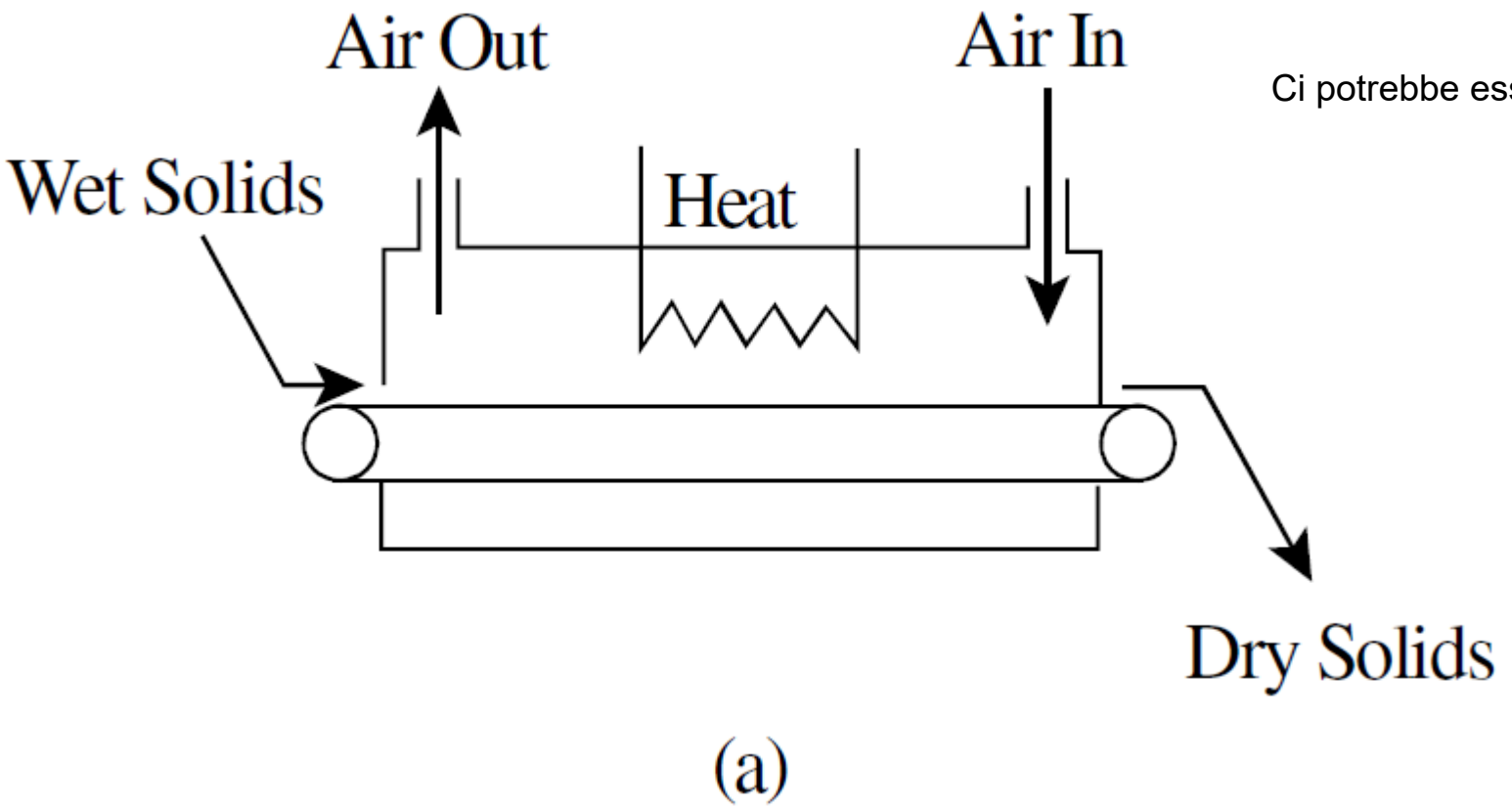
La valvola fa diminuire la pressione e
l aria passa in gas



Costo di compressione

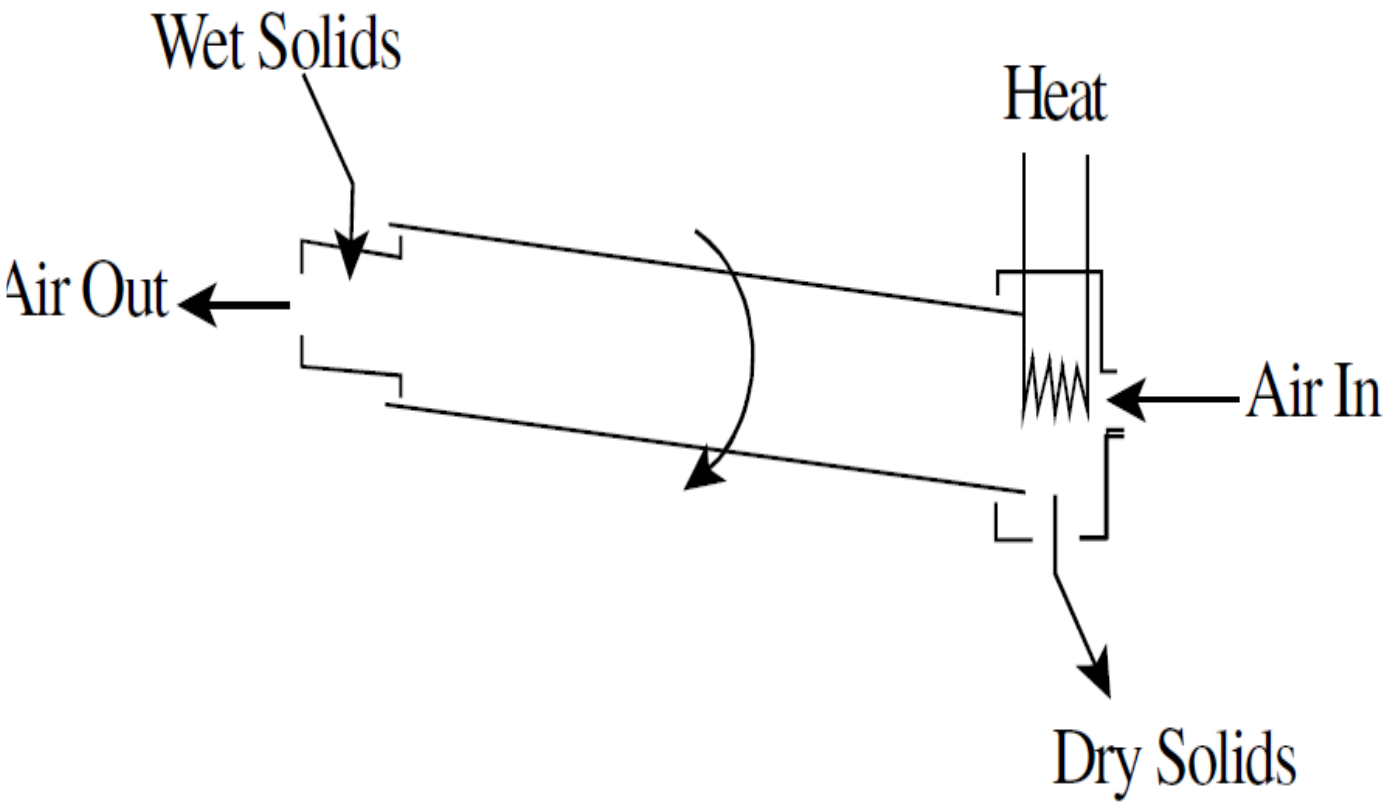
(b) Dissolved air flotation (DAF).

Essiccamento

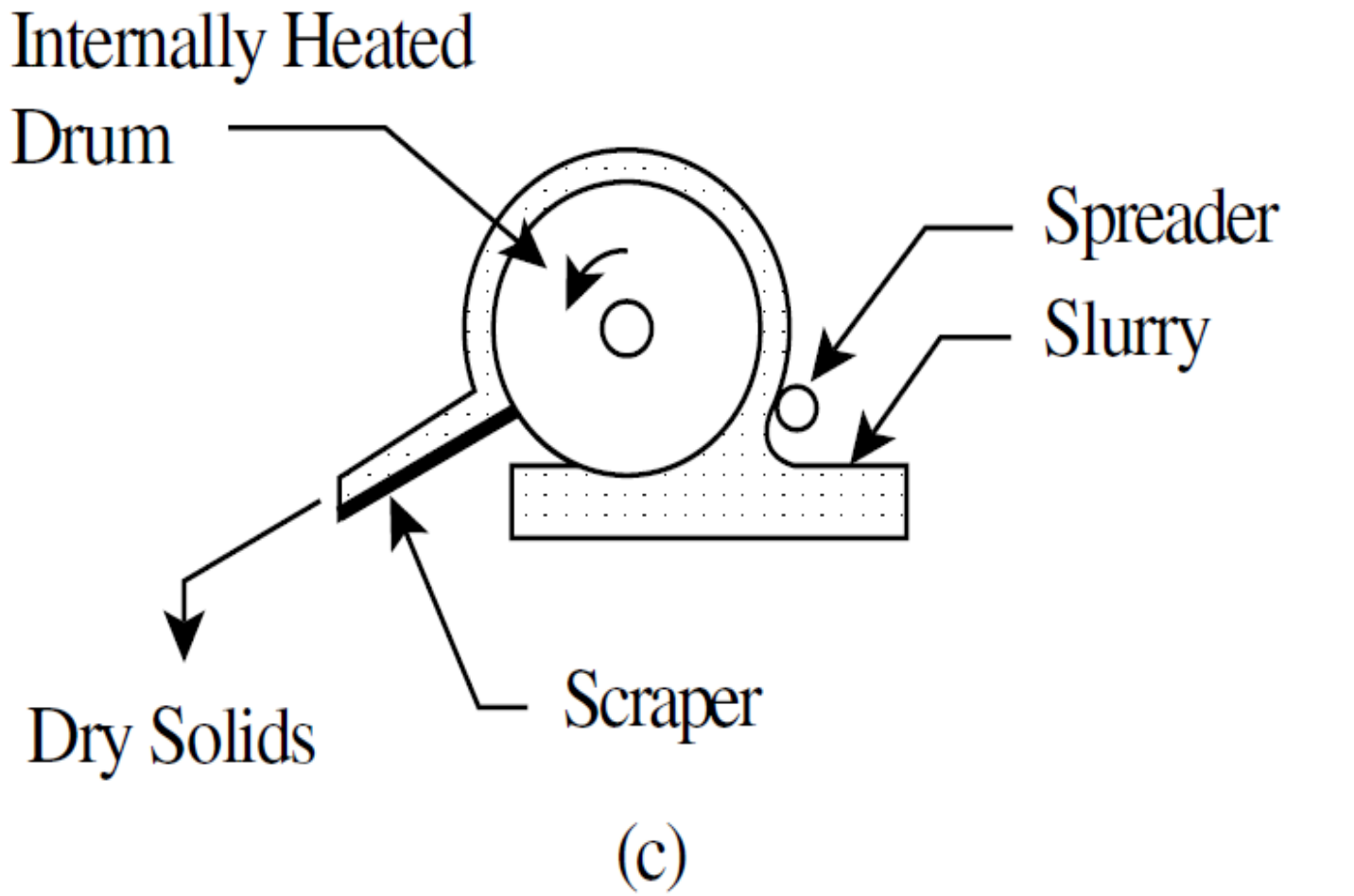


Ci potrebbe essere il problema dal solido che si degrada

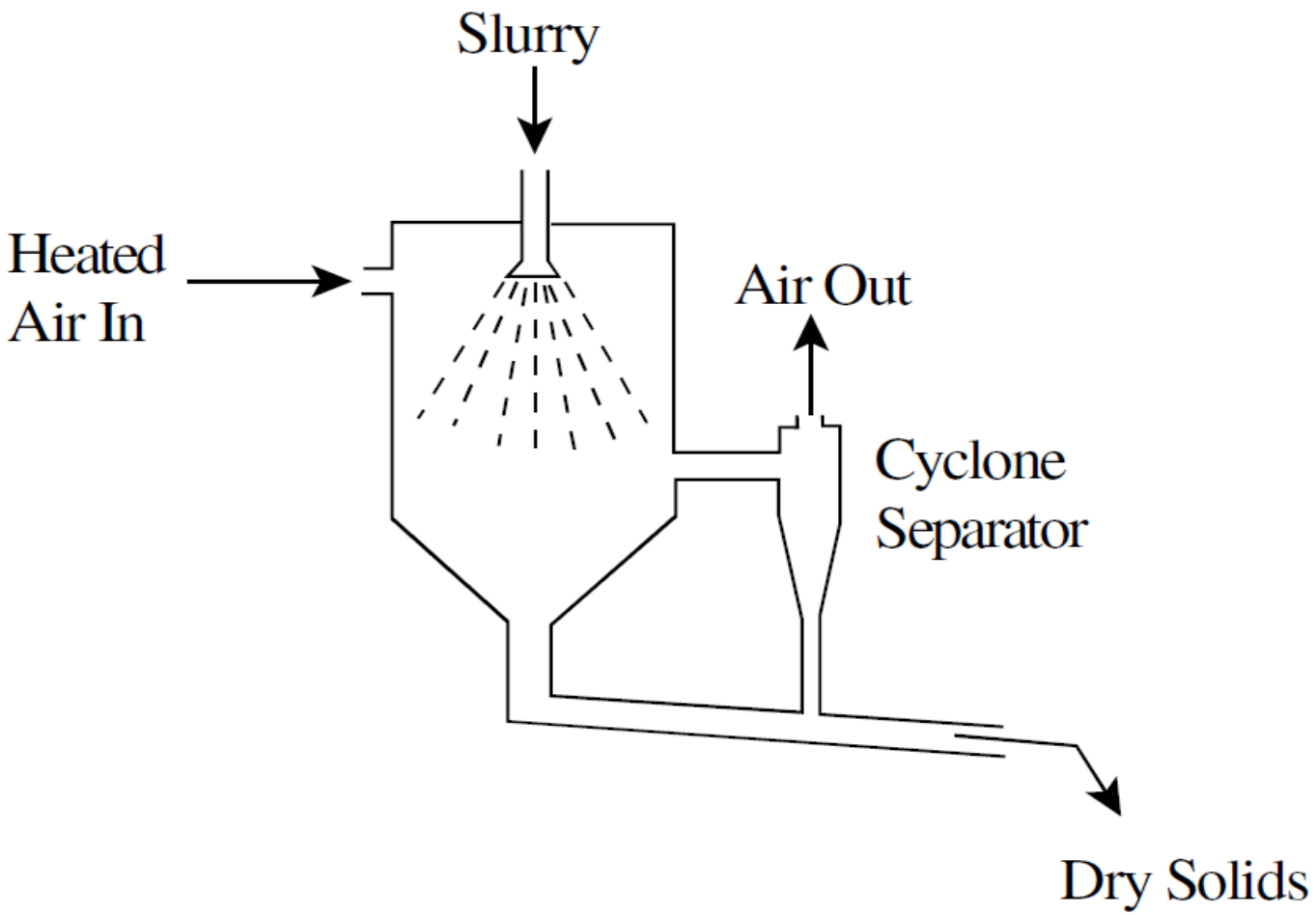
Essiccatore a tunnel (flusso controcorrente)



Essiccatore a tunnel (flusso equicorrente)

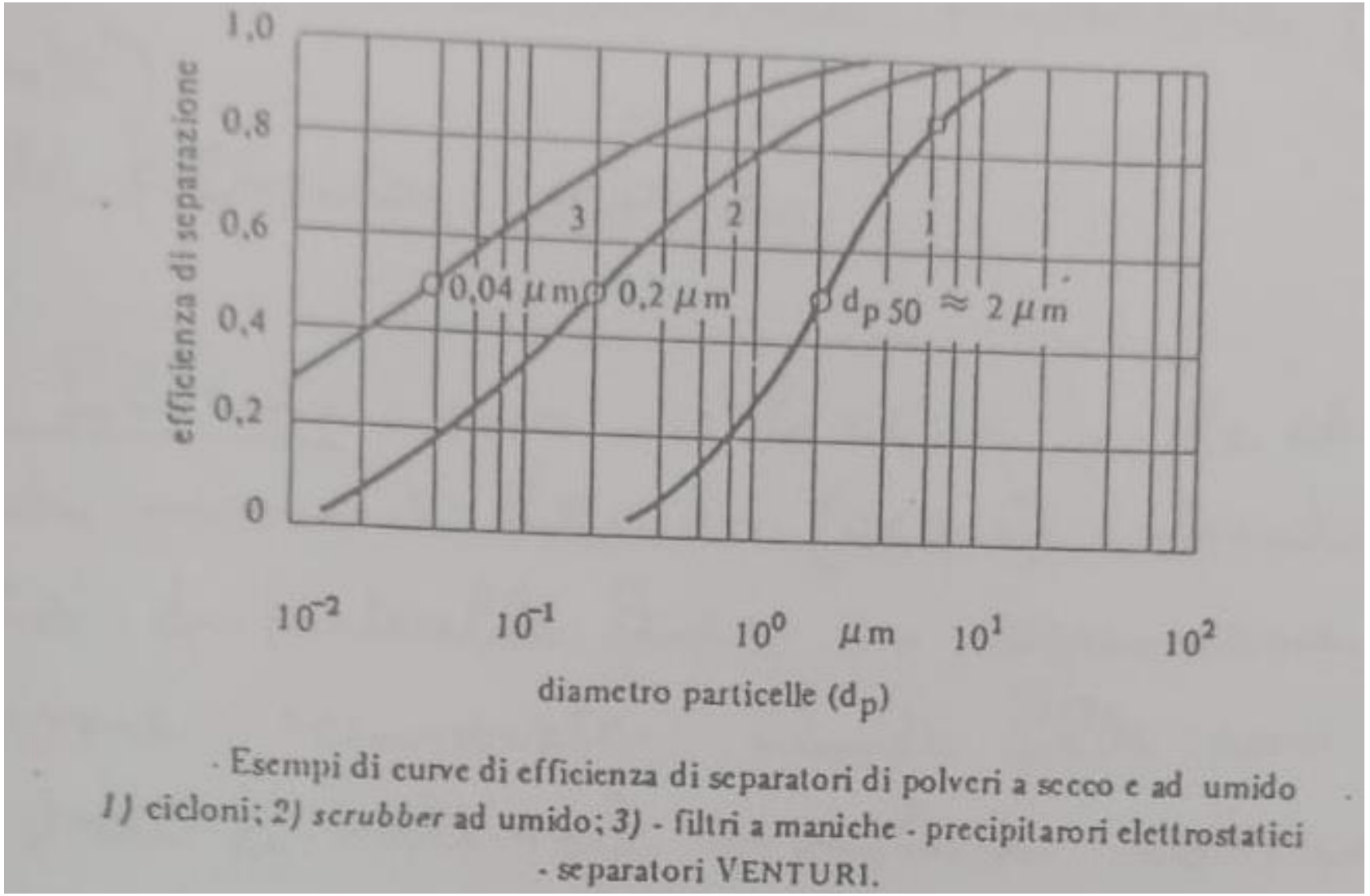


Senza contatto diretto con l'aria

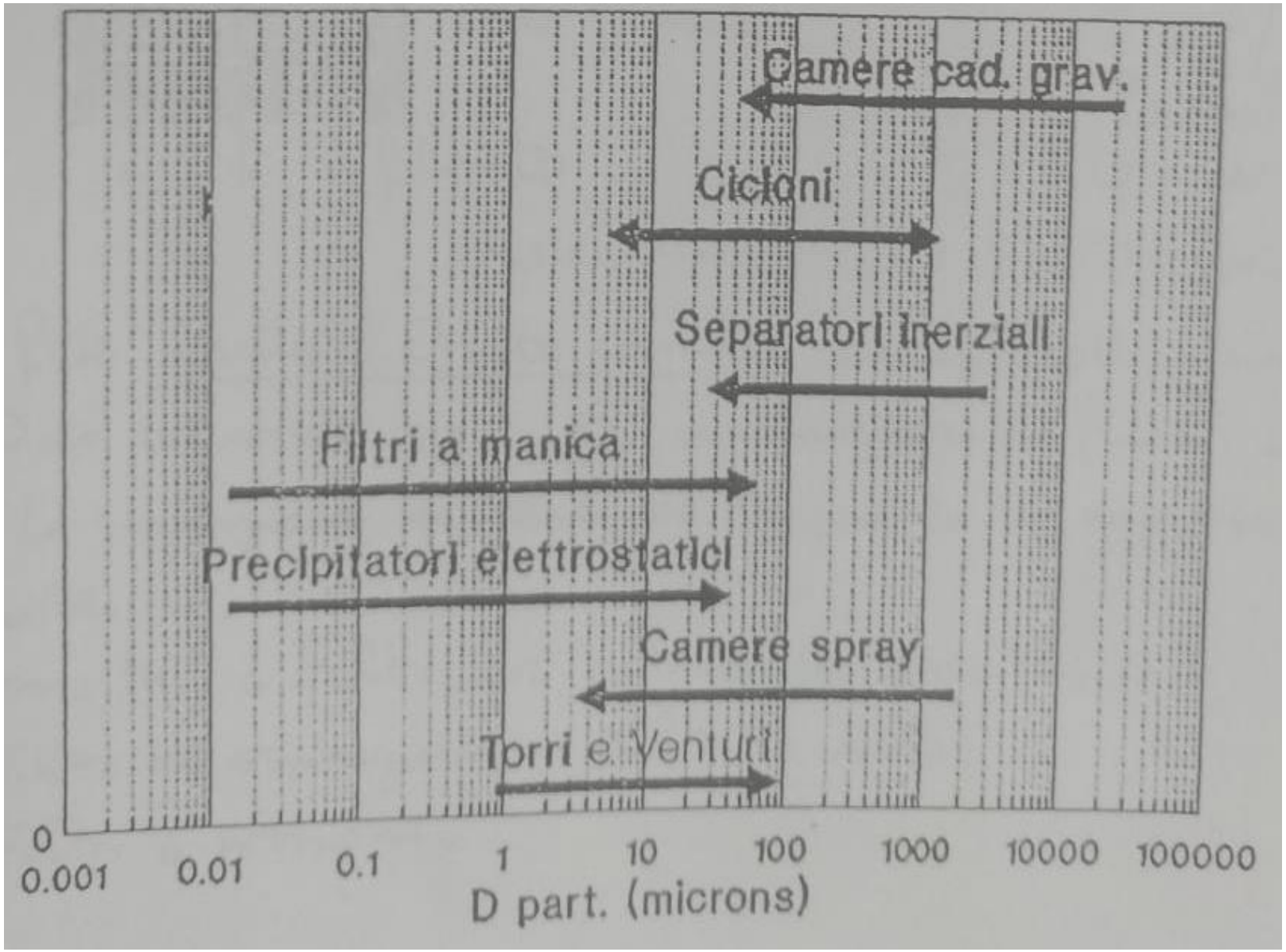


(d)

Essiccatore spray



- Esempi di curve di efficienza di separatori di polveri a secco e ad umido
1) cicloni; *2) scrubber* ad umido; *3)* - filtri a maniche - precipitatori elettrostatici - separatori VENTURI.


Camere cad. grav.
Cicloni
Separatori inerziali
Filtri a manica
Precipitatori elettrostatici
Camere spray
Torri e Venturi
0
0.001
0.01
0.1
1
10
100
1000
10000
100000
D part. (microns)