D.PHARM • FIRST YEAR

Pharmaceutics

CHAPTER 4.4

Filtration



ENGLISH CHAPTER NOTES

DIPLOMA IN PHARMACY

FILTRATION

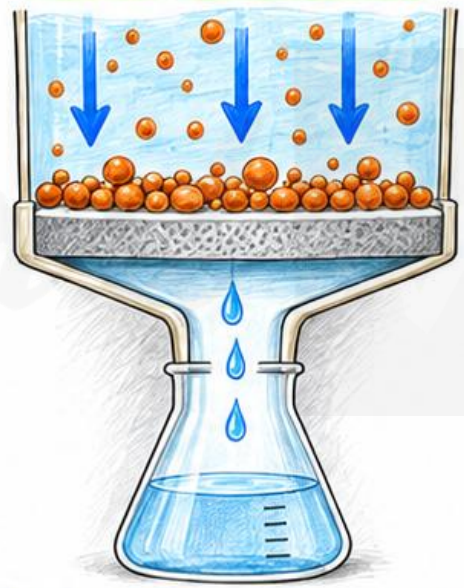
Filtration separates suspended solids from a fluid using a porous medium.

OBJECTIVES

- Clarify a liquid or gas by removing particles.
- Recover a useful solid cake or concentrate suspended solids.
- Protect downstream equipment and improve product quality.
- Use validated sterilizing filtration for suitable solutions when required.

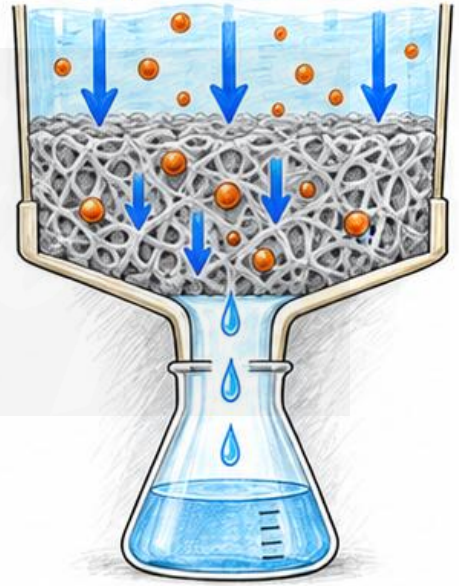
MECHANISMS

Surface filtration



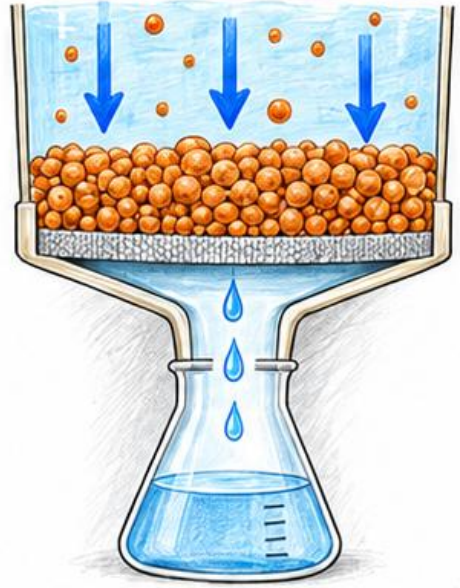
Surface filtration: particles are retained mainly on the medium surface.

Depth filtration



Depth filtration: particles are trapped within a porous medium.

Cake filtration



Cake filtration: deposited solids form a layer that also acts as a filter.

★ Filtration does not automatically remove dissolved chemicals, endotoxins or every microorganism.

FACTORS AFFECTING FILTRATION

Flow depends on the driving force and resistance of the medium and cake.

FLUID AND PARTICLES

- High viscosity generally reduces filtration rate.
- Temperature may lower viscosity, but product stability must be protected.
- Particle size, shape and concentration influence retention and cake structure.
- Fine or compressible particles can form a high-resistance cake.



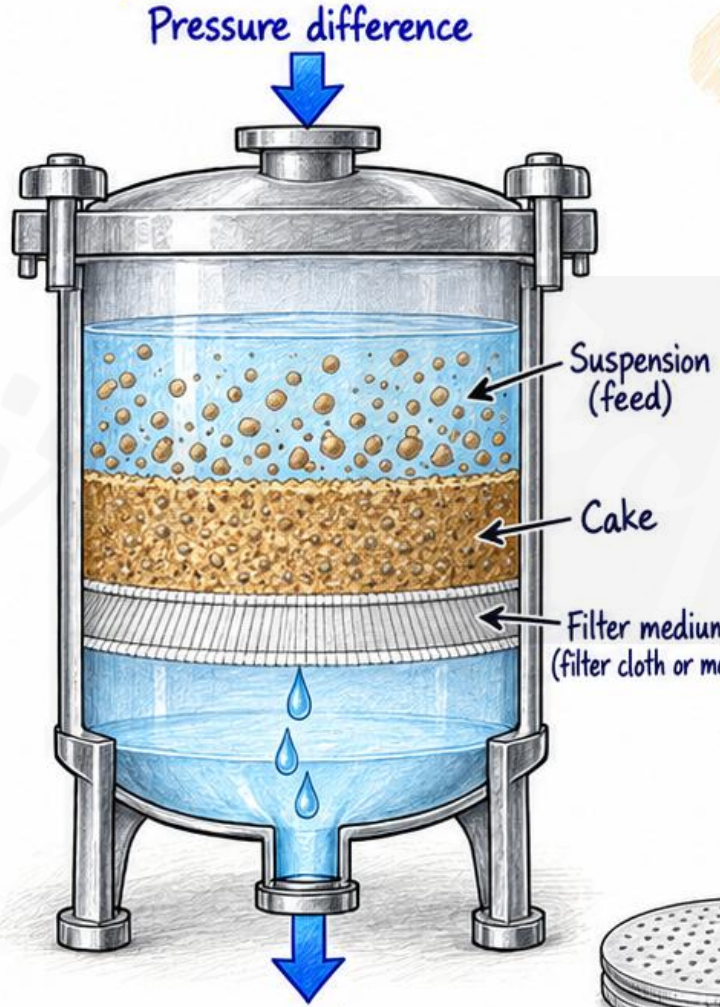
High viscosity (slower flow)



Lower viscosity (faster flow)



Particle size, shape and concentration

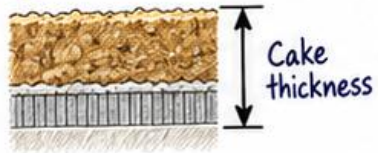


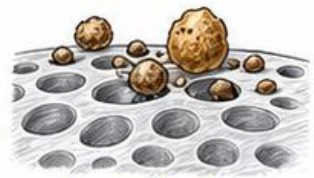
EQUIPMENT AND OPERATION

- Greater effective filter area usually increases capacity.
- Pressure difference drives flow through the filter.
- Pore structure, cake thickness and clogging increase resistance.
- Excess pressure can compact a compressible cake rather than improve flow.
- Select conditions that give adequate clarity without damaging product quality.



Greater effective filter area





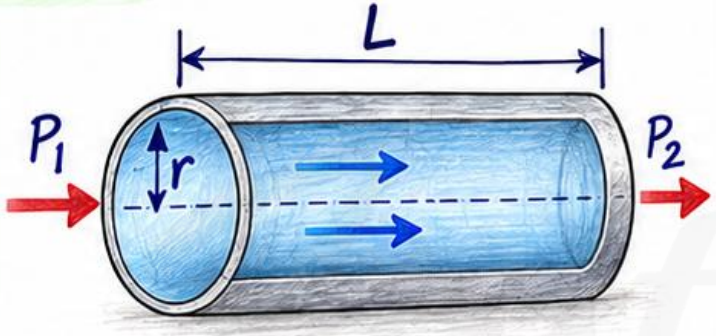
Pore structure and clogging

FLOW LAWS IN FILTRATION

These idealized relations connect flow with pressure, viscosity and geometry.

POISEUILLE'S LAW

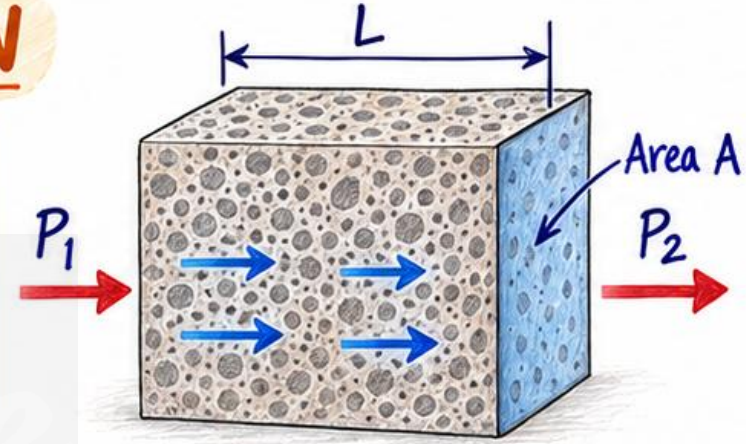
$$Q = \frac{\pi r^4 \Delta P}{8 \eta L}$$



- Describes laminar flow through a cylindrical capillary.
- r: radius. L: capillary length. η: dynamic viscosity.
- Larger radius strongly increases flow because Q depends on r^4.

DARCY'S LAW

$$Q = \frac{kA\Delta P}{\eta L}$$



- Describes flow through a porous medium under suitable conditions.
- k: permeability. A: filter area. L: medium thickness.

COMMON SYMBOLS

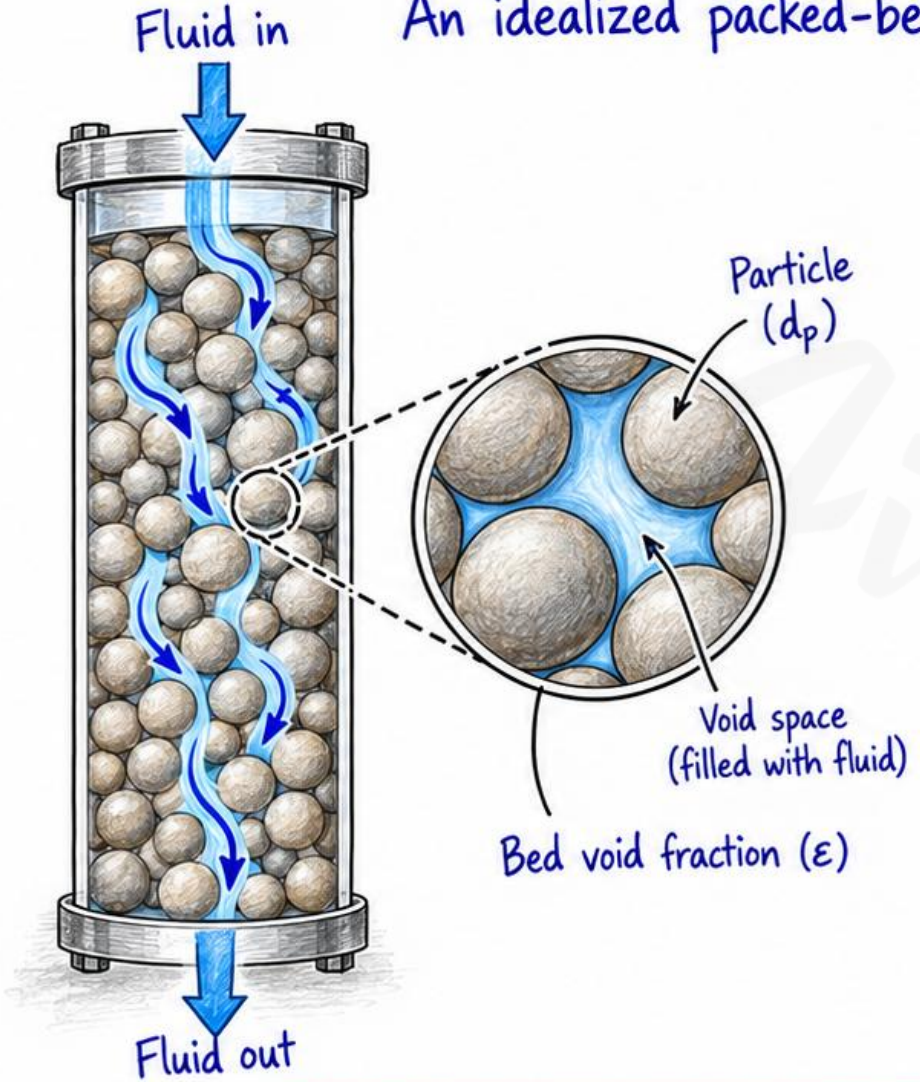
Q: volume flow rate. ΔP: pressure difference.

Higher viscosity or thickness lowers flow; higher area or pressure increases it when resistance is unchanged.

These models require appropriate assumptions; real cakes can change resistance.

CARMAN-KOZENY EQUATION

An idealized packed-bed relation describes viscous flow through particle spaces.



EQUATION

$$\frac{\Delta P}{L} = \frac{180 \eta v (1-\varepsilon)^2}{d_p^2 \varepsilon^3}$$

SYMBOLS

- ΔP: pressure drop.
- L: bed thickness.
- η: dynamic viscosity.
- v: superficial velocity.
- ε: bed void fraction.
- d_p: particle diameter.

INTERPRETATION

- Smaller particles and lower void fraction increase resistance.
- Greater viscosity, velocity or bed thickness increases pressure drop.
- The stated form assumes a suitable bed of approximately uniform spherical particles and laminar flow.
- The coefficient is model-dependent, not a universal filtration constant.
- Real irregular or compressible cakes may not follow this ideal equation.

⚠ **Caution:** Real irregular or compressible cakes may not follow this ideal equation.

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