SOLID-LIQUID SEPARATION: FILTRATION

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Downstream Processing Course

FILTRATION THEORY

Poiseulle's Law

$$\frac{1}{A}\frac{dV}{dt} = \frac{\Delta P}{\mu(R_m + R_c)}$$

Filtration Rate

Broth Viscosity

Resistance to Flow

Cake Resistance

$$R_m = \frac{\alpha W}{A}$$

Specific Cake Resistance

$$\alpha = \alpha' \Delta P^S$$

V=filtrate volume
A=Filter area
t=Time
ΔP=Pressure Driving Force
μ=Broth viscosity
W=Mass of filter cake
R=Resistance
α=Specific cake resistance
S=Compressability factor

The filter resistance is much less than the cake resistance

Rc<<Rm

$$\frac{1}{A}\frac{dV}{dt} = \frac{\Delta P}{\mu(\frac{\alpha' \Delta P^{S} W}{A})}$$

When the filter cake is incompressible, S=0

$$\frac{1}{A}\frac{dV}{dt} = \frac{\Delta P}{\mu(\frac{\alpha' W}{A})}$$

When the filter cake is very compressible, S=1.0

$$\frac{1}{A}\frac{dV}{dt} = \frac{1}{\mu(\frac{\alpha' W}{A})}$$

Flocculation of Cells

Sedimentation Rate

$$V_S = \frac{d_p^{\ 2}(\rho_p - \rho_s)}{18\mu} g_c$$

Filtration Rate

$$\frac{dV}{dt} = \frac{k\Delta P}{VS_0^2}$$

S_0=K'(1/D_p)^2

S_0^2 = K''/D_p^4

$$\frac{dV}{dt} = \frac{k_0 \Delta P D_p^4}{V}$$

Mechanism of Flocculation

- **Particle bridging**
- **Charge neutralization**
- **Charge patch neutralization**

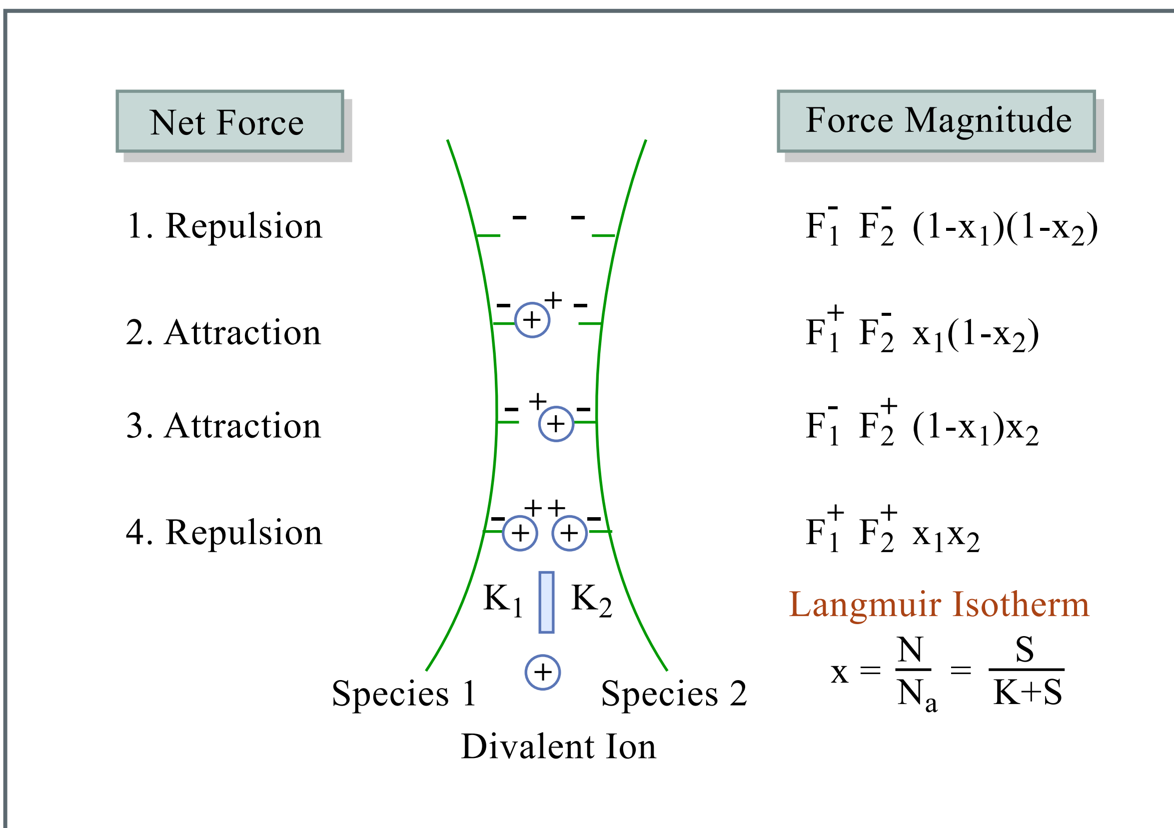
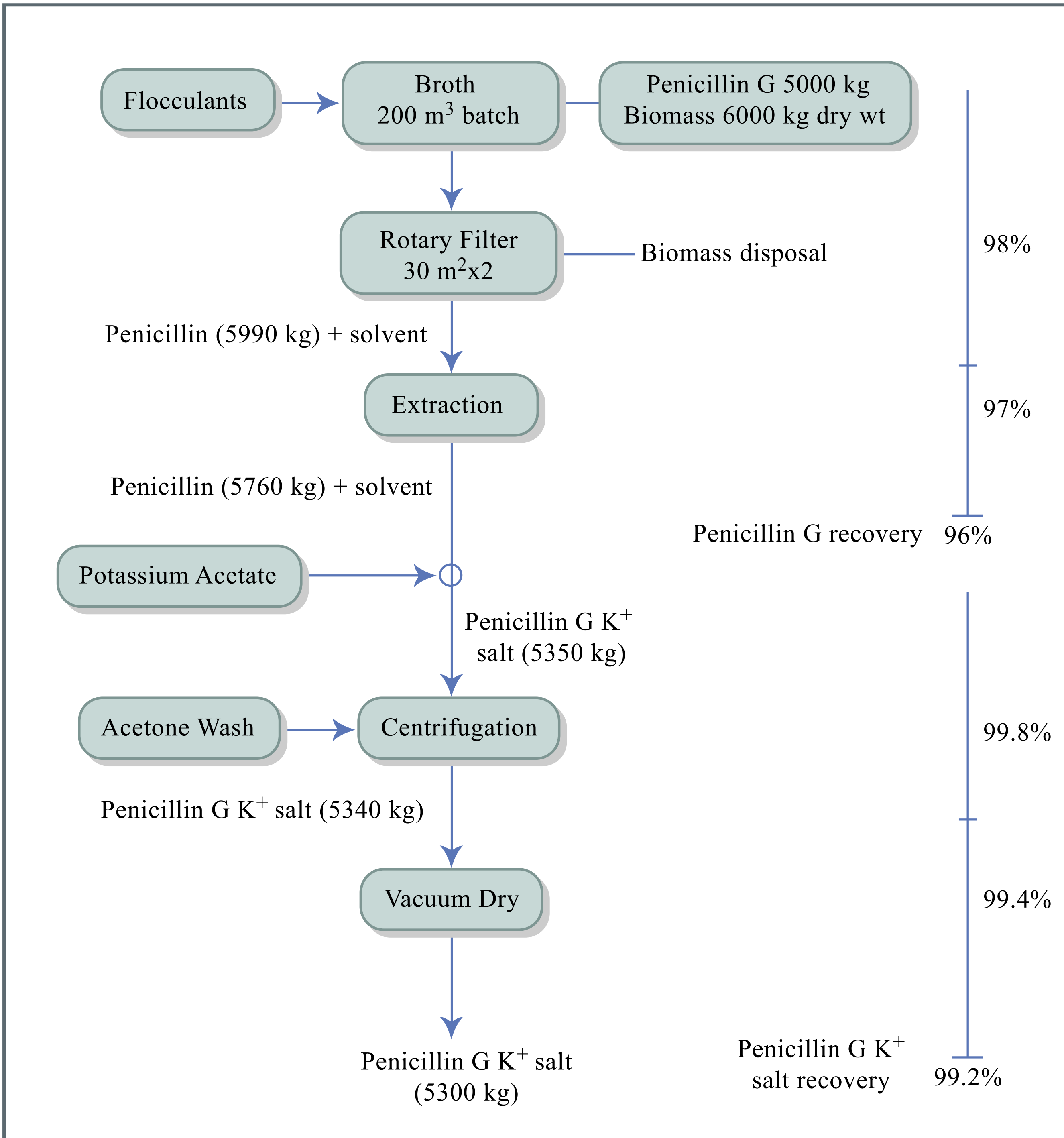


Figure by MIT OCW.

Recovery of Penicillin G from 200 m^3 Fermentation



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