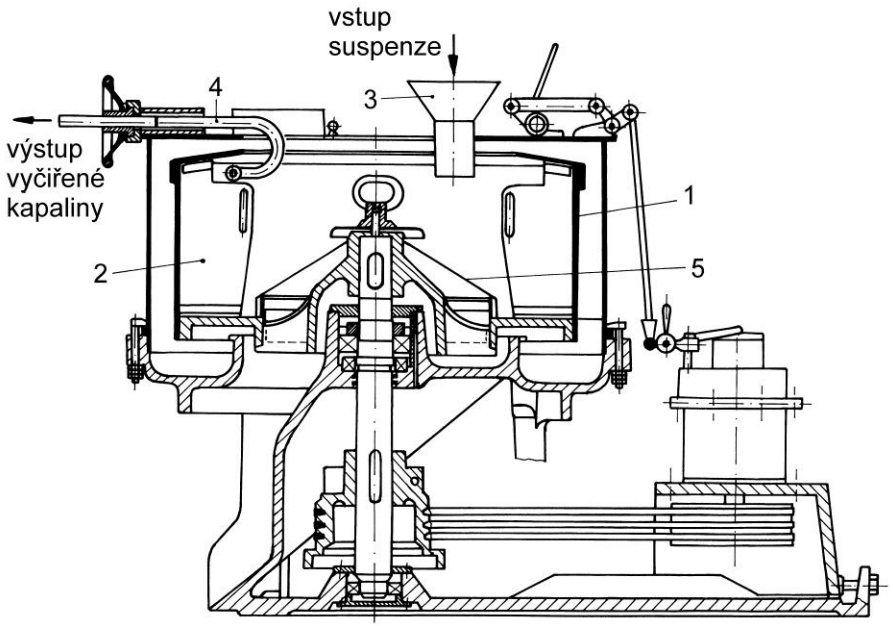
CENTRIFUGAL SEPARATION PROCESSES

Settling or separation of particles from fluid by centrifugal forces acting on the particles. The particles can be solid, gas or liquid drops and the fluid can be a liquid or a gas.

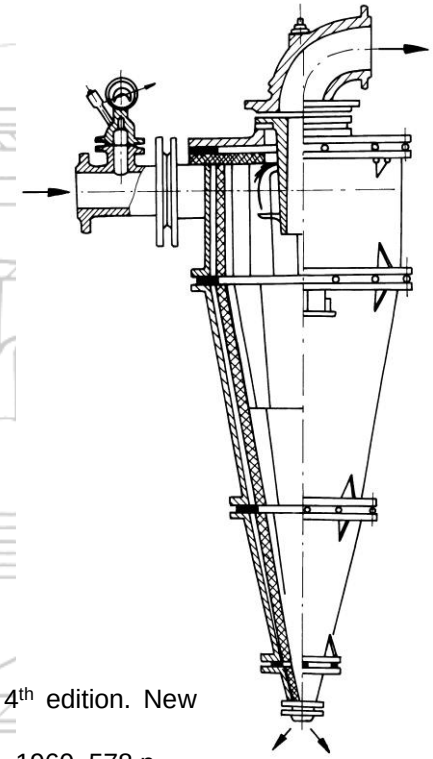
Centrifuges

bowl with liquid rotates



Cyclones

stationary apparatus, mixture rotates



- Geankopolis, C. J.: ***Transport Processes and Separation Process Principles.*** 4th edition. New Jersey: Publishing as Prentice Hall PTR, 2003.1026 p. ISBN 0-13-101367-X.
- Foust, A. S. et al.: ***Principles of Unit Operations.*** New York: Jon Wiley & Sons, Inc., 1960. 578 p.
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Action of centrifugal force on particle

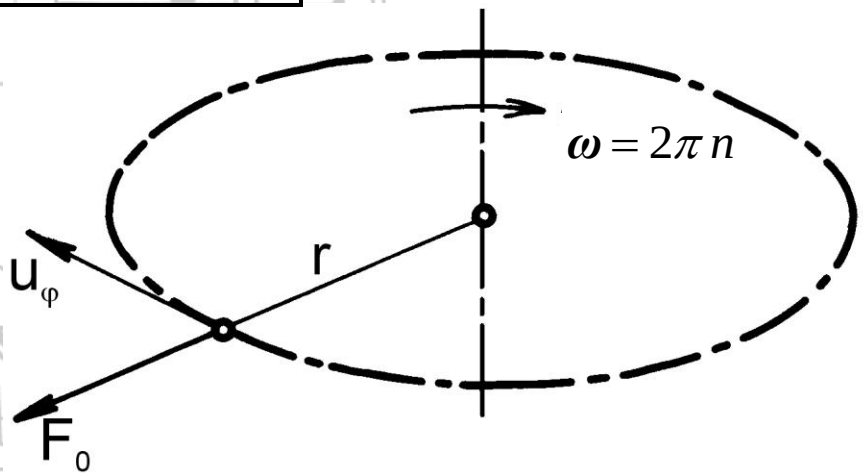
Centrifugal force

$$F_o = V\rho_s a_o = V\rho_s r\omega^2 = V\rho_s \frac{u_\varphi^2}{r} = 4\pi^2 V\rho_s n^2 r$$

centrifugal acceleration

Buoyant force by centrifugal power on liquid with density ρ having same angular velocity as particle acts on rotating particles.

$$F_{ov} = 4\pi^2 V\rho n^2 r$$



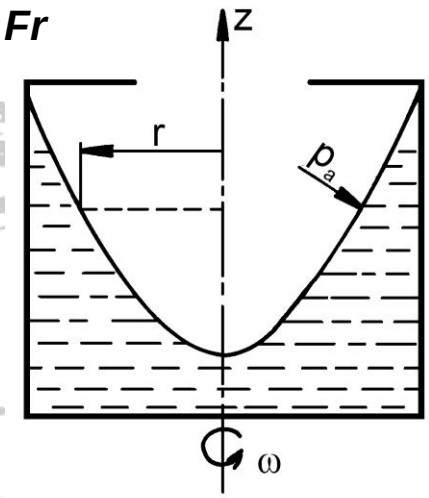
Action of ***Gravitation force*** on particle and fluid has practically negligible effect in centrifuges compared to centrifugal forces. Ratio of centrifugal to gravitation force has for centrifuges value in range $50 \div 5\cdot10^4$ and for ultra-centrifuges up to $1\cdot10^6$.

Froude number

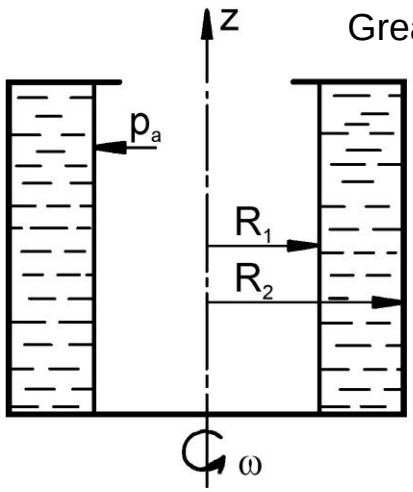
$$Fr = \frac{F_o}{G} = \frac{u_\varphi^2}{rg}$$

Action of centrifugal force on fluid

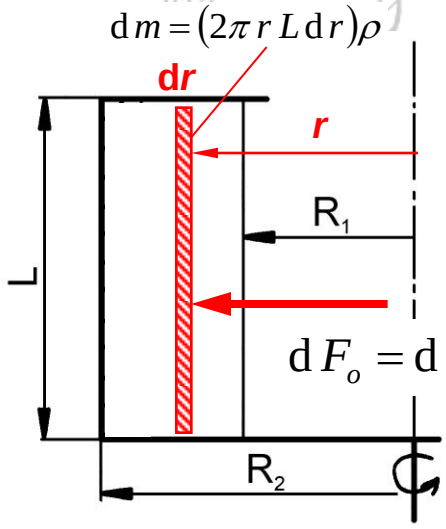
Low value of ***Fr***



Great value of ***Fr***



Pressure acting on the liquid



$$dp = \frac{dF_o}{S} = \rho\omega^2 r\,dr \Rightarrow p = \frac{1}{2}\rho\omega^2 r^2 + const.$$

$$S = 2\pi r L$$

Pressure acting on the bowl shell

$$p = p_a + \frac{1}{2}\rho\omega^2\left(R_2^2 - R_1^2\right)$$