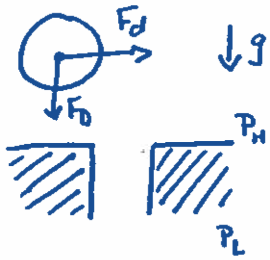
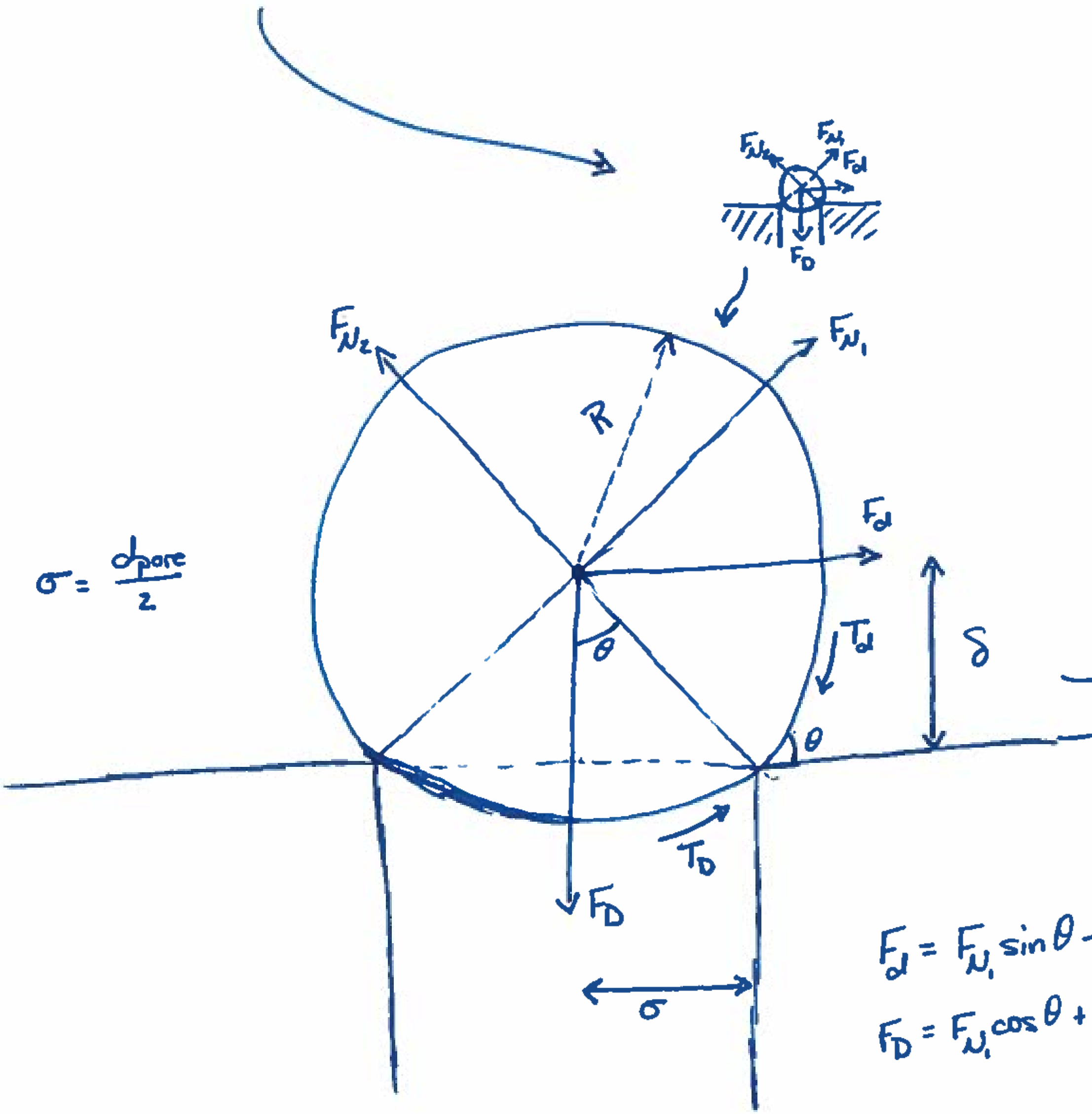
Particle capture, 7/13/16 w/ help from Tejas:
- Updated 7/7/17



$$F_D = F_g + F_{TMP}$$
$$= mg + \Delta P \cdot A_{pore}$$

$$F_d = 6\pi\mu R V$$



$$\sigma = \frac{d_{pore}}{2}$$

$$F_{N_2} = F_{N_2}\sin\theta + F_{N_2}\cos\theta$$
$$F_{N_1} = F_{N_1}\sin\theta + F_{N_1}\cos\theta$$

$$F_d = F_{N_1}\sin\theta - F_{N_2}\sin\theta$$
$$F_D = F_{N_1}\cos\theta + F_{N_2}\cos\theta$$

$$T_d = F_d \cdot \delta + F_{N_1} \cdot R$$
$$T_d = F_D \cdot \sigma$$

Solve for the normal forces:

$$F_d = F_{N_1}\sin\theta - F_{N_2}\sin\theta$$

$$\frac{F_d}{\sin\theta} = F_{N_1} - F_{N_2} \; ; \; F_{N_1} = F_d\csc\theta + F_{N_2}$$

$$F_D = F_{N_1}\cos\theta + F_{N_2}\cos\theta$$

$$\frac{F_D}{\cos\theta} = F_{N_1} + F_{N_2}$$

$$F_D\sec\theta = F_d\csc\theta + F_{N_2} + F_{N_2}$$

$$F_{N_2} = \frac{F_D\sec\theta - F_d\csc\theta}{2}$$

$$F_{N_1} = F_d\csc\theta + F_{N_2}$$

$$F_{N_1} = F_d\csc\theta + \frac{F_D\sec\theta - F_d\csc\theta}{2}$$

$$F_{N_1} = \frac{F_d\csc\theta + F_D\sec\theta}{2}$$

Balance the torque on the particle; when it is stuck, the torques are equal:

$$T_d = T_D$$

$$F_d\cdot\delta + F_{N_1}\cdot R = F_D\cdot\sigma$$

Solve for the condition where the pressure is enough to retain the particle:

$$T_D > T_d$$

$$F_D\sigma > F_d\delta + F_{N_1}\cdot R$$

$$(mg + \Delta P\cdot A_{pore})\frac{d_{pore}}{2} > 6\pi\mu RV\cdot\delta + \left[\frac{(mg + \Delta P\cdot A_{pore})\sec\theta - (6\pi\mu RV)\csc\theta}{2}\right]\cdot R$$

continued from (2):

$$\left(mg+\Delta P\cdot A_p\right)\frac{d_p}{2} > 6\pi\mu RV\delta + \frac{(mg+\Delta P A_p)\sec\theta - (6\pi\mu RV)\csc\theta}{2}\cdot R$$

$$(mg+\Delta P A_p)d_p > 12\pi\mu RV\cdot\delta + \left((mg+\Delta P A_p)\sec\theta - (6\pi\mu RV)\csc\theta\right)\cdot R$$

$$(mg+\Delta P A_p)d_p - \left[(mg+\Delta P A_p)\sec\theta\right]R > 12\pi\mu RV\cdot\delta - \left[(6\pi\mu RV)\csc\theta\right]\cdot R$$

$$mg(d_p - R\sec\theta) + \Delta P(A_p d_p - A_p R\sec\theta) > 12\pi\mu RV\cdot\delta - 6\pi\mu RV\csc\theta\cdot R$$

$$\Delta P\cdot(A_p d_p - A_p R\sec\theta) > 6\pi\mu RV(2\delta - R\csc\theta) - mg(d_p - R\sec\theta)$$

$$\boxed{\Delta P > \frac{6\pi\mu RV(2\delta - R\csc\theta) - mg(d_p - R\sec\theta)}{(A_p d_p - A_p R\sec\theta)}}$$

Is the pressure required to retain the particle on the pore.