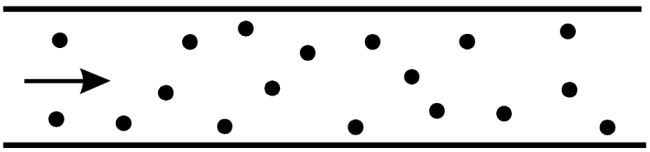
Multiphase Flow
Fall 2021
Hyungmin Park

Homework #1
Due: October 5 (Tuesday), 2021

*You may submit your homework to TA (chl_ghdtjr@naver.com) by email or submit to 313-222.

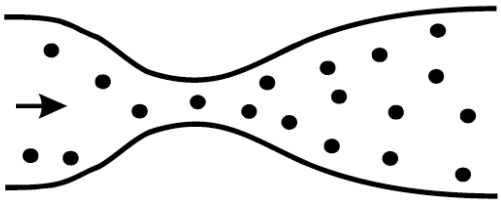
1. Consider a sand-water slurry mixture that has a concentration of 0.3. Find the particle volume fraction and the inter-particle spacing (normalized by the particle size). Use the typical material property of sand and water.

2. Droplets are released in a hot air stream and evaporate as they are convected with the flow as shown. The mass coupling parameter is small while the latent heat coupling parameter is large. Sketch the variation of the gas temperature, gas velocity, gas density, and droplet velocity for both one-way and two-way coupling in the duct.



3. Coal particles, 100 μm in diameter and with a material density of 1200 kg/m^3, flow in an air stream into a venturi section with a 2-cm diameter throat. The flow velocity at the throat is 10 m/s, the loading is 1.0 and the air viscosity is 1.8×10^{-5} Ns/m^2. Evaluate the magnitude of the momentum coupling parameter. Assume that the loading is a measure of the concentration.

4. A gas-particle flow accelerates through a venturi as shown. Sketch the pressure distribution through the venturi for a small momentum and large momentum coupling parameter, respectively, and explain the rationale for your choice.



5. Water droplets are evaporating in an air flow at standard pressure and temperature. The air flow rate is 1.0 kg/s and the water flow rate is 0.01 kg/s. The droplet velocity is 30 m/s and the droplet diameter is 100 microns. The pipe diameter is 5 cm. The evaporation time for a water droplet is given by $\tau_e = D^2/\lambda$, where D is the droplet diameter and λ is the evaporation constant equal to 0.02 cm^2/s for water droplets. Evaluate the mass coupling parameter and the energy coupling due to mass transfer (latent heat). Is mass coupling or energy coupling important?