Liquid-solid separation Exercices

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Calculation of settling velocity

1. Calculate the terminal settling velocity in water at 20 °C for the particles below, using the appropriate model/flow regime (proceed iteratively if needed).

   The properties of water (at 20°C) are: ρ = 0.9982 g/cm3 μ = 1.0 mPa·s

Particle	Diameter [µm]	Density [g·cm^{-3}]
E. coli	1.2	1.01
S. cerevisiae	6.0	1.01
Microcarrier	150	1.02
Seasand	400	2.65
Lead shots	1500	11.40

2. What would be the impact of a temperature increase on the settling velocity?

Centrifugation of algae

Chlorella cells are grown in an open pond and this biomass needs to be harvested using a disk stack centrifuge. The terminal settling velocity of the cells in water at 20 °C, $v_{lim,p}$, has been measured and is equal to $1.07 \cdot 10^{-4}$ cm/s. The flow is laminar.

The centrifuge has 80 disks with an angle of 40° from the vertical. These disks have an external radius of 15.7 cm, while the internal radius is 6 cm. It is planned to work at 6000 rpm.

1. Estimate the equivalent diameter of the cells if their density is 1.01 g·cm^{-3}

2. Calculate the volumetric capacity of the centrifuge under the above-described working conditions

Filtration of calcium silicate

Calcium silicate particles have been filtered on a paper disk 9 cm in diameter and at two different values of Δp, namely 69 and 138 kPa. The liquid is water at 20 °C, which has the following properties: $\rho = 0.9982$ g/cm^3 $\mu = 1.0$ mPa·s. The solid concentration in the suspension, c_{ms}, is measured at 50 kg/m^3.

The filtrate volume has been registered as a function of time. The corresponding data are in the table below.

1.   Determine the filter resistance R_F and the cake specific resistance α for each trial.
2.   Is the cake of a compressible nature?

Δp= 69 kPa

t [s]	0.0	2.0	5.0	8.6	15.1	21.8	39.9	66.0	95.7
V_f [L]	0.000	0.096	0.198	0.294	0.398	0.497	0.698	0.900	1.098

Δp=138 kPa

t [s]	0.0	2.0	4.5	7.0	15.8	28.6	45.0	63.3	82.0
V_f [L]	0.000	0.104	0.203	0.304	0.507	0.702	0.903	1.106	1.202