

BCHE 4520
Test 2
October 2, 2026

You have decided to go into the juice-making business with a marketing student friend. You are designing a process to filter incompressible solids from raw pomegranate juice using a small rotary vacuum filter you purchased on eBay. The drum is 80 cm long and has a diameter of 40 cm. You want to filter 100 cm³/s. The cake parameter having the collection of terms $\mu\alpha\rho_c/2\Delta P$ has previously been found to be 55 s/cm² and R_M is negligible. The unit has a submerged fraction β equal to 0.29.

- a) What cycle time of the unit is necessary to filter this material adequately?
- b) The cake will need to be washed, and you read on a juice-making blog that the washing step has an efficiency of 70%. About 5% of the volume of the original liquid is entrained in the fluid, and you want to wash the cake so that only 4% of that original entrained liquid remains.
 - i. What should the washing time be in this process?
 - ii. What is the angle of the drum that should receive washing?
- c) You decide that you might occasionally have a juice stream that exceeds 100 cm³/s. Should you operate the drum at a higher or lower rate of filtration or does it matter? Explain.

$A = \pi D L = 3.1416(40)(80) = 10054 \text{ cm}^2$
 $Q = 100 \text{ cm}^3/\text{s}$ THIS IS NOT V_F !
 $\frac{\mu\alpha\rho_c}{2\Delta P} = 55 \text{ s/cm}^2$

a) $t_F = 55 \left(\frac{V_F}{A} \right)^2$ $V_F = Q t_c$
 $t_F = \beta t_c$
 so $\beta t_c = 55 \left(\frac{Q t_c}{A} \right)^2$
 OR $t_c = \frac{A^2 \beta}{55 Q^2} = \frac{(10054)^2 (0.29)}{55 (100)^2} = \underline{\underline{53.35}}$

b) $R = (1 - E)^n$
 $0.04 = (1 - 0.70)^n$
 $n = \frac{\ln(0.04)}{\ln(0.30)} = 2.67$
 $t_w = 2 t_F n^2 = 2(\beta t_c) n^2 = 2(0.29)(53.35)(2.67)(0.05) = \underline{\underline{4.15}}$
 ANGLE FOR WASHING = $\frac{4.1}{53.3} \times 360^\circ = \underline{\underline{28^\circ}}$
 DIDN'T ASK FOR IT, BUT FILTRATION TIME IS $\beta t_c = 15.5 \text{ s}$ AND
 ANGLE FOR FILTRATION IS $\frac{15.5}{53.3} \times 360 = \underline{\underline{104^\circ}}$

c) $t_c \propto \frac{1}{Q^2}$ so, IF FLOWRATE Q INCREASES, THEN TO CYCLE TIME WILL HAVE TO DECREASE TO ACCOMMODATE HIGHER FLOW. IN OTHER WORDS, RATE OF ROTATION INCREASES.
 ESSENTIALLY, MORE FILTER AREA IS NEEDED IN A GIVEN TIME TO FILTER MORE VOLUME.

SHOULD HAVE USED WORD "ROTATION". MY BAD. TRIED TO CONSIDER FOR GRADING.