Assignment #2
Problems on Economic Analysis of Cyclic Processes
Deadline for assignment : 22 October, 2019

Instructions:

1. Use a clean neat A4 sheet for writing the assignment
2. Do not copy from your friends assignment
3. Try to make your own effort and show all the steps involved the derivations.
4. Avoid skipping the steps in the derivations
5. Submit the assignment on or before the deadline and the deadline for submission is 22nd October, 2017.
6. Do not submit the assignment after the deadline

Problem #1

An organic chemical is being produced by a batch operation in which no product is obtained until the batch is finished. Each cycle consists of the operating time necessary to complete the reaction plus additional time of 1.4h is required for discharging and charging. The operating time per cycle is equal to 1.5 $P_b^{0.25}$ h, where P_b is the kilograms of product produced per batch. The operating costs during the operating period are \$20 per hour, while the costs during the discharge-charge period are \$15 per hour. The annual fixed costs C_F for the equipment vary with the size of the batch in the following manner:

$$C_F = 340 P_b^{0.8} \text{ \$/yr}$$

Inventory and storage charges may be neglected. If necessary, the plant can be operated 24 h/day for 300 days/yr. The annual production is 10^6 kg of product. At this capacity, raw material and miscellaneous costs, other than those already mentioned, amount to \$260,000 per year. Determine the cycle time for conditions of minimum total cost per year.

Problem #2

Tests with a plate-and-frame filter press, operated at constant pressure, have shown that the relation between the volume of filtrate delivered and the time in operation can be represented as:

$$P_f^2 = 18(\Theta_f + 0.11)$$

Where, P_f is the filtrate in cubic meters delivered during Θ_f hours of filtering time. The cake formed in each cycle must be washed with an amount of water equal to 1/16th times the volume of filtrate delivered per cycle. The washing rate remains constant and is equal to 1/4th of the filtrate delivery rate at the end of the filtration. The time required per cycle for dismantling, dumping, and reassembling is 6 h. Under the conditions where the preceding information applies, determine the total cycle time necessary to permit the maximum output of filtrate during each 24 h.

Reference: Max S. Peters, Klaus D. Timmerhaus, Ronald E. West, *Plant Design and Economics for Chemical Engineers*, 5th Edition, McGraw Hill Education.