



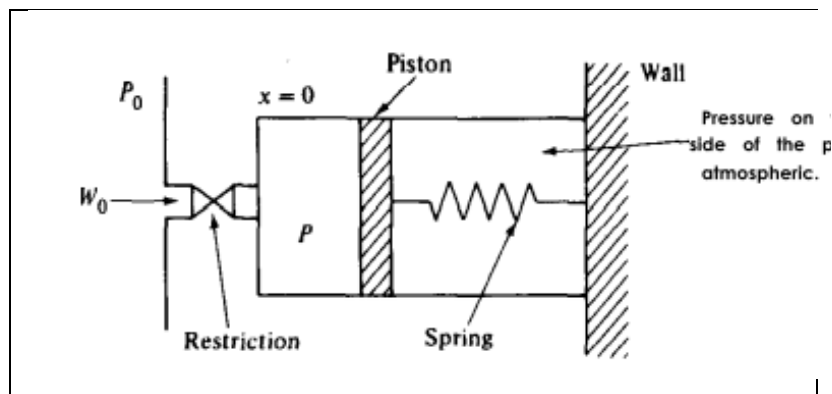
Sardar Beant Singh State University, Gurdaspur  
Department of Chemical Engineering & Bio Technology

Subject: Process Modeling & Simulation

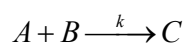
**Assignment No.3**

Topic: Semi Batch Reactor & Piston displacement

Q1. A perfect gas with molecular weight  $M$  flows at  $W_0$  into a cylinder through a restriction. The flow rate is proportional to square root of the pressure drop over the restriction.  $W_0 = k_0 \sqrt{P_0 - P}$ , where  $P$  is the pressure in the cylinder and  $P_0$  is constant upstream pressure. Piston enforced to right direction as pressure build up. A spring resists the movement of the piston with the force that is proportional to the axial displacement  $x$  of the piston



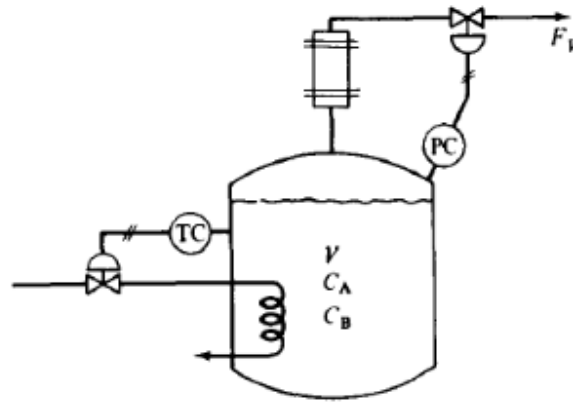
Q2. A semi batch reactor is run at constant temperature by varying the rate of addition of one of the reactants A. The irreversible exothermic reaction is first order in reactants A and B.



The tank is initially filled to its 40% level with pure reactant B at the concentration  $C_{B0}$ . Maximum cooling water flow is begun, and reactant A is slowly added to the perfectly stirred vessel. Write the equations describing the system. Solving the equation, sketch the profile of  $F_A$ ,  $C_A$  and  $C_B$  with time during the batch cycle.

Q3. The reaction  $3A + 2B + C$  is carried out in an isothermal semi batch reactor. B is the desired product. Product C is a very volatile by-product that must be

vented off to prevent a pressure buildup in the reactor. Gaseous C is vented off through a condenser to force any A and B back into the reactor to prevent loss of reactant and product.



Assume  $F_V$  is pure C. The reaction is first-order in  $C_A$ . The relative volatilities of A and C to B are  $\alpha_{AB} = 1.2$  and  $\alpha_{CB} = 10$ . Assume perfect gases and constant pressure. Write the equations describing the system. List all assumptions.

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