Quiz 8 Name:

Please put name on back of last sheet to simplify return.

An unsteady state ideal mixed flow bioreactor is converting glucose (G) and water (W) into acetic acid (A), hydrogen (H), ethanol (E) and carbon dioxide (X) via 2 different enzymatic reactions (see diagram below). The gaseous products leave in a different stream (stream 3) than the liquid components (stream 2) (see diagram).

MFR

V, CG, CW, CH, CA, CH, CE

F1 , CG1, CW1

F2 , CG2, CW2, CA2, CE2

F3 , CX3, CH3

Fj refers to the volumetric flowrate of stream j (gal/hr)

Cij refers to concentration of component i in stream j (mol/gal)

V – reactor volume (gal); Ci – component concentrations in reactor (mol/gal)

Reactions

Reaction 1 GG + WW ->  H +  A + X X rG1 = - Vm1\*CG/[Km1 + CG]

{C6H12O6+2H2O -> 4H2+2C2H4O2+2CO2}

Reaction 2 G2 G -> X2X + E2 E rG2 = - Vm2\*CG/[Km2 + CG]

{C6H12O6 -> 2CO2+2C2H5OH}

ik refers to the stoichiometric coefficient for component i in reaction k

Vmk, Kmk refer to enzymatic reaction rate constants for reaction k (mol/gal-hr, mol/gal)

Reaction rate equations are based on the reaction rate of the glucose component.

Please use general stoichiometric nomenclature (ik) in your component mass balance equations. Chemical structure and numerical stoichiometric coefficients are given only for reference.

Write component mass balances for the reactor system using the nomenclature provided.

Notes:

1. It is not acceptable to simply write ‘in-out+reaction = accumulation’ for the component mass balances. You must use the flow, concentration, and reaction nomenclature given in the problem.
2. You must use the nomenclature given. You will lose points if you do not use the nomenclature given.

Solutions: IN OUT REACTED ACCUMULATED

Glucose F1 CG1-F2CG2-(G1/G1)\*V\*VM1\*CG/[KM1+CG] - (G2/G2)\*V\*VM2\*CG/[KM2+CG] =d(VCG)/dt

Water F1 CW1 - F2 CW2 - (W1/G1)\*V\*VM1\*CG/[KM1 + CG] = d(VCW)/dt

Acetic acid - F2 CA2 - (A1/G1)\*V\*VM1\*CG/[KM1 + CG] = d(VCA)/dt

Hydrogen - F3 CH3 - (H1/G1)\*V\*VM1\*CG/[KM1 + CG] = d(VCH)/dt

Carbon dioxide - F2 CX3-(X1/G1)\*V\*VM1\*CG/[KM1+CG]-(X2/G2)\*V\*VM2\*CG/[KM2+CG]= d(VCX)/dt

Ethanol - F2 CE2 - (E1/G1)\*V\*VM1\*CG/[KM1 + CG] = d(VCE)/dt

Notes:

G1, W1, G2 < 0 H1, A1, X2, X2, E2 > 0

Since there are 2 outlet streams in the process, the outlet flow concentrations are not numerically the same as the concentrations in the reactor, e.g. CE is not the same as CE2

This is not a steady state system, so all the parameters may be functions of time (with the exception of the reaction rate constants and stoichiometry)