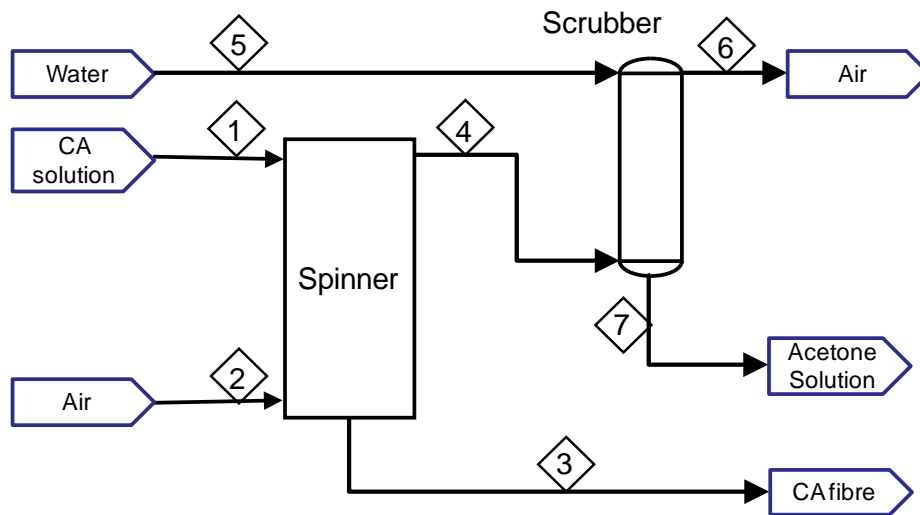


**CME 265 Process Analysis Midterm 1
February 9, 2011**

The exam is 50 minutes long.
 Approved programmable calculators, textbooks and one 8.5x11" crib sheet permitted.
 Do ALL questions and provide all answers on the question sheet.
 Observe standard notation and problem solving methods for all solutions.

1. In the steady state spinning process shown below, cellulose acetate fibres (CA, stream 3) are spun from a solution of CA and acetone (stream 1). The liquid fibres are dried with warm air (stream 2), and all of the acetone leaves with the air (stream 4). The majority of the acetone is absorbed into water (stream 5) in a scrubber, and recycled back to the process for acetone recovery (stream 7). The exiting air contains a small percentage of acetone (stream 6) which is neglected for the moment.



Air: M=29; SG is unknown
 Acetone (C₃H₆O): M=58; SG=0.791
 Cellulose Acetate: molar mass and SG are unknown

Material Balance Table: Mass Basis SS, no rxn: IN=OUT

Component	1	2	3	4	5	6	7
Cellulose acetate (CA)	0.20	-	1.0	-	-	-	-
Acetone (S)	0.80	-	-	x _{S4} =_____	-	-	x _{S7}
Air (A)	-	1.0	-	x _{A4} =_____	-	1.0	-
Water	-	-	-		1.0	-	x _{w7}
Flow (T/day)	50	F ₂	F ₃	F ₄	2	F ₆	F ₇

- a) (10 points) Stream 4 is 20 mole percent acetone. Convert this composition to a mass basis, and enter the result in the material balance table.

- b) (10 points) Now that you have solved for the stream 4 composition, complete a degrees of freedom analysis on the process. *If you were not able to solve part (a), use $x_{S4}=0.20$ and $x_{A4}=0.80$.*

Process step	Spin	Scrubber	Overall
Streams			1,2,3,5,6,7
Unknowns			6
Material Balances			4
$\sum x_i$			1
Process Spec			0
Basis			0
Degrees of freedom			1

- c) (5 points) What vessel(s) or process step(s) should be chosen as the starting point for the material balance solution? Why?

NAME _____

d) (10 points) Write the material balances and other equations which apply to the spinner, and solve as many as possible.

e) (15 points) Complete the material balances for the rest of the process, solving for all remaining unknowns.

2. The production of acetylsalicylic acid involves two reaction stages, cooling, and a final filtration step. In the first stirred tank reactor, two feed streams (crystalline salicylic acid (SA), and pure acetic anhydride (H)) are combined at 70°C. The product stream from the first reactor contains some unreacted H and the products acetylsalicylic acid (ASA) and acetic acid (AA). This stream is fed to a second stirred tank reactor, where fresh water (W) is added and the remaining H reacts to completion, giving a liquid product stream of ASA and AA. The product stream from the second reactor is cooled in a heat exchanger to crystallize the ASA out of solution, and then filtered to separate the wet ASA crystals from the liquid AA byproduct.

a) (15 points) Draw a flowsheet of the process using best practices and equipment icons.

b) (10 points) Complete the material balance table below, following the notation in the first two streams. If a component is present, insert the appropriate x_{ij} variable. Otherwise, insert a dash (-). The stream numbers must match your flowsheet above: add or delete columns if necessary.

Component	1	2	3	4	5	6	7	8	9
SA	$x_{SA,1}$	-							
H	-	$x_{H,2}$							
W	-	-							
ASA	-	-							
AA	-	-							
Flow	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8	F_9