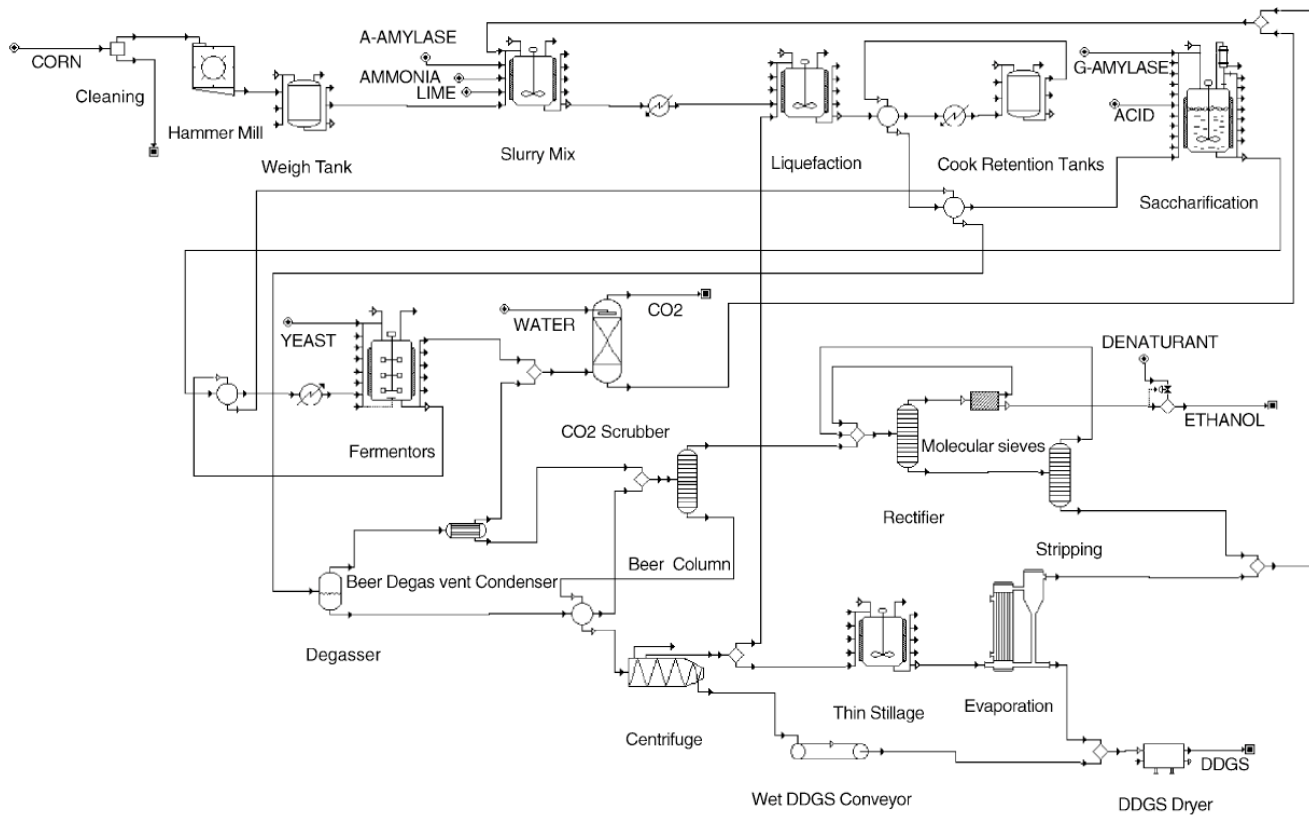


**CENG 122 Separation Processes**  
**Homework Assignment #1, Due on 10-13-09 (in class)**  
Homework office hour: Tuesday 5:00PM – 6:00PM

**PROBLEM 1 (30 points):**

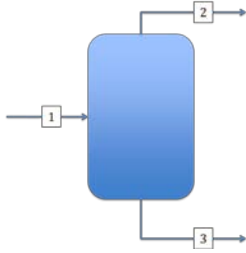
The corn dry-grind process is the most widely used method in the U.S. for generating fuel ethanol by fermentation of grain. Increasing demand for domestically produced fuel and changes in the regulations on fuel oxygenates have led to increased production of ethanol mainly by the dry-grind process. Below is a block flow diagram of the corn dry-grind process. (Reference: Kwiatkowski et al. *Industrial Crops and Products*, 2006. [Article Link](#), Activate your UCSD proxy setting to access the article outside the UCSD network)

Review the block flow diagram carefully, identify all of the separation techniques involved in this process and use one sentence to describe each separation technique (**6 points per distinct separation technique**).



**PROBLEM 2 (50 points):**

A distillation process contains 70 plates is carried out at 700kPa with a condenser duty of 27,300,000kJ/hr. Using the following data and an infinite surrounding temperature 298.15K, compute the following:



	Feed (1)	Distillate (2)	Bottoms (3)
Phase	Liquid	Liquid	Liquid
Temperature (K)	348	323	343
Pressure (kPa)	1950	700	700
Ethalpy (kJ/kmol)	17000	13420	15840
Entropy (kJ/kmol-K)	25.05	5.87	21.22
Flow rate (kmol/hr)	445.5	175.5	270

- The duty of the reboiler in kJ/hr; **(10 points)**
- The irreversible production of entropy in kJ/hr-K, assuming the use of cooling at a nominal temperature of 25°C for the condenser and saturated steam at 100°C for the reboiler; **(10 points)**
- The lost work in kJ/hr; **(10 points)**
- The minimum work of separation in kJ/hr; **(10 points)**
- The second-law efficiency. **(10 points)**

(You can assume the shaft work of the reflux pump is negligible)

**PROBLEM 3 (20 points):**

The separation of isopentane ( $iC_5$ ) from n-pentane ( $nC_5$ ) by distillation is difficult (approximately 100 trays are required), but is commonly practiced in industry. Using the extended Antoine vapor pressure equation (2-39, textbook), with the constants below and in conjunction with Raoult's law, calculate relative volatilities for the isopentane/n-pentane system and compare the values on a plot with the following smoothed experimental values.

Temperature, F	$\alpha_{iC_5, nC_5}$
125	1.26
150	1.23
175	1.21
200	1.18
225	1.16
250	1.14

What do you conclude about the applicability of Raoult's law in this temperature range for this binary system? Vapor pressure constant for (2.39) with vapor pressure in kPa and temperature in K are:

	$iC_5$	$nC_5$
$k_1$	13.6106	13.9778
$k_2$	-2345.09	-2554.6
$k_3$	-40.2128	-36.2529
$k_4, k_5, k_6$	0	0