Chemical Engineering 140 **November 4, 2009**

Midterm Examination #2

(135) 1. The catalytic dealkylation of toluene to benzene involves recycling of unreacted toluene after removal of byproduct phenylbenzene. Figure 1 pictures a flow sheet of the process. Conversion of toluene per pass is 25%; the yield of benzene (based on toluene consumed) per pass is 75%

Reactions:

Toluene + H2 ---------> Benzene + CH4 (1)

2 Benzene ----------> Phenyl Benzene + H2 (2)

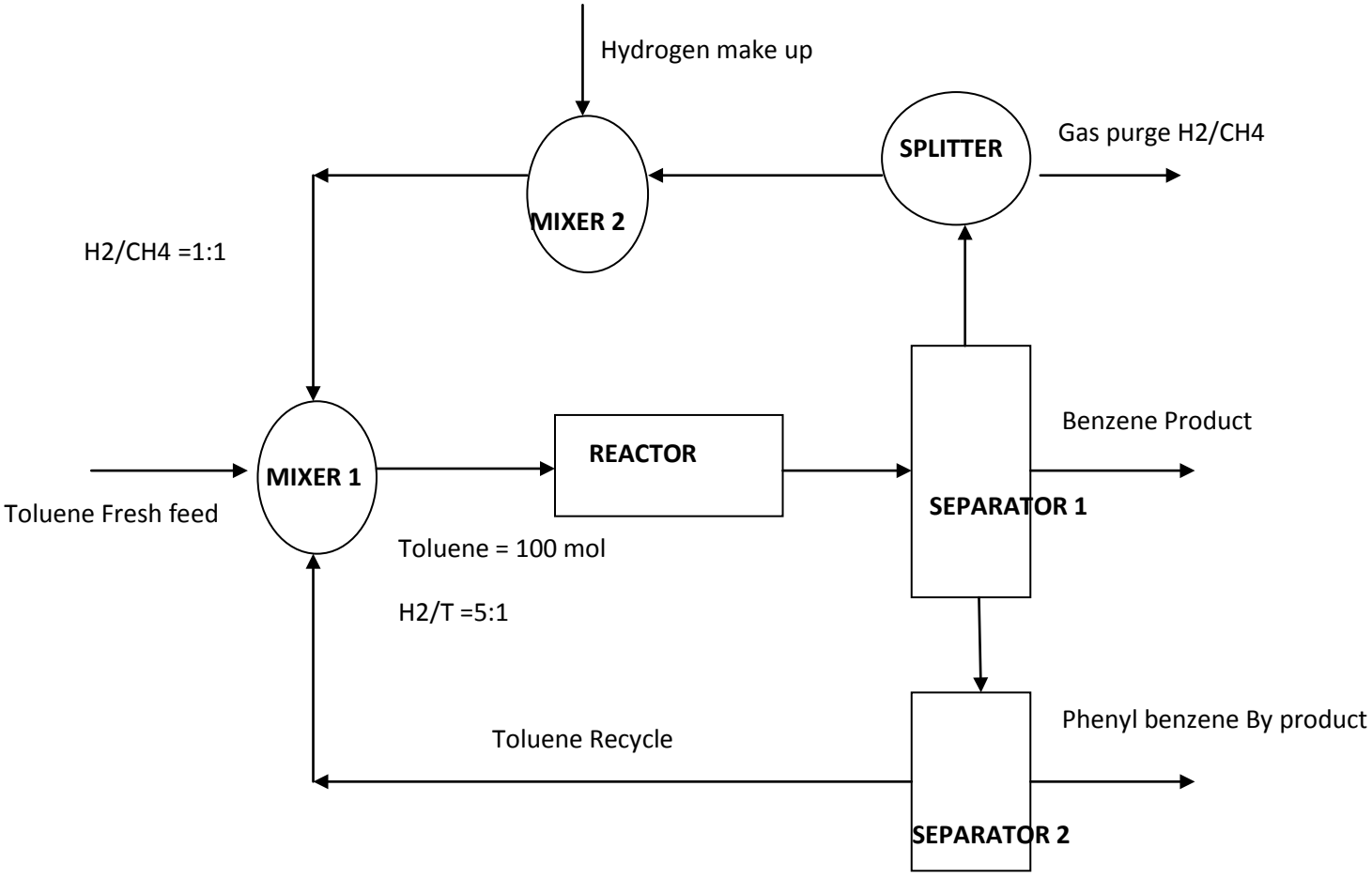

Figure 1. Dealkylation of Toluene

Using the information shown on the process flow sheet determine the following

(25) a. the extent of reaction for both reactions.

(25) b. the composition of the purge stream.

(25) c. the recycle ratio for both the gas (from mixer 2) and toluene recycle streams

(25) d. the ratio of hydrogen makeup per mole of toluene feed.

(15) e. What separation processes might you suggest for separators 1 and 2?

(10) f. Explain the meaning of dealkylation

(10) g. Write down the chemical formula for phenylbenzene

(65) 2. An equimolar mixture of gaseous NO3, H2, and H2O is reacted in a closed tank. These compounds react according to the equation NO3 + H2 <===> NO2 + H2O , and the equilibrium constant K = 0.85.

(50) a. What is the composition of the gas in the tank after a very long time?

(15) b. State all assumptions.