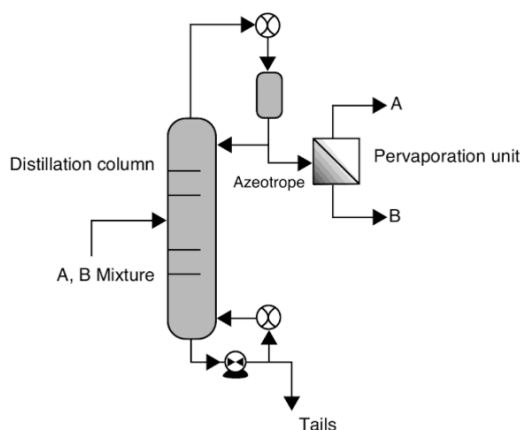


COURSE "Introduction to Green and Sustainable Chemistry"

Written exam – February 04 2017 (Part I)

- 1) Define sustainability and provide three ways that Triple Bottom Line companies promote sustainability. The examples must come from industrial sectors.
- 2) Name and briefly define the 5 principle of green chemistry and the 10 principle of chemical engineering. What the two items can reduce if implemented?
- 3) In a navy, which consumes 13,200 liter of diesel fuel per year, the Diesel fuel was changed to Biodiesel (B20 = 20% of biodiesel and 80% v/v of conventional diesel). What are the CO₂ savings if 2.7 kg of CO₂ is emitted per liter of regular diesel fuel? How much methanol must be used to prepare the appropriate amount of biodiesel for this substitution?
- 4) Describe the life cycle of a plastic bottle. Describe two alternatives that can simplify and reduce the life cycle cost.
- 5) Butyl etanoate (1) can be synthetized by two different approaches in one (1) and two (2) steps:
 - 1) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{H}_2\text{O}$.
 - 2) $\text{CH}_3\text{COOH} + \text{SOCl}_2 \rightarrow \text{CH}_3\text{COCl} + \text{SO}_2 + \text{HCl}$
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{CH}_3\text{COCl} \rightarrow \text{CH}_3\text{COOCH}_2\text{CH}_2\text{CH}_2\text{CH}_3 + \text{HCl}$In the first process 6.25 grams of butan-1-ol forms 6.57 g of butyl ethanoate, whereas in the second process 5.450 grams of ethanoic acid produces 9.806 g of Butyl ethanoate. Calculate the overall percentage yield for both processes. Which have the best atom economy and E_m factors? Suggest 2 reasons why butyl ethanoate is manufactured by process 1 rather than by process 2.
- 6) What is the difference between a homopolymer and a copolymer? Explain the term branching and crosslinking and how they affects a material's mechanical and rheological (flow when melted) properties. Provide examples using the 5 main polymers.
- 7) Hydrogen can provide energy for a car in different way by burning in an appropriate engine or as reagent for a fuel cell. Describe briefly the uses and advantages/disadvantages for both technologies.
- 8) To reduce the impact of plastics in the environment the strategies adopted has been changed during time. Which is in this direction the role of industrial recycling and why this is restricted only to some type of plastic materials? Provide examples.
- 9) How should the combined impacts of the landfilling of wastes (air and groundwater pollution, transport impacts, etc.) be compared with those produced by the burning of wastes for energy production (predominantly emissions to air) on a LCA perspective?
- 10) *In the scheme is reported a flow diagram for a dehydration plant of ethanol to ethylene which contains a pervaporation unit to break the azeotrope water/ethanol instead of using azeotropic and extractive distillation. What advantages and disadvantages in term of green chemistry and green engineering can this process have?



- 11) * & ** someone wrote 'It is very difficult to achieve step-change improvements in environmental and economic performance through incremental improvements in conventional chemical production technologies. For a growing number of chemical companies, inspiration is coming from biomimicry.' With examples approve or disprove this sentence.
- 12) **Name four functional groups in organic chemistry and what important biomolecules are they used to build.
- 13) ** Is the decomposition of a DNA a chemical process? If you think it is, please draw the reactants and the products including the energy (is this process Endo- or exothermic?) and catalysts. Can the process originate mutations in living organisms?

* Responses due by Eng. Chem. Students.

** Responses due by Eng. Environ. Students.