

COURSE "INTRODUCTION TO GREEN AND SUSTAINABLE CHEMISTRY"

Written exam - January 19, 2018 (part II)

PLAGIARISM. The Course takes plagiarism very seriously. Cutting and pasting from an article or any another person's work is plagiarism, even if you cite them (the exception to this is quotations).

- 1) In process intensification (PI) which are the aims to reach and the principles to apply? Schematically illustrate, with examples, the benefits produced in the application of three main PI principles.
- 2) Some years ago was proposed a method to evaluate the intrinsic safety of a chemical process based on two major classifications: 1) process equipment and 2) properties of the substances present in the process. Discuss briefly the specific factors and indices which in your opinion must be taken into account to reach good intrinsic safety process. The Sustainable Process Index (SPI) can be a good starting point for the development of an intrinsic safety process?
- 3) Someone believes that embracing in the risk assessment the concept of reducing the danger associated with chemicals will lead to a reduction in the emanation of new laws in the environmental field. Do you agree with this opinion? Clarify, with examples, what the replacement of a dangerous chemical means and why this target, in principle always possible, is so difficult to achieve
- 4)* A relatively large laboratory with a volume of 1100 m³ at 22°C and 1 atm contains a reactor which may emit as much as 0.75 gmol of a hydrocarbon (HC) into the room if a safety relief valve ruptures. If the hydrocarbon mole fraction in the room air becomes greater than 425 parts per billion (ppb_v), it constitutes a health and safety hazard. Suppose the reactor valve ruptures and the maximum amount of HC is emitted almost instantaneously. Assume that the air flow in the room is sufficient to make the room behave like a continuous stirred tank reactor (CSTR), that is, the air composition is spatially uniform. Calculate the ppb of hydrocarbon in the room. Is there a health risk? From a treatment point of view, what can be done to either decrease the environmentally hazardous nature or improve the safety of the reactor? From a pollution prevention perspective, what might be done to implement source reduction measures?
- 5) Provide two examples of C-5 natural building blocks and discuss briefly which biochemical processes are applied to convert them into useful commercial product, emphasizing advantages and disadvantage.
- 6) Which are the main strategies and methods of PAT and QdB in developing a process whose target is a quality based product?
- 7) Hydrogen economy is considered by some people a fantasy and by other a great opportunity. Explain, with examples, which are the main issues in the adoption of the hydrogen economy in the everyday life.
- 8) Gas hydrates can be considered fossil fuels or biogenetic renewable fuels? How is obtained biogas? and pure methane from biogas? Evidence the main advantages and issues in the use of these three different energy sources.
- 9) Integrated biorefinery (IB) has been proposed as an important infrastructure for sustainable development of industrial society. What the IB term means? Explain with examples what has been done in this direction until now and what you can expect for the future.
- *10) Which of the following is the greenest solvent: formic acid, toluene, ethanol, ethyl lactate? Why? Which strategy can be applied in the selection of a green solvent and why in chemical industry the substitution of a solvent is more difficult than in the paint industry?
- **11) Explain with examples how modern society can provide a sustainable use of the three main constituents of non-food biomasses in everyday life. Taking poplar as an example, summarize the different potentiality explored.
- **12) Can the amino acids be considered as biobased platform chemicals? Which are the main sources of amino acids and how is possible to convert these compounds into currently used nitrogen-containing commodity chemicals in a more economically and sustainable way than from petroleum hydrocarbons? Make examples.
- **13) Can you justify with examples this trend and can you clarify which are the technologies used to produce a biogas? Synthetic Biology is one of science's newest areas of research but has great potential for future development.
 - a) Define Synthetic Biology in your own words.
 - b) Provide a specific example of a product produced through synthetic biology and how it was created.
 - c) Explain how synthetic biology could be used to improve the process of producing cellulosic biofuels.