Chemical Reactors

Calendar: 4th day semester

Contact Hours: T 30,0h; TP 22,5h: OT 7,5h

Scientific Area: Processes in Chemical and Biological Engineering

Intended learning outcomes (knowledge, skills and competences to be developed by the students):

The aim of this curricular unit is to present topics of intermediate and advanced level for the selection and sizing of different types of reactors ideal and real.

After completed this curricular unit, students should have able to identify important parameters in the selection criteria of chemical reactors and measure different types of reactors, calculate time and spatial distribution of residence time in chemical reactors and determining the causes for deviation to the ideal behavior of the reactors.

Syllabus:

1. Introduction to chemical reactors.

2. Energy balance of a chemical transformation. Kinetics. Half-life time. Temperature influence.

3. Selection criteria of reactors. Main features of a reactor. Homogeneous, discrete and continuous reactors. Different types of reactors comparison. Material and energy balance formulation. Residence time and space time. Stirring design and classification.

4. Material and energy balances, characteristic equation, scaling under isothermal, adiabatic and industrial applications:

a) Single-phase batch reactors in the transient regime.

b) Continuous tubular reactors.

c) Continuous stirred tank reactors (CSTR). Association in series of continuous reactors.

5. Distribution of residence times. Deviations causes from the ideal behavior of the reactor RTD function for PFR and CSTR reactors in series. Reactors with the RTD function design, segregation model, maximum mixing model.

Evidence of the syllabus coherence with the curricular unit's intended learning outcomes:

This UC aims to approach some concepts required for the design of reactors with the ability to identify important parameters in the selection of reactors and scaling of different types of reactors, as well as calculate spatial times, DTR and determination/modeling of causes for deviation from the ideal behavior.

In 1st and 2nd chapters a small introduction to chemical reactors is made as well as a resume of some concepts of the chemistry kinetics needed for sizing of this type of equipment. In the 3rd chapter it will be lectured the concepts regarding the selection of reactors, as well as specific concepts for their sizing. In the 4th chapter several types of chemical reactors are lectured, in detail, as well as the equations necessary for the implementation of mass and energy balances in different types of reactors when they present an ideal behavior. Finally, it is mentioned some deviations to the ideal behavior of reactors, emphasizing the use of RTD and modeling using the RTD.

References:

1. A. M. Nunes dos Santos, Reactores Químicos, vol I - Fundação Calouste Gulbenkian (1990);

2. H. Scott Fogler, Elements of Chemical Reaction Engineering, 4rd edition, Prentice-Hall, 2006.

3. M. Smith, Chemical Engineering Kinetics, 3rd edition, McGraw-Hill, 1981.

4. F. Lemos, J. M. Lopes, F. Ramôa Ribeiro, Reactores Químicos- Colecção Ensino da Ciência e Tecnologia, IST, 2002