Course guide
330151 - ERQ - Chemical Reaction Engineering

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Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2016). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: MARIA DOLORS GRAU VILALTA

Others: ANTONIO DAVID DORADO CASTAÑO - NÚRIA TORRAS MELENCHÓN

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Calculate and design ideal and homogeneous chemical reactors, from a material and energy point of view.
2. Distinguish the different types of heterogeneous reactors.

Transversal:
3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
4. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
5. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

TEACHING METHODOLOGY

The subject consists of four hours of class a week, which are dedicated to explain the theoretical foundations and solving problems.

LEARNING OBJECTIVES OF THE SUBJECT

Having the necessary base for the calculation and design of ideal chemical reactors, from the material and energy point of view, and to know the different types of heterogeneous reactors.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	15,0	10.00
Self study	90,0	60.00
Hours large group	45,0	30.00

Total learning time: 150 h

CONTENTS

1. INTRODUCTION TO CHEMICAL REACTION ENGINEERING

Description:
Classification of chemical reactions.
Classification of chemical reactors.

Specific objectives:
Distinguishing the different types of reactors and chemical reactors.

Related activities:
3, 5.

Full-or-part-time: 5h
Theory classes: 4h
Self study : 1h

2. KINETICS OF HOMOGENEOUS REACTIONS

Description:
Definition of the reaction rate.
Kinetic equation: determination of the reaction order and the rate constant.
Concentration-dependent factor: reactions at constant temperature (in liquid phase and in gas phase).
Temperature dependent factor: Arhenius equation.

Specific objectives:
Check the influence of concentration and temperature on the reaction rate.
Determine the kinetic equation of a chemical reaction.

Related activities:
1, 2, 3, 5.

Full-or-part-time: 50h
Theory classes: 15h
Practical classes: 5h
Self study : 30h

3. MATERIAL ASPECT IN THE DESIGN OF REACTORS: IDEAL ISOTHERMAL REACTORS

Description:
Aspects to consider in the design: Mathematical model of a chemical reactor.
Simple reactor design: Discontinuous reactor; Tabular continuous reactor; Continuous stirred tank reactor.
Multiple reactors: stirred tank and tubular reactors in series
Comparison of reactors.
Reactor optimization.

Specific objectives:
Designing ideal isothermal reactors.
Deciding the best form of operation for certain operating conditions.

Related activities:
1, 2, 3, 4, 5.

Full-or-part-time: 66h
Theory classes: 16h
Practical classes: 8h
Self study : 42h

4. ENERGY ASPECT IN THE DESIGN OF REACTORS

Description:
Thermal balance and heat transfer.
Complete mathematical model of the reactor.
Specific models according to the thermal regime: reactors with heat transfer (isothermal and non-isothermal); adiabatic reactors.
Strong exothermic reactions.

Specific objectives:
Knowing the energy aspects of reactor design.
Identifying the problem of temperature control in a chemical reactor.

Related activities:
1, 3, 5.

Full-or-part-time: 23h
Theory classes: 6h
Practical classes: 2h
Self study : 15h

5. REACTORS FOR HETEROGENEAL SYSTEMS

Description:
Types of heterogeneous reactions.
Contact models for two-phase systems.
Reactions between fluids catalyzed by solids.

Specific objectives:
Distinguishing the different types of heterogeneous reactors.

Related activities:
3, 5.

Full-or-part-time: 6h
Theory classes: 4h
Self study : 2h

ACTIVITIES

1. RESOLUTION OF PROBLEMS IN CLASS

Description:
Solving problems in class by students individually or in groups. The teacher will guide the resolution.

Specific objectives:
Understanding, applying, analyzing and discusssing the theoretical concepts of the related content.

Material:
Compilation of problems (at the Atenea campus, or occasionally on paper).
Recommended bibliography.
Problems solved by the teacher in class.

Delivery:
Delivery of the problems solved in group.
Evaluation by the teacher or co-evaluation between students (problem section).

Full-or-part-time: 7h
Theory classes: 4h
Self study: 3h

2. TROUBLESHOOTING AT HOME

Description:
Solving problems at home by individual students.

Specific objectives:
Understanding, applying, analyzing and discusssing the theoretical concepts of the related content.

Material:
Compilation of problems (at the Atenea campus, or occasionally on paper).
Recommended bibliography.
Problems solved by the teacher in class.

Delivery:
Delivery of solved problems.
Evaluation by the teacher and delivery of the correction to the students (problem section).

Full-or-part-time: 18h
Self study: 18h

3. ATENEA QUESTIONNAIRES

Description:
There will be 2 questionnaires that students must answer on their own.
They will have 3 days to respond and 3 attempts for each questionnaire.
The maximum grade obtained will be the one that will be taken into account for the continuous evaluation.

Specific objectives:
Check the follow-up of the subject and the consultation of the available material.

Material:
Material at the Athena campus.
Recommended bibliography.

Delivery:
The questionnaires must be answered within the established period.
Your evaluation will be taken into account in the participation section.

Full-or-part-time: 4h
Self study: 4h

4. PRESENTATION OF A GROUP PROBLEM

Description:
Resolution of different problems by groups of 4 students.
Oral and written presentation of the results.

Specific objectives:
Understanding, applying, analyzing and discusssing the theoretical concepts of the related content.

Material:
Problem proposed to each group on paper.
Recommended bibliography.
Problems solved by the teacher in class.

Delivery:
The problem must be delivered resolved in writing and defended orally.
The evaluation will correspond to the problems section.

Full-or-part-time: 9h
Theory classes: 4h
Self study: 5h

5. WRITTEN INDIVIDUAL EVIDENCE

Description:
Individual tests in the classroom for the evaluation of the theoretical concepts and the resolution of problems, related to the content of the subject.
There will be 2 tests lasting 2 hours each:
- Test 1: Contents 1 and 2
- Test 2: Contents: 3, 4 and 5

Specific objectives:
Determine the kinetic equation of a chemical reaction.
Calculate and design ideal chemical reactors from the material point of view.
Calculate and design ideal chemical reactors from the energy point of view.
Choose the most suitable type of reactor according to the operating conditions.
Know the different types of heterogeneous reactors.

Material:
Statements and calculator.
Compilation of tables and graphs.
Form made by each student.

Delivery:
Resolution of the evidence and presentation in writing.

Full-or-part-time: 14h
Theory classes: 4h
Self study: 10h

GRADING SYSTEM

Problems (evaluable activity: 1, 2, 4): 30%
Participation (evaluable activity: 1, 4): 10%
Individual tests (evaluable activity 5): 60%

EXAMINATION RULES.

- Class attendance.
- Delivery of the proposed problems.
- Group problem delivery.
- Completion of the Athena questionnaires.
- Carrying out individual tests.

BIBLIOGRAPHY

Basic:
- Levenspiel, Octave. Ingeniería de las reacciones químicas [on line]. 3ª ed. México: Limusa Wiley, 2004 [Consultation: 27/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5758266. ISBN 9681858603.
- Fogler, H. Scott. Elementos de ingeniería de las reacciones químicas. 3ª ed. México: Pearson Educación, 2001. ISBN 9702600790.
- Westerterp, K. R.; Swaaij, W. P. M. Van; Beenackers, A. A. C. M. Chemical reactor design and operation. Chichester: John Wiley & Sons, 1984. ISBN 0471901830.
- Smith, J. M. Ingeniería de la cinética química. 3ª ed. México: Compañía Editorial Continental, 1986. ISBN 9682606284.
- Froment, Gilbert F.; Bischoff, Kenneth B. Chemical reactor analysis and design. 2nd ed. New York: John Wiley & Sons, 1990. ISBN 0471510440.

Complementary:

- Walas, Stanley M. Chemical reaction engineering handbook of solved problems. Austraulia: Gordon and Breach, 1995. ISBN 2884491597.
- Hill, Charles G. An introduction to chemical engineering kinetics & reactor design. New York: Wiley, 1977. ISBN 0471396095.
- Levenspiel, Octave. El omnilibro de los reactores químicos [on line]. Barcelona: Reverté, 1986 [Consultation: 31/05/2022]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=5758255. ISBN 8429173366.

RESOURCES

Other resources:

Grau i Vilalta, M. Dolors. Enginyeria de la reacció química : Recull de problemes. Manresa: EPSEM, 2011.
Grau i Vilalta, M. Dolors. Enginyeria de la reacció química: Taules, gràfiques i esquemes. EPSEM, 2011.
Grau i Vilalta, M. Dolors. Cinètica de la reacció. EPSEM, 2005.
Grau i Vilalta M. Dolors. Classificació de reactors (multimèdia): EPSEM, 2008.
Grau i Vilalta M. Dolors. Reactors ideals isotèrmics. EPSEM, 2011.
Grau i Vilalta M. Dolors. Règim tèrmic d'un reactor. EPSEM 2011.