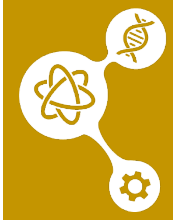
Academic Year 2026/2027

Couse Guide:

POWDER TECHNOLOGY



FACULTY OF CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Program	Bachelor's degree in chemical engineering			Code	801560
Course	Powder Technology			ECTS	6
Subject Area	Chemical Industry Operations				
Module	Chemical Technology				
Course Type	Optional	Year	Fourth	Semester	Second
Responsible Department	Chemical Engineering and Materials				

Teaching Staff

Activity	Lecturer	Email	Office
Lectures Seminars Tutorials	ARACELI RODRÍGUEZ RODRÍGUEZ	arodri@ucm.es	QA-168
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Powder Technology Laboratory

Group	Lecturer	Email	Office
A1	DAVID LORENZO FERNANDEZ	dlorenzo@ucm.es	QAB-60
A2	EDUARDO DÍEZ ALCÁNTARA	ediezalc@ucm.es	QP-110

2. OBJECTIVES

General Objective

Study of the characteristics of solid substances, mainly in granular or powdery form, and of the different operations of interest in Chemical Engineering that involve the handling of these substances.

Specific objectives

- Know and understand the primary and secondary properties of particulate solids.
- Describe and size the operations of classification, reduction and increase in size.
- Describe and understand the mechanisms of mixing and segregation.
- Describe the methods of transport and storage of solids.
- Describe and size different basic mechanical operations involving particulate solids in fluid streams.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

Following this course satisfactorily requires the student to have previously acquired the knowledge and competences corresponding to the following courses: "Fundamentals of Chemical Engineering". Although enrolment is not formally conditioned on these prior knowledge, effective mastery of this knowledge is essential to follow this course with reasonable prospect of success.

Recommendations

It is recommended that the student has a basic level of English that allows him or her to handle bibliography in English, search for information and communicate in writing and orally in that language. It is also recommended that you be familiar with tools and software for solving complex problems, as well as applications for writing, editing, and presenting technical reports.

4. CONTENTS

Brief description

Powder particle size analysis. Mechanical disintegration of solids. Other methods of particle size reduction. Increased particle size. Mixing and segregation. Solids Storage. Fluidization. Transport of solids. Separation of solids in fluid streams. Security.

Course Syllabus

Block I: Characterization of Solids

Topic 1.

Characterization of solid particles. Primary and secondary properties. Characterization techniques. Sampling.

Topic 2.

Individual particles. Shape and size descriptors.

Topic 3.

Powdery substances. Rheology of powdery solids.

Block II: Size Conditioning

Topic 4.

Downsizing. Fracture mechanisms. Energy requirements of the grinding. Team.

Topic 5.

Increase in size. Agglomeration and compaction. Team.

Block III: Storage, sorting and mixing

Topic 6.

Classification of Solids. Sifting. Team.

Topic 7.

Mixing and segregation of solids. Types of mixers. Mixing cohesive substances. Segregation of particle mixtures.

Topic 8.

Solids storage and flow. Hoppers: types, design. Solids flow.

Block IV: Solid-fluid interactions

Topic 9.

Fluidisation. Types of fluidised beds. Minimum fluidisation speed. Bubbling beds. Dragging. Heat transfer.

Topic 10.

Transport of solids. Pneumatic and hydraulic conveying. Dilute-phase and dense-phase transport.

Item 11.

Gas cleaning. Solid-gas separation operations. Gas filtration. Cyclonic separation. Electrostatic Separation Wet Separators.

Block V: Practical aspects

Topic 12.

Safety and risks in the handling of powdery substances. Explosion and fire in powdery substances. Application to industrial processes. Health risks.

Topic 13.

Manufacturing process case studies related to solids technology. The case of cement manufacturing. Food and Pharmaceutical Industry. Fertilizer manufacturing and mineral treatment.

5. COMPETENCIES

General

CG1-TQ1	Use concepts for the autonomous learning of new methods and theories.
CG1-TQ2	Design and manage applied experimentation procedures, especially for the determination of thermodynamic and transport properties, and for the modelling of phenomena and systems in the field of chemical engineering, systems involving fluid flow, heat transfer, mass-transfer operations, chemical reaction kinetics, and reactors.
CG1-TQ3	Design, manage, simulate, and control instrumentation for chemical processes.
CG5-TQ1	Analyse, design, simulate and optimise processes and products.

Specific

CE4-OIQ1	Describe the properties of particulate solids.
CE20-OIQ1	Explain the principles on which the different separation operations are based.
CE20-OIQ2	Design the equipment in which to carry out the different separation operations.
CE20-OIQ3	Describe classification, size-reduction, and size-enlargement operations.
CE20-OIQ4	Describe methods for storing solids
CE20-OIQ5	Describe the unit operations involving particulate solids (fluidization, filtration, sedimentation, centrifugation, and particle separation in fluid streams).
CE20-OIQ6	Describe methods for transporting solids.

CE20-OIQ7	Carry out the basic design of the different operations involving the handling, storage, transport, and separation of particulate solids.

Cross-cutting

CT1-TQ1	Develop capacity for analysis and synthesis.
CT2-TQ1	Solve problems in the area of Chemical Technology.
CT4-TQ1	Communicate in Spanish using standard audiovisual media.
CT5-TQ1	Consult, use and analyse bibliographic sources in the area of Chemical Technology.
CT5-TQ2	Consult, use and analyse specialised databases and resources accessible through the Internet.
CT6-TQ1	Use computer tools and programs to calculate, simulate, and approximate.
CT7-II1	Work in a team
CT8-TQ1	Demonstrate capacity for critical and self-critical reasoning.
CT10-II1	Integrate acquired knowledge and apply it to solving problems in Industrial Engineering.
CT11-TQ1	Learn autonomously.
CT12-TQ1	Develop sensitivity to the social and environmental repercussions of engineering solutions.
CT13-II1	Demonstrate initiative and creativity in solving new situations.

6. WORKLOAD DISTRIBUTION BY ACTIVITY

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures	30	60	3,6
Seminars	15	15	1,2
Tutorials / guided work	3	4,5	0,3
Laboratory	8	6	0,56
Preparation ofassignments and exams	4	4,5	0,34
Total	**60**	**90**	**6**

7. METHODOLOGY

Teaching practice will follow a mixed methodology based on cooperative learning, collaborative learning and self-learning. This methodology will be developed through theoretical classes, seminar classes, individual or group work, directed tutorials and laboratory practices.

The **lectures**, which will be developed in a single group, will consist, as a priority, of master classes in which the complete syllabus of the subject will be presented in an orderly manner with the help of audiovisual material.

The **seminars**, which will be developed in a single group, will consist of the formulation and resolution of problems, previously proposed to the student, which involve the application of theoretical knowledge, as well as the development of some complementary and eminently practical topics.

The **tutorials** will consist of levelling training sessions to facilitate access to specific resources such as the Aspen Plus simulation program, supervision of the students' progress in their personalized work, visits to process facilities in which particulate solids are handled.

The **laboratory practices** will consist of the collection of experimental data and the calculation of the different parameters involved in the development of the practice, as well as the simulation of processes in which operations with solids are involved using the solids module of the Aspen Plus program. The critical discussion and analysis of the results obtained in each practice will constitute the fundamental part of the technical reports to be delivered in each case. Likewise, visits may be made to different facilities in which operations related to particulate solids technology are used.

The UCM Virtual Campus **will be used** as an instrument to make available to students the material that will be used in theoretical classes, seminars, tutorials and laboratories, and as a means of communication between the professor and the students.

8. BIBLIOGRAPHY

Basic

- RHODES, M.: "*Principles of Powder Technology*", Wiley, Nueva York, 1990.
- RHODES, M.: "*Introduction to Particle Technology*", 2ª Ed., Wiley, New York, 2008.
- FAYED, M.E. y OTTEN, L.: "*Handbook of Powder Technology Science and Technology*", 2ª Ed., Chapman and Hall, New York, 1997.
- MASUDA, H.; HIGASHITANI, K. y YOSHIDA, H.: "*Powder Technology Handbook*", Taylor and Francis, Boca Raton, 2006.

Complementary

- McCABE W.L.; SMITH, J.C. and HARRIOT, P.: "*Basic Operations of Chemical Engineering*", 4th Ed., McGraw Hill, Madrid, 1991.
- COULSON, J.M., RICHARDSON, J.F., BACKHURST, J.R. and HARKER, J.H.: "Chemical *Engineering*", Vol. II, 4th Ed., Pergamon, London, 1991. Spanish translation of the third English edition: "*Ingeniería Química*", Reverté, Barcelona, 1981.
- VILA JATO, J.L.: "Pharmaceutical *Technology. Volume I: Fundamental aspects of pharmaceutical systems and basic operations*", Síntesis, Madrid, 2001.
- RODRÍGUEZ, F.: "*Ingeniería de la Industria Alimentaria. Volume II. Food processing operations*", Síntesis, Madrid, 2002.
- KUNII, D. y LEVENSPIEL, O.: "*Fluidization Engineering*", 2ª Ed., Butterworth Heineman.
- ALLEN, T.: "*Powder Sampling and Particle Size Determination*", 1ª Ed., Elsevier, Amsterdam, 2003.
- PIETSCH, W.: "*Agglomeration in Industry*", Wiley VCH Verlag., Weinheim, Alemania, 2005.

9. ASSESSMENT

Participation in directed tutorials and laboratory sessions is mandatory, as well as attendance at 70% of the problem seminars and 70% of the theoretical classes in the classroom. The final grade of the subject will be obtained as a weighted average, after exceeding the minimums established in each section, of the evaluations of each of the activities listed below.

The student's academic performance, as well as the final grade for the course, will be calculated as a weighted average according to the percentages shown below, which will be maintained in all assessment periods.

The final course grade will be calculated as the weighted average of the different assessable activities. However, to pass the course, students must obtain the minimum grade established for each activity. If this requirement is not met, the final grade will be the weighted average, capped at 4.5 out of 10. This criterion shall apply to both the ordinary and extraordinary assessment periods. The grades of the activities planned for the evaluation of the subject (midterm exams, laboratories, tutorials, delivery of problems...) will be communicated to students sufficiently in advance before the final exam, so that they can properly plan the study of this or other subjects.

In any case, the minimum period of ten days between the publication of the grades and the date of the final exam of the subject will be respected.

- **WRITTEN EXAMS: 60%**

  There will be two written exams, mainly practical, which represent 60% of the overall evaluation. It will be necessary to obtain a minimum score of 5 points out of 10 in this activity to pass the subject.

  The assessment will allow the degree of achievement of competences CG1-TQ1, CG5-TQ1, CE4-OIQ1, CE20-OIQ1, CE20-OIQ2, CE20-OIQ3, CE20-OIQ4, CE20-OIQ5, CE20-OIQ6, CE20-OIQ7, CT1-TQ1, CT2-TQ1, CT8-TQ1, CT13-II1.

- **INDIVIDUAL WORK AND GUIDES ACTIVITIES (ASSIGNMENTS): 25%**

  A set of model problems will be proposed for each of the parts of the subject, which must be submitted before their discussion and resolution in the seminar classes. In addition, each student must develop personalized work throughout the subject, the evolution of which will be assessed in the tutorials directed. Likewise, formative tests of a theoretical-practical nature will be carried out for continuous evaluation, discussing the results to improve student learning (feedback). All this will represent 25% of the global evaluation. Continuous assessment will only be conducted if the student attends 70% of the classroom problem seminars. If this criterion is not met, the personal work will be rated 0 out of 10.

  The assessment will allow the degree of achievement of competences CG1-TQ1, CG1-TQ2, CG5-TQ1, CE20-OIQ2, CE20-OIQ4, CE20-OIQ3, CE4-OIQ1, CE20-OIQ1, CE20-OIQ5, CT13-II1, CE20-OIQ7, CT1-TQ1, CT2-TQ1, CT4-TQ1, CT5-TQ1, CT5-TQ2, CT6-TQ1, CT7-II1, CT8-TQ1, CT10-II1, CT11-TQ1, CT12-TQ1, CE20-OIQ6.

- **ATTENDANCE AND ACTIVE PARTICIPATION IN CLASSES**

  In order to carry out the overall assessment of the subject, the student must have participated in at least 70% of the face-to-face classroom activities (theory and seminars).

- **LABORATORY PRACTICES: 15%**

  The student's attendance at the practical sessions of the laboratory will be mandatory. The evaluation will be carried out considering their answers to specific questions raised by the teacher, as well as the quality of the technical report presented on the internship. Laboratory practices account for 15% of the overall assessment.

  Students who have carried out the internship in previous years will have the option of requesting the non-repetition of these, provided that no more than 2 years have elapsed since they carried out these internships.

  The assessment will allow the degree of achievement of competences CG5-TQ1, CE20-OIQ7, CT1-TQ1, CT4-TQ1, CT13-II1, CT5-TQ2, CT6-TQ1, CT7-II1, CT8-TQ1, CT10-II1, CT11-TQ1, CT12-TQ1, CT5-TQ1.

ACTIVITY PLANNING - SCHEDULE

TOPIC	ACTIVITY	HOURS	GROUPS	HOME	END
Block I	Lectures	8	1	1st Week - 3rd Week	
	Seminars	4	1	2nd Week - 4th Week	
Block II	Lectures	5	1	4th Week	5th Week
	Seminars	2	1	4th Week - 5th Week	
Block III	Lectures	5	1	6th Week	7th Week
	Seminars	2	1	Week 6	Week 7
Block IV	Lectures	9	1	Week 7	Week 10
	Seminars	4	1	Week 9	Week 10
Block V	Lectures	3	1	Week 11	Week 11
	Seminars	3	1	11th Week	Week 11
Blocks I to V	Tutoring	3	1	3rd Week	11th Week
Blocks I to V	Laboratory	8	1	Week 10	11th Week

SUMMARY OF ACTIVITIES

ACTIVITY	ASSOCIATED COMPETENCIES	TEACHING ACTIVITY	STUDENT ACTIVITY	ASSESSMENT	P	NP	TOTAL	C
Lectures	CG1-TQ1, CE4-OIQ1, CE20-OIQ6, CE20-OIQ3, CE20-OIQ4, CE20-OIQ5, CE20-OIQ1	Oral presentation of the main lines of each agenda item	Attention and active participation in the development of the class.	Written exams	30	60	90	
Seminars	CG1-TQ2, CG1-TQ3, CG5-TQ1, CE20-OIQ2, CE20-OIQ7, CT2-TQ1, CT1-TQ1, CT4-TQ1.	Posing and solving questions and problems of a numerical nature.	Discussion and resolution of the proposed issues and problems	Assessment of the resolution and discussion of the proposed issues and problems	15	15	30	**25%**
Tutorials / guided work	CG1-TQ2, CG1-TQ3, CG5-TQ1, CE20-OIQ2, CE20-OIQ7, CT2-TQ1, CT1-TQ1, CT4-TQ1, CT7-II1, CT8-TQ1, CT10-II1, CT13-II1, CT12-TQ1, CT11-TQ1.	Monitoring students' progress in their personal work	Development of your personal work	Assessment of the work carried out by the student in the development of the proposed personal work	3	4,5	7,5	
Laboratory Practices	CG1-TQ2, CG1-TQ3, CG5-TQ1, CT2-TQ1, CT1-TQ1, CT4-TQ1, CT7-II1, CT8-TQ1, CT10-II1, CT13-II1, CT12-TQ1, CT11-TQ1	Explanation and supervision of the development of the practice	Collection, analysis and discussion of experimental data to calculate the different parameters. Preparation of the technical report of the development of the practice	Assessment of the student's work during the development of the practice and the technical report.	8	6	14	**15%**
Exams	CE5-TQ1, CE4-OIQ1, CE20-OIQ1, CE20-OIQ2, CE20-OIQ3, CE20-OIQ5, CE20-OIQ6, CE20-OIQ7, CT8-TQ, CT10-I1, CT2-TQ1	Design and correction of the exam. Student Rating	Conducting the exam	Exam	4	4,5	8,5	**60%**

P: Contact activities, **NP:** Non-contact activities (independent study), **C:** Grade