UNIT OPERATIONS

LEVEL: MASTER 1
PERIOD: SEMESTER 1
LANGUAGE: EN
ECTS: 6
TEACHER/COORDINATOR: ALEXANDRE BERTH

2019-2020

1-Main objectives

Unit Operations in Agri-Food Engineering deals with the design and selection of process equipment or process plants. Each piece of equipment that could be combined to make a «unit» in a process should have a clearly defined function. For example: mixing, separating solids and liquid, separating mixtures from fluids, size separation of solid particles, or transport of a fluid. The number of the most important and basic Unit Operations is not very large and are governed by the fundamental laws of mathematics, physics, chemistry, and mechanics, which provide an approximate description of the real processes. The 'Unit Operations' concept allows for the analysis of unit operations in terms of fundamental principles such as mass and energy balances, phase equilibria, and transport of momentum, energy and mass. In this course we examine a systematic way of approaching design and selection of process equipment.

2-Skills developed

- Name the main unitary operations used in the industry, give specific definitions of them and sort them into relevant categories. The operations evoked in the course are sterilization, frozen, filtration, drying, atomization (spray drying).
- Name several precise examples of industrial applications for each unitary operation
- Describe precisely the working principle of each unitary operation both at the macroscopic scale (in flow, out flow, energy flows) and at the microscopic level (particle, interface, molecule). This description will concern both the physical and chemical phenomena involved and the thermodynamic and kinetic constraints that dictate the separation.
- Identify to operating parameters that determine the efficiency of each process
- Calculate mass and energy balance for discontinuous, semi-continuous and continuous processes and dimensioning the facilities that allow to perform them
- Re-write and interpret the main mathematical developments that lead to the useful equations for process dimensioning and remember at the same time what are all the simplifying hypotheses that must sometimes be used to establish models and dimensioning methods.
- Apply empirical, analytical and graphical methods classically used for unitary operation dimensioning.
- Gather information (field visits, literature search, interviews, etc.) on a unitary operation involved in an existing industrial process and elaborate a critical analysis of this step of the process, describing its interactions with previous and subsequent steps, evaluating if its operating conditions are optimal and providing recommendations for improvement (in addition to technical and economic criteria, the standards of 'sustainable development' will also be used as evaluation benchmarks).

3-General content

Lectures, practical class, visits of food plant, project. Topics covered:

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- Thermal unit operations (evaporation-concentration, spray-drying, heat treatments).
- Mechanical processes for physical separation: sedimentation, decantation, centrifugation, filtration, cycloning, membrane separation, solid-liquid extraction.
- Drying processes: drying, lyophilisation, atomisation.
- Diffusion, mass transfer and energy transfer between phases (diffusion theory, mass transfer coefficients, film theory).
- Phase equilibrium.

4- Evaluation

Written reports on practicals, written exam