SCUOLA DI SCIENZE AGRARIE, FORESTALI, ALIMENTARI ED AMBIENTALI

ACADEMIC YEAR: 2019-2020

COURSE: Unit Operations in Food Technologies

TYPE OF EDUCATIONAL ACTIVITY: Characteristic

TEACHER: Grasso Gianni

e-mail: gianni.grasso@fastwebnet.it

phone: personal phone 338 7010509

Language: Italian

ECTS: 9 (8 of lectures; 1 of numerical and computer exercitations)	n. hours: 64 of lectures + 16 of numerical exercitations and a conclusive numerical computer exercitation	Place: Potenza School: SAFE Program: L26 Food Technology	II semester

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

Knowledge and understanding: The purpose of the course is to provide knowledge for the description of the fundamental phenomena of the Food Technologies and their classification in the scheme of approach of "Unit Operations". The contents, starting from a formal framework of general and broad application value, which incorporates the basic principles of Chemistry-Physics and Technical Physics, based on the form and meaning of the "velocity" equations (transport of matter, energy and quantity of motion, chemical kinetics and microbial), balance and thermophysics, will therefore cover the main fluid transfer operations, fracture and change of consistency (grinding, coagulation etc.), phase separation (filtration, centrifugation, sedimentation, permeation on membrane etc.), transfer of thermal energy (tube heating, plate irradiation, cooking, blanching, pasteurization and thermal sterilization, refrigeration, freezing), material exchange (extraction etc.), phase transitions (evaporation , distillation, crystallization) with application examples of type in any case quantitative. Understanding of the path that links the physical principles behind the specific operations with their microscopic mechanisms, their technological aims and with the equipment usable for their realization (considered as the “environment of the matter systems”). Criteria for recognize process-variables by an examination of the laws-equations are also presented.

Applying knowledge and understanding: Capability to utilize quantitative computation methods applied to the solution of exercises related to real, practical “cases”, with the aid of graphical methods (abaci and nomograms). Capability to use the phases state diagrams as simulative analogical tools of the transformation processes, from a predictive viewpoint, and others technical diagrams.

Autonomy of judgment: the class aims to enable the student to develop an autonomous capacity to express evaluations and to make simple decisions through the acquired knowledge. Capability to manage formal tools such as laws-equations and state-diagrams for the purpose of their application, among a range of choices, to the real Unit Operations contexts. Ability to identify the correct procedures of transformation, stabilization/food spoilage microorganisms reduction according to the compositional characteristics and packaging of foodstuffs.

Communication skills: Ability to communicate the own learned knowledge, structured in a proper vocabulary, to skilled or unskilled people in the field and to interface professionals out in the field.

Learning skills: Ability to gather new technical information and structure it in the learned metacognitive framework. Capability to recognize the knowledge fields that have to be study in deep in front of a new technical situation. The class aims to give students the tools and bases to their further training (*scholar* learning) and for future work (*lifelong* learning).

PRE-REQUIREMENTS

Basic algebra and mathematics knowledge, numerical data expression in exponential scientific standard form, systems of equations, measure units conversion and dimension analysis;

Thermodynamics basic knowledge (“system” concept, Thermophysics (enthalpy changes), state diagrams of unary and binary systems);

Technical-Physics basic knowledge concerning the calculation diagrams of the hydrodynamic friction factor (Moody), of the thermal and refrigeration parameters (enthalpy-temperature H-T of the water vapour and enthalpy-pressure H-P of the refrigeration fluids), of the psychrometric parameters (ASHRAE state diagram of the wet air);

Chemical and microbiological kinetics basic knowledge (first order dynamics);

Computer-science basic knowledge (*Excel* program for draw simple graphics from a data table and make previsions,

see after optional test);
Basic knowledge of English language.

SYLLABUS
Knowledge about the basic phenomena concerning the Food Technologies and their framing in the context of the Unit Operations and Thermodynamics as thread in order to present in an unified, interconnected and comparative approach the heterogeneous and fragmented scenery of the foods technological transformations.

Block 1. Unit-operations notion and classification: separation, mixing-assembling, transforming. System concept. System/Environment interaction. State variables; application to plant machines, physical products and biological organisms as raw input matter in the course of development. Apparatuses as “thermodynamical systems” and their "T, P, n" and mechanical variables approach. Physical, chemical and microbiological models. Dynamical models (transformation/evolution kinetics) and equilibrium models (statics configurations). Mass and energy balances. Transport phenomena: fluxes, potentials, driving forces. Momentum, mass and heat transport. Transport mechanisms and transports classes: conductive (molecular), convective (mass/macroscopic), radiation (electromagnetic), with exchanges at interphases. Diffusion. Exchanges in stationary and non stationary regimes. Rate operations: physical, chemical (heterogeneous systems) and microbiological kinetics.
Quantitative methods for the technical computation: graphical computation of derivatives and proportionality constants of linear law. Nomograms, graphical abaci and math procedure algorithms (8 + 2 h).
Block 2. Mechanical operations I: momentum transport: a) electro-mechanical: motor-utilizer couple and power general equation; b) fluid-mechanical: mixing, power equation. Fluids transport, laminar and turbulent. Viscosity (Newton eq., newtonian and non-newtonian fluids). Mass and energy balance (Bernoulli generalized eq). Laminar and turbulent flow. Poiseuille, Fanning and Darcy-W. fluid-dynamical equations. Filtration (8 + 2 h).
Block 3. Mechanical operations II: Solids mechanics and grinding. Ventilation, cyclonic separation. Sedimentation, Centrifugation. Spraying. Agitation. Combined chemical-mechanical operations: emulsifying. Operations based on mechanical advantage: extrusion-texturization, pressing-squeezing, cutting. Operations based on composite motions: drumming, sieving, washing (8 + 2 h).
Block 4. Heat transport Operations I. Heat transport in homogeneous (one body) and heterogeneous bodies (multi-bodies): constitutive equations with physical constants and technical equations with mixed geometrical and physical coefficients. Thermo-physical calculations (latent and sensible heat/enthalpy) in heating and cooling. Specific heat. Conduction (plane and cylindrical walls), convection (wall/fluid, two fluids separated by a plane and cylindrical wall), Newton and Dittus-B. eq. Heat exchangers. Radiation. Equi- and counter-current heat exchangers (8 + 2 h).
Block 5. Heat transport Operations II. Heat generation (boiler, furnace). Concentration-evaporation. Steam thermodynamical and thermotechnical states. Radiation, view and radiation technical factors; grill and microwave heating systems. Chill generation (freezing apparatus), refrigerator effect. Freezing and Planck equation (8 + 2 h).
Block 6. Mass transport Operations I. Matter classification and physical/technical properties: solids, liquids, gases/vapours, supercritical fluids; homogeneous and heterogeneous systems of technical interest. Diffusion and permeation. Film permeation and packaging. Heterogeneous distribution equilibria and water adsorption isotherm (water thermodynamical activity), state diagrams of mono-, bi- and tri-component systems; l/v, s/l, s/g (adsorption, desorption) and g/v or dry air – water vapour (psychrometric diagram), enthalpic diagrams l/v of the technical vapour-fluids. Lever equation in bicomponent systems (8 + 2 h).
Block 7. Mass transport Operations II. Membrane ultra- and hyper-filtration processes (reverse osmosis), Packaging, gaseous permeation and diffusive migration. Distillation, one-step, fractional and water steam. Crystallization. Extraction (leaching), triangular diagrams. Supercritical extraction. Freeze drying (lyophilisation) sublimation process . Drying and mass and heat process parameters from balance equation and psychrometric data (8 + 2 h).
Block 8. Operations based on non-conventional transport processes. General technological characters of the microscopic chemical and “animated matter” (concentration-pH chemical species distribution diagrams; “T, pH, aw“ microorganisms state-diagrams). Dynamics (Kinetics) applied to physical, chemical and microbial systems. a) Chemical operations: hydrogenation, neutralizing, clotting. b) Biochemical and biotechnological operations: fermentation, mass

and energy balance; enzymatic transformation on immobilized cells or enzymes. Combined operations (combined transports): c) Microbiological operations: pasteurization and sterilization (D10 e Z thermo-kinetical factors, "Fo" factor as algorithm of calculus); d) Cooking (8 + 2 h).

Computation exercitations, applied to solve simple problems of determination of significant unit-operations parameters, were performed by means of tables, nomograms, diagrams and abaci too.

Computer-science final test (optional): computation of a proportionality constant of a linear physical, chemical or microbiological kinetic law from a series of numerical data.

TEACHING METHODS

Lessons are conducted by monitoring with steadiness the students attention and understanding by means of the "maieutics" socratic technique, stimulating the students deductive capability concerning the "pull out" of the conclusions by means of directed interrogations and questions.

Students with a 66 % of frequency can take the computer-science final test (additional final score of maximum 2/30, that can be added to the score achieved in the written-graphical basic course test).

EVALUATION METHODS

The final exam is composed of 2 parts:

- A written-graphical test on all the course subjects (solution of 7 numerical problems; minimum effective score 18/30).
- A final talk in order to check the student competency toward the formal aspects of the several transdisciplinary treated subjects (additional, maximum score of 2/30, added to the previous score of the written-graphical test).

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

- lecture notes delivered: Elementi di teoria dei fenomeni di trasporto e delle operazioni unitarie, Parte Generale del Corso (on magnetic support), edited by G. Grasso;
- more specific lecture notes delivered, concerning the transformed products, the apparatuses, the numerical examples, etc (on paper support), collected, elaborated and edited by G. Grasso;
- Peri C., Le Operations Fondamentali della Tecnologia Alimentare, CEA, 2009, Milano;
- McCabe W.L., Smith J.C., Harriott, P. (2005) Unit Operations of Chemical Engineering, 7th ed., McGraw-Hill, New York, NY, 5th ed. Online: http://cc.sit.edu.cn:805/upload/2016_1/3_8/gKauNveQ/Unit%20Operations%20of%20Chemical%20EngineeringWarrenL.%20McCabe.pd
- Singh R.P., Heldman D.R., Introduction to food engineering, Academic Press, San Diego, 2001; trad. It. Principi di Tecnologia Alimentare, Casa Editrice Ambrosiana/ Zanichelli, 2015.

INTERACTION WITH STUDENTS

After any lesson are delivered the related lecture notes.

After any written-graphical test is given the solution of the presented exercises.

Reception: Tuesday from 14:30 to 15:30 (room 218, 2nd floor, SAFE).

Teacher available via e-mail.

EXAMINATION SESSIONS (TENTATIVE)

20/07/2020, 28/09/2020, 26/10/2020, 30/11/2020, 19/12/2020, 25/01/2021, 22/02/2021, 29/03/2021, 26/04/2021, 31/05/2021, 28/06/2021

EVALUATION COMMITTEE

Grasso Gianni (president), Galgano Fernanda (member), Caruso Marisa Carmela (replacement member).

SEMINARS BY EXTERNAL EXPERTS NO □