SCUOLA DI SCIENZE AGRARIE, FORESTALI, ALIMENTARI ED AMBIENTALI

ACADEMIC YEAR: 2016-2017

ACADEMIC COURSE: Unit Operations in Food Technologies

FORMATIVE ACTIVITY: Characterizing

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Language: italian

n. CFU: 9 (8 of lessons; 1 of numerical and computer exercitations)	n. hours: 64 of lessons + 16 of numerical exercitations and a conclusive numerical computer exercitation	place: Potenza School: SAFE CdS: L. 26 Tecnologie Alimentari	II semester

FORMATIVE TARGETS AND LEARNING RESULTS

Contents and knowledge

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. See the analytical description in the next "COURSE CONTENTS ".

Skills

Competence to:

1) utilise in a systematic way the concepts of "system" and of the "environment/system interaction" in order to visualize any technical phenomenon at the both macro- and micro-scale. Widening of the typical thermodynamical system state variables (temperature, pressure, concentration) to the physical ones (mechanical stress, energy fields) and microbiological (microorganisms populations). Framing of the observed phenomena with proper "space" and "time" references;

2) apply the general formula of the transport equations, while also in the simple form of algebraic relations among fluxes and gradients, indifferently to phenomena of the following nature:

a) hydrodynamic of hydraulic conductance and permeation, with specific application to industrial operations as pumping and filtration;

b) thermal of heat transport IN or OUT, with specific application to such industrial operations as the thermal exchange among fluids and freezing of solids;

c) mass, with specific application to such industrial operations as the separation by crystallization and by membranes;

3) frame the main transformation operations in an organic features pattern of:

a) phenomenological and microphysical structural description of the involved physical systems, characterizing dimensions and physical and/or physical-chemical concerned principles, mechanisms, phase equilibria relations, state diagrams;

b) mathematical models describing such mechanisms action as related to the processes and products parameters (kinetic, equilibria, balance, phenomenological and dimensional equations);

These 1-3 sections can be included in an embryonal aspect of beginning toward a "management capability" of the scientific and technical multi-disciplinary informations concerning the applied technologies, that is desirable could be *by himself* followed in the course of the subsequent, masterly studies;

4) utilize quantitative computation methods applied to the solution of exercises related to real, practical "cases", with the aid of graphical methods (abaci and nomograms); brief notes related to the processes apparatus (in order to link the equations to the physical systems and environments of their practical application), the critical process parameters and the related measurement and control instruments. This aspect is fundamental about the capability of the treatment of the "numerical date".

PREREQUISITES

Basic algebra and mathematics knowledge, numerical data expression in exponential scientific standard form, 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 technical previsions, see after computer optional test).

COURSE CONTENTS

Lessons

GENERAL PART

- Unit-operation notion. Apparatuses as "thermodynamical systems" and their "*T, P, n*" approach. Mass and energy balances. 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.

Transport phenomena: fluxes, potentials, driving forces. Momentum, mass and heat transport. Transport mechanisms and transports classes: conductive (molecular), convective (mass/macroscopical), radiation (electromagnetic), with exchanges at interphases. Diffusion. Exchanges in stationary and non-stationary regimes; (8 + 2 h)

- Fluids transport, laminar and turbulent; limit boundary. Viscosity (Newton eq., newtonian and non-newtonian fluids). Fluids mechanics: static and dynamics. Mass and energy balance (Bernoulli generalized eq.). Laminar and turbulent flow. Poiseuille, Fanning and Darcy-W. fluid-dynamical equations; (8 + 2 h)

- Heat transport. Thermo-physical calculations (latent and sensible heat/enthalpy). Conduction (plane and cylindrical walls), convection (wall/fluid, fluids separated by a plane and a cylindrical wall), Newton and Dittus-B. eq. Radiation. Thermal exchange, equi- and counter-current exchangers. Specific heat; (8 + 2 h)

- Mass transport. Matter classification: solids, liquids, aeriforms; homogeneous ed heterogeneous systems. Heterogeneous equilibria, state diagrams of mono- and bi-component systems; l/v, s/l and s/g equilibria. Air/vapour systems: psychrometric diagram. General characters of the microscopic "animated matter" and "*T*, pH, a_w" microorganisms state-diagrams; (8 + 2 h)

SPECIAL PART

Unit-operations classification: separation-fractionation, combination-assembling, mixing, stabilization, conditioning and transformation.

Physical operations:

- momentum transport: hydraulic conduction; agitation, sedimentation, centrifugation; extrusion-texturization; mechanical operations: lamination, milling, squeezing; (8 + 2 h)

- heat transport: thermal exchange, evaporation, freezing; (8 + 2 h)

- mass transport: filtration, reverse osmosis, ultrafiltration; extraction, supercritical extraction; distillation; crystallization, crioconcentration; drying (desorption), liofilization (sublimation); (8 + 2 h)

- Operations with a non-conventional mass transport, inanimate (chemical) and animate (microbial):

a) chemical operations: hydrogenation;

b) biochemical and biotechnological operations: fermentation, enzymatic transformation on immobilized cells or enzymes;

c) combined operations (combined transports): pasteurization and sterilization ("Fo" factor), cooking; (8 + 2 h)

Computation Exercitations, applied to solve simple problems of determination of significant unit-operations parameters, by means of tables, nomograms, diagrams end 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.

TUTORIAL METHODS

Lessons 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 interrogations and questions.

Students with a 50 % 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).

CHECKING OF UNDERSTANDING

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 and the ability to manage structure/process relations (additional, maximum score of 2/30, added to the previous score of the written-graphical test).

TEXTS AND TUTORIAL SUPPORTS

- 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. [disponibile online] http://cc.sit.edu.cn:805/upload/2016_1/3_8/gKauNveQ/Unit%20Operations%20of%20Chemical%20EngineeringWarrenL.%20McCabe.pd

INTERACTIONS WITH THE 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 stage II Agrifood building).

Teacher available via e-mail.

EXAMS FREQUENCIES

Almost monthly

EXPERTS SEMINARS NO □