Discipline Description

Discipline: Processes and devices of chemical technology
The Basic Educational Program specialty: Chemical Engineering
The department of general chemistry and chemical engineering
Instructor: Natalya V. Usoltseva (labs)
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Learning Outcomes:
The course deals with the general regularities and principles of analysis and calculation of chemical technology processes, the foundations of the theory of hydromechanical, thermal and mass-exchange processes. The course focuses on identification the common regularities of processes; development of common principles and mathematical description of the methods of process calculation; determination of optimal technological regime and design parameters; definition of methods for increasing the efficiency and intensity of processes and devices. The knowledge gained in the course will help students to develop the skills of designing simple machines of chemical industry. Students will be able to carry out the technological calculations and select the design of normalized contact devices for the most common processes.

Theoretical skills:
1. know the basic principles of the mathematical description of processes and devices of chemical technologies;
2. know the basic physical and chemical properties as well as thermodynamic properties of liquids, gases and solids, the main methods for their determination and calculation;
3. know the compilation principles of thermal and material balances, the methodology for kinetics calculation of heat transfer and mass transfer processes, the basic laws and the calculation of interphase thermodynamic equilibrium, including the calculations of the driving forces and the process rate;
4. know the design and the principle of operation of the basic standard equipment for heat exchange and mass exchange; the basis for the design of heat and mass transfer equipment and methods for intensifying heat and mass transfer processes; characteristics of the main industrial heat transfer agents; application of methods of the similarity theory in solving practical problems of heat and mass transfer;
5. know the basic methods of optimization of heat and mass transfer processes and the ways to increase their efficiency.

Practical skills:
1. apply the knowledge of laws, theories, equations and methods of processes and devices of chemical technology in the study and development of chemical and engineering processes;
2. carry out technological calculation of the main devices of chemical technologies when developing technical projects, including material, thermodynamic, thermal, mass, hydraulic and economic calculations.
3. perform the calculations of the main characteristics of various heat and mass transfer processes, including the heat loads of the apparatus, the driving forces of heat and mass transfer processes, the coefficients of heat and mass transfer;
4. carry out thermal and structural calculations of heat exchangers for various purposes; select the normalized designs of heat exchangers for solving practical problems of heat exchange.

Skills:

1. design the simplest typical devices of the chemical industry, including vessels and apparatus for storage of liquids and gases, hydraulic pipeline systems with the selection of pumps and fans, as well as hydromechanical equipment for the separation of heterogeneous systems;
2. design the equipment for heat-exchange and mass-exchange processes;
3. optimize the technological parameters of typical chemical and engineering processes and chemical equipment.

Section 1. Basic process regularities and general principles of device calculation in chemical technology.
Section 2. Hydromechanical processes and devices.
Section 3. Separation of heterogeneous systems.
Section 4. Heat exchange processes and devices.
Section 5. Mass exchange processes and devices.

Practice 1. Physical quantities and systems of measurement units. Properties of liquids and gases.
Practice 2. Solving problems on basic applied hydrostatics issues.
Practice 3. Solving problems on basic applied hydrodynamics issues.
Practice 4. Calculation of hydraulic systems and pump selection.
Practice 5. Separation of heterogeneous systems by precipitation and filtration.
Practice 6. Calculation of basic thermophysical properties. Thermal balances.
Practice 7. Calculation of heat transfer by thermal conductivity.
Practice 8. Calculation of convective heat exchange and heat transfer process.
Practice 9. Concentration units. Calculation and construction of equilibrium lines.
Practice 10. Calculation of physical absorption processes.
Practice 11. Calculation of the processes of simple distillation and rectification.
Practice 12. Parameters and phase diagram of humid air.

Lab 1. Determination of hydraulic resistances of pipeline.
Lab 2. Hydraulics investigation of fluidized bed reactor.
Lab 3. Study of the laboratory filter press.
Lab 4. Shell and tube heat exchanger.
Lab 5. Heat exchangers of type “pipe in the pipe”.
Lab 6. Evaporation with direct electric heating.
Lab 7. Evaporation with steam heating.
Lab 8. Rectification column of periodic action.
Lab 9. Study of the kinetics of convective drying of wet materials

Course Delivery: two semester, 36 weeks

Prerequisites:
Math module: Mathematics, Informatics.
Physical module: Physics.
Chemical module: General and Inorganic Chemistry, Organic Chemistry, Physical Chemistry, Colloidal Chemistry, Analytical Chemistry, Ecology.
Overall module: Engineering Graphics, Applied Mechanics, Electrical Engineering and Industrial Electronics, Materials Science, Metrology, Standardization and Certification.

Co-requisites:
Foreign language module: Professional Training in English.
Economic module: Fundamentals of Economics and Production Management.
Chemical module: Colloidal Chemistry, Analytical Chemistry.
Overall module: Applied Mechanics, Health and Safety, Resources Efficiency.
Technology module: General Chemical Engineering, Chemical Reactors; Modeling of Chemical And Engineering Processes.
Special module: Student Research Work.

Final Assessment: exam
Course Developer: Irina V. Frolova, PhD