MINISTRY OF EDUCATION AND SCIENCE OF THE RUSSIAN FEDERATION

Federal State Autonomous Education “Ural Federal University named after the first President of Russia B.N. Yeltsin”

Institute of Construction and Architecture

Signed and Approved

Vice-rector for Research

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ V.V. Kruzhaev

«\_\_\_» \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2018 г.

COURSE PROGRAM

**Water supply, sewerage, engineering of water resources protection systems**

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| **Information about the course program** | **Accounting data** |
| **Education program**  The main education doctoral graduate program  (the highly qualified personnel level of training ) | **Specialty code**  08.06.01/09.11 |
| **Major**  Engineering and Construction Technologies **Training program**  Water supply, sewerage, engineering of water resources protection systems | **Training program code**  08.06.01 |
| **Qualification**  Researcher, Research Instructor |
| **Federal State Educational Standard** | **The Ministry of Education and Science of the Russian Federation approval FSES HE order details:**  July 30, 2014 No. 873 |

Yekaterinburg 2018

**1. GENERAL CHARACTERISTICS OF THE course**

**Water Supply, Sewerage, Engineering Of Water Resources Protection Systems**

* 1. **Abstract of the course content**

Course studying is based on student’s knowledge gained by mastering of a number of natural-science, professional and special courses such as “Water Chemistry and Microbiology”, “Colloid Systems”, “Applied Chemistry”, “Theoretical Foundations of Mechanical Water Treatment”, “Hydraulics”, “Geo-engineering” , “Building structures”, “Pumps and blowing stations”, etc.

**1.3. Planned learning outcomes**

After mastering this discipline, the graduate student must acquire the following competencies:

* the ability to critically analyze and evaluate current scientific achievements, generate new ideas in solving research and practical problems, also in the interdisciplinary fields (UC-1);
* the ability to formulate and present the results of researches professionally in the form of scientific publications and presentations (GPC-5);
* the ability to develop new research methods and use them in independent researches in the field of construction (GPC-6);
* the ability to analyze and synthesize new processes and technologies of water supply systems, sewerage, construction systems for the protection of water resources (PC-2);
* the ability to develop technical tasks and feasibility studies for the development of science-intensive projects for the construction, provision of production and technological processes for water supply, sewerage, construction systems for the protection of water bodies, and the formation of quality indicators for products and processes in accordance with the national and international rules (PC-3);
* knowledge of software and programming languages ​​in the field of design and engineering, means of automated product, systems and processes design (PC-4);
* the ability to collect, process, analyze and systematize information on the research topic, choose methods and means for solving research problems (PC-5);
* the ability to use the knowledge of theoretical and experimental methods of scientific research, the principles of organization of research activities (PC-6);
* readiness to use modern achievements of science and advanced technologies in research works in the field of water supply, sewerage and construction systems for the protection of water bodies (PC-7);

After mastering this discipline, the graduate student must:

To know:

• phase equilibrium in water systems;

• composition and structure of water systems;

• processes at the phase interface;

• differences in the distribution of substances between phases;

• ways to implement the distribution of substances between phases;

• basic methods of water treatment and machines (facilities) for the purification of natural and waste water

• Configuration of vehicles and facilities

• The main technological parameters of vehicles and facilities

To be able to:

• make a technological water purification scheme;

• select reagents for water treatment;

• justify the choice of equipment for water treatment;

• make a measurement of water treatment machines;

• apply the acquired knowledge to the study of subsequent disciplines and professional activities.

• choose the most rational methods of water treatment and the optimal composition of facilities in the design of water treatment and wastewater treatment plants, taking into account local conditions and feasibility issues,

• make a measurement of vehicles and facilities,

Master (demonstrate skills and experience):

• assessing the quality of wastewater treatment;

• knowing criteria for discharge of sewage into water bodies;

• using methodology of environmental and economic assessment of damage from pollution by sewage of natural objects;

• knowing means to ensure reliable operation of wastewater treatment systems.

• applying solutions that ensure the technical effectiveness of the processes and devices used for water treatment.

• choosing the most optimal methods of water treatment

• mastering the technological skills of analyzing the work of structures and teach you how to evaluate the advantages and disadvantages of the construction of sewage treatment plants and structures

.**2. COURSE CONTENTS**

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| **№** | **Section, topic** | **Contents** |
| **1** | Processes and technologies of mechanical purification | Lattices. Mechanized gratings. Combined crusher grills. Constructions and calculation. Purpose and technological role of treatment facilities in the settling processes. Hydraulic size of suspended solids.  Sand trap horizontal, vertical, tangential, aerated. Processes of clarification of sewage. |
| ***2*** | Processes and technologies of physical and chemical purification | The essence of adsorption-bubble processes. Classification of surfactants. The structure is difilty. Micelle formation. Coefficient of hydrophilicity. Solubility. Experimental determination of the adsorption value. Ultimate adsorption. The rate at which sorption equilibrium is established. Selectivity of adsorption. Concentration areas of application of adsorption-bubble processes. Features of adsorption processes. Kinetics of adsorption processes. Adsorption isotherms. The nature of the adsorption interaction. Porous granular adsorbents and their properties. Natural inorganic adsorbents. Artificial inorganic adsorbents. Natural organic adsorbents. Artificial organic adsorbents. |
| ***3*** | Membrane processes and technologies | **Fundamentals of reverse osmosis, nanofiltration, ultrafiltration and microfiltration.**  Scheme of occurrence of direct and reverse osmosis. Determination of osmotic pressure. The concept of an ideal and real semipermeable membrane. The concept of nanofiltration, ultrafiltration and microfiltration. The difference between the processes of membrane filtration and simple mechanical filtration. Determination of concentration polarization and degree of concentration.  **The influence of various factors on the processes of baromembrane filtration**  Determination of the main parameters and optimal conditions of the membrane filtration process. Influence of size, degree of hydration, valence of metal ions on the selective properties of semipermeable membranes. Assessment of osmotic pressure. Determination of the driving force of the reverse osmosis process. The difference between reverse osmosis and nano- and ultrafiltration processes. Pore ​​sizes in reverse osmosis membranes, nanofiltration and ultrafiltration. Working pressures and selectivity values ​​for substances of inorganic and organic origin.  **Capillary-filtration, electrochemical, diffusion mechanisms of membrane semipermeability**.  Hydrophilic properties of semipermeable membranes and the structure of layers of a bound liquid on the membrane surface. The ratio of the thickness of the layer of the bound fluid, effective pore diameter and membrane selectivity. Effect of the magnitude and sign of the surface charge of the membrane on its selective properties. Influence of concentration and the nature of dissolved substances on their diffusion properties.  **Classification of membranes and methods for obtaining them. Structure and structure of membranes. Requirements for membranes.**  The role of the active layer on the selective properties of asymmetric membranes. Materials used to make membranes and various types of filter elements.  **The device of various types of membrane filter elements and devices based on them. Fields of application of membrane apparatuses.**  Apparatuses of filter press, roll and tubular types and in the form of a hollow fiber. Use of devices of various designs for processing of liquid systems. |
| ***4*** | Processes and technologies of biochemical water treatment | Processes of water purification in artificially created conditions.  Biofilters. Classification of biofilters. Biofilters with planar and bulk loading, their calculation and design.  Ventilation of drip and high-load biofilters. Recycling. Calculation of biofilters of various designs. Distribution of sewage by biofilters.  Aerotanks. Principle of operation and classification of aeration tanks. Aerotanks for full and partial cleaning. Aerotanks with separate regeneration of activated sludge. Aerotanks with unevenly distributed water supply, aerotank-mixers, aerotanks-propellants. Aerotanks with long aeration. Methods for calculating aeration tanks.  Pneumatic and mechanical methods of air supply to the aeration tanks. Elite and jet air supply.  Intensification of biological treatment facilities.  Reconstruction of biofilters and aerotanks. Intensification and reconstruction of biological aerobic and anaerobic treatment facilities of low-capacity stations. |
| ***5*** | Processes and technologies of water disinfection | Chlorination. Ozonation. Ultraviolet irradiation. Process characteristics. Physicochemical regularities of processes. The influence of various factors on the effectiveness of processes. Basic parameters and boundaries of use. |
| ***6*** | Processes and technologies for processing precipitation | Classification of precipitation by different signs of their genesis Specific precipitation; chemical and granulometric composition of precipitation; the form of the bond of water with the particles of the solid phase of the precipitate; filtration properties of precipitation, thermal characteristics of precipitation  Dehydration of sediments by thickening methods (gravity, flotation, centrifugal, in mesh thickeners); methods of filtration under gravity conditions, under pressure and vacuum; Dehydration of precipitation in a centrifugal field; drying precipitation-freezing precipitation, incineration |

**7 METHODICAL AND INFORMATION SUPPORT**

**7.3.Software**

1. Microsoft Excel.
2. Internet Explorer browser
3. Graphics editing Compas 8-12
4. MathCad 2014

**7.4. Search systems and information and reference systems**

1. proekt-gaz.ru/load/4
2. gumarika.kz/publ/perechen
3. normativa.ru/content/view/283/33

**7.5. Electronic educational resources**

<URL:http://lib.urfu.ru/>

**8 base of materials for current academic performance Evaluation and interim assessment**

**8.2.4. List of sample questions for credit**

1. Flotation of mineral particles (macro-flotation).

2. Flotation of ions and colloids (micro flotation).

3. The essence of adsorption-bubble processes.

4. Classification of surfactants.

5. Properties of aqueous solutions of surfactants. (structuraldiffiility, micelle formation, hydrophilicity coefficient, solubility).

6. Adsorption of surfactants on the surface of floating air bubbles (experimental determination of adsorption, limiting adsorption, rate of establishment of sorption equilibrium, selectivity of adsorption).

7. Concentration areas of adsorption-bubble processes.

8. Evaluation of the efficiency of adsorption-bubble processes.

9. Methods for obtaining a gas dispersion in water.

10. Separators for adsorption-bubble processes.

11. Principles of technological calculation of separators.

12. Technological scheme of wastewater treatment by the method of adsorption with air bubbles emerging.

13. Equilibrium of ion exchange.

14. Statics of ion exchange.

15. Dynamics of ion exchange.

16. Ion exchange chromatography.

17. Optimization of ion-exchange processes.

18. Selective ion-exchange recovery of sewage components.

19. Mechanism and kinetics of electrode processes.

20. Composition of natural, domestic, industrial and municipal wastewater.

21. Physical and chemical characteristics of suspended solids

22. Classification of suspended solids: mineral, organic, including bacterially contaminated.

23. Insoluble, colloidal. Pop-up and settling. Sanitary and technical analysis.

24. Biochemical oxygen demand (BOD), chemical oxygen demand (COD) and other water quality indicators. The active reaction is the pH of the medium.

25. Determination of the content of contaminants.

26. Lassification of mechanical water treatment processes. Strain, sedimentation - sedimentation, thickening - condensation of sediments, filtration, centrifugation.

27. Apparatus for mechanical water treatment

28. Lattices. Mechanized gratings. Combined crusher grills. Constructions and calculation.

29. The designation and technological role of mechanical treatment facilities in settling processes.

30. Hydraulic size of suspended solids.

31.Peskolovki horizontal, vertical, tangential, aerated.

32. Methods of calculation and design.

33. Treatment and utilization of sand pellets. Sand areas of construction, calculation. Sand bunkers, construction, calculation.

34. Processes of clarification of sewage.

35. Co-precipitation in cramped conditions of high suspended matter content.

36. Isolation of pop-up substances. Behavior of petroleum products.

37. Calculation of the hydraulic size of suspended solids.

38. Septic tanks are horizontal, vertical, radial, thin-layered. Their purpose, design and calculation. Technical and economic conditions of use and the best choice.

39. Clarification of water in clarifiers with suspended sediment. The principle of the clarifiers. Clarifying clarifiers.

40. Clarifier with a bottom sediment packer.

41. Clarifier with preliminary mechanical stirring of the precipitate. Calculation of clarifiers

42. Secondary sedimentation tanks. Purpose, design, calculation.

43. Oil trap, construction. Oil product removal systems.

44. Radial oil trap. Calculation of oil traps.

45. Reagent and non-reagent methods for intensifying primary clarification of sewage. Modernization of primary settler designs in order to increase their technological efficiency.

46. ​​Hydrocyclones. Open hydrocyclones without internal devices, with diaphragm, cylindrical partition, multi-tiered. Pressure hydrocyclones.

47. Materials filtering the load of filters.

48. Processes of water purification from undissolved and dissolved substances on the material of the filtering charge.

49. Classification of granular filters. The device and process of operation of the fast filter.

50. Drainage systems and flushing of fast filters.

51. Definition of the concept of a semipermeable membrane.

52. The essence of reverse osmosis, nanofiltration and ultrafiltration.

53. The concept of concentration polarization in membrane processes and its influence on the technological characteristics of the separation process.

54. Effect of working pressure, concentration of solutes, pH, temperature, degree of conversion on selectivity and permeability of membranes.

55. Definition of the notions of membrane selectivity, specific productivity and degree of conversion.

56. Types of semipermeable membranes, filter elements and apparatus.

57. Mechanisms of the processes of semipermeability: diffusion, capillary-filtration, charge.

58. The concept of osmotic pressure of solutions and its effect on the driving force of the reverse osmosis process.

59. Areas of application of reverse osmosis, nanofiltration and ultrafiltration.

60. Preparation of groundwater with the help of membrane-sorption methods for water supply of settlements.

61. Additional purification of effluent from neutralization stations from heavy metal ions.

62. Principles of technological calculation of membrane plants.

63. Use of membrane-sorption methods for water supply of apartment houses.

64. Preparation of water for the needs of galvanic production.

65. Extraction of heavy metal ions from the water of the recovery baths in order to reuse metal and water in production.