**THERMAL POWER PLANTS, THEIR ENERGY SYSTEMS AND THEIR UNITS**

# GENERAL DESCRIPTION OF THE DISCIPLINE

The work programme of the discipline is compiled according to the Federal State Higher Professional Education Standards

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| --- | --- | --- | --- |
| Code of the field of study and attainment level | Field of study | Details of the order of the Ministry of Education and Science of the Russian Federation on approval and commissioning of the Federal State Higher Educational Standard | |
| Date | **Number of order** |
| 13.06.01 | Thermal Engineering and Electrical Engineering | 30 July 2014 | 881 |

## Abstract of the discipline content

The discipline falls under the post-graduate programme. The main goal of studying the discipline is the creation of a set of basic knowledge and practical skills for postgraduates, which allow analysing the problems of science and production in the heat-and-power industry in tune with the times (meeting up-to-date requirements) in order to improve it.

## Planned results of mastering the discipline

As a result of mastering the discipline, a student should acquire the competences as follows:

* the ability to critically analyse and evaluate current scientific achievements, generate new ideas for solving research and practical problems, including in interdisciplinary areas (UC-1);
* the ability to design and implement complex research including inter-disciplinary one based on a holistic and scientific view of the world using knowledge in the field of history and philosophy of science (UC-2).
* the ability to scientifically justify evaluating new solutions in the field of construction and modelling of the dedicated heat and power machinery as well as techniques for production (GPC-1);
* the ability to formulate and solve non-typical problems of the mathematical, physical, engineering, process-related and electrical engineering nature in the design, manufacture and operation of new machines and technology (GPC-2);
* the ability to plan and conduct experimental research with subsequent adequate evaluation of the results obtained (GPC-5);
* the ability to develop physical and mathematical models of objects in the design of new machines, automatic and automated control systems for process equipment and power engineering processes (PC-1);
* the ability to conduct kinematic and dynamic analysis and synthesis of modern machine tools, robotic, information, measurement and diagnosis systems, automation and control systems for process equipment and heat-and-power engineering processes (PC-2);
* the ability to develop Terms of Reference (ToR) and feasibility studies for the development of science-intensive products for the heat-and-power industry, the provision of production and engineering processes, and the creation of quality indicators for products and processes according to the existing national and international regulatory framework (PC-3);
* the knowledge of the software of modern production systems, knowledge of programming languages in the field of design and technology-related preparation of production, automated product design tools as well as the production and engineering processes and systems (PC-4);
* the readiness to use recent achievements in science and advanced technologies in research work in the field of heat power engineering (PC-7).

As a result of mastering the discipline, a post-graduate student should:

Know:

- the areas of technical progress in heat-and-power engineering,

- the heat-and-power engineering prospects and areas,

- the current trends and methods for increasing the efficiency, reliability and safety of the heat-and-power machinery,

- the basis for modern methods of a technical and economic analysis in relation to the heat-and-power engineering challenges.

Be able:

- to analyse the information received from heat-and-power facilities and take reasonable technical decisions based on it;

- to determine possible areas for improving the heat-and-power machinery at various stages of their life cycle.

Demonstrate skills and experience:

- in the practical activities for determining the effectiveness of certain machinery;

## Discipline scope

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| --- | --- | --- |
| **Types of the educational work, forms of control** | **Hours, total** | **Study terms,**  **number** |
| **6** |
| In-class learning, hours | **4** | **4** |
| Lectures, hours | 4 | 4 |
| Practical exercises, hours | - | - |
| Laboratory-based work, hours | - | - |
| Self-guided work of students, hours | **104** | **104** |
| Interim attestation | **-** | **Test, 4** |
| Total work intensity according to the curriculum, hours | 108 | |
| Total work intensity according to the curriculum, credits | 3 | |

# DISCIPLINE CONTENT

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| --- | --- | --- |
| **Code of section, topic** | **Discipline section, topic\*** | **Content** |
| **Р1** | Thermal power plants | Electrification and its development in Russia. Energy resources and the fuel and energy balance of the country. Unified energy system and its national economic importance. The structure of Russia’s energy capacities.  Classification and the process flow designs of thermal power plants of various types. Determination of heat, steam and fuel costs for separate and combined energy supply methods. Electrical and thermal loads and their coverage. |
| **Р2** | Thermal process flow designs of TPPs | Thermal process flow designs of steam turbine power plants and their computations. The heat balance diagrams of gas-turbine and steam-gas plants and their computations. District heat supply systems. The power plant process water supply. |
| **Р3** | Basic equipment of thermal power plants, their units and modules. | The general classification and characteristics of modern energy and heat-generating boiler units. The main methods of burning organic fuels of various types. The thermal balance and efficiency of a boiler unit.  Principal thermal flow diagrams of steam-turbine units of condensation power plants and CHP plants. The main losses and efficiency factors of the turbine stage and the turbine plant as a whole.  The methods of delivery of organic fuel of various types. The classification, composition and technical characteristics of fuel and its impact on the flow design and equipment of the power plant fuel economy. Elements of the furnace process theory. Fundamentals of the theory of combustion. Information on the kinetics of chemical reactions.  The aerodynamic basis for fuel combustion. Regularities of the propagation of turbulent gas jets. The combustion of solid, liquid and gaseous fuels. The main environmental impact of TPPs; the impact of various combustion technologies. The prospects for joint operation of TPPs and power generation facilities through non-traditional and renewable sources. |
| **Р4** | Use of the fluidised bed and devices with swirling flows in heat power engineering | The main characteristics of solid particles and a granular material layer. Hydrodynamics of the blown layer. Combustion in the fluidised bed of solid, liquid and gaseous fuels. Boilers with boiling and circulating fluidized bed.  Aerodynamics of a swirling flow in cyclone-vortex chambers. The stamping process in swirling (vortex) torches of furnaces of various types. Vortex burners, their purpose, characteristics and purpose of use. The structure of a swirling torch of the main types of vortex burners.  The relation between the environmental safety of fuel combustion and the characteristics of the torch and furnace torches. |
| **Р5** | Non-traditional methods of using fuels | Thermal processing of solid fuels. The essence and types of gasification processes. Types and features of gas generators and applications of artificial gases.  The process-related and environmental aspects of the operation of power equipment with in-cycle gasification on low-calorific fossil fuels and biomass. The use of solar energy to heat water and generate electricity. |

**3. PROCEDURES FOR THE LEARNING OUTCOME MONITORING AND EVALUATION**

The discipline provides for the final attestation in the form of a test.

**List of sample questions for a test**

1. Electrification and its development in Russia. The role of the Russian power engineering in the global energy industry.

2. Classification and process flow designs of various kind of thermal power plants. Determination of heat, steam and fuel costs for separate and combined methods of energy supply.

3. Applied thermal designs of thermal power plants and their characteristics. Schemes of heating network and make-up water at the CHP.

4. Applicable thermal flow designs of gas turbine and combined-cycle plants and their energy characteristics.

5. The main heat supply systems and their characteristics. The main machinery of the heat supply system. Applied heat-transfer media and their energy characteristics.

6. Waste heat removal methods. Water balance of condensation power plants and CHP plants. Water supply sources and systems and their characteristics.

7. General classification and characteristics of modern energy and heat-generating boilers.

8. The main methods for burning organic fuels of various types. Heat balance and the efficiency of a boiler unit.

9. Principal thermal flow designs of steam-turbine units of condensation power plants and CHP plants. Classification and main types of turbines of thermal power plants and nuclear power plants.

10. Main losses and efficiency factors of the turbine stage and turbine plant as a whole.

11. Classification, composition and technical characteristics of fuel and its effect on the flow design and machinery of the fuel economy of a power plant.

12. Elements of the theory of furnace processes. Fundamentals of the combustion theory. Information on the kinetics of chemical reactions.

13. Aerodynamic basis for the fuel combustion. Regularities of the transmission of turbulent gas jets.

14. The main environmental impacts of TPPs; the impact of various combustion technologies. The relation between the type and flow designs of TPPs and the problems of impact on soil, atmosphere, hydrosphere and climate.

15. Use of fluidised bed in heat-and-power engineering. The main characteristics of solid particles and granular material layer.

16. Combustion in the fluidised bed of solid, liquid and gaseous fuels. The combustion mechanism.

17. Aerodynamics of a swirling flow in cyclone-vortex chambers (CVC). The connection between the basic design characteristics of a CVC, the structure of the formed flow and the turbulent transfer in it with the features of the design of the CVC.

18. The firing process in swirling (vortex) torches of furnaces of various types.

19. Vortex burners (VB), their purpose, characteristics and purpose of use. The structure of a swirling torch of the main types of VB.

20. Relationship between the environmental safety of fuel combustion and the characteristics of torch and furnace torches.

21. Thermal processing of solid fuels. Essence and types of gasification processes.

22. Technology-related and environmental aspects of the power machinery operation with in-cycle gasification on low-calorific fossil fuels and biomass.

23. Use of solar energy to heat water and generate electricity.

**Databases, information, reference and search systems**

1. http://www.google.com and others.

2. The official website of the Ministry of Energy of the Russian Federation: http://minenergo.gov.ru