**PHYSICO-CHEMICAL BASES OF THERMAL PROCESSES**

1. GENERAL DESCRIPTION OF THE DISCIPLINE

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

|  |  |  |
| --- | --- | --- |
| 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 | Electrical- and Thermal Engineering | 30 July 2014 | 878 |

* 1. Abstract of the discipline content

During the study of the discipline, the main information from chemical thermodynamics, which are necessary for heat engineering and heat power engineering professionals, is considered. The general conditions for the equilibrium of thermodynamic systems are considered, in particular, when chemical reactions take place in them. A technique for calculating the equilibrium composition of combustion products is given. The thermodynamics of phase transitions in one-component and two-component systems is described. The thermodynamics of surface phenomena is considered, i.e. surface tension, capillary effect, adsorption of gases and vapours.

* 1. Discipline mastering outcome requirements

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

* the ability and willingness to apply modern research methods, conduct technical tests and scientific experiments, evaluate the results of the work performed (PK-1);
* the readiness to use the latest achievements of modern science and advanced technology in research (PK-3);
* the readiness to use in the practical activities the theoretical foundations of working processes in power machines, units and installations, the methods for the calculating analysis of professional activity items (Professional Competence-5);
* the readiness on the basis of a systematic approach to build and use models to describe and predict various phenomena, to carry out a qualitative and quantitative analysis of them (Professional Competence-6).

As a result of mastering the discipline, a postgraduate student should:

Know:

basic laws and regularities of chemical thermodynamics.

Be able:

To calculate the equilibrium composition of the combustion products.

To demonstrate skills and experience:

To master the simplest calculation methods for solving physical and chemical problems, the ability to search physicochemical data in an open source (including information databases) and apply them in tackling practical problems.

1.3. Scope of the discipline

|  |  |  |
| --- | --- | --- |
| Types of the educational work, forms of control | Total, hours | Number of the academic semester |
| 5 |
| In-class learning, hours | 4 | 4 |
| Lectures | 4 | 4 |
| Practical exercises | - | - |
| Laboratory-based work | - | - |
| Self-guided work including all types of the current attestation | 104 | 104 |
| Interim assessment | - | test |
| Total scope according to the curriculum, hours | 108 |
| Total scope according to the curriculum, credits | 3 |

**2. CONTENTS OF THE DISCIPLINE**

|  |  |  |
| --- | --- | --- |
| Section and topic code | Discipline section, topic | Contents |
| 1 | Topic 1. Basic concepts and relations of chemical thermodynamics | Individual substances and their mixtures (solutions). Partial quantities. Gibbs-Duhem equation. Chemical potential. Chemical (isobaric-isothermal) potential of a real substance. Activity. |
| 2 | Topic 2. Equilibrium of thermodynamic systems | General conditions of thermodynamic equilibrium of physical and chemical systems. Analysis of the general conditions of equilibrium and stability. Le Chatelier-Braun principle. Gibbs’ phase rule. |
| 3 | Theme 3. Equilibrium in chemically reacting systems | The equilibrium constant of chemical reactions between ideal gases. Equilibrium in the chemically reacting system of real bodies. The features of calculating the equilibrium of reactions involving solid and liquid components. Thermal effects. Dependence of the equilibrium constant on temperature. The effects of pressure and temperature on the equilibrium mixture composition. Degree of gas dissociation. Dissociation of salts and oxides. The relationship between the equilibrium constants in a complex mixture. |
| 4 | Topic 4. Calculation of the equilibrium composition of combustion products | General calculation procedure, *I-s*-diagram of combustion products. The calculation of the equilibrium composition of products of incomplete combustion of hydrocarbon fuels. |
| 5 | Topic 5. Methods for calculating the equilibrium constants and the Gibbs free energy | Methods for finding equilibrium constants. Calculation of the equilibrium constants through the free Gibbs energy. |
| 6 | Topic 6. Thermodynamics of phase transitions | Equilibrium of one-component heterogeneous systems. The mutual solubility of components taken in identical aggregate states. Equilibrium in binary systems. Separation of the solution components. |
| 7 | Topic 7. Thermodynamics of surface phenomena | Surface tension. Surface pressure. Saturated steam pressure over a curved surface. Wetting properties, capillary effect. Adsorption. |

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

1. Zonal Scientific Library of UrFU http://lib.urfu.ru/
2. The Russian State Library http://www.rsl.ru/
3. The Russian National Library http://www.nlr.ru/
4. The Russian National Public Library for Science and Technology http://www.gpntb.ru/
5. Public Internet Library http://www.public.ru/
6. Students Library http://www.lib.students.ru/
7. Scientific Library of the St. Petersburg State University http://www.lib.pu.ru/
8. Scientific electronic library http://www.eLIBRARY.ru/

**SET OF EVALUATION TOOLS FOR CONDUCTING INTERMEDIATE ATTESTATION**

**List of sample questions for the test**

1. What is called the chemical potential? (PC-1, PC-3, PC-5, PC-6)

2. What is meant by the real gas volatility? (PC-1, PC-3, PC-5, PC-6)

3. What is the component activity in the solution? (PC-1, PC-3, PC-5, PC-6)

4. How to determine the equilibrium constant of the reaction? (PC-1, PC-3, PC-5, PC-6)

5. List the main features of calculating the equilibrium of reactions involving solid and liquid components. (PC-1, PC-3, PC-5, PC-6)

6. Why does the surface tension strongly depend on the ‘surface cleanliness’? (PC-1, PC-3, PC-5, PC-6)

7. How does the Gibbs energy change with an increasing droplet radius when it forms in a pair (at *p, T* = const)? (PC-1, PC-3, PC-5, PC-6)

8. What is roughly the thermal effect of the hydrogen burning reaction? (PC-1, PC-3, PC-5, PC-6)

9. What is the thermal effect of the formation of an ideal solution from the components that are in the same aggregate state as the solution? (PC-1, PC-3, PC-5, PC-6)

10. Why do the solution components separate during rectification? (PC-1, PC-3, PC-5, PC-6)