

Siberian Federal  
University

## **Entrance test**

### **02.00.13 Petroleum Chemistry**

*Course (module) Title*

Entrance test for applicants to graduate school

02.00.13 Petroleum Chemistry Guide

*Course (module)*

Krasnoyarsk, 2020

## **Table of Contents**

- 1. Course (module) Description**
- 2. Course (module) requirements**
- 3. Prerequisites**
- 4. The list of the main questions to the exam**
- 5. Grading scale**

# Course (module) Guide Actual Problems of Petrochemistry

## 1. Course (module) Description

### 1.1. Course (module) overview

The program is designed to prepare for the admissions test to postgraduate studies of a program 02.00.13 Petroleum Chemistry. The program is part of the major study field 04.06.01 Chemical sciences. The program is designed on the bases that an applicant knows and understands sufficiently general issues of oil and gas processing, petrochemical processes and oil field chemistry.

## 2. Course (module) requirements

### 2.1 Required text(s)

#### Main literature

1. Petroleum Chemistry and Refining [Text]: monograph / ed. J. G. Speight. - London: Taylor & Francis, 1998. - xiv p. : ill. - (Applied Energy Technology Series / Editor: J.G. Speight). - Glossary: p. 247-262.
2. The chemistry and technology of petroleum [Text] / J. G. Speight. - 4th ed. - Boca Raton ; London ; New York : CRC Press : Taylor & Francis Group, 2006. - 919 p.
3. Applied process design for chemical and petrochemical plants [Electronic resource]. Vol. 1 / E. E. Ludwig. - 3th ed. - Electronic text data (28,8 MB). - Boston : Butterworth-Heinemann, 1999. - 630 p.
4. Applied process design for chemical and petrochemical plants [Electronic resource]. Vol. 2 / E. E. Ludwig. - 3th ed. - Electronic text data (38,3 MB). - Boston : Butterworth-Heinemann, 1999. - 486 p
5. Applied process design for chemical and petrochemical plants [Electronic resource]. Vol. 3 / E. E. Ludwig. - 3th ed. - Electronic text data (24,4 MB). - Boston : Butterworth-Heinemann, 1999. - 690 p.
6. Handbook of Vinyl Polimers. Radical Polymerization, Process and Technology [Text]: monograph / Y. Vagci; Ed. M.K. Mishra. - 2nd ed. - London: CRC Press, 2009. - 763 p.
7. Handbook of MTBE and Other Gasoline Oxygenates [Text] / ed.: H. Hamid, M. Ashraf Ali. - New York : Marcel Dekker, 2004. - 381 p.

8. Polymer Chemistry [Text]: monograph / W. R. Moore. - London: University of London Press LTD, 1967. - 270 p.
9. Petroleum Processing Handbook [Text]: monograph / ed. J. J. McKetta. - Basel; Hong Kong: Marcel Dekker, 2010. - 774 p.
10. Practical Advances in Petroleum Processing [Text] / ed. : C. S. Hsu, P. R. Robinson. - Berlin: Springer, 2006 -. Volume 2. - 2006. - xv, 411 p.
11. Purification of laboratory chemicals [Electronic resource] / Wilfred L. F. Armarego, Christina L. L. Chai. - Electronic text data (20,1 MB). - Amsterdam: Butterworth-Heinemann, 2003. - 634 p. - Ver. with the title. screen. - Electron. version of the printer. publication.
12. Organic chemistry [Electronic resource] / J. Clayden. - Electronic text data (33,9 MB). - [S. l. : s. n.], 2001. - 1490 p
13. Polymers a Property Database [Text]: monograph / ed. : B. Ellis, R. Smith. - 2nd ed. - London: CRC Press, 2009. - xxii p. : tabul. - Name and Synonym index: p.1089-1106.
14. Petroleum Refining. Tehnology and Economics [Text] / J. H. Gary, G. E. Handwerk, M. J. Kaiser. - 5th ed. - Boca Raton; London: CRC Press; London; New York: Taylor & Francis Group, 2007. - 463 p.
15. Essentials of Petroleum. A Key to Oil Economics [Text]: monograph / P. H. Frankel; foreword by M. A. Adelman. - London: Frank Cass, 2005. - xiii, 188 p.
16. Petroleum Refinery Process Economics [Text]: a monograph / R. E. Maples. - 2nd ed. - Tulsa: Penn Well, 2000. - xxix, 474 p.

**The list of information and telecommunication resources required for mastering the discipline (module) is available via Internet network**

1. [www.eLIBRARY.RU](http://www.eLIBRARY.RU) - Scientific electronic library. Access mode is free.
2. [www.sciencedirect.com](http://www.sciencedirect.com) - Elsevier Database. Access mode is free.
3. [www.nature.com](http://www.nature.com) - Scientific journal Nature. The access mode is free.
4. [www.scopus.com](http://www.scopus.com) - Scopus peer-reviewed literature database. Access mode is free.
5. [www.springerlink.co](http://www.springerlink.co) - Springer Database.
6. [www.isiknowledge.com](http://www.isiknowledge.com) - Web of Science Database. Access mode is free.

## **2.2 Web page of the course (module)**

You can receive the information about the postgraduate program 02.00.13 Petroleum Chemistry and about the course in SibFU website: [www.e.sfu-kras.ru](http://www.e.sfu-kras.ru). You must be logged in to access to some sections. The section, that shows the main demands and terms of the postgraduate program, is freely available. The applicants

can be advised on issues of admission to the program and about other possibilities and questions via electronic services like Skype or Zoom by person responsible for this task. The contact person can be found through SibFU website: [www.e.sfu-kras.ru](http://www.e.sfu-kras.ru).

### **3. Prerequisites**

Background in general chemistry, organic chemistry, refining.

### **4. The list of the main questions to the exam**

The general information about energy sources.

World oil and gas markets and the position of the Russian Federation; political, economic and environmental aspects of crude oil recovering and refining in Russia. Russian oil and gas complex. Theories of the hydrocarbon raw materials origin, classification of hydrocarbon deposits, chemical and fractional composition of oil and gas.

Properties of raw materials and marketable products.

Physical and chemical properties of natural hydrocarbon raw materials. Requirements for oil refining and petrochemical feedstock. Oil classifications. Chemical characteristics of motor fuels. Analysis and brief characteristics of additives for motor fuels. Basic chemical requirements for oils. Methods for the analysis of oil and oil products. Basics of compounding petroleum products.

Theoretical foundations of chemical technology of organic substances.

The structure of organic substances. Classification of organic substances. Nomenclature of organic compounds. The main classes of organic compounds: structure, physical properties, preparation, chemical properties (alkanes, alkenes, alkadienes, alkynes, aromatic hydrocarbons, halogen derivatives, alcohols and phenols, carbonyl compounds, carboxylic acids and their derivatives, nitrogen compounds, heterocycles). Preparation processes and oil and natural gas processing. Starting materials for basic organic synthesis. The main processes of petrochemical synthesis: halogenation, hydration / dehydration, esterification, hydrogenation / dehydrogenation, oxidation, alkylation.

Theoretical foundations of organic substances.

Kinetics and thermodynamics of chemical reactions. Equilibrium of chemical reactions. Heat balance of a chemical-technological process. Chemical reaction rate. Calculation of homogeneous and heterogeneous chemical processes. The influence of various factors (temperature, pressure, etc.) on the indicators of

chemical production and chemical technological process. Catalytic processes, homogeneous and heterogeneous catalysis. The processes of transformation of organic compounds, the mechanisms of organic reactions, methods for establishing mechanisms, the relationship between the structure of organic molecules and their reactivity, the effect of the solvent, the features of homogeneous and heterogeneous, homophase and heterophase processes.

Processes and devices of chemical technology.

Classification and physical and chemical foundations of typical oil refining processes (hydromechanical, mechanical, thermal, mass transfer, chemical). The main types, structure and principle of operation of machines and apparatus of oil refining industries (pipelines, pipeline fittings, pumps, compressors, turbines, separators, sedimentation tanks, cyclones, centrifuges, filters, heat exchangers, refrigerators, condensers, tube furnaces, rectification columns, absorbers, adsorbers, extractors, reactor devices). Calculation methods and principles of selection of the main and auxiliary technological equipment for oil refining at the given process parameters. Principles of choosing devices with different design features.

Fundamentals of Catalysis.

General information about catalysis and catalysts, the nature of the catalysts action, properties of catalysts. The course examines the main mechanisms of heterogeneous catalysis, the kinetics of heterogeneous catalytic reactions. Students learn the basic requirements for industrial catalysts, catalyst preparation methods, and the main types of heterogeneous catalysis.

Primary oil refining processes.

The current state of the fuel and energy complex. Classification and characteristics of oil refineries. Modern global trends in the development of oil refining. Theoretical foundations and technology of primary oil and gas processing processes (electrical desalting dehydrating unit, atmospheric oil distillation unit, fuel oil vacuum distillation unit, gas fractionation unit).

Technology of deep oil refining processes.

Theoretical foundations and technologies of hydrocatalytic processes of oil refining and upgrading of oil raw materials (catalytic reforming, catalytic isomerization, hydrotreating, hydrocracking). Theoretical foundations and technology of catalytic heterolytic processes of oil refining (catalytic cracking, alkylation). Theoretical foundations and technology of thermolytic processes of oil and petroleum feedstock refining (visbreaking, thermal cracking, coking, production of bitumen, pitch, pyrolysis). Technologies for primary processing of heavy and superheavy oils and natural bitumen.

Petrochemical synthesis process technology.

Basic processes and technologies of petrochemical synthesis. Methods for obtaining raw materials for petrochemical processes from oil and gas. Methods for the isolation and purification of petrochemical synthesis products. Ethylene and propylene production. Aromatic hydrocarbon production. Vinyl chloride production. Production of monomers for rubbers (butadiene, isoprene, ethylbenzene / styrene,  $\alpha$ -methylstyrene, acrylonitrile). Phthalic acid production. Polymerization processes. Main petrochemical products: benzene, toluene, xylenes, ethylbenzene, styrene. The main petrochemical products are organic acids, their anhydrides and esters. The main petrochemical products are aldehydes and ketones. The main petrochemical products are alcohols and phenols. The main petrochemical products are polymers.

Simulation of chemical technological processes.

Methods for calculating and processing experimental data in order to obtain mathematical models. Experiment planning methods. Basics of processing experimental information. Factors affecting the quality of mathematical models. Calculation of mathematical models.

## **5. Grading scale**

Grade policy for both home assignments and the exam is:

- A (excellent work) 91–100 points
- B (above average work) 81–90 points
- C (average work) 71–80 points
- D (below average work) 50–70 points
- F (failed work) < 50 points