**Getting complex mineral fertilizers on the basis of technogenic waste phosphoric production**

**Nazarbek Ulzhalgas**

PHD-doctoral student in "Chemical technology of inorganic substances" M.Auezov South Kazakhstan State University, Shymkent, Kazakhstan,

160012, Kazakhstan, Shymkent, Tauke khan avenue, 5,

**Besterek Uylesbek**

doctor of technical sciences**,** professor of chemical technology of inorganic substances, doctor of technical sciences, professor M.Auezov South Kazakhstan State University, Shymkent, Kazakhstan,

160012, Kazakhstan, Shymkent, Tauke khan avenue, 5,

**Petropavlovsky Igor Aleksandrovich**

doctor of technical sciences, professor of technology of inorganic substances,

D. Mendeleev University of Chemical Technology of Russia,

125047, Russia, Moskow, Miusskaya square, 9

e-mail:ipetropavlovsky@gmail.com

**Pochitalkina Irina Alexandrovna**

candidate of technical sciences, docent of technology of inorganic substances,

D. Mendeleev University of Chemical Technology of Russia,

125047, Russia, Moskow, Miusskaya square, 9

e-mail: pochitalkina@list.ru

**Nazarbekova S.P.**

doctor of chemistry, рrofessor M.Auezov South Kazakhstan State University, Shymkent, Kazakhstan,

160012, Kazakhstan, Shymkent, Tauke khan avenue, 5,

**Bolysbek A.A.**

candidate of technical sciences, M. Auezov South Kazakhstan State University, Shymkent, Kazakhstan,

160012, Kazakhstan, Shymkent, Tauke khan avenue, 5,

**Keywords:** phosphorus sludge, dust kottrelnaya, humic acid, ammonium sulfate, complex fertilizers, ammonium phosphate, superphosphate.

Production of phosphorus is associated with the formation of technogenic waste: phosphorus sludge, kottrelnoy dust, gas emissions. Phosphorus sludge and dust kottrelnaya represent a valuable secondary raw material for the production of phosphate fertilizers.However, sound and practically implemented technologies for processing waste in fertilizing products are still not existed. In this context, the search for new opportunities, large tonnage recycling of secondary phosphorus raw materials is an important task.In this paper, for the type of fertilizer MAP a mixture of phosphorus sludge, dust , ammonium sulfate and humic acid were used. For the proposed process technologial conditions and key performance indicators were developed.

**References**

1. Strategija razvitija «Kazachstan». [Development Strategy "Kazakhstan-2030"]. (in Russ.)

2. Elektronniy resurs: <http://www.inform.kz/rus/article/228083>. [Electronic resource: <http://www.inform.kz/rus/article/228083>]. (in Russ.)

3. Aldashov B.A., Lisitsa V.I. Disposal of waste rock phosphate Karatau - the path to a competitive economy and improve the environment. Gilim [Gilim], 2007, 428 p. (in Russ.)

4. Postnikov N.N. Thermal phosphoric acid. Chimiya. [Chemistry], 1972, 308 p. (in Russ.)

5. Dzhusipbekov U.Z., Chernyakova R.M., Oshakbayev M.T., Nurgaliyeva G.O. Processing of substandard phosphorite Karatau and industrial waste for fertilizer - Gilim [Gilim], 2000, 132 p. (in Russ.)

6. Batkaev R.I. Development of technology for commodity products from industrial waste products of phosphorus. Yuzno-Kazachstanskiy gosudarstvenniy Universitet im. M. Auezova. Shymkent. [South-Kazakhstan State University. M. Auezova], 2010, 64 p. (in Russ.)

7. Development of technology for complex fertilizers, ameliorants developed soil based on modified polyampholytes with controlled properties, synthesized using recycled acrylate and hydrocarbon feedstock. Shymkent [South-Kazakhstan State University. M. Auezova], 2013. (in Russ.)

8. Nazarbek U.B., Besterek W., Petropavlovsky IA, Beisenbayev D.C., S.P. Nazarbekova. Features of technogenic wastes microstructure of phosphorus production, applicable for obtaining compound fertilizers. Sbornik nautschnych trudov Mezdunarodnoi nautschnoi konferencii «International Conference of Industrial Technologies and Engineering». Shymkent. [South-Kazakhstan State University. M. Auezova], August 30, 2014, pp. 176-181 (in Russ.)

9. M.E. Posin. Technology fertilizer. Utschebnik dlya vuzov [Textbook for high schools - 6 th ed., Rev.]. Chemistry, 1989, 352 p. (in Russ.)

10. Reed S. Dzh. B. Electron probe microanalysis and scanning electron microscopy in geology Technosphera [Technosphere], 2008, 232 p. (in Russ.)

11. Mineral fertilizer. Test methods. Sbornik GOSTov [Publishing IEC standards] 2003. pp. 68 (in Russ.)

12. Gorshkov V.G., Timashev V.V. Savelyev V.G. Methods of physicochemical analysis binders. Utschebnoe posobie [Textbook]. M.: High School, 1981, 333 p. (in Russ.)

**The improved method of purification solutions of sodium tungstate from the impurities forming heteropolyanions**

**Giganov Vladimir** G., Ph.D., leading researcher D.I. Mendeleev University of Chemical Technology of Russia, e-mail: [giganov.v@mail.ru](mailto:giganov.v@mail.ru)

**San Yu Aung**, post graduate student, D.I. Mendeleev University of Chemical Technology of Russia, tel. +7(495) 496-68-42

**Keywords:** carbonation, heteropolyanions, silicon, phosphorus, tungsten, reextract.

The purification of solutions of sodium tungstate from silicon and phosphorus was studied. It is shown that the use of carbonic acid to neutralize the carbonate-alkaline solutions of sodium tungstate eliminates formation of heteropolyanions and reduces the residual silicon content of less than 0.1 g/l . The eguilibricem in wolframate solutions during carbonization is achieved in 3 to 4 times faster at 70-80 оС than at normal temperatures. To achieve the degree of purification from silicon > 90 % , it is useful to introduce a solution of aluminum salts as coagulants. It is shown that together with silicon the wolfra-foul solutions is cleaned from phosphorus.

**References**

1. Patent US №3042416 Evaporator plates, Willard R Stephen, 09.1962.

2. Patent US №3206303 Process for precipitating solubilized silica from acidic aqueous media, Goren Vayer B, 09.1965.

3. Penchalov V.A., Fomenko I.P., Kharkovsky I.A. Method of production of tungstic acid // Avtorskoe svidetelstvo USSR № 914511/22-2 bul. №16, 1967. ( in Russ).

4. Patent US №4092400 Caustic leaching, filtration, chemical treatment, acidification //Vladimir Zbranek, Zdenka Zbranek, Daniel Arthur Burnham, 05.1978.

**Modification process as a variant of expansion of sulfur use area**

**Skripunov Denis**

Gas sulfur laboratory, Gazprom VNIIGAS LLC., Research associate

Razvilka, Moscow region, Gazprom VNIIGAS LLC.

e-mail: [D\_Skripunov@gwise.vniigaz.gazprom.ru](mailto:D_Skripunov@gwise.vniigaz.gazprom.ru)

**Nikolay Motin**

Gas sulfur laboratory, Gazprom VNIIGAS LLC., The head of laboratory

Razvilka, Moscow region, Gazprom VNIIGAS LLC.

e-mail: [N\_Motin@gwise.vniigaz.gazprom.ru](mailto:N_Motin@gwise.vniigaz.gazprom.ru)

**Vladimir Nedelkin**

Moscow State University of Technologies and Management   
named after K.G. Razumovskiy, department «Inorganic and analytical chemistry named Klyachko Y.A.», The head of the Department, Sc.D., prof.

Moscow, Shabolovka, 14

e-mail: [Nedelkinvi@mgutm.ru](mailto:Nedelkinvi@mgutm.ru)

**Keywords:** Sulfur, surplus, modification, modified sulfur, sulfurconcrete, sulfurasphaltic concrete, construction industry.

Russia is a major producer of elemental sulfur. In 2012, sulfur production was   
6.4 million tons, the level of consumption was 2.9 million tons. The main direction of use of sulfur is production of sulfuric acid for fertilizers. A surplus of 3.5 million tons sold to foreign markets (exports). In the medium and long term excess of world sulfur production is projected. By 2020, surplus of world production could reach 5 million tons per year. In the present article the problem definition of expansion of area of use of sulfur is realized. Theoretical bases of process of chemical modification of sulfur that can be used as component of construction materials are given. Some positive properties of the modified sulfur and materials on its basis are shown. The prospect of use of modified sulfur in construction industry and in production of asphaltic concrete mixtures is proved.

**References**

1. Chem-Courier. Chem-Expert. Sulfur. Statistics, <http://www.him-kurier.ru/>
2. Skripunov D. A., Filatova O.E. Problem of surplus of gas sulfur, decision variants. Gasochem, 2011 (in Russ.).
3. Motin N.V., Alekhina M.N., Skripunov D.A. Modern problems of production and application of technical sulfur in various industries. Scientific and practical conference "Prospects and problems of implementation in civil, industrial and road construction of sulfur composites", SOPS, 2013, pp. 27-36 (in Russ.).
4. McBee W. C., Sullivan T.A. Sulfur in construction materials. Bulletin/Bureau of Mines; 678, 1985, 31 p.
5. Oae S. Chemistry of organic sulfur compounds. Chemistry, 1975, 512 p.  
    (in Russ.).
6. Nedelkin V.I., Savin E.D., Frolova N.G. Polymeric sulfur: scientific and practical aspects. Khimiya v Rossii [Chemistry in Russia], 2000, no. 10, pp. 18-19 (in Russ.).
7. Rylova M.V., Samuilov A.J. Interaction of dicyclopentadiene with elemental sulfur. The initial stage of the reaction. Khimiya i komp'yuternoye modelirovaniye. Butlerovskiye soobshcheniya [Chemistry and Computational Simulation. Butlerov Communications], 2002, Vol.2, no. 9, pp.29-32.
8. Penczek S., Duda A. Anionic copolymerization of elemental sulfur. Pure & Appl. Chem., 1981, vol. 53, pp. 1679-1687.

**Changing the surface properties of the phthalocyanine pigment**

**by chemical modification**

**Zuev Kirill Vladimirovich**

D. Mendeleyev University of Chemical Technology of Russia,

Chair of chemistry of dyes, postgraduate student

Moscow, 125047, Miusskaja sq., 9

phone: +7(915)121-19-05, e-mail: [zuev.kirill@inbox.ru](mailto:zuev.kirill@inbox.ru)

**Smrchek Vladimir Alekseevich,** *Ph.D. (Chemistry).*

D. Mendeleyev University of Chemical Technology of Russia,

Chair of chemistry of dyes, consultant

Moscow, 125047, Miusskaja sq., 9

phone: +7(495)496-69-09, e-mail: [tdindlak@yandex.ru](mailto:tdindlak@yandex.ru)

**Fedoseeva Marija Sergeevna**

D. Mendeleyev University of Chemical Technology of Russia,

Chair of chemistry of dyes, student

Moscow, 125047, Miusskaja sq., 9

phone: +7(499)978-88-20, e-mail: [mariya\_fedoseeva@list.ru](mailto:mariya_fedoseeva@list.ru)

**Koldaeva Tat'jana Jur'evna**

D. Mendeleyev University of Chemical Technology of Russia,

Chair of chemistry of dyes, senior research assistant

Moscow, 125047, Miusskaja sq., 9

phone: +7(499)978-88-42, e-mail: [tkoldaeva@muctr.ru](mailto:tkoldaeva@muctr.ru)

**Perevalov Valerij Pavlovich***, DSc (Chemistry), professor*

D. Mendeleyev University of Chemical Technology of Russia,

Chair of chemistry of dyes, Head of Chair

Moscow, 125047, Miusskaja sq., 9

phone: +7(499)978-99-91, e-mail: [pvp@muctr.ru](mailto:pvp@muctr.ru)

**Keywords**: organic pigments, chemical technique of surface modification, nanosized materials, Gomberg-Bachmann reaction.

The paper describes the method of synthesis and the application’s way of new reagents for the chemical modification of blue copper phthalocyanine pigment (P.B.15:3, C.I.:12474). Modifiers are derived from 4-aminobenzoic acid and tertiary amines (di- and triethanolamines) having hydroxyethyl groups. The functional fragments of these compounds were fixed on the surface of pigment particles by Gomberg-Bachmann arylation. The presence of polar bulky groups on the surface of particles are increase its affinity for aqueous media. The dispersion degree of powdery pigment are also increased. The improvement of technical and performance characteristics of the pigment after modification was shown in various laboratory tests.

**References**

1. Belen'kij E.F., Riskin I.V. Chemistry and technology of pigments. 4-th ed. – L.: Himija [Chemistry], 1974. – 656 p. (in Russ.).
2. Herbst W., Hunger K. Industrial Organic Pigments: production, properties, applications. Weinheim, WILEY-VCH Verlag GmbH & Co. KGaA, 2004. – 672 s.
3. Shakhnovich A., Belmon J. Pigments for Inkjet Applications. The Chemistry of Inkjet Inks, Ch.6 – Singapore: World Scientific Publishing Co. Pte. Ltd., 2010. – 339 s.
4. Kalinskaja T.V., Dobronevskaja S.G., Avrutina Je.A. Сoloring of polymer materials. – L.: Himija [Chemistry], 1985. – 184 p. (in Russ.).
5. Patent of WIPO № 2007045311. Pigment concentrates based on diketopyrrolo-pyrroles. Reipen T., Plueg C., Weber J., 2007.
6. Patent of Germany № 2017040. Phthalocyanine pigment compositions. Bagai S., Topham A., 1970.
7. Patent of USA № 6264733. Pigment particle growth and/or crystal phase directors. Baebler F., 2001.
8. Patent of USA № 5571311. Ink jet ink formulations containing carbon black products. Belmont J.A., Johnson J.E., Adams C.E., 1996.
9. Cepanec I. Synthesis of biaryls. – Netherlands: Elsevier Ltd, 2004. – 365 s.
10. GOST [State Standard] № 21119.6-92. Common methods of testing the pigments and fillers. Determination of compacted volume, apparent density and bulk volume (in Russ.).
11. GOST [State Standard] № 21119.8-75. Common methods of testing the pigments and fillers. Determination of oil-adsorption (in Russ.).

**Environmentally friendly inhibitors for petrochemical production**

**water recycling systems**

**Dilyara I. Khasanova**

Research and Development Center, PJSC «Nizhnekamskneftekhim»

The Head of Research Laboratory of Anticorrosive Processes, Candidate of Technical Sciences

Address: 423574 Nizhnekamsk Republic of Tatarstan RUSSIA

8(8555) 377424; 375705

e-mail: [ntc.ilap@mail.ru](mailto:ntc.ilap@mail.ru)

**Damir Kh. Safin**

Kazan National Research Technological University

Professor, Doctor of Technical Sciences

Address: 420029 Kazan Republic of Tatarstan RUSSIA

8987296758

e-mail: [Safin\_Damir@kos.ru](mailto:Safin_Damir@kos.ru)

**Elena A. Kovrizhnyh**

Research and Development Center, PJSC «Nizhnekamskneftekhim»

Engineer of Research Laboratory of Anticorrosive Processes

Address: 423574 Nizhnekamsk Republic of Tatarstan RUSSIA

8(8555) 379119

e-mail: [kovrizhnyh\_2011@mail.ru](mailto:kovrizhnyh_2011@mail.ru)

**Keywords**: recycling water supply, corrosion and scale inhibitor.

A new environmentally friendly corrosion and scale inhibitor for cooling water treatment – OPC-800 was developed. Gravimetric method showed that inhibitor exhibits the maximum protection against carbon steel corrosion and calcium carbonate deposition at a dose of 50 mg/L. In the potentiostatic study it was defined that reagent OPC-800 is a mixed-type inhibitor that provides high level protection of carbon steel in water of low and medium mineralizaton. The inhibitor effectively reduces the possibility of scale formation keeping water stability in the temperature range of 25 oC to 75oC. The data of application of this inhibitor in recycling water supply system of PJSC «Nizhnekamskneftekhim» are presented.

**References**

1. Balaban-Irmenin Yu.V., Rudakova G.Ya. Use of antifouling compositions in the energy aties of low parameters. Novosti teplosnabzheniya [News of heat supply], 2011 (in Russ.).
2. Korobeinikova E.Yu., Avtonomova A.Yu. Heteroligand complex formation of copper with 2-phosphonobutane-1,2,4-tricarboxylic acid and carboxylic acids in aqueous solutions. Vestnik udmurtskogo universiteta [Herald of Udmurt University], 2012, no 2 (in Russ.).
3. GOST 9.502.-82. Inhibitors of metals corrosion for aqueous systems. Methods of corrosion tests. Izdatelstvo standartov [Standards Press], 1988 (in Russ.).
4. Anofriev N.G. Universal automatic corrosimeter Expert-004 (v.1.19-3.10). Rukovodstvo po expluatacii [Guidance for use and certificate], 2010 (in Russ.).
5. Akol'zin P.A. Corrosion and metal protection of heat power equipment. Moscow, Energoizdat, 1982. ( in Russ)/
6. Kemmer F.N. The Nalco Water Handbook, Second Edition. McGraw-Hill Book Company 1989 /

**The development of energy saving technological line of the rectification in the production of the aromatic hydrocarbons from light alkanes**

**Catherine A. Borovkova**

The graduate student of Department of Computer Science & Computer Aided Design (CAD).

Address:Russia, 125047 Moscow 9 Miusskaya square

E-mail: catherine.borovkova@gmail.com

Numbers of telephones: (499)-978-84-18

**Filipp S. Sovetin**

Associate professor (docent) of Department of Computer Science & Computer Aided Design (CAD).

Address:Russia, 125047 Moscow 9 Miusskaya square

E-mail: [fsovetin@inbox.lv](mailto:fsovetin@inbox.lv)

Numbers of telephones: +7(499)-978-84-18, (499)-500-19-17

**Alina A. Ramazanova**

Student-diplomant of Department of Computer Science & Computer Aided Design (CAD).

Address:Russia, 125047 Moscow 9 Miusskaya square

E-mail: alishka\_li@inbox.ru

Telephone:+7 (499)-978-84-18

**Tamas N. Gartman**

The director of Department of Computer Science & Computer Aided Design (CAD).

Address: Russia, 125047 Moscow 9 Miusskaya square

E-mail: [gartman@muctr.ru](mailto:gartman@muctr.ru)

Numbers of telephones: +7(499)-973-12-85, (499)-978-84-11

**Keywords:** simulator, reflux ratio, model, module.

Evolutionary algorithm of synthesis of the energy and resources saving technologies of the rectification is realized by simulator ChemCAD. Computer models of the 5 different variants of the technological lines of the rectification of the aromatic hydrocarbons (in the production of the arenes from the light alkanes) are developed. The best variaut from the position of the energy and resources saving is selected by different criterion for the efficiency of technological lines (annual charges, total heat duty). Identical results are observed at a choice of the most effective technological line of the rectification by using 2 different criterion for the efficiency by using simulation.

**References**

1. Lisicyn V. N. Chemistry and technology of the intermediate substances in the productions of the dyes. Moscow: “Himia”. 1987. 368 pp. (in Russian).

2. Gorelik M. V., Efros L. S. The bases of the chemistry and technology of the aromatic substances. Moscow: “Himia”. 1992. 640 pp. (in Russian).

3. Orehov V. S., D’yachkova T.P., Subocheva M. Y., Kolmakova M. A. The techonology of the intermediate substances in the productions of the dyes. Tambov: TSTU. 2007. 140 pp. (in Russian).

4. Sovetin F. S., Gartman T. N. The development of the computer model of the technological line of the nitration in the large-capacity production of the nitrobenzene. // Himicheskaya tehnika [Chemical equipment]. 2012. no.4. pp. 44-45 (in Russian).

5. Dorogochinsky A. Z., Proskurin A. L., Ovcharov S. N., Krupina N. N.. Aromatization of the light paraffin hydrocarbons on the zeolite calysts. Moskow: “CNIITENEnethim”. 1989. 84 pp. (in Russian).

6. Kutepov B. I., Belousova O. Y. Aromatization of the hydrocarbons on the pentasit catalysts. Moscow: “Himia”. 2000. 95 pp. (in Russian).

7. Haimova T. G., Mhitarova D. A., Trenina N. M. New methods of the synthesis of the aromatic hydrocarbons. // Neftepererabotka i neftehimia [Oil processing and petrochemistry]. 1986. no.7 pp. 18-20 (in Russian).

8. Tullo A.H. Technology spurs aromatics rush. //Chem. Eng. News. 2001. nn. 35. pp. 28-30.

9. Mamaeva I. M. Development of process and research of aromatization of C2-C4 paraffin on the pentasits. *Cand. Sci. (Chem.) Dissertation.* Grozny: Institute of the petro chemistry. 1995 (in Russian).

10. Nagamori Y., Kawase M. Converting light hydrocarbons containing olefins to aromatics (Alpha Process). // Microp. Mesop. Mater. 1998. V. 21. pp. 439-445.

11. Kartashev I. Y. The aromatization of the light alkanes on the promoted high-silica zeolites. *Cand. Sci. (Chem.) Dissertation.* Moscow: Gubkin Russian State University of Oil and Gas. 2005 (in Russian).

12. Golovanov M. L. The development of the energy saving technology of the rectification of products of catalytic cracking. *Cand. Sci. (Eng.) Dissertation.* Moscow: Lomonosov Moscow University of Fine Chemical Technology. 2007 (in Russian).

13. Gartman, T.N. Klushin, D.V. The bases of computer modeling of the technological processes in chemical industry, Moscow: Akademkniga, 2008. 415 pp. (in Russian).

14. Gartman T. N., Sovetin F. S. The computer modeling of processes of multicomponent rectification in stage columns in the production of synthetic liquid fuel by simulator CHEMCAD // Himicheskaya tehnika [Chemical equipment]. 2010. no.2. pp. 36-38 (in Russian).

15. Gartman T. N., Sovetin F. S. The computer modeling of the technological line of the rectification in the production of methanol by simulator CHEMCAD // Himicheskaya tehnika [Chemical equipment]. 2010. no.4. pp. 12-14 (in Russian).

16. Sovetin F. S., Gartman T. N., Safonova V. D., Shumakova O. P., Tambovcev I. I. The development of the computer model of Berkman technological line of the chlorination of benzene by simulator CHEMCAD // Himicheskaya tehnika [Chemical equipment]. 2014. no.10. pp. 39-42 (in Russian).

17. Gartman T. N., Sovetin F. S., Losev V. A., Drobyshevsky N. A., Hvorostyany V. S. The development of the computer model of the multistage production of synthetic liquid fuel from natural gas. Khimicheskaya promyshlennost segodnya [Chemical industry today]. 2009. no.1. pp.40-50.

18. Gartman T. N., Sovetin F. S., Novikova D. K. The development of the computer model of the multistage production of methanol from natural gas. Khimicheskaya promyshlennost segodnya [Chemical industry today]. 2012. no.3. pp.45-53.

19. Kafarov V. V., Petluk F. B., Groisman S. A., Telkov Y. K., Belov M. V. The synthesis of optimal technological lines of the rectification of multicomponent mixes by dynamic programming method // Teoreticheskie osnovy himicheskoy tehnologii [Theoretical Foundations of Chemical Engineering]. 1975. t.9. no.2. pp.262-269 (in Russian).

20. Gartman T. N., Sovetin F. S., Novikova D. K., Semenihin Y. V. The development of the models of processes of water treatment and water purification when in the production of synthetic liquid fuel by using simulator CHEMCAD // Himicheskaya tehnika [Chemical equipment]. 2011. no.3. pp. 34-35 (in Russian).

21. Gartman T. N., Sovetin F. S., Novikova D. K., Senner S. A. The synthesis of the integrated technological line of the production synthetic liquid fuel and methanol from natural gas by using simulator CHEMCAD // Himicheskaya tehnika [Chemical equipment]. 2011. no.9. pp. 41-44 (in Russian).

22. Viktorov V. K., Malutin A.Y. The method of the synthesis of the technological lines of the rectification columns // Izvestia Sankt-Peterburgskogo gosudarstvennogo tehnologicheskogo instituta (tehnicheskogo universiteta) [Bulletin of the Saint Petersburg State Institute of Technology (Technical University)]. 2012. no.14(40). pp. 97-101 (in Russian).

23. Malutin A.Y. The synthesis of the optimal heatintegrated rectification systems *Cand. Sci. (Eng.) Dissertation.* Saint Petersburg: Saint Petersburg State Technological Institute (technical university). 2012 (in Russian).

24. Timoshenko A.V., Ahapkina O. A., Anohina E. A., Aristovich Y. V. Energy saving subsystems of rectification of butanes and pentanes // Khimicheskaya Technologiya [Chemical Engineering]. 2012. no. 11. pp.681-687.

25. Timoshenko A.V., Timofeev V. S., Hahin L. A., Ivanov I. V., Treger Y. A., Rozanov V. N. The synthesis and optimization of an energy saving subsystem of division in the process of receiving olefins from natural gas // Khimicheskaya promyshlennost segodnya [Chemical industry today]. 2013. no.1. pp.40-52.

26. Komissarov Y. A., Gordeev L. S., Vent D. P. Scientific bases of processes of rectification. By Serafimov's edition. In 2 volumes. Moskow. “Himia” 2004. pp. 270 (in Russian).

27. Gartman T.N, Sovetin F. S., Proskuro E. A., Shvets V. F., Kozlovskiy R. A., Suchkov Y.P, Sapunov V.N., Loktev A. S., Levchenko D. A., Dedov A.G. Computation of the Solid Catalyzed Gas Phase Reactions with a Simultaneous Choice of the Scheme of the Reactions for Different Composition of the Initial Reaction Mixture // Chemical engineering transactions. 2014. Vol. 39. pp.1009-1014.

28. Gartman T.N, Sovetin F. S. The state-of-the-art review of modern simulators for the computer modeling of the technological lines of chemical productions // Uspehi v himii i himicheskoy tehnologii [Advances in Chemistry and Chemical Technology]. 2012. V. 26. nn. 11(140). pp.117-120 (in Russian).

29. Sovetin F. S. The development and application of methodical ensuring of the block computer modeling of energy and resource-intensive chemical technological lines of the chemical productions by using simulators. *Cand. Sci. (Eng.) Dissertation.* Moscow: D. Mendeleev University of Chemical Technology of Russia. 2011 (in Russian).

30. Kafarov V. V. Meshalkin V. P. Analysis and synthesis of the technological lines of the chemical productions. Moscow: “Himia”. 1991. pp. 432.

31.Gartman T. N. The analysis and synthesis of continuous technological lines of the rectification on the basis of the automated accumulation and classification of information. *Doct. Sci. (Eng.) Dissertation.* Moscow: D. Mendeleev University of Chemical Technology of Russia. 2000 (in Russian).

**Mathematical modeling of network interaction of innovation processes participants in petrochemical clusters**

**Shinkevich Aleksey Ivanovich**, Kazan National Research Technological University, the chair of department of logistics and management, professor, 420015, Kazan, K. Marksa st., 68, tel./fax (843) 231-43-13, e-mail: [ashinkevich@mail.ru](mailto:ashinkevich@mail.ru)

**Zaraychenko Irina Anatolyevna**, Kazan National Research Technological University, associate professor of department of logistics and management, 420015, Kazan, K. Marksa st., 68, tel./fax (843) 231-43-13, e-mail: [irina-zar@mail.ru](mailto:irina-zar@mail.ru)

**Ahmetova Venera** Nailovna, Gasprom transgas Kazan Ltd., vice director of economics and finance, e-mail: [ashinkevich@mail.ru](mailto:ashinkevich@mail.ru)

**Keywords**: innovation process, organizational structure, innovation network, a cluster, a member of the network, networking, the utility function, Petrochemical industry, chemical technological system, the external network effects, externalities, the space-time conditions.

Networks provide the acceleration of the diffusion of innovations, stimulating innovation activity of network participants. The appearance of positive external network effects leads to the recruitment of new participants, which in turn provides the growing importance of the utility function. The objective of the processes of formation of innovation networks becomes the optimization of the number of the network participants. The article contains the mathematical model of innovation network, which is determined, on the one hand, by the dynamics of the utility function of its members, and on the other - the space-time conditions of network operating. Proposed the particular mathematical model for valuation of the external network effects made by the functioning of the innovation network at the petrochemical industry, which takes into account the specificity of chemical and technological processes, as well as features of the structure of the industry due to raw material orientation of the industry.

**References**:

1. Algazin G.I. Game theoretic modeling of network interaction of targeted parties in multi-agent system “center-agent-competitive market”. Izvestiya AltGU. [AltSU news], 2012, no.1/2 (73), pp.61-65 ( in Russ).
2. Ardasheva L.M. Positive connection between purposes for profit of franchisor and the growth of franchise system. Upravlenie ekonomicheskimi sistemami: electron nauchnij jurnal. [Economic systems management: electron scientific journal], 2007, no.2(10), URL: http://uecs.mcnip.ru. ( in Russ).
3. Bulavskiy V.A. The model of oligopoly of production factors markets. Ekonomika i matematicheskie metodyi [Economics and mathematics methods], 1999, Т.35, no.4, pp.78-86. ( in Russ).
4. Kats M.L. Network external effects, competition and compatibility. Vehi ekonomicheskoy myisli. Teoriya otraslevyih ryinkov. [Bases of economic thought. The theory of industrial markets], SPb.: Ekonomicheskaya shkola, 2003, pp. 500-535( in Russ)..
5. Markvart O.I. Features of network markets and network monopoly in innovation process. Vestnik OGU. [OSU news], 2007, no.77, pp.146-151. ( in Russ).
6. Meshalkin V. P., Kakatunova T. V., Dli M. I. The influence of information risks on innovation activity in regional industry complexes. Transportnoe delo Rossii. [Transport business of Russia], 2011, no.4, pp. 56-59. ( in Russ).
7. Nizhegorodtsev R.M., Karev R.M. Network effects, the problem of balance and feedback. Institutional aspects of global technological shifts: Materials of The fifth Druker’s readings. M.: Dobroe slovo, 2011, pp.146-158. ( in Russ).
8. The plan of development of petrochemical industry in Russia for the period to 2030. Ministerstvo energetiki Rossiyskoy Federatsii: official web-site [Electronic resource]. URL: http://www.minenergo.gov.ru/press/doklady/11723.html. ( in Russ).
9. Reyngold G. The smart crowd: the new social revolution. Moscow: Fair press, 2006, 416 p. ( in Russ).
10. Shinkevich A.I., Malyisheva T.V., Zaraychenko I.A. The concept of formation of industry innovation clusters. Vestnik KNITU. [KNRTU news], 2011, no.22, pp.299-306. ( in Russ).