

ISSN 2518-1491 (Online),
ISSN 2224-5286 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

Д.В.СОКОЛЬСКИЙ АТЫНДАҒЫ «ЖАНАРМАЙ,
КАТАЛИЗ ЖӘНЕ ЭЛЕКТРОХИМИЯ ИНСТИТУТЫ» АҚ

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН

АО «ИНСТИТУТ ТОПЛИВА, КАТАЛИЗА И
ЭЛЕКТРОХИМИИ ИМ. Д.В. СОКОЛЬСКОГО»

NEWS

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN

JSC «D.V. SOKOLSKY INSTITUTE OF FUEL,
CATALYSIS AND ELECTROCHEMISTRY»

ХИМИЯ ЖӘНЕ ТЕХНОЛОГИЯ СЕРИЯСЫ



СЕРИЯ ХИМИИ И ТЕХНОЛОГИИ



SERIES CHEMISTRY AND TECHNOLOGY

6 (432)

**ҚАРАША – ЖЕЛТОҚСАН 2018 ж.
НОЯБРЬ – ДЕКАБРЬ 2018 г.
NOVEMBER – DECEMBER 2018**

1947 ЖЫЛДЫҢ ҚАҢТАР АЙЫНАН ШЫҒА БАСТАҒАН
ИЗДАЕТСЯ С ЯНВАРЯ 1947 ГОДА
PUBLISHED SINCE JANUARY 1947

ЖЫЛЫНА 6 РЕТ ШЫҒАДЫ
ВЫХОДИТ 6 РАЗ В ГОД
PUBLISHED 6 TIMES A YEAR

NAS RK is pleased to announce that News of NAS RK. Series of chemistry and technologies scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of chemistry and technologies in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of chemical sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Химия және технология сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Химия және технология сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді химиялық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия химии и технологий» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по химическим наукам для нашего сообщества.

Б а с р е д а к т о р ы
х.ғ.д., проф., ҚР ҰҒА академигі **М.Ж. Жұрынов**

Р е д а к ц и я а л қ а с ы:

Ағабеков В.Е. проф., академик (Белорус)
Волков С.В. проф., академик (Украина)
Воротынцев М.А. проф., академик (Ресей)
Газалиев А.М. проф., академик (Қазақстан)
Ергожин Е.Е. проф., академик (Қазақстан)
Жармағамбетова А.К. проф. (Қазақстан), бас ред. орынбасары
Жоробекова Ш.Ж. проф., академик (Қырғыстан)
Иткулова Ш.С. проф. (Қазақстан)
Манташян А.А. проф., академик (Армения)
Пралиев К.Д. проф., академик (Қазақстан)
Баешов А.Б. проф., академик (Қазақстан)
Бүркітбаев М.М. проф., академик (Қазақстан)
Джусипбеков У.Ж. проф. корр.-мүшесі (Қазақстан)
Молдахметов М.З. проф., академик (Қазақстан)
Мансуров З.А. проф. (Қазақстан)
Наурызбаев М.К. проф. (Қазақстан)
Рудик В. проф., академик (Молдова)
Рахимов К.Д. проф. академик (Қазақстан)
Стрельцов Е. проф. (Белорус)
Тәшімов Л.Т. проф., академик (Қазақстан)
Тодераш И. проф., академик (Молдова)
Халиков Д.Х. проф., академик (Тәжікстан)
Фарзалиев В. проф., академик (Әзірбайжан)

«ҚР ҰҒА Хабарлары. Химия және технология сериясы».

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» Республикалық қоғамдық бірлестігі (Алматы қ.)

Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген №1089-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,
www.nauka-nanrk.kz / chemistry-technology.kz

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2018

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

Главный редактор
д.х.н., проф., академик НАН РК **М. Ж. Журинов**

Редакционная коллегия:

Агабеков В.Е. проф., академик (Беларусь)
Волков С.В. проф., академик (Украина)
Воротынцев М.А. проф., академик (Россия)
Газалиев А.М. проф., академик (Казахстан)
Ергожин Е.Е. проф., академик (Казахстан)
Жармагамбетова А.К. проф. (Казахстан), зам. гл. ред.
Жоробекова Ш.Ж. проф., академик (Кыргызстан)
Иткулова Ш.С. проф. (Казахстан)
Манташян А.А. проф., академик (Армения)
Пралиев К.Д. проф., академик (Казахстан)
Баешов А.Б. проф., академик (Казахстан)
Буркитбаев М.М. проф., академик (Казахстан)
Джусипбеков У.Ж. проф. чл.-корр. (Казахстан)
Мулдахметов М.З. проф., академик (Казахстан)
Мансуров З.А. проф. (Казахстан)
Наурызбаев М.К. проф. (Казахстан)
Рудик В. проф., академик (Молдова)
Рахимов К.Д. проф. академик (Казахстан)
Стрельцов Е. проф. (Беларусь)
Ташимов Л.Т. проф., академик (Казахстан)
Тодераш И. проф., академик (Молдова)
Халиков Д.Х. проф., академик (Гаджикистан)
Фарзалиев В. проф., академик (Азербайджан)

«Известия НАН РК. Серия химии и технологии».

ISSN 2518-1491 (Online),

ISSN 2224-5286 (Print)

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан» (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан №10893-Ж, выданное 30.04.2010 г.

Периодичность: 6 раз в год

Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел. 272-13-19, 272-13-18,
<http://nauka-nanrk.kz/chemistry-technology.kz>

© Национальная академия наук Республики Казахстан, 2018

Адрес редакции: 050100, г. Алматы, ул. Кунаева, 142,
Институт органического катализа и электрохимии им. Д. В. Сокольского,
каб. 310, тел. 291-62-80, факс 291-57-22, e-mail: orgcat@nursat.kz

Адрес типографии: ИП «Аруна», г. Алматы, ул. Муратбаева, 75

E d i t o r i n c h i e f

doctor of chemistry, professor, academician of NAS RK **M.Zh. Zhurinov**

E d i t o r i a l b o a r d :

Agabekov V.Ye. prof., academician (Belarus)
Volkov S.V. prof., academician (Ukraine)
Vorotyntsev M.A. prof., academician (Russia)
Gazaliyev A.M. prof., academician (Kazakhstan)
Yergozhin Ye.Ye. prof., academician (Kazakhstan)
Zharmagambetova A.K. prof. (Kazakhstan), deputy editor in chief
Zhorobekova Sh.Zh. prof., academician (Kyrgyzstan)
Itkulova Sh.S. prof. (Kazakhstan)
Mantashyan A.A. prof., academician (Armenia)
Praliyev K.D. prof., academician (Kazakhstan)
Bayeshov A.B. prof., academician (Kazakhstan)
Burkitbayev M.M. prof., academician (Kazakhstan)
Dzhusipbekov U.Zh. prof., corr. member (Kazakhstan)
Muldakhmetov M.Z. prof., academician (Kazakhstan)
Mansurov Z.A. prof. (Kazakhstan)
Nauryzbayev M.K. prof. (Kazakhstan)
Rudik V. prof., academician (Moldova)
Rakhimov K.D. prof., academician (Kazakhstan)
Streltsov Ye. prof. (Belarus)
Tashimov L.T. prof., academician (Kazakhstan)
Toderash I. prof., academician (Moldova)
Khalikov D.Kh. prof., academician (Tadjikistan)
Farzaliyev V. prof., academician (Azerbaijan)

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of chemistry and technology.
ISSN 2518-1491 (Online),
ISSN 2224-5286 (Print)

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)

The certificate of registration of a periodic printed publication in the Committee of Information and Archives of the Ministry of Culture and Information of the Republic of Kazakhstan N 10893-Ж, issued 30.04.2010

Periodicity: 6 times a year

Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
<http://nauka-nanrk.kz/chemistry-technology.kz>

© National Academy of Sciences of the Republic of Kazakhstan, 2018

Editorial address: Institute of Organic Catalysis and Electrochemistry named after D. V. Sokolsky
142, Kunayev str., of. 310, Almaty, 050100, tel. 291-62-80, fax 291-57-22,
e-mail: orgcat@nursat.kz

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

NEWS

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

SERIES CHEMISTRY AND TECHNOLOGY

ISSN 2224-5286

<https://doi.org/10.32014/2018.2518-1491.32>

Volume 6, Number 432 (2018), 102 – 108

D.I. Chyrkun¹, A.E. Leudanski¹, V.G. Golubev², D. Sarsenbekuly², S.A. Kumisbekov²

¹Belorussian State Technological University, Minsk, Belarus;

²M. Auezov South Kazakhstan State University, Shymkent, Kazakhstan

email: alex_levdansky@mail.ru nii_mm@mail.ru alex_levdansky@mail.ru serik_argin@mail.ru

ANALYSIS OF INDUSTRIAL DRUM MILLS' OPERATION AND WAYS OF THEIR IMPROVEMENT

Abstract. There has been done the analysis of existing industrial drum mills, which has permitted to reveal their design imperfection. In order to increase the intensity of heterogeneous processes, it is proposed to aim at increasing the surface of contacting phases, involved in the process. For this purpose, it is necessary to combine such processes as grinding, activation, classification, mixing and chemical synthesis in the grinding device, which enables to intensify the subsequent operations for processing of dispersed compositions. The efficiency of mill operation in a closed cycle can be further improved, if to provide a highly efficient classification of ground products, removed from the mill. It is proposed to divide the whole drum of the mill along its length by lattice partitions into a large number of chambers, with a certain distance between the chambers of about $1,5 \div 2$ meters; to install two lattice partitions between the chambers, with a distances of $0,25 \div 0,4$ meters between the partitions; to fix the blades to the drum wall in the space between the partitions, similar to the drum dryer. It is recommended that in order to reduce energy costs, there should be provided a rational organization of the grinding process with optimal process conditions for industrial mills, applied in cement milling, with the air speed in the free drum space having to be within $0,7 \div 1,4$ m/sec.

Keywords: industrial drum mills, continuous classification of ground products, particles, process intensification, material cooling energy, specific energy costs, designs.

Introduction. Improving production efficiency is an essential part of the economic strategy of the country and, finally, is shown in increasing the output of high quality products at lowest costs. This is achieved through technical re-equipment, wide introduction of advanced technologies and equipment.

To increase the intensity of heterogeneous processes, it is necessary to aim at increasing the surface of contacting phases, involved in the process. Therefore, at present, many products for most industries are obtained in a fine-disperse state, with the requirements for powder dispersity continuously growing.

The modern direction in the development of technological production equipment is a combination of technological processes. The combination of such processes as grinding, activation, classification, mixing and chemical synthesis in the grinding device enables to intensify the subsequent operations for processing of dispersed compositions.

Grinding of various materials to the particles of less than a tenth of a millimeter is the most important technological process in the production of cement, lime, ceramic products, ore dressing, etc. [1-4].

Methods of research. To carry out the research, there were used analytical and numerical methods with the computers applied.

Results of research. As is known, the main drawback of the milling process is high energy intensity, although directly on the material grinding there is spent a small part of the energy, consumed by the machine.

In modern large-tonnage production there are mainly used drum mills for grinding. However, a very low-efficiency coefficient of these mills forces the researchers to work on their improvement, as well as to develop and apply mills of other designs. Such mills as medium-speed, impact, impact-centrifugal and others are beginning to find more and more application in the processes of fine grinding [5,6].

Drum mills are hollow rotating drums, in which there are grinding bodies (in most cases, steel balls), and just here the material is fed for grinding. Grinding is carried out by impact, crushing and attrition. These mills have been used in industry since the beginning of the twentieth century. The reason for such a long life of this mill is in reliability and simplicity of its design, and due to these characteristics, being very important for production, it is still out of competition in comparison with other designs. Therefore, it is necessary to remember that the newly created designs of mills can move from the development phase to the implementation phase only when they will be comparable by reliability to the drum ones. During the long period of their application, the drum mills have undergone some design changes that have enabled slightly to reduce energy losses, but they still remain very high.

In paper [7, p.17-18] there is given an approximate balance of power consumption items in the drum ball mill:

1. Formation of new surfaces	– 0,6%
2. Losses in the transformation of electricity into the kinetic energy of ball lifting	– 12,3%
3. Heating of the drum	– 6,4%
4. Heating of the medium	– 31%
5. Heating of the material	– 47,6%
6. Other losses	– 2,1%

The balance shows that the main energy losses are related to heating of the material, the medium and the drum itself. Heat in the mill is released as a result of friction between the particles, the friction of the particles on the grinding bodies and the drum wall, as well as due to the volumetric and plastic deformations. Often, high specific energy consumption in fine grinding is explained only by strength change. The smaller the particles, the smaller the internal defects in the material, the stronger they are and, therefore, their grinding requires more energy costs. This explanation is true, but far from being exhaustive. In grinding, part of the particles, having reached the desired size, remaining in the whole mass of the material, take over them the part of acting forces, dissipate them, are over-ground and slow down sharply the process in the right direction. With increasing the dispersity of particles, the effect of interaction of the particles between each other also increases. As a result, there is observed the formation of very small particles' coagulation structures, the destruction of which consumes a significant portion of the energy, supplied to the particle.

The main ways of reducing the energy losses and improving the efficiency of grinding in a drum mill are as follows. By grinding method, the drum mills can be dry and wet grinding. Wet grinding is used in those cases, when the material to be ground is further processed in the form of suspensions, for example, in mineral processing by flotation or extraction of certain components by chemical means.

The advantages of wet grinding, compared to dry grinding, are as follows:

1. less energy consumption per 1 ton of the material;
2. higher grinding capacity of the mill (approximately by 15%), absence of dust and, accordingly, aspiration ventilation and air purification systems;
3. facilitation of transportation and distribution of the material: the hydraulic transport can be used;
4. wet classification is more effective than air classification

The energy consumption reduction in wet grinding and the growth of mill capacity are explained by the fact that the liquid penetrates into cracks and causes tensile stresses that contribute to the destruction of the material, in addition, the friction force between the particles of the ground material decreases.

However, if after grinding the material, the further technology requires its use in a dry form, the dry grinding appears to be more feasible economically due to the large heat consumption for drying.

By operation principle, the drum mills are subdivided into batch and continuous. Batch mills are working by wet method. These mills are not used for operation by dry method because of great difficulties, arising in their discharge. A major drawback of batch mills is a large loss of energy to the mill operation at the end of the grinding cycle, when a very small amount of underground material is left in it. Batch mills are operated very much at the enterprises of the Republic and in order to reduce energy costs they are to be replaced by continuous mills.

To improve the process and to reduce energy costs per unit of the ground material in long drum mills, for example, tube ones, is possible by dividing them along the length into several chambers by installing

lattice partitions. Since the size of the material to be crushed is decreasing while it is moving from the charging spout to the discharge one, in accordance with this, each chamber should be charged with grinding bodies, the size of which corresponds to the size of the material to be crushed. The largest bodies will be in the first chamber and the smallest bodies - in the last one.

To increase the grinding capacity and to reduce the energy costs substantially when grinding in a drum mill is possible by converting its operation from an open cycle to a closed one.

The open cycle operation circuit, when all the material to be crushed is passed through the drum once, is simpler. In this operation circuit there are no devices, providing the finished product selection, and therefore all the material is in the mill until it is completely crushed, as a result of which there will be observed the finished product grinding heterogeneity, part of the material will be over-ground. Naturally, in the open cycle operation there will be low grinding capacity and high specific energy consumption for grinding. However, it should be noted that the mills, working by open method, are simple in design and are not difficult to operate, which ensures their application up to the present time.

In a closed grinding cycle there is no aim to bring the whole material to the desired grinding fineness, and at the exit of the mill it is sent for separation to the separator, when using a dry grinding method, and to the screens or hydrocyclones, when using wet grinding. After separation, the fine fraction as a finished product is removed from the circuit, and the coarse fraction is sent again to the mill for re-grinding. The fresh and underground material is charged into the mill through the second hollow spout or the finished product - through the hollow spout, while the underground material is charged through a special hole in the middle part of the drum wall. Andreyev S. Ye. [8, p. 330-338] proved theoretically that grinding capacity of the mill, working in a closed cycle with a classifier is proportional to the content of coarse size grains in it. At the same time, it is easy to prove that the content of coarse size grains in the mill is directly proportional to the frequency rate of the circulating load. However, the increasing frequency rate of circulation results in the increased energy costs at the stage of classification and transportation of the material under the scheme: mill → classifier → mill. The conditions are considered to be optimal, when the material makes three to six passes through the mill [9, p. 94-95]. The mill's grinding capacity here increases, in comparison with the open cycle, by 20%, with a decrease in energy costs by $15 \div 20\%$; in addition, the specific consumption of grinding bodies is reduced and the service life of the lining is extended.

Taking into account the advantages of a closed grinding cycle, in most countries in cement production and other large-tonnage industries the drum mills are converted to a closed cycle of operation, and only in recent years, such reconstruction has begun to be carried out at some enterprises of our Republic.

The efficiency of closed cycle mills can be further improved, if to provide a highly efficient classification of ground products, removed from the mill. Many researchers, on the basis of evaluation of the existing industrial separators [10, p.130-135; 11, p.42-43], note that the applied designs have low separation efficiency and about $40 \div 70\%$ of the finished finely ground material, having not separated in separators, return again to the mill. The use of screens and hydrocyclones in the wet grinding method also does not provide a high-quality classification, since these devices can work well on low-concentrated suspensions [10, p. 34-35].

Thus, the classification problems in grinding are very acute and need to be solved.

Practice [12, p. 3-6] and studies [13, p. 12-16; 14] show that the air blowing of a drum mill has a positive effect on the grinding process by dry method. Moreover, it was found that with increasing intensity of aspiration to a certain limit, the mill's grinding capacity increases substantially. Thus, monograph [7] gives the graphic dependence, obtained on the basis of the drum mill's industrial testing, which shows that due to active blowing it is possible to increase the mill's grinding capacity by 25%.

The increase of the mill's grinding capacity when blowing it with air can be explained by several factors, the degree of influence of each of which on the process has not yet been determined. Some researchers [13, p. 12- 16; 14; 15, p. 6-8] believe that the improvement of tube mills' grinding capacity with their intense aspiration occurs due to removal of the crushed material's fine fraction from the grinding area, which results in the increase of the coarse fraction portion and the increase of the relative grinding velocity.

It is also known that in fine grinding there are observed aggregation and sticking of small particles on grinding bodies and lining, which has a negative influence on the process. Examination of industrial mills in clinker grinding shows that with increasing the intensity of aspiration, the temperature in the mill is reducing by $35 \div 40^{\circ}\text{C}$, the aggregation and sticking of fines fractions of the material to the grinding bodies and lining are reducing, and in milling a relatively cold clinker ($60 \div 70^{\circ}\text{C}$) there is no sticking at all. The particle sticking occurs due to the action of electrostatic charges on the surface of particles. Water vapors, contained in the air, washing the small particles of the material, form temporary "bridges", which are a kind of conductors, through which the neutralization of electrostatic charges is carried out. Thus, aggregation and sticking are eliminated and due to this the grinding process is intensified.

The grinding degree increase with increasing air speed in the mill is explained by some researchers [16, p. 38-45] not only by the removal of fine fractions of the material from the grinding zone, but also by the influence of the environment on the grinding process. Adsorption of water vapors, which in this case are surface-active substances, from the air, passing through the mill, facilitates the deformation and destruction of the solid body. The effect of adsorption strength reduction is determined primarily by the fact that surface-active substances, reducing the material's surface energy, contribute to the development of various defects at lower stresses. To adsorption influence there are primarily exposed the surface defects of structure – weak points that are always present in any solid body and even in the most well-formed crystals. Into the defects of structure - the micro-cracks, being present in a solid body and appearing in the process of its exposure to the grinding media, with air, there penetrate the water vapors, covering the surface, available to them inside the deformed body, with a uniform adsorption layer. When the liquid comes to the mouth of a micro-crack, its molecules are distributed on both surfaces of the micro-crack up to the narrowest places, where their further penetration is prevented by the size of the molecules themselves. The adsorption layer of water molecules prevents the closure of the micro-cracks and thus reduces the hardness of the material to be ground.

Thus, the air purging of the drum mill chamber can have a positive effect on the grinding process for the following reasons:

1. Due to continuous removal of a fine fraction from the grinding zone;
2. Due to removal of electrostatic charges from the surface of very fine particles and thus, reduction of their aggregation and prevention of sticking to the grinding media and lining;
3. Due to adsorption effect of the air moisture on the particle defective structures and thus, reduction of the material's strength.

All these factors, undoubtedly, have a positive influence on the grinding process, and it is very difficult to give preference to any of them. One thing is clear that the closer contact will be in the mill between the air and the particles of the crushed material, the more effective will be the influence of these factors on grinding.

If we consider the movement of flows in the drum mill in the cross section, we shall see that in the operating state all the grinding bodies and the material occupy a little more than 50% of the section (the bottom and side part along the way of the mill's movement).

If we supply air to the mill, it will move in its free space without a sufficiently good contact with the material. Of course, during the rise and fall of the grinding media and the material there will be their intensive mixing and, naturally, a certain part of the fine-disperse material will be thrown into the free space, where the fine particles will be picked up by the air flow and carried away to the separator. However, there will be no good air purge of the whole mass of the material in the existing structural design and therefore the bulk of the crushed material will be in the general flow.

When solving the problem of a close contact between the material and air in a drum mill, it is necessary to take into account the recommendations of Andreyev S. Ye. and Sidenko P. M. [16, p.337; 16, p.26-41], who repeatedly note that in a drum mill it is not advisable to conduct a process with a high degree of grinding in one chamber. It is more economical to conduct it in several serially mounted chambers with the necessary intermediate selection of fractions that do not need grinding in the next chamber. It is also important that to the grinding chamber there came the material with a narrow size range, and the frequency rate of destruction in it was minimal. So, Andreev S.Ye. notes that, from the theoretical point of view, the perfect one there would be a method of grinding in a series of ball mills, each

operating in a closed cycle with a classifier and so short that the material, passing through the mill, would be subjected to a limited number of ball impacts and all the resulting finished product would be immediately removed from the classification cycle.

On the basis of the above, we offer a more perfect version of the drum mill. The whole drum of the mill along its length should be divided by lattice partitions into a large number of chambers, with a distance between the chambers, being, for example, $1,5 \div 2$ meters; to set not one lattice partition between the chambers, but two, with a distance of $0,25 \div 0,4$ meters between the partitions; to fix blades to the drum wall in the space between the partitions, similar to the drum dryer, as shown in Fig. 1.

In this case, the material is crushed in the chamber, passes through the first lattice partition and, falling on the blades, rises up and falls down from above. Since there are many blades, the falling particles will fill almost the whole cross section of the mill. The air, moving in the longitudinal direction, will enter the flow of falling particles, cool them and, depending on the speed, will pick up the particles of certain sizes and carry them away with it. This separation process will be observed after each chamber. The air velocity must be such that the near-mesh size particles, picked up by the air flow before they settle, could fly over the whole length of the chamber.

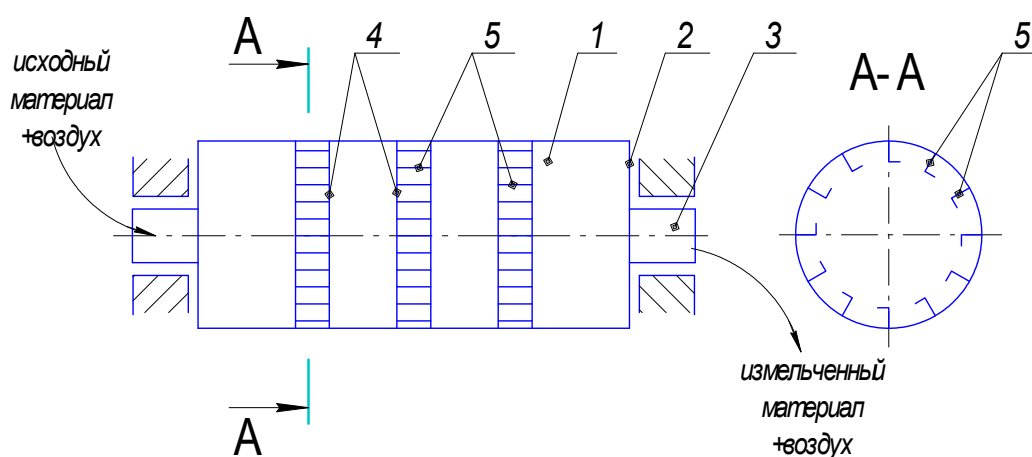


Figure 1. The scheme of reconstruction of the drum mill
1 – the drum; 2 – the end covers; 3 – the spouts; 4 – the lattice partitions; 5 – the blades.

To calculate the air velocity in the chamber, it is necessary to calculate the settling velocity of near-mesh size particles in the drum, using the Stokes formula. Knowing the particle settling velocity and the mill diameter, we determine the particle settling time. During this time, the particle should manage to pass the whole length of the chamber in the horizontal direction. Knowing the length of the chamber and the settling time, we determine the air velocity in the chamber. According to our approximate calculations, for industrial mills, used for cement milling, the air velocity in the free space of the drum should be within $0,7 \div 1,4$ m/sec. [16].

Conclusions. Thus, with the help of such reconstruction, there will be carried out continuously almost complete removal of crushed particles from the mill, there will be intensified the processes of cooling the material and the adsorption of moisture on its surface, which will significantly increase the grinding capacity of the mill, with reducing its energy costs.

However, at the exit of the mill, the ground material must be subjected to a highly efficient classification, so that the finished product could be almost completely removed from the system, and only the underground particles returned back for re-grinding. It is known that there are used medium-speed mills, having much lower energy consumption due to a highly organized grinding process, but having a much more complicated design.

REFERENCES

- [1] Bobrova N. V. Influence of the wear of impact elements of crushers on their performance characteristics. //International scientific conference "Actual problems and prospects of the agro-industrial complex development", Ivanovo, 2007. P. 124-125.
- [2] Lapshin V. B., Abalikhin A. M., Bobrova N. V., Bogorodskiy A.V., Kolobov M. Yu. Ways of improving the durability of the centrifugal-impact grinders' operating elements // Repair. Reconstruction.Modernization.No. 8.M.; Science and technology, 2008. - P. 41-44.
- [3] Abalikhin A. M., Bobrova N. V., Subbotin K. V. Ways of improving the durability of the impact- centrifugal grinders' operating elements. // Proceedings of the international scientific and methodical conference " Modern problems of the agro-industrial complex development in the works of young scientists and students of the FSEI HPE (Federal State Educational Institution of Higher Professional Education) "Ivanovo SAA (State Agricultural Academy) named after academician D. K. Belyaev"", Ivanovo, 2008. P. 203-204.
- [4] Verigin Yu. A., Tolstenev S. V. Synergetic bases of processes and technologies. Barnaul: AltSTU, 2007. 172 p.
- [5] Gridchin A. M., Sevostyanov V. S., Lesovik V. S., Gorlov A., Perelygin D. N., Romanovich A. A., Kolesnikov A.V. Energy saving complexes of fine and ultrafine grinding of the materials// IzvestiyaVUZov. Construction, 2006. №11. P. 60-67.
- [6] Baranov V. F., Weisberg L. A. Trends in the development of technology and technique of ore preparation // "Modern methods of technological mineralogy in the processes of complex and deep processing of mineral raw materials".- Proceedings of the international meeting "Plaksinsky readings – 2012", Petrozavodsk, September 10-14, 2012. p. 12 - 16.
- [7] Lowrison G. Crushing and grinding. London, Butterworth's, 1974, V.1.
- [8] Andreyev S. Ye., Perov V. A., Zverevich V. V. Crushing, grinding and screening of minerals. Moscow: Nedra, 1980. 415 p.
- [9] Sapozhnikov M. Ya. Mechanical equipment of the enterprises of building materials, products and structures. Moscow: Higher school, 1971. - 382 p.
- [10] Deshko Yu. I., Kramer, M. B., Krykhtin G. S. Grinding of materials in cement industry. M.: Ed. liter. on construction, 1966. 274 p.
- [11] The trend of development of hammer mills with separators. Review.Power engineering, 1976. - 62 p.
- [12] Cherep I. L., Belkoskiy G. V. Increase of the cement mills' capacity. Cement № 3, 1956. P. 13-14.
- [13] Krykhtin G. S. Influence of ventilation on the main indices of tubular cement mills' operation. / Proceedings of NIICement, Issue 12, 1959. 86 p.
- [14] Apimakh Ye.V. and etc. Promising directions of reducing specific energy costs in grinding // News of the academy of sciences of the Republic of Kazakhstan. Series chemistry and technology, No5 (431), 2018. P.32-41. <https://doi.org/10.32014/2018.2518-1491>
- [15] Tovarov V. V. Ways to improve the grinding capacity of mills.// Cement № 2, 1962. P. 16-17.
- [16] Khodakov G. S. Physics of grinding. - Moscow: Science, 1972. 256 p.
- [17] Levdanskiy A. E. Scientific and practical bases of applying the flowing currents for intensification of classification and grinding processes: dis. ... Dr. Techn. Sciences: 05.17.08 / A. E. Levdanskiy. Minsk, 2004. 272 p.

Д. И. Чиркун¹, А. Э. Левданский¹, В.Г. Голубев², Д. Сарсенбекулы², С.А. Кумисбеков²

¹ Белорусский государственный технологический университет, г. Минск, Беларусь;

² М.Әуезов атындағы Оңтүстік Қазақстан мемлекеттік университеті, Шымкент, Қазақстан

ӨНЕРКӘСІПТІК БАРАБАНДЫ ДИІРМЕНДЕР ЖҰМЫСЫН САРАПТАЛАУ ЖӘНЕ ОЛАРДЫ ЖЕТІЛДІРУ ЖОЛДАРЫ

Аннотация. Олардың конструкциялық жетілдірілмегендігін анықтауға мүмкіндік берген қолданыстағы өнеркәсіптік барабанды диірмендердің жұмысына сараптама жүргізілді. Гетерогендік процесстердің қарқындылығын жоғарылату мақсатында процеске қатысатын түйісуші фазалардың беттерін ұлғайтуға ұмтылу ұсынылады. Бұл үшін дисперсті композицияларды өңдеу бойынша кейінгі операцияларды қарқындыруға мүмкіндік беретін ұсақтау, активация, классификация, жылжыту және аппараттағы химиялық синтез сияқты процесстерді біріктіру қажет. Егер диірменнен шығарылатын ұсақтау өнімдерін жоғары тиімді классификацияды қамтамасыз ететін болса тұйық цикл бойынша диірмен жұмысының тиімділігін тағы көбірек жоғарлатуға болады.

Диірмен барабанын ұзына бойы торлы қалқалар мен үлкен камераларға белгілі бірарақашықтықта камералар арасы шамамен 1,5÷2 метр бөлу ұсынылды. Камералар арасына қалқалар арасының қашықтығы 0,25÷0,4 м болатын екі торлық алқалар орнатылсын. Қалқалар арасындағы кеңістікте барабан қабырғасына барабанды кептіргіштегідей күрекшелерді орнату. Энергия шығындарын төмендету үшін цементті ұнтақтауда қолданылатын өнеркәсіптік диірмендер үшін процесс өтуінің оңтайлы шарттарымен ұсақтау процесін ұтымды ұйымдастыруды қамтамасыз ету ұсынылады, барабанның еркін кеңістігіндегі ауа жылдамдығы шамамен 0,7÷1,4 м/с болуы қажет.

Түйін сөздер: Өнеркәсіптік барабанды диірмендер, ұсақтағыш өнімдердің үздіксіз классификациясы, бөлшектер, процесті қарқындастыру, материалды салқындату энергиясы, меншікті энергия шығындар, конструкциялар.

УДК 621.926.4

Д. И. Чиркун ¹, А. Э. Левданский ¹, В.Г. Голубев ², Д. Сарсенбекулы ², С.А. Кумисбеков ²

¹Белорусский государственный технологический университет, г.Минск, Беларусь;

²Южно-Казахстанский государственный университет им.М.Ауэзова, г.Шымкент, Казахстан

АНАЛИЗ РАБОТЫ БАРАБАНЫХ ПРОМЫШЛЕННЫХ МЕЛЬНИЦ И ПУТИ ИХ УСОВЕРШЕНСТВОВАНИЯ

Аннотация. Выполнен анализ работы существующих барабанных промышленных мельниц, который позволил определить их конструктивное несовершенство. С целью повышения интенсивности гетерогенных процессов предлагается стремиться к увеличению поверхности контактирующих фаз, участвующих в процессе. Для этого необходимо объединение таких процессов, как измельчение, активация, классификация, смешение и химический синтез в аппарате – измельчителе, позволяет интенсифицировать последующие операции по обработке дисперсных композиций. Эффективность работы мельниц по замкнутому циклу можно еще более повысить, если обеспечить высокоэффективную классификацию продуктов измельчения, выводимых из мельницы.

Предложено весь барабан мельницы по длине разделить решетчатыми перегородками на большое количество камер, с определенным расстоянием между камерами, порядка 1,5÷2 метра. Между камерами установить две решетчатые перегородки с расстояниями между перегородками 0,25÷0,4. В пространстве между перегородками к стенке барабана закрепить лопасти, аналогично как в барабанной сушилке. Рекомендовано, что для снижения энергозатрат должна обеспечиваться рациональная организация процесса измельчения с оптимальными условиями протекания процесса для промышленных мельниц, применяемых для помола цемента, скорость воздуха в свободном пространстве барабана должна быть в пределах 0,7÷1,4.

Ключевые слова: барабанные промышленные мельницы, непрерывная классификация продуктов измельчения, частицы, интенсификация процесса, энергия охлаждения материала, удельные энергозатраты, конструкции.

Information about the authors:

Chyrkun Dzmitry Ivanovich - Candidate of Technical Sciences, teacher of the Department "Processes and Apparatuses of Chemical Production", Belorussian State Technological University, e-mail: alex_levdansky@mail.ru

ORCID: 0000-0003-0195-2575;

Leudanski Aliaksandr Eduardovich - Doctor of Technical Sciences, Associate Professor of the Department "Processes and Apparatuses of Chemical Production", Belorussian State Technological University, e-mail: alex_levdansky@mail.ru

ORCID: 0000-0003-2684-7771;

Golubev Vladimir Grigorievich - Doctor of Technical Sciences, Professor of the Department of Oil & Gas Business, M.Auezov South Kazakhstan State University, e-mail: nii_mm@mail.ru

ORCID: 0000-0001-7370-3872;

Sarsenbekuly Didar - PhD, teacher of the Department of Technological Machines and Equipment, M.Auezov South Kazakhstan State University, e-mail: nii_mm@mail.ru

ORCID: 0000-0003-0595-4375;

Kumisbekov Serik Arginbaevich - Candidate of Technical Sciences, Associate Professor of the Department of Technological Machines and Equipment, M.Auezov South Kazakhstan State University, e-mail: serik_argin@mail.ru

ORCID: 0000-0003-4440-5520.

МАЗМҰНЫ

<i>Тунгатарова С.А., Ксандопуло Г., Кауменова Г.Н., Жумабек М., Байжуманова Т.С., Григорьева В.П., Комашко Л.В., Бегимова Г.У.</i> Метанды синтез газға каталитикалық риформингілеуде жану әдісімен композитті материалдарды жасау...6	
<i>Johann Dieck, Tатаева Р., Байманова А., Бакешова Ж., Капсалямов Б.</i> Ақаба суларды биологиялық өңдеу: теориялық негіздері және эксперименттік зерттеулер.....	16
<i>Орымбетова Г.Э., Conficoni D., Касымова М.К., Кобжасарова З.И., Орымбетов Э.М., Шамбулова Г.Д.</i> Сүт және сүт өнімдерінде қорғасын тәуекелін бағалау.....	23
<i>Талғатов Э.Т., Әуезханова А.С., Тумабаев Н.Ж., Ахметова С.Н., Сейтқалиева Қ.С., Бегмат Е.Ә., Жармағамбетова Ә.Қ.</i> Фенилацетиленді гидрлеуге арналған магнитті тасымалдағышқа отырғызылған полимер-палладий катализаторлары	29
<i>Ермағамбет Б.Т., Ремнев Г.Е., Мартемьянов С.М., Бухаркин А.А., Касенова Ж.М., Нурғалиев Н.У.</i> Майқұбы және Экібастұз көмір бассейндерінің диэлектрикалық қасиеттері.....	38
<i>Бейсенбаев А.Р., Жабаева А.Н., Сунцова Л.П., Душкин А.В., Адекенов С.М.</i> Оксима пиностробинның супрамолекулярлық кешенін синтездеу мен зерттеу.....	46
<i>Jadhav A. S., Mohanraj G. T., Mayadevi S., Gokarn A. N.</i> Йодты адсорбцияның саны бойынша катеху атты жаңғақтың қабығынан алынатын нано-беттік белсендірілген көмірдің көлемін анықтаудың жылдам әдісі.....	53
<i>Нуркенов О.А., Фазылов С.Д., Исаева А.Ж., Сейлханов Т.М., Животова Т.С., Шұлғау З.Т., Қожина Ж.М.</i> Функционалдык-орынбасылған изоникотин қышқылының гидразондары мен циклодекстриндердің комплекстік кешендері жән.....	57
<i>Ермағамбет Б.Т., Нурғалиев Н.У., Абылгазина Л.Д., Маслов Н.А., Касенова Ж.М., Касенов Б.К.</i> Көмір шлак қалдықтарының өнімдерінен бағалы компоненттер алуудың әдістері.....	67
<i>Шоманова Ж.К., Сафаров Р.З., Жумаканова А.С., Носенко Ю.Г., Жанибекова А.Т., Шапекова Н.Л., Лорант Д.</i> Феррокорытпаны өндеу қалдықтары негізінде алынған катализаторлар бетін электрондық микроскопия әдісімен зерттеу.....	79
<i>Баешов А., Гаишов Т.Э., Баешова А.К., Колесников А.В.</i> Мыс (II) иондарын үш валентті титан иондарымен цементациялау арқылы нано – және ультрадисперсті мыс ұнтақтарын алу.....	87
<i>Баешов А.Б., Мырзабеков Б.Э., Колесников А.В.</i> Құрамында титан (IV) иондары бар күкірт қышқылы ерітіндісінде мыс анодын қолдану кезінде электролит көлемінде дисперсті мыс ұнтақтарының түзілу заңдылықтары.....	96
<i>Чиркун Д. И., Левданский А.Э., Голубев В.Г., Сарсенбекулы Д., Кумисбеков С.А.</i> Өнеркәсіптік барабанды диірмендер жұмысын сарапталау және оларды жетілдіру жолдары.....	102
<i>Бродский А.Р., Григорьева В.П., Комашко Л.В., Нурмаканов Е.Е., Чанышева И.С., Шаповалов А.А., Шлыгина И.А., Яскевич В.И.</i> Молекула зонды бар Fe/γ-Al ₂ O ₃ катализдік жүйенің өзара әрекеттестігі I. γ-Al ₂ O ₃ және Fe/γ-Al ₂ O ₃ бастапқы жүйенің зерттелуі.....	109
<i>Бродский А.Р., Григорьева В.П., Комашко Л.В., Нурмаканов Е.Е., Чанышева И.С., Шаповалов А.А., Шлыгина И.А., Яскевич В.И.</i> Взаимодействие каталитической системы Fe/γ-Al ₂ O ₃ с молекулами-зондами II. Исследование носителя γ-Al ₂ O ₃ и системы Fe/γ-Al ₂ O ₃ после взаимодействия с водородом и аммиаком.....	120
<i>Доспаев М. М., Баешов А., Жумаканова А.С., Доспаев Д.М., Сыздықова Б.Б., Какенов К.С., Есенбаева Г.А.</i> Калий метасиликаты ертіндісінде мыс анодын поляризациялау кезіндегі нанодисперсті мыс силикаты ұнтағының түзілу механизм.....	130
<i>Надиоров К.С., Черкаев Г.В., Чихонадских Е.А., Маккаевева Н.А., Садырбаева А.С., Орымбетова Г.Э.</i> Екі отынды ііж кемелердің пайдаланылған газдарымен зиянды заттардың шығарылуының қоршаған ортаға және тұрғындар денсаулығына әсерін талдау	138
<i>Хусаин Б.Х., Винникова К.К., Сасс А.С., Рахметова К.С., Кензин Н.Р.</i> Бейтараптандыру процестегі пайдаланылған газдар шығудың аэродинамикалық модельдеу.....	150
<i>Утегенова Л.А., Нурлыбекова А.К., Хажиакбер Аиса, Жеңіс Ж.</i> Ақшыл сепкіл гүлөсімдігінің майда еритін құрамын зерттеу.....	156

СОДЕРЖАНИЕ

Тунгатарова С.А., Ксандопуло Г., Кауменова Г.Н., Жумабек М., Байжуманова Т.С., Григорьева В.П., Комашко Л.В., Бегимова Г.У. Разработка композитных материалов методом горения для каталитического риформинга метана в синтез-газ.....	6
Johann Duesck, Tатаева Р., Байманова А., Бакешова Ж., Капсалямов Б. Биологическая обработка сточных вод: теоретическая основа и экспериментальные исследования.....	16
Орымбетова Г.Э., Conficoni D., Касымова М.К., Кобжасарова З.И., Орымбетов Э.М., Шамбулова Г.Д. Оценка риска свинца в молоке и молочной продукции	23
Талгатов Э.Т., Ауезханова А.С., Тумабаев Н.Ж., Ахметова С.Н., Сейткалиева К.С., Бегмат Е.А., Жармагамбетова А.К. Полимер-палладиевые катализаторы на магнитном носителе для гидрирования фенилацетилена.....	29
Ермагамбет Б.Т., Ремнев Г.Е., Мартемьянов С.М., Бухаркин А.А., Касенова Ж.М., Нурғалиев Н.У. Диэлектрические свойства углей Майкубенского и Экибастузского бассейнов.....	38
Бейсенбаев А.Р., Жабаяева А.Н., Сунцова Л.П., Душкин А.В., Адекенов С.М. Синтез и изучение супрамолекулярного комплекса оксима пиностробина.....	46
Jadhav A. S., Mohanraj G. T., Mayadevi S., Gokarn A. N. Быстрый метод определения площади нано-поверхности активированного угля полученного из оболочки ореха катеху по числу адсорбции йода.....	53
Нуркенов О.А., Фазылов С.Д., Исаева А.Ж., Сейлханов Т.М., Животова Т.С., Шульгау З.Т., Кожина Ж.М. Комплексы включения функционально-замещенных гидразонов изоникотиновой кислоты с циклодекстринами и их антирадикальная активность.....	57
Ермагамбет Б.Т., Нурғалиев Н.У., Абылгазина Л.Д., Маслов Н.А., Касенова Ж.М., Касенов Б.К. Методы извлечения ценных компонентов из золошлаковых отходов углей.....	67
Шоманова Ж.К., Сафаров Р.З., Жумаканова А.С., Носенко Ю.Г., Жанибекова А.Т., Шапекова Н.Л., Лорант Д. Исследование методом электронной микроскопии поверхности катализаторов, полученных на основе отходов ферросплавного производства.....	79
Баешов А., Гаитов Т.Э., Баешова А.К., Колесников А.В. Получение нано- и ультрадисперсных порошков меди цементацией ионов меди (II) ионами трехвалентного титана	87
Баешов А.Б., Мырзабеков Б.Е., Колесников А.В. Закономерности образования дисперсных медных порошков в объеме электролита при использовании медного анода в растворе серной кислоты, содержащей ионы титана (IV)	96
Чиркун Д. И., Левданский А. Э., Голубев В.Г., Сарсенбекулы Д., Кумисбеков С.А. Анализ работы барабанных промышленных мельниц и пути их усовершенствования	102
Бродский А.Р., Григорьева В.П., Комашко Л.В., Нурмаканов Е.Е., Чанышева И.С., Шаповалов А.А., Шлыгина И.А., Яскевич В.И. Взаимодействие каталитической системы Fe/ γ -Al ₂ O ₃ с молекулами-зондами I. Исследование γ -Al ₂ O ₃ и исходной системы Fe/ γ -Al ₂ O ₃	109
Бродский А.Р., Григорьева В.П., Комашко Л.В., Нурмаканов Е.Е., Чанышева И.С., Шаповалов А.А., Шлыгина И.А., Яскевич В.И. Взаимодействие каталитической системы Fe/ γ -Al ₂ O ₃ с молекулами-зондами II. Исследование носителя γ -Al ₂ O ₃ и системы Fe/ γ -Al ₂ O ₃ после взаимодействия с водородом и аммиаком	120
Доспаев М. М., Баешов А., Жумаканова А.С., Доспаев Д.М., Сыздыкова Б.Б., Какенов К.С., Есенбаева Г.А. Механизм образования нанодисперсного порошка силиката меди в растворе метасиликата калия	130
Надилов К.С., Черкаев Г.В., Чихонадских Е.А., Маккаевеева Н.А., Садырбаева А.С., Орымбетова Г.Э. Анализ влияния выбросов вредных веществ с отработавшими газами судовых двухтопливных двс на окружающую среду и здоровье населения.....	138
Хусаин Б.Х., Винникова К.К., Сасс А.С., Рахметова К.С., Кензин Н.Р. Аэродинамическое моделирование прохождения выбросов в процессе нейтрализации.....	150
Утегенова Л.А., Нурлыбекова А.К., Хажиакбер Аиса, Жеңіс Ж. Исследование жирорастворимого состава рябчика Бледноцветного.....	156

CONTENTS

<i>Tungatarova S.A., Xanthopoulou G., Kaumenova G.N., Zhumabek M., Baizhumanova T.S., Grigorieva V.P., Komashko L.V., Begimova G.U.</i> Development of composite materials by combustion synthesis method for catalytic reforming of methane to synthesis gas.....	6
<i>Dueck Johann, Tatayeva R., Baymanova A., Bakeshova Zh., Kapsalyamov B.</i> Biological treatment of waste water: theoretical background and experimental research.....	16
<i>Orymbetova G.E., Conficoni D., Kassymova M.K., Kobzhasarova Z.I., Orymbetov E.M., Shambulova G.D.</i> Risk assessment of lead in milk and dairy products	23
<i>Talgatov. E.T., Auyezkhanova A.S., Tumabayev N.Z., Akhmetova S.N., Seitkaliyeva K.S., Begmat Y.A., Zharmagambetova A.K.</i> Polymer-palladium catalysts on magnetic support for hydrogenation of phenylacetylene.....	29
<i>Ermagambet B.T., Remnev G.E., Martemyanov S.M., Bukharkin A.A., Kasenova Zh.M., Nurgaliyev N.U.</i> Dielectric properties of the coals of Maykuben and Ekibastuz basins.....	38
<i>Beisenbayev A.R., Zhabayeva A.N., Suntsova L.P., Dushkin A.V., Adekenov S.M.</i> Synthesis and study of pinostrobin oxime supramolecular complexes.....	46
<i>Jadhav A. S., Mohanraj G. T., Mayadevi S., Gokarn A. N.</i> Rapid method for determination of nano surface area of arecanut shell derived activated carbon by iodine adsorption number.....	53
<i>Nurkenov O.A., Fazylov S.D., Issayeva A.Zh., Seilkhanov T.M., Zhivotova T.S., Shulgau Z.T., Kozhina Zh.M.</i> Complexes of inclusion of functionally-substituted hydrasons of isonicotic acid with cyclodextrines and their antiradical activity.....	57
<i>Yermagambet B.T., Nurgaliyev N.U., Abylgazina L.D., Maslov N.A., Kasenova Zh.M., Kasenov B.K.</i> Methods for extraction of valuable components from ash-and-slag coal wastes.....	67
<i>Shomanova Zh.K., Safarov R.Z., Zhumakanova A.S., Nosenko Yu.G., Zhanibekova A.T., Shapekova N.L., Lorant D.</i> Electron microscopy surface study of catalysts based on ferroalloy production waste.....	79
<i>Bayeshov A., Gaipov T.E., Bayeshova A.K., Kolesnikov A.V.</i> Synthesis of nano- and ultradisperse copper powders by cementation of copper (II) ions by three-valent titanium ions.....	87
<i>Bayeshov A.B., Myrzabekov B.E., Kolesnikov A.V.</i> Patterns of formation of dispersed copper powders in the body of electrolyte during the use of copper anode in sulfuric acid solution along with titanium (IV) ions.....	96
<i>Chyrkun D.I., Leudanski A.E., Golubev V.G., Sarsenbekuly D., Kumisbekov S.A.</i> Analysis of industrial drum mills' operation and ways of their improvement.....	102
<i>Brodskiy A.R., Grigor'eva V.P., Komashko L.V., Nurmakanov Y.Y., Chanysheva I.S., Shapovalov A.A., Shlygina I.A., Yaskevich V.I.</i> Interaction of the Fe/ γ -Al ₂ O ₃ catalytic system with probe molecules I. Research of the γ -Al ₂ O ₃ and the Fe/ γ -Al ₂ O ₃ initial system	109
<i>Brodskiy A.R., Grigor'eva V.P., Komashko L.V., Nurmakanov Y.Y., Chanysheva I.S., Shapovalov A.A., Shlygina I.A., Yaskevich V.I.</i> Interaction of the catalytic Fe/ γ -Al ₂ O ₃ system with probe molecules II. Study OF γ -Al ₂ O ₃ support and Fe/ γ -Al ₂ O ₃ system after interaction with hydrogen and ammonia.....	120
<i>Dospaev M.M., Bayeshov A., Zhumakanova A.S., Dospaev D.M., Syzdykova B.B., Kakenov K.S., Esenbaeva G.A.</i> Mechanism of forming nanodisperse copper silicate powder during anodic polzrization of copper electrode in potassium silicate solution.	130
<i>Nadirov K.S., Cherkaev G.V., Chikhonadskikh E.A., Makkaveeva N.A., Sadyrbaeva A.S., Orymbetova G.E.</i> Analysis of influence of emissions of harmful substances with exhaust gases of marine dual fuel internal combustion engine on the environment and human health.....	138
<i>Khusain B.Kh., Vinnikova K.K., Sass A.S., Rakhmetova K.S., Kenzin N.R.</i> Aerodynamic modeling of emissions passage in the neutralization process.....	150
<i>Utegenova L.A., Nurlybekova A.K., Hajiakber Aisa, Jenis J.</i> Liposoluble constituents of <i>Fritillaria pallidiflora</i>	156

Publication Ethics and Publication Malpractice in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see <http://www.elsevier.com/publishingethics> and <http://www.elsevier.com/journal-authors/ethics>.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see <http://www.elsevier.com/postingpolicy>), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service <http://www.elsevier.com/editors/plagdetect>.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации
в журнале смотреть на сайте:

www.nauka-nanrk.kz

<http://www.chemistry-technology.kz/index.php/ru/>

ISSN 2518-1491 (Online), ISSN 2224-5286 (Print)

Редакторы: *М. С. Ахметова, Т. А. Апендиев, Аленов Д.С.*
Верстка на компьютере *А.М. Кульгинбаевой*

Подписано в печать 05.12.2018.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
9,8 п.л. Тираж 300. Заказ 6.