

ISSN 2518-1483 (Online),  
ISSN 2224-5227 (Print)

2017 • 5

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ

## БАЯНДАМАЛАРЫ

## ДОКЛАДЫ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
РЕСПУБЛИКИ КАЗАХСТАН

## REPORTS

OF THE NATIONAL ACADEMY OF SCIENCES  
OF THE REPUBLIC OF KAZAKHSTAN

ЖУРНАЛ 1944 ЖЫЛДАН ШЫҒА БАСТАҒАН  
ЖУРНАЛ ИЗДАЕТСЯ С 1944 г.  
PUBLISHED SINCE 1944



Бас редакторы  
х.ғ.д., проф., ҚР ҰҒА академигі **М.Ж. Жұрынов**

Редакция алқасы:

**Адекенов С.М.** проф., академик (Қазақстан) (бас ред. орынбасары)  
**Величкин В.И.** проф., корр.-мүшесі (Ресей)  
**Вольдемар Вуйцик** проф. (Польша)  
**Гончарук В.В.** проф., академик (Украина)  
**Гордиенко А.И.** проф., академик (Белорус)  
**Дука Г.** проф., академик (Молдова)  
**Илолов М.И.** проф., академик (Тәжікстан),  
**Леска Богуслава** проф. (Польша),  
**Локшин В.Н.** проф. чл.-корр. (Қазақстан)  
**Нараев В.Н.** проф. (Ресей)  
**Неклюдов И.М.** проф., академик (Украина)  
**Нур Изура Удзир** проф. (Малайзия)  
**Перни Стефано** проф. (Ұлыбритания)  
**Потапов В.А.** проф. (Украина)  
**Прокопович Полина** проф. (Ұлыбритания)  
**Омбаев А.М.** проф., корр.-мүшесі (Қазақстан)  
**Өтелбаев М.О.** проф., академик (Қазақстан)  
**Садыбеков М.А.** проф., корр.-мүшесі (Қазақстан)  
**Сатаев М.И.** проф., корр.-мүшесі (Қазақстан)  
**Северский И.В.** проф., академик (Қазақстан)  
**Сикорски Марек** проф., (Польша)  
**Рамазанов Т.С.** проф., академик (Қазақстан)  
**Такибаев Н.Ж.** проф., академик (Қазақстан), бас ред. орынбасары  
**Харин С.Н.** проф., академик (Қазақстан)  
**Чечин Л.М.** проф., корр.-мүшесі (Қазақстан)  
**Харун Парлар** проф. (Германия)  
**Энджун Гао** проф. (Қытай)  
**Эркебаев А.Э.** проф., академик (Қырғыстан)

«Қазақстан Республикасы Ұлттық ғылым академиясының баяндамалары»

ISSN 2518-1483 (Online),

ISSN 2224-5227 (Print)

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» Республикалық қоғамдық бірлестігі (Алматы қ.)  
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж.  
берілген №5540-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік

Мерзімділігі: жылына 6 рет.

Тиражы: 2000 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,  
[http://nauka-nanrk.kz\\_reports-science.kz](http://nauka-nanrk.kz_reports-science.kz)

© Қазақстан Республикасының Ұлттық ғылым академиясы, 2017

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

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

Редакционная коллегия:

**Адекенов С.М.** проф., академик (Казахстан) (зам. гл. ред.)  
**Величкин В.И.** проф., чл.-корр. (Россия)  
**Вольдемар Вуйцик** проф. (Польша)  
**Гончарук В.В.** проф., академик (Украина)  
**Гордиенко А.И.** проф., академик (Беларусь)  
**Дука Г.** проф., академик (Молдова)  
**Илолов М.И.** проф., академик (Таджикистан),  
**Леска Богуслава** проф. (Польша),  
**Локшин В.Н.** проф. чл.-корр. (Казахстан)  
**Нараев В.Н.** проф. (Россия)  
**Неклюдов И.М.** проф., академик (Украина)  
**Нур Изура Удзир** проф. (Малайзия)  
**Перни Стефано** проф. (Великобритания)  
**Потапов В.А.** проф. (Украина)  
**Прокопович Полина** проф. (Великобритания)  
**Омбаев А.М.** проф., чл.-корр. (Казахстан)  
**Отелбаев М.О.** проф., академик (Казахстан)  
**Садьбеков М.А.** проф., чл.-корр. (Казахстан)  
**Сатаев М.И.** проф., чл.-корр. (Казахстан)  
**Северский И.В.** проф., академик (Казахстан)  
**Сикорски Марек** проф., (Польша)  
**Рамазанов Т.С.** проф., академик (Казахстан)  
**Такибаев Н.Ж.** проф., академик (Казахстан), зам. гл. ред.  
**Харин С.Н.** проф., академик (Казахстан)  
**Чечин Л.М.** проф., чл.-корр. (Казахстан)  
**Харун Парлар** проф. (Германия)  
**Энджун Гао** проф. (Китай)  
**Эркебаев А.Э.** проф., академик (Кыргызстан)

Доклады Национальной академии наук Республики Казахстан»

ISSN 2518-1483 (Online),

ISSN 2224-5227 (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 №5540-Ж, выданное 01.06.2006 г.

Периодичность: 6 раз в год.

Тираж: 2000 экземпляров

Адрес редакции: 050010, г.Алматы, ул.Шевченко, 28, ком.218-220, тел. 272-13-19, 272-13-18

<http://nauka-nanrk.kz> [reports-science.kz](http://reports-science.kz)

---

©Национальная академия наук Республики Казахстан, 2017 г.

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 :****Adekenov S.M.** prof., academician (Kazakhstan) (deputy editor in chief)**Velichkin V.I.** prof., corr. member (Russia)**Voitsik Valdemar** prof. (Poland)**Goncharuk V.V.** prof., academician (Ukraine)**Gordiyenko A.I.** prof., academician (Belarus)**Duka G.** prof., academician (Moldova)**Ilolov M.I.** prof., academician (Tadjikistan),**Leska Boguslava** prof. (Poland),**Lokshin V.N.** prof., corr. member. (Kazakhstan)**Narayev V.N.** prof. (Russia)**Nekludov I.M.** prof., academician (Ukraine)**Nur Izura Udzir** prof. (Malaysia)**Perni Stephano** prof. (Great Britain)**Potapov V.A.** prof. (Ukraine)**Prokopovich Polina** prof. (Great Britain)**Ombayev A.M.** prof., corr. member. (Kazakhstan)**Otelbayv M.O.** prof., academician (Kazakhstan)**Sadybekov M.A.** prof., corr. member. (Kazakhstan)**Satayev M.I.** prof., corr. member. (Kazakhstan)**Severskyi I.V.** prof., academician (Kazakhstan)**Sikorski Marek** prof., (Poland)**Ramazanov T.S.** prof., academician (Kazakhstan)**Takibayev N.Zh.** prof., academician (Kazakhstan), deputy editor in chief**Kharin S.N.** prof., academician (Kazakhstan)**Chechin L.M.** prof., corr. member. (Kazakhstan)**Kharun Parlar** prof. (Germany)**Endzhun Gao** prof. (China)**Erkebayev A.Ye.** prof., academician (Kyrgyzstan)**Reports of the National Academy of Sciences of the Republic of Kazakhstan.****ISSN 2224-5227****ISSN 2518-1483 (Online),****ISSN 2224-5227 (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 5540-Ж, issued 01.06.2006

Periodicity: 6 times a year

Circulation: 2000 copies

Editorial address: 28, Shevchenko str., of.219-220, Almaty, 050010, tel. 272-13-19, 272-13-18,

<http://nauka-nanrk.kz> / [reports-science.kz](http://reports-science.kz)

© National Academy of Sciences of the Republic of Kazakhstan, 2017

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

UDC621.928.37

**B.N. Azamatov<sup>1</sup>, K.A. Ozhikenov<sup>2</sup>, Zh. K. Azamatova<sup>1</sup>**

<sup>1</sup>East Kazakhstan State Technical University, named after D. Serikbaev, Ust'-Kamenogorsk, Kazakhstan;

<sup>2</sup>Kazakh national research technical university named after K. I. Satpayev, Almaty, Kazakhstan

E-mail: [Azamatovy@mail.ru](mailto:Azamatovy@mail.ru), [kas\\_ozhiken@mail.ru](mailto:kas_ozhiken@mail.ru), [Zhanerkeaz@mail.ru](mailto:Zhanerkeaz@mail.ru)

## ACS OF THE SET OF HYDROCYCLONES WITH A VARIABLE GEOMETRY IN THE SYSTEM OF HAR TPP

**Abstract.** The paper deals with hydraulic ash removal (HAR) at TPP. A new design of hydrocyclones with variable geometry was proposed. In this paper, automation control system for hydrocyclones with variable geometry was proposed and practically implemented. The parameters of the proposed system operation were determined. Description of controls and process equipment is given. A general block diagram and mimic diagram of automated control system for hydrocyclones with variable geometry was constructed in GENIE SCADA-system. Developed ACS of the hydrocyclone allows to carry out pilot studies to assess the performance of the proposed design of the hydrocyclone with variable internal geometry. Development of ACS of the HAR process at TPP and boilers will provide undrained operation, elimination of periodic or continuous purging discharges into water bodies and optimization of the parameters ash waste transported to ash dumps.

**Keywords:** hydraulic ash removal, thermal power plants, ACS, variable geometry, hydrocyclone, ash dump, microprocessor.

**Introduction.** Relevance of the research. In connection with the aggravation of environmental issues it is of particular relevance to create effective centrifugal separators for separation of liquid heterogeneous systems for the process of wastewater and gas emission purification from the fine particles. Promising devices for the separation of liquid heterogeneous systems are hydrocyclones.

Intensive introduction of hydrocyclones in industry is due to the number of significant advantages [1] compared to devices that perform similar tasks, but operating on the other principles, such as clarifiers, thickeners, classifiers and others. In some cases, hydrocyclones are used in conjunction with this equipment, significantly increasing the reliability and overall separation efficiency.

Currently, there is essentially no research summarizing hydraulics and pumping units of hydrocyclones operating under different physical conditions.

Existing hydrocyclones are designed for separation of specific homogeneous suspension, that is, regardless of the incoming fluid separation size of particles does not change. This problem is acute in the use of hydrocyclones at TPP. Coal arriving at TPP often has a different quality, so when cleaning the boiler with water, resulting liquid has different composition characteristics every time. Installed hydrocyclones clean the income flow only from particles of a certain size, so each cleaning cycle requires the adjustment of the hydrocyclone parameters so the purified water has the characteristics of the standards.

Goal of the study. The aim of this work is to improve the effectiveness of the separation of ash condensations products due to changes in the geometry of the cyclone using a micro-processor control circuit.

**Research tasks statement.** The use of hydrocyclones and hydrocyclone units in various industrial processes, where technology often need to change the output parameters in time or, on the contrary, to keep them strictly at a certain level, regardless of the varying input parameters, set the task of designing and creating a way to control the operation of hydrocyclones automatically.

At present, this issue has received the greatest development in the mining and coal industries [2].

A large number of the methods of the control of hydrocyclone operation used in the production and

proposed in the literature does not allow to evaluate adequately each of them individually in relation to the conditions of their work.

Thus, to achieve the above mentioned goal it is necessary to solve the following tasks:

- to develop the design of hydrocyclone with variable in-ternal geometry;
- to develop the microprocessor-based ACS of hydrocyclone;
- to develop the hydrocyclone control units;
- to select the technological equipment;
- to develop the mimic diagram showing schematically the controlled process.

**Theory.** On this basis, the methods of control of hydrocyclone operation using generalizing principles are to be analyzed.

Control methods, which are currently most widely used, are assigned to the one of three groups, as using different prin-ciples, or combinations of them.

The first group includes the methods which use the princi-ple of changing the geometric dimensions of the elements of hydrocyclones structures; the second group of methods is those which use the principle of changing the pulp physical properties and (or) mechanical properties of the solid part of the slurry (the unit of the hydrocyclone or placed inside the device), the third group includes the methods which use the principle of pressure variation within the hydrocyclone, which occurs without changing the geometric dimensions of structural elements and physical properties of the feed slurry.

At present, the largest number of the methods to control the operation of hydrocyclones can be attributed to the first group [3]. This is apparently due to the positive sides of it such as simplicity in manufacturing and operation of the structural elements in its implementation; the possibility of regulating a number of devices or systems; a large adjustment range.

However, there are also disadvantages, the main of which are: the lack of smooth regulation; irrational use of energy costs; large and uneven wear of regulated units placed either in the zone of the greatest abrasion (sand nozzle) or in zones influencing substantially the flow pattern within the hydrocyclone (inlet and drain pipes), changing the geometric dimensions of which also leads to the rearrangement of the mode of the hydrocyclone, whereby the method has a low reliability, and fails to obtain stable technological parameters.

The second group of methods to control the operation of the hydrocyclones [4], and others have the following advantages: smooth regulation; constancy of the technological parameters over time; a large range of regulation and others.

However, the main drawback, such as the inability to control the input parameters of the pulp at some sites (e.g. in hydraulic engineering), as even in the closed technological schemes it is not always possible (if the system has a large volume) due to a large inertia, prevents wide use of the methods belonging to the second group and makes them impossible to use in hydraulic engineering.

Methods to control the operation of hydrocyclones of the third group [5] have the following advantages: energy efficiency; ease of implementation and operation; smooth operation; high reliability; the possibility of switching to manual or automatic adjustment and others. At the same time, these methods fit efficiently into the alluvium control technology in irrigation systems in mountain and piedmont areas. Based on this, it can be concluded that the methods referred to the third group are those to use in regulation of hydrocyclones in irrigation and drainage systems.

However, the ultimate choice of the method for controlling the operation of hydrocyclones using one or other principle or combination of them, must be done by comparing the feasibility when bound to a specific object. In the same time both the specific conditions of the proposed work of hydrocyclones and the methods to control them should be taken into account.

**Proposition and the results of implementation.** The problem to be solved in this work is to improve the effectiveness of the products separation of by changing the geometry of the cyclone using a microprocessor control circuit [6-8].

The technical result of the use of a new hydrocyclone with variable geometry [9, 10] is the automation of products separation process, reduction of the time of separation, extension of the service life of the hydrocyclone. Fig. 1 shows a typical hydrocyclone without changing the internal geometry, and Fig. 2 shows the proposed hydrocyclone with variable internal geometry.

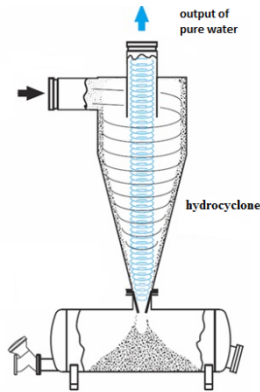


Figure 1 - A typical hydrocyclone

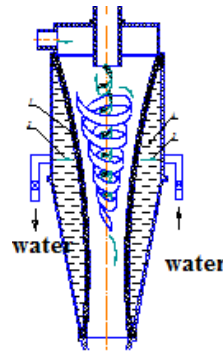


Figure 2 - The proposed hydrocyclone with variable internal geometry

**Development of ACS of hydrocyclone, control units and selection of process equipment.**

Automation scheme based on hydrocyclones geometry control has been developed to control the operation of the set of hydrocyclones in the overall scheme of technological process of HAR. Fig. 3 shows the functional diagram of the automation system to control the hydrocyclones.

The automation system is based on CPU188-5 IBM-PC compatible industrial controller of FASTWEL company. The controller software was developed in C++. The upper level is associated with the medium level by Modbus protocol. Modbus is a communication protocol, based on client-server architecture and developed by Modicon for the use in programmable logic controllers (PLC). It became de facto standard in the industry and is widely used for the connection of industrial electronic equipment. For data transition, it uses RS-485, RS-422, RS-232 serial lines and others, as well as TCP/IP network.

Devices from different manufacturers, that support the Modbus protocol, are easy to integrate into a single automation network. The market represented almost the entire range of necessary equipment, from simple input-output modules to inverters. All universal SCADA/HMI systems support this protocol.

Process parameters are controlled by sensors with standardized output signal. The signal from the sensors is fed to 5V32-01 "current-voltage" conversion module (manufactured by ANALOG DEVICES). Next, the signal is inserted in the memory of the controller by AMUX-32 input-output module where the signal is processed and transmitted to the computer in the developed upper level software, written in C#, where the process can be visualized.

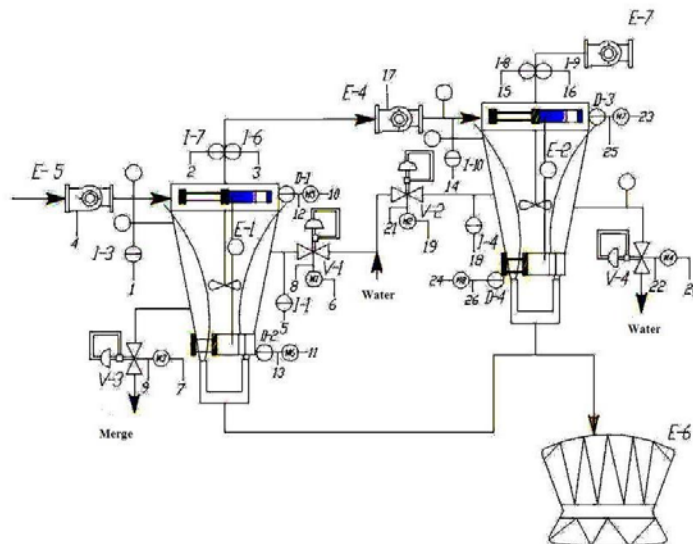


Figure 3 - Functional diagram of hydrocyclones automation control system

After processing, the signal from the controller is supplied to the output charge, and starts an actuator that controls the regulator.

Hydrocyclones automation control system loops are:

1. The unit for the monitoring of pressure of sulfur and slag supply to the cyclone E-1 is shown in Fig. 4.

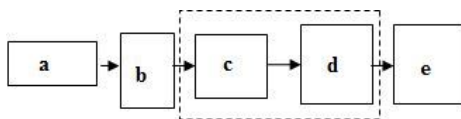


Figure 4 - The unit for the monitoring of pressure of sulfur and slag supply to the cyclone E-1

Symbols in the figure have the following meanings:

- a) pressure sensor I-3;
- b) "current-voltage" conversion module (5B32-01);
- c) analog signals input/output module (AMUX32C) - analog input;
- d) controller (CPU188-5);
- e) computer.

2. Circuit of the concentration I-7 and pressure I-6 control at the outlet of the hydrocyclone E-1 is shown in Fig. 5.

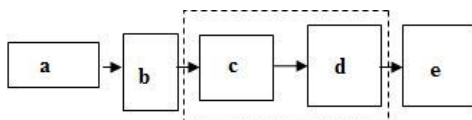


Figure 5 - Circuit of the concentration I-7 and pressure I-6 control at the outlet of the hydrocyclone E-1

Symbols in the figure have the following meanings:

- a) concentration I-7 and I-6 pressure sensor;
- b) "current-voltage" conversion module (PSA-01);
- c) analog signals input/output module (AIMUX-32) - analog input;
- d) controller (CPU188-5);
- e) computer.

3. Minimization of concentration I-7 and pressure I-6 of slag and ash at the outlet of hydrocyclone E-1. Minimization is due to the following control systems.

3.1 Control of the pressurized feeding of slag and ash to the hydrocyclone (controlled by I-3, pressure changes due to changes in E-5 pump rotation speed).

The block diagram is shown in Fig. 6.

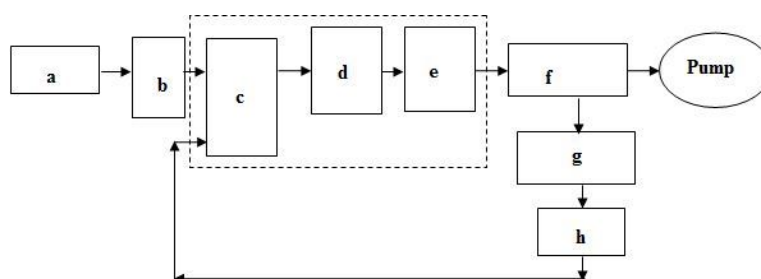


Figure 6 - The block diagram of the control of the pressurized feeding of slag and ash to the hydrocyclone

Symbols in Fig. 6 have the following meanings:

- a) pressure sensor I-6, concentration sensor I-7 (see paragraph 2) and pressure sensor I-3;
- b) "current-voltage" conversion module (PSA-01);
- c) analog signals input/output module (AMUX32C) - analog input;
- d) controller (CPU188-5);
- e) analog signals input/output module (AIMUX-32) - analog output;
- f) MICROMASTER 420 frequency converter;



- g) "current-voltage" conversion module (PSA-01);
- h) E-5 pump rotation speed; the degree of V-1 and V-3 regulators opening and closing (indicators).

3.2 Changes in the hydrocyclone geometry by changing the pressure in a sealed rubber insert (controlled by I-1 sensor), regulated by water supply (V-1 valve) and drain (V-3 valve).

The block diagram is shown in Fig. 7.

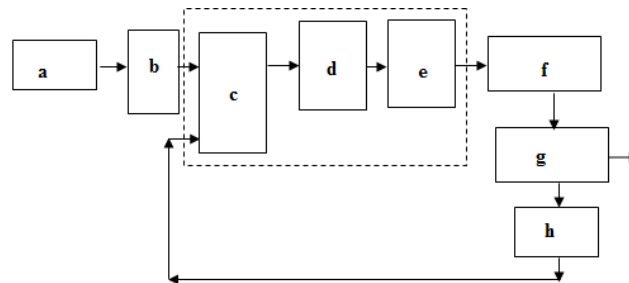


Figure 7 -The block diagram of the modification of the hydrocyclone geometry by changing the pressure in the sealed rubber insert

Symbols in Fig. 7 have the following meanings:

- a) pressure sensor I-6, concentration sensor I-7 and pressure sensor I-1;
- b) "current-voltage" conversion module (PSA-01);
- c) analog signals input/output module (AMUX32C) - analog input;
- d) controller (CPU188-5);
- e) discrete signals input/output module (TBI-24 0/C) - discrete output;
- f) PCLD-8115 relay outputs module;
- g) The opening/closing degree of regulator V-1 and V-3;
- h) ESA position.

4. Regulation (minimization) of the concentration I-7 and pressure I-6 at the outlet of the hydrocyclone E-1 due to changes in D-1 and D-2 valve position is shown in Fig. 8.

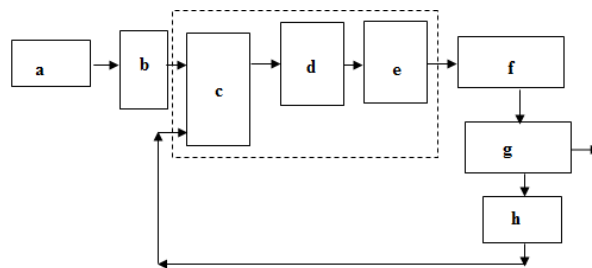


Figure 8 - Circuit of concentration and pressure control at the outlet of the hydrocyclone due to changes in valves position

Symbols in Fig. 8 have the following meanings:

- a) pressure sensor I-6, concentration sensor I-7 and D-1 and D-2 displacement sensors;
- b) "current-voltage" conversion module (PSA-01);
- c) analog signals input/output module (AMUX32C) - analog input;
- d) controller (CPU188-5);
- e) discrete signals input/output module (TBI-24 0/C) - discrete output;
- f) PCLD-8115 relay outputs module;
- g) D-1 and D-2 valves positions;
- h) ESA position.

The use of GENIE SCADA-system eliminates the need for controller, but there is the need in the acquisition of IO modules, which are directly connected to the computer. Software implementation schemes in GENIE SCADA-system are shown in Fig. 9-13.

1. Control of pressure of sulfur and slag supply to the cyclone E-1:

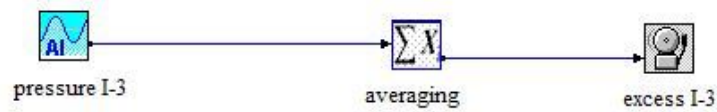


Figure 9 -Circuit of the control of pressure of sulfur and slag supply to the cyclone E-1

2. Concentration I-7 and pressure I-6 control at the outlet of the hydrocyclone E-1:

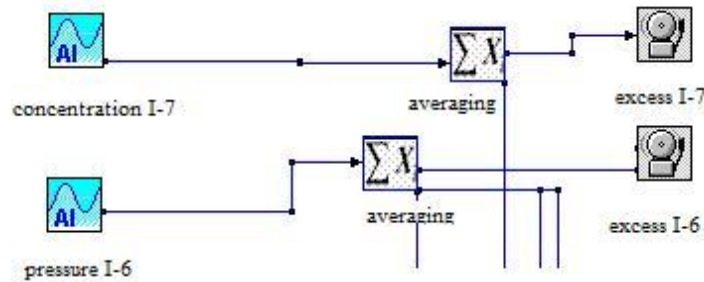


Figure 10 -Circuit of concentration I-7 and pressure I-6 control at the outlet of the hydrocyclone E-1

3 Control of slag, ash feed at the input of the hydrocyclone and pressure in the hydrocyclone rubber insert

3.1 Control of pressurized feed of slag and ash in a hydrocyclone (controlled by I-3, pressure changes due to changes in E-5 pump rotation speed).

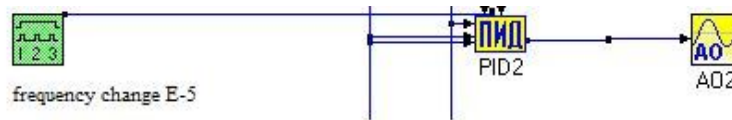


Figure 11 -Circuit of the control of pressurized feed of slag and ash in a hydrocyclone

3.2 Changing the geometry of the hydrocyclone by changing the pressure in the sealed rubber insert (controlled by I-1 sensor), regulated by water supply (valve V-1) and drain (valve V-3).

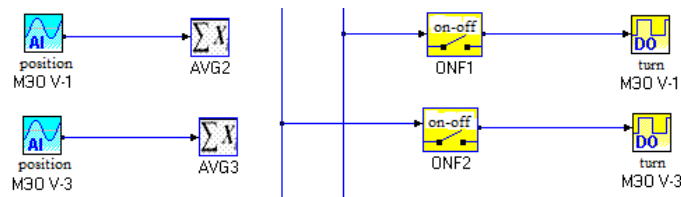


Figure 12 -Circuit of changing the geometry of the hydrocyclone by changing the pressure in the sealed rubber insert

4. Regulation (minimization) of the concentration I-7 and pressure I-6 at the outlet of the hydrocyclone E-1 by changing the position of D-1 and D-2 valves.

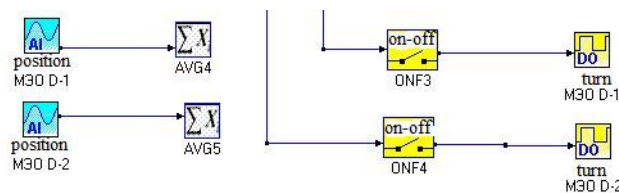


Figure 13 -Circuit of regulation (minimization) of the concentration I-7 and pressure I-6 at the outlet of the hydrocyclone E-1

Fig. 14 is the mimic diagram of the automated control system of hydrocyclones. Mimic diagram depicts schematically the controlled process and serves for visualization of the process.

This mimic diagram is made in GENIE SCADA-system in "forms editor" and is a flow diagram of the hydrocyclones operation process.

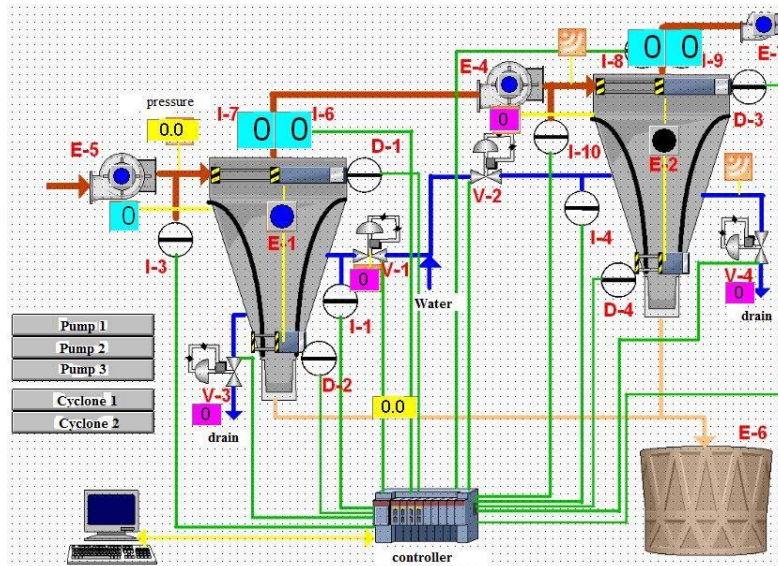


Figure 14 - Flow diagram of the hydrocyclones operation process. Forms editor

**Conclusions.** In this paper, automation control system for hydrocyclones with variable geometry was proposed and practically implemented. The parameters of the proposed system operation were determined.

The upper-level controller control program, determining the operating modes of CPU188-5 controller of Fastwell company and providing the control of the operation of the automated control system for hydrocyclones due to the regulation of the cyclone geometry elements, is given.

Control units and process equipment was described. Control loops of the automated system of the hydrocyclone were described: the circuit of the control of pressure of initial pulp supply into the cyclone, the circuit of the concentration and pressure control at the hydrocyclone outlet, the circuit of the control of pressure of intermediate pulp supply into the cyclone, the circuit of modification of hydrocyclone geometry by changing the pressure in the sealed rubber insert, as well as the circuit of the concentration and pressure control at the hydrocyclone outlet due to changes in the valve position.

ACS of the hydrocyclone allows to carry out the pilot studies to assess the performance of the proposed design of the hydrocyclone with variable internal geometry.

The general block diagram was designed in GENIE SCADA-system. The mimic diagram of ACS of the hydrocyclones with variable geometry was developed, which allows to visualize the HAR process.

Development of ACS of the HAR process at TPP and boilers will provide undrained operation, elimination of periodic or continuous purging discharges into water bodies and optimization of the parameters ash waste transported to ash dumps.

#### REFERENCES

- [1] Akopov M.G. The use of hydrocyclones in the enrichment of coals / M.G. Akopov, V.I. Klassen. Moscow: Gosgortekhzdat, **1960**. 128 p.
- [2] Povarov A.I. Automatic control of hydrocyclones / A.I. Povarov, Zabiroy M.G. Moscow: Obogaschenierud, **1958**. №3, pp 23-26.
- [3] Zhityanny V.Yu. Theoretical and experimental studies of the processes of separation of suspensions with the amorphous structure of the solids in pressure hydrocyclones: Abstract for CSc thesis. Gorkiy, **1980**. 21 p.
- [4] Khan G.A. Automation of enrichment processes / Khan G.A. Moscow: Nedra, **1964**. 372 p.
- [5] Degtyaryov G.V. Automatic adjustment of the hydrocyclone // G.V. Degtyaryov, V.Kh. Denisov. Publ. in BI, **1981**, #16.
- [6] Mutanov G.M., Azamatova Zh.K., Kvassov A.I., Baklanov A.Ye., Azamatov B.N. Certificate of state registration of intellectual property "Program simulation of hydrocyclone with variable geometry" // #1580 from 19.10.2010.

[7] Mutanov G.M., AzamatovaZh.K., Kvassov A.I., BaklanovA.Ye., Azamatov B.N. Certificate of state registration of intellectual property "Automated control system for the parameters of hydrocyclones with variable geometry" // # 1396 from 19.08.2010.

[8] Mutanov G.M., AzamatovaZh.K., Kvassov A.I., BaklanovA.Ye., Azamatov B.N. Patent "Method of regulation of hydrocyclone" // #2010/0710.1.

[9] Mutanov G.M., AzamatovaZh.K., Kvassov A.I., BaklanovA.Ye., Azamatov B.N. Patent "Hydrocyclone" // №2010/0708.1.

[10] SoltanG.Zh., Syzdykpaeva A.R. Optimization of drainage-free systems of water supply of dust-coal TPP // Proceedings of the International Kazakh-Russian scientific-practical conference. - Ust-Kamenogorsk, 2004. pp 295-297.

**Б.Н. Азаматов<sup>1</sup>, Қ.А. Ожикенев<sup>2</sup>, Ж.К. Азаматова<sup>1</sup>**

<sup>1</sup> Д.Серікбаев атындағы Шығыс-Қазақстан мемлекеттік техникалық университеті, Өскемен, Қазақстан;

<sup>2</sup> Қ. И. Сәтбаев атындағы қазақ ұлттық техникалық зерттеу университет, Алматы, Қазақстан

### **ЖЭС ГИДРАВЛИКАЛЫҚ КҮЛЖОЮ ЖҮЙЕСІНДЕ ГЕОМЕТРИЯСЫ БАСҚАРЫЛАТЫНГИДРОЦИКЛОНДАР БАТАРЕЯСЫН АВТОМАТТЫ БАСҚАРУ**

**Аннотация.** Мақалада ЖЭС гидравликалық күлді жою сұрақтары қарастырылған. Жаңа геометриясы өзгеретін гидроциклонның құрылымы ұсынылған. Осы жұмыста геометриясы өзгеретін гидроциклондарды автоматты басқарудың сұлбасы ұсынылып отыр және аталған сұлба тәжірибеде жүзеге асқан. Ұсынылған жүйенің жұмыс параметрлері анықталған. Басқару элементтері мен технологиялық құралдардың сипаттамасы берілген. Геометриясы өзгеретін гидроциклондарды автоматты басқарудың сұлбасы мен GENIE SCADA-жүйесіндежалпы блок сұлбалары жасалған. Жасалған автоматты басқару жүйесі ұсынылған ішкі геометриясы өзгеретін гидроциклондардың жұмыс істеу қабілетін бағалау бойынша эксперименттік зерттеулерге мүмкіндік береді. Жасалған АБЖ ЖЭС мен қазандақтардың күл жою технологиялық процесінтерінде уақыт сайын немесе тұрақты үрлеу суларын тоғандарға ағызуды жояды және күлқожды қалдықтарды күл үймесіне тасымалдау кезінде параметрлерін оңтайландырады.

**Түйін сөздер:** гидравликалық күлжою, ЖЭС, АБЖ, өзгеретін геометрия, гидроциклон, күл үймесі, микропроцессор.

**Б.Н. Азаматов<sup>1</sup>, Қ.А. Ожикенев<sup>2</sup>, Ж.К. Азаматова<sup>1</sup>**

<sup>1</sup> Восточно-Казахстанский государственный технический университет им. Д.Серикбаева, Усть-Каменогорск, Казахстан;

<sup>2</sup> Казахский национальный исследовательский технический университет им. К.И. Сатпаева, Алматы, Казахстан

### **АСУ БАТАРЕЙ ГИДРОЦИКЛОНОВ С УПРАВЛЯЕМОЙ ГЕОМЕТРИЕЙ В СИСТЕМЕ ГЗУ ТЭС**

**Аннотация.** В статье рассмотрены вопросы гидрозола-удаление (ГЗУ) на ТЭС. Предложена принципиально новая конструкция гидроциклонов с изменяемой геометрией. В данной работе предложена и практически реализована схема автоматизации системы управления гидроциклонами с изменяемой геометрией. Определены параметры работы предложенной системы. Произведено описание элементов управления и технологического оборудования. Разработана общая схема блоков в SCADA-системе GENIE и мнемосхема автоматизированной системы управления гидроциклонами с изменяемой геометрией. Разработанная АСУ гидроциклона позволяет провести экспериментальные исследования по оценке работоспособности предложенной конструкции гидроциклона с изменяемой внутренней геометрией. Разработка АСУ технологическим процессом ГЗУ ТЭС и котельных позволит обеспечить бессточный режим работы, устранить периодические или постоянные сбросы продувочных вод в водоемы и оптимизировать параметры транспортируемых в золоотвал золошлаковых отходов.

**Ключевые слова:** гидрозолаудаление, ТЭС, АСУ, изменяемая геометрия, гидроциклон, золоотвал, микропроцессор.

#### **Сведения об авторах:**

Азаматов Бағдат Нурланович – докторант кафедры «Приборостроение и автоматизация технологических процессов» Восточно-Казахстанского государственного технического университета имени Д. Серикбаева, Казахстан, специальность 6D070200 – Автоматизация и управление, e-mail: [Azamatovy@mail.ru](mailto:Azamatovy@mail.ru);

Ожикенев Касымбек Адильбекович – кандидат технических наук, профессор, заведующий кафедрой «Робототехника и технические средства автоматики» Казахского национального исследовательского технического университета имени К.И. Сатпаева, Казахстан, e-mail: [kas\\_ozhiken@mail.ru](mailto:kas_ozhiken@mail.ru), [ozhikenovk@gmail.com](mailto:ozhikenovk@gmail.com);

Азаматова Жанерке Кыдырбековна - кандидат технических наук, старший преподаватель кафедры «Приборостроение и автоматизация технологических процессов» Восточно-Казахстанского государственного технического университета имени Д. Серикбаева, Казахстан, e-mail: [Zhanerkeaz@mail.ru](mailto:Zhanerkeaz@mail.ru)

МАЗМҰНЫ

**Техникалық ғылымдар**

<i>Жусупов Б., Hermosilla S., Терликбаева А., Айфah А., Жумадилов З., Абильдаев Т., Муминов Т., Исаева Р.</i>	
Қазақстанда туберкулездің жаңа жағдайлары бойынша уақыттық тізбекті талдау.....	5
<i>Бутурлакина Е.Г., Квасов И.А.</i> Инвестициялық шешімдерді қолдаудың таралған көпагентті ақпараттық жүйесі.....	12
<i>Азаматов Б.Н., Ожикенев Қ.А., Азаматова Ж.Қ.</i> ЖЭС гидравликалық күлжою жүйесінде геометриясы	
Басқарылатын гидроциклондар батареясын автоматты басқару .....	20
<i>Ahmetov B., Korchenko A., Alimseitova Zh., Zhumangalieva N.</i> A system for identifying abnormal state in informational systems.....	28
<i>Баймаханова С., Байқоңырова Ә.Ө., Усольцева Г.А., Қоныратбекова С.С.</i> Кемпірсай кен орынының тотыққан никельқұрамды кендерін күкірт қышқылды шаймалау кинетикасын зерттеу .....	38
<i>Генбач А.А., Бондарцев Д.Ю.</i> Электр станцияларының және оларды жасау ғылыми әдісін жылу-механикалық жабдықтарын жылу әдістері мен құрылғылар әзірлеу.....	45
<i>Казиев М.Т.</i> Заттардың сұйық күйіндегі құрылымының кванттық теориясы.....	53
<i>Нұрғалиева М.Т., Календарь Р.Н., Смағұлов А.Қ., Искакова Ж.А.</i> Ретротранспозон тізбектер негізінде ет шикізатын және ет өнімдерін сәйкестендіру үшін праймерлерды тестілеу.....	63
<i>Нуртай Ж.Т., Наукенова А.С., Аубакирова Т.С., Шапалов Ш.К.</i> Таулы аймақтардағы халықты табиғи сипаттағы төтенше жағдайдан құтқару мақсатында өндірістік қалдықтарды қолдана отырып композициялық материалдар алу.....	69

**Физика**

<i>Жантаев Ж.Ш., Шығайев Д.Т., Қалдыбаев А.А., Нұрақынов С.М., Бреусов Н.Г., Мамырбек Ф.Б., Мұқашева С.Н.</i>	
Шардара су кешенінің аумағын жер серіктік радиолокациялық интерферометрия деректері негізінде бақылау.....	75

**Химия**

<i>Закарина Н.А., Акурпекова А.К., Джумабаева Л.С., Жумадуллаев Д.А.</i> Al-Zr-мен пилларирленген монтмориллонитке қондырылған нанодисперсті Pd-катализаторлардағы H-гексан изомеризациясы.....	83
---	----

**Жер туралы ғылым**

<i>Жантаев Ж.Ш., Хачикян Г.Я.</i> Сейсмикалық болжамды мониторингінің мемлекетаралық жүйесін құру.....	93
--	----

**Биология және медицина**

<i>Есжан Б.Ф., Орынбаева З.С., Төлеуханов С.Т.</i> «Сүт безінің әртүрлі патологияларында даназол препаратының қолданылуының салыстырмалы сипаттамалары».....	100
<i>Турмагамбетова А.С., Алексюк П.Г., Алексюк М.С., Омиртаева Э.С., Анаркулова Э.И., Молдаханов Е.С., Богоявленский А.П., Березин В.Э.</i> Ағзадағы қабыну реакциясы бойынша индукцияға вирустық антигендерінің кеңістіктік құрылымын әсері.....	107
<i>Жамбакин К.Ж., Шамекова М.Х., Даурова А.К., Дауров Д.Л., Жанар К.К., Волков Д.В., Едилова А.К., Бакбергеннова М.О., Толегенова Д.А.</i> Рапстың ( <i>Brassica napus</i> ) қышабас ( <i>Brassica campestris</i> ) және қыша ( <i>Brassica juncea</i> ) өсімдіктерімен тұраралық будандарын алу.....	114

**Қоғамдық ғылымдар**

<i>Айтхожаева Е.Ж., Сейлова Н.А.</i> Сандық қоғам қауіптері.....	123
<i>Аюпова З.К., Құсайынов Д.Ө.</i> Ұлттық сана – отансүйгіштіктің қайнар бастауы ретінде.....	131
<i>Жұмақаева Б.Д.</i> Сайсаттанудағы саяси мінез құлық мәселесін зерттеудің концептуалдық негізгі.....	136

## СОДЕРЖАНИЕ

## Технические науки

<i>Жусупов Б., Hermosilla S., Терликбаева А., Aifan A., Жумадилов З., Абильдаев Т., Муминов Т., Исаева Р.</i> Анализ временных рядов по новым случаям туберкулеза в Казахстане.....	5
<i>Бутурлакина Е.Г., Квасов И.А.</i> Распределенная многоагентная информационная система поддержки инвестиционных решений.....	12
<i>Азаматов Б.Н., Ожикенев К.А., Азаматова Ж.К.</i> АСУ батарей гидроциклонов с управляемой геометрией в системе ГЗУ ТЭС.....	20
<i>Ахметов Б., Корченко А., Алимсеитова Ж., Жумангалиева Н.</i> Система выявления аномального состояния в информационных системах.....	28
<i>Баймаханова С., Байқоңырова Ә.Ө., Усольцева Г.А., Қоңыратбекова С.С.</i> Изучение кинетики серноокислотного выщелачивания окисленных никельсодержащих руд кемпирсайского месторождения.....	38
<i>Генбач А.А., Бондарцев Д.Ю.</i> Разработка тепловых способов и устройств для тепломеханического оборудования электростанций и научная методика их создания.....	45
<i>Казиев М.Т.</i> Квантовая теория структуры жидких состояний веществ.....	53
<i>Нургашиева М.Т., Календарь Р.Н., Смагулов А.К., Искакова Ж.А.</i> Тестирование праймеров для идентификации мясного сырья и мясных продуктов на основе последовательностей ретротранспозонов.....	63
<i>Нуртай Ж.Т., Наукенова А.С., Аубакирова Т.С., Шапалов Ш.К.</i> Получение композиционных материалов с использованием промышленных отходов с целью защиты население высокогорных районах от чрезвычайных ситуациях природного характера.....	69

## Физика

<i>Жантаев Ж.Ш., Шигаев Д.Т., Калдыбаев А.А., Нурақынов С.М., Бреусов Н.Г., Мамырбек Г.Б., Мукашева С.Н.</i> Мониторинг территории шардаринского гидрокомплекса на основе данных спутниковой радиолокационной Интерферометрии.....	75
--	----

## Химия

<i>Закарина Н.А., Акурпекова А.К., Джумабаева Л.С., Жумадуллаев Д.А.</i> Изомеризация n-гексана на нанодисперсных Pd-катализаторах, нанесенных на пилларированный Al-Zr- монтмориллонит.....	83
--	----

## Наука о Земле

<i>Жантаев Ж.Ш., Хачикян Г.Я.</i> О создании межгосударственной космической системы сейсмопрогнозного мониторинга.....	93
--	----

## Биология и медицина

<i>Есжан Б.Ф., Орынбаева З.С., Тулеуханов С.Т.</i> «Об лечебных и сравнительных особенностях препарата даназола при лечении разной патологии молочных желез».....	100
<i>Турмагамбетова А.С., Алексюк П.Г., Алексюк М.С., Омиртаева Э.С., Анаркулова Э.И., Молдаханов Е.С., Богоявленский А.П., Березин В.Э.</i> Влияние пространственной структуры вирусных антигенов на индукцию воспалительных реакций в организме.....	107
<i>Жамбакин К.Ж., Шамекова М.Х., Даурова А.К., Дауров Д.Л., Жапар К.К., Волков Д.В., Едилова А.К., Бакбергенова М.О., Толегенова Д.А.</i> Получение межвидовых гибридов рапса ( <i>Brassica napus</i> ) с сурепицей ( <i>Brassica campestris</i> ) и горчицей ( <i>Brassica juncea</i> ).....	114

## Общественные науки

<i>Айтхожаева Е.Ж., Сейлова Н.А.</i> Риски цифрового общества.....	123
<i>Аюпова З.К., Кусаинов Д.У.</i> Национальное сознание как основа патриотизма.....	131
<i>Жумакаева Б.Д.</i> Концептуальные основы исследования политического поведения в политологии.....	136

CONTENT

**Technical sciences**

<i>Zhussupov B., Hermosilla S., Terlikbayeva A., Aifah A., Zhumadilov Z., Abildayev T., Muminov T., Issayeva R.</i>	
Time-series analysis on new tb cases in Kazakhstan.....	5
<i>Buturlakina E.G., Kvasov I.A.</i> Multi-agent based distributed information system of investment decisions support.....	12
<i>Azamatov B.N., Ozhikenov K.A., Azamatova Zh. K.</i> ACS of the set of hydrocyclones with a variable geometry in the system of har TPP .....	20
<i>Ahmetov B., Korchenko A., Alimseitova Zh., Zhumangaliev N.</i> A system for identifying abnormal state in informational systems.....	28
<i>Baimakhanova S., Baikonurova A.O., Ussoltseva G.A., Konyratbekova S.S.</i> Study of kinetics of sulfuric acid leaching of oxidized nickel-containing ore of the kempirsai deposit.....	38
<i>Genbatch A.A., Bondartsev D.Yu.</i> Development of thermal methods and devices for thermal mechanical equipment of power plants and the scientific methodology for their creation.....	45
<i>Kaziev M.T.</i> Quantum theory of the liquid structure of condition substances.....	53
<i>Nurgaliyeva M.T., Kalendar R.N., Smagulov A.K., Iskakova Zh.A.</i> Testing of primers for identification of meat raw materials and meat products on the basis of the sequences retrotranspozons.....	63
<i>Nurtai Zh.T., Naukenova A.S., Aubakirova T.S., Shapalov Sh.K.</i> The obtaining of compositional materials with industrial waste using with the purpose of hing – mountain areas people protection from emergency situations of natural character.....	69

**Physics**

<i>Zhantayev Zh.Sh., Shigayev D.T., Kaldybayev A.A., Nurakynov S.M., Breusov N.G., Mamyrbek G.B., Mukasheva S.N.</i>	
Monitoring of the territory of the chardara hydro complex based on satellite radar interferometry data.....	75

**Chemistry**

<i>Zakarina N.A., Akurpekova A.K., Djumabaeva L.S., Zhumadullaev D.A.</i> Isomerization of n-hexane over nanodisperse Pd-catalysts supported on al-Zr- pillared montmorillonite.....	83
--	----

**Earth science**

<i>Zhantayev Zh., Khachikyan G.</i> On creation of interstate space system for seismic-prognostic monitoring.....	93
---	----

**Biology and Medicine**

<i>Yeszhan B.G., Orynbayeva Z.S., Tuleukhanov S.T.</i> "On the medical and comparative features of danazol drug in treatment of different pathology of mammary gland".....	100
<i>Turmagambetova A.S., Alexyuk P.G., Alexyuk M.S., Omirtaeva E.S., Anarkulova E.I., Moldakhanov E.S., Bogoyavlenskiy A.P., Berezin V.E.</i> Influence of the spatial structure of viral antigens for ability to induce of inflammatory reactions in the organism....	107
<i>Zhambakin K.Zh., Shamekova M.Kh., Daurova A.K., Daurov D.L., Zhapar K.K., Volkov D.V., Edilova A.K., Bakbergenova M.O., Tolegenova D.A.</i> Production of rapeseed ( <i>Brassica napus</i> ) interspecific hybrids with rape ( <i>Brassica campestris</i> ) and mustard ( <i>Brassica juncea</i> ).....	114

**Social Sciences**

<i>Aytkhozhaeva E.Zh., Seilova N.A.</i> Digital society risks.....	123
<i>Ayupova Z.K., Kussainov D.U.</i> National consciousness as the bases of patriotism.....	131
<i>Zhumakayeva B.D.</i> Conceptual bases of research of political behavior are in political science.....	136

---

---

**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 work described 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](http://publicationethics.org/files/u2/New_Code.pdf)). To verify originality, your article may be checked by the originality detection service Cross Check <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.nauka-nanrk.kz)

**ISSN 2518-1483 (Online), ISSN 2224-5227 (Print)**

<http://www.reports-science.kz/index.php/ru/>

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

Подписано в печать 13.10.2017.  
Формат 60x881/8. Бумага офсетная. Печать – ризограф.  
9 п.л. Тираж 2000. Заказ 5.

---

---

*Национальная академия наук РК*  
050010, Алматы, ул. Шевченко, 28, т. 272-13-18, 272-13-19