Suvni kimyoviy tuzsizlantirish uchun ionit filtrlarni regeneratsiya qilish qurilmasini avtomatlashtirish

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Dolzarblik: ushbu maqolada suvni kimyoviy tuzsizlantirish jarayonida ion almashinuv filtrlarini qayta tiklash qurilmasini avtomatik boshqarish tizimi ishlab chiqilgan. Suvni kimyoviy tuzsizlantirish vaqtida ion almashinuv filtrlarini qayta tiklash qurilmasi avtomatlashtirildi. Ishlab chiqilgan algoritm asosida mantiqiy boshqarish tizimining funksional sxemasi yaratildi va boshqarish oralig'ini belgilash uchun KPRS 600 klapanining maksimal o'tkazuvchanlik quvvati aniqlandi.

Maqsad: kimyoviy reagentlar asosida suv tuzsizlantirishda qo'llaniladigan ion almashinuv filtrlarini qayta tiklash tizimini avtomatlashtirish.

Usullar: kanallardagi massa va energiya saqlanishi qonunidan kelib chiqqan differensial diskretlash chekli ayirmalar usuli yordamida amalga oshirildi.

Natijalar: taklif etilgan kimyoviy reagentlar asosidagi suvni tuzsizlantirish samaradorligi O'zbekistonning beshta shahri (issiq-quruq iqlimli Qarshi va Termiz, issiq-nam iqlimli Toshkent, Andijon, Namangan va Farg'ona) uchun har oyda baholandi. Ushbu tadqiqot davomida suvni kimyoviy tuzsizlantirishda qo'llaniladigan ion almashinuv filtrlarini qayta tiklash qurilmasi avtomatlashtirildi. Ishlab chiqilgan algoritm asosida boshqaruv tizimining funksional sxemasi yaratildi hamda boshqaruv oralig'ini belgilash uchun KPRS 600 klapanining maksimal o'tkazuvchanlik quvvati aniqlandi.

Kalit so'zlar: Ion almashinuvi va suvni tuzsizlantirish uchun regeneratsiya qurilmasi, logik boshqaruv tizimi.

Автоматизация установки для регенерации ионных фильтров химического обессоливания воды

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Актуальность: в данной статье разработана система автоматического управления блоком регенерации ионообменных фильтров при химическом опреснении воды. Блок регенерации ионообменных фильтров при химическом опреснении воды был автоматизирован. На основе алгоритма разработана функциональная схема системы логического управления и определена максимальная пропускная способность клапана типа КПРС 600 для установления диапазона управления.

Цель: автоматизация системы регенерации ионообменных фильтров, применяемых для опреснения воды с использованием химических реагентов

Методы: дифференциальная дискретизация, основанная на законах сохранения массы и энергии в каналах, была применена с использованием метода конечных разностей.

Результаты: эффективность предложенного метода опреснения воды на основе химических реагентов оценивалась ежемесячно в пяти городах Узбекистана (Карши и Термез с жарким сухим климатом, а также Ташкент, Андижан, Наманган и Фергана с жарким влажным климатом). В ходе этой работы была автоматизирована установка регенерации ионообменных фильтров, используемых при химическом опреснении воды. На основе разработанного алгоритма была создана функциональная схема системы управления и определена максимальная пропускная способность клапана КПРС 600 для установления диапазона регулирования.

Ключевые слова: установка регенерации для ионного обмена, опреснения воды, система логического управления.

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Automation of the unit for regeneration of ionic filters for chemical desalination of water

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Relevance: in this article, an automatic control system for the regeneration unit of ionic exchange filters during chemical desalination of water has been developed. the regeneration unit for ion exchange filters during chemical desalination of water was automated. Based on the algorithm, a functional diagram of the logic control system was developed, and the maximum throughput of the KPRS 600 valve was determined to establish the control range.
Aim: automation of the system for regenerating ionic exchange filters used in water desalination based on chemical reagents
Methods: differential discretization derived from conservation of mass and energy in the channels was used using the finite difference method.
Results: the effectiveness of the proposed chemical reagent-based water desalination was evaluated on a monthly basis for five cities in Uzbekistan (Karshi and Termez with hot-dry climates, and Tashkent, Andijan, Namangan, and Fergana with hot-humid climates). During this work, the regeneration unit for ionic exchange filters used in chemical water desalination was automated. Based on the developed algorithm, a functional diagram of the control system was created, and the maximum flow capacity of the KPRS 600 valve was determined to establish the control range.
Keywords: regeneration unit of ion exchange, desalination of water, the logic control system.

1. Introduction

The efficiency of water purification and the volume of waste, convenience and safety of maintenance are largely determined by the hardware design of the water treatment process. Hundreds of types of ion exchange devices of various types, periodic and continuous, with massive and fluidized layers of ion exchangers have been developed.

In the republic, only periodic devices with a massive layer of filter-type ion exchanger are used for water treatment. Batch-operating devices are characterized by the fact that all technological processes (cleaning, loosening) are countercurrent (counterflow).

Direct-flow (parallel-flow) filters are the simplest devices, consisting of a housing equipped with an upper distribution device and a lower drainage device. The latter is a collector with drainage caps or made of perforated drainage pipes. Intro the constructive case there is a layer of ion exchange resin. It should not exceed 0.5-0.7 heights of the filter, so that during periodic loosening of the layer when it expands, there is no carryover and loss of the ion exchanger [5].

2. Methods and materials

Literature survey. Shut-off valves with manual, hydraulic or electric drive are installed next to the filter on the supply pipelines [1-4].

The filter operation consists of the following operations:

- ***water purification***.

Water purification is carried out from top to bottom with valves 3 - 4 open; an increase in the pressure drop across the filter, an increase in hardness (Na leakage) after the filter and the total water flow through it serves as a reliable indirect indicator of its contamination. Therefore, when these indicators increase, the ion exchange filter is put into regeneration;

- loosening to remove suspended matter.

The first stage of regeneration is loosening the filter layer with water. Loosening the cation exchanger is necessary to eliminate caked layers and remove mechanical impurities from it, the presence of which leads to an increase in the pressure drop in the ion exchanger layer. When loosening, water is supplied to the filter from bottom to top at a speed of 7 - 10 m/h. First, valves 3-4 are closed, valves 5-6 are opened. The loosening process takes about 20 minutes;

- ionic exchanger regeneration.

This is done by closing valves 5 - 6 and opening valves 7 - 8. During regeneration, the supply of a regenerating solution (1.5% sulfuric acid solution) begins sequentially for 30 - 40 minutes at a speed of at least 10 m/h to avoid “plastering” cationite flushing.

3. Results and Discussion

The regeneration solution is prepared as follows:

- opening valve 11 to supply sulfuric acid;
- supply of chemically purified water (opening valve 12);
- switching on the dosing pump;
- according to the consumption of clarified water, using a dosing pump, we supply the required amount of concentrated sulfuric acid, as a result we obtain a 1.5% solution of sulfuric acid.

For the above-described algorithm (Fig. 1) for automatic control of the regeneration process of ion exchange filters, a functional process control diagram was developed.

Description of scheme. The installation of the required heat output is shown in Fig.1. First, valve 7 is closed, valve 9 is opened.

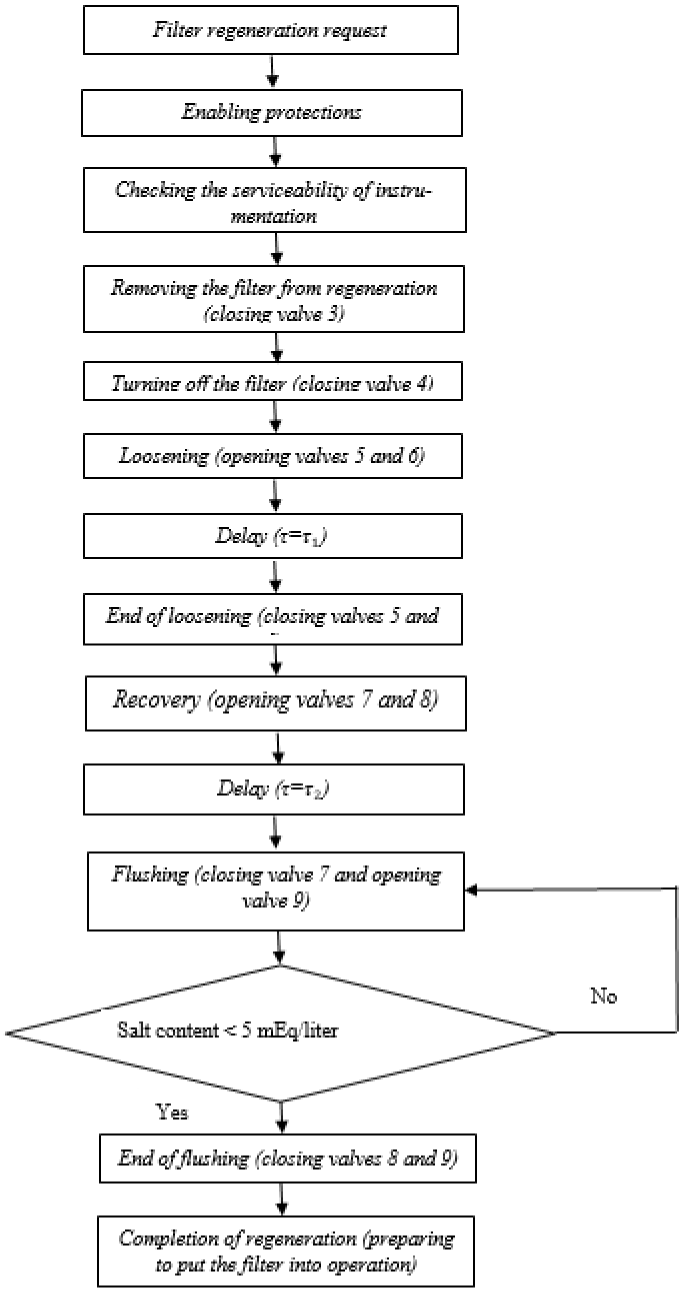

Fig. 1. Algorithm for automatic control of the regeneration process of ion exchange filters

The ion exchanger layer is washed from regeneration products and residues of this solution by passing wash water from top to bottom for 30 minutes at a speed of 8 - 10 m/h. The completion of the washing and regeneration processes as a whole is judged by an indirect indicator - a decrease in the water pressure drop across the filter to the initial steady-state value and salt concentration (5.0 mEq/l). After that, valves 8 - 9 are closed and the filter is put into operation by opening valves 3 - 4.

The diagram (Fig. 2) shows sensors, electric drives, control and shut-off valves, as well as a microprocessor controller and controls.

A regulatory verification calculation was also carried out for the proposed scheme.

As an example, below is a test calculation for the KPRS 600 valve.

Initial data:

- Limits for changes in flow rate, 120 m/h;
- Valve nominal bore, 150 mm;
- Valve hydraulic resistance, 520 kPa.

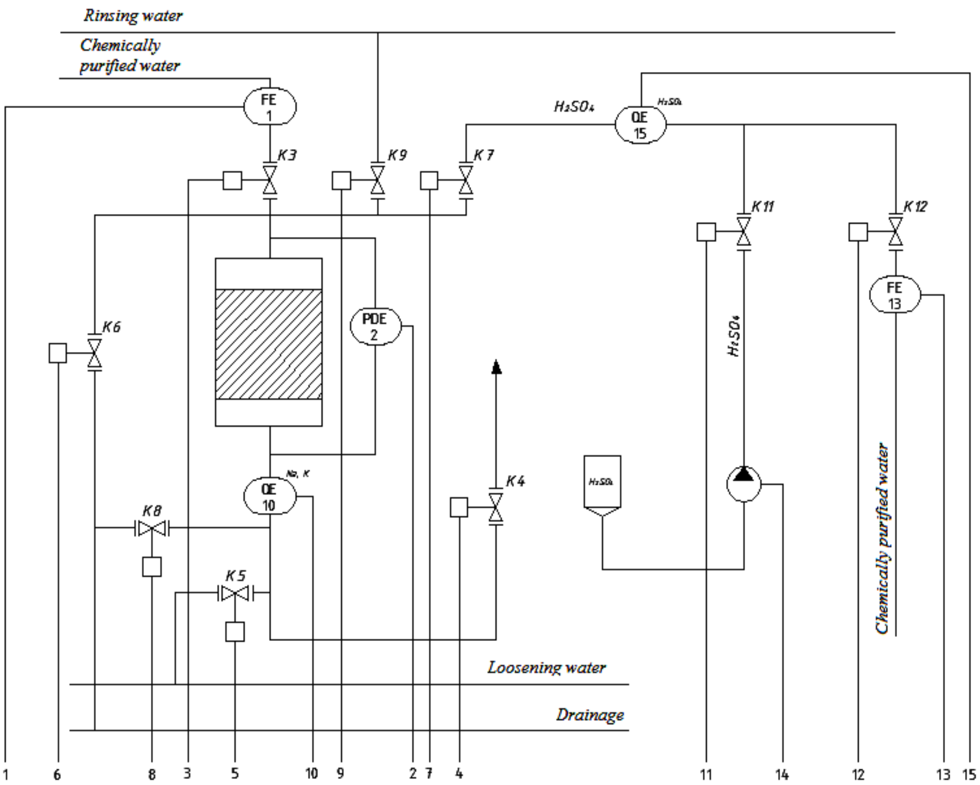

Fig.2. Functional diagram

Methodology:

A. Survey of publications

B. Calculation of the characteristics

Results of culculations. For computer processing of iterative calculations, an algorithm was compiled for calculating the characteristics of the purpose of the verification calculation is to determine the maximum capacity of the KPRS 600 valve to establish control ranges.

For this purpose, we determine the volumetric flow rate of steam [6]:

$$G = \mu_{fl} \cdot F \cdot \varepsilon \cdot \sqrt{2\Delta P/\rho}\text{, m}^3\text{/s ;} \quad (1)$$

here μ_{fl} is the flow coefficient, which is understood as the ratio of the actual measured flow rate of the medium to the calculated one. Are accepted μ_{fl}= 7 with F/F_{MAX} = 1; F is the opening area of the regulatory body, m^2:

$$F = \pi \cdot R^2 = 3{,}14 \cdot \left(\frac{0{,}150}{2}\right)^2 = 0{,}177\text{ , m}^2\text{ ;} \quad (2)$$

Δp - hydraulic resistance of the throttle device, Pa; Δp = 520 kPa ρ - density of the substance, kg/m^3, ρ = 1000 kg/m^3.

$$G = 7 \cdot 0{,}0177\sqrt{2 \cdot 520000/1000} = 3{,}996\text{ , m}^3 \quad (3)$$

G_{pipe} = 120 m^3/h= 0,033 m^3/s < G therefore the valve is selected correctly.

4. Conclusion

In the course of this work, the installation of regeneration of ion-exchange filters during chemical desalination of water was automated. Based on the algorithm, a functional diagram of the logical control system was developed and the maximum throughput of the valve type KPRS 600 was determined to establish the control range.

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