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THE PERFECTION OF HARDWARE OF INFORMATION-MEASURING SYSTEMS FOR THE CHECKING OF PARAMETERS OF CHEMICAL-TECHNOLOGICAL PROCESSES WITH THE USE OF FLOW-INJECTION METHOD

The work is devoted to the perfection of hardware of information-measuring systems for the checking of parameters of chemical-technological processes with the use of flow-injection method. The types of its use are presented and parameters of technological water in chemical-technological processes are analyzed. The method of continuous pumping of fluids and reagents through analytical module and a detector in relevant volumetric ratios at a fixed speed by using electromagnetic pump is described. The optimization of design parameters is fulfilled and the optimum operating conditions of electromagnetic pump work are chosen.

Keywords: *chemical-technological process, technological water, electromagnetic pump, optimization of parameters, flow-injection analysis.*

Chemical industry is one of the largest consumers of water. A rate-of-flow in chemical productions is very great. On some chemical enterprises the consumption of water reaches a 1 million м^3 in twenty-four hours. Water is used almost in all chemical productions for various aims: washing, cooling of aggregates, dilution of industrial effluents. On total water consumption chemical industry occupies the first place among enterprises of manufacturing industry [1].

Converting of water into one of the major elements of chemical production is explained by:

- the presence of complex of valuable properties (high heat capacity, small viscidity, subzero temperature of boiling and other);
- availability and cheapness (expenses exceptionally on extraction and cleaning);
- non-toxicity;
- the convenience of the use in a production and transporting.

In chemical industry water is used in such directions [2]:

1. For technological aims in quality:

- solvent of hard, liquid and gaseous substances;
- environments for realization of physical and mechanical processes (flotation, transporting of hard materials as pulp and other);
- the stream liquid for gases;
- extractant and absorbent of different substances.

2. As a coolant-moderator – as hot water and steam and cooling agent for heating and cooling of apparatus.

3. As raw material and reagent for the production of various chemical goods.

In chemical productions three charts of water rotation depending on those changes that water undergoes in the process of production are used:

- water is only heated and must be chilled before a return in cooling towers or pools;
- water is only contaminated and must be cleared before a return in special sewage treatment plants;
- water is heated and contaminated. This type of water rotation presents the combination of water rotations of the first and second types.

Water used in chemical industry (technological water) must satisfy in quality the certain requirements of one or another production.

Quality of water is determined by the totality of its physical and chemical descriptions: color, transparency, smell, common soil maintenance, inflexibility, oxidability, reaction (pH), that depend on different admixtures content in water.

Harmful influence of admixtures contained in technological water depends on their chemical nature, concentration, dispersible state and also the technology of certain production, using water. All substances being in water can be in solid state (of salt, gases, some organic compounds, in colloid state (made of flint acid, organic compounds of lignin type and other) and in suspended state (clay, sandy and lime particles).

In water permeates form a heating scum on the walls of apparatus and cause its corrosive destruction. Colloid admixtures cause contamination of diaphragms of electrolyzers, making foam of water. Coarse particles dredge little pipelines, reducing their productivity, and can cause their corking [3].

All of it causes the necessity of pre-treatment of water acting on a production – water preparation.

We consider the complex of operations of water preparation on moving away from natural water of harmful for production admixtures, contained in it as dredges, colloid particles, cut-in salts and gases. In water preparation are included [4]: operations of lighting up, disinfection, degassing, and on occasion demineralization and for drinking-water – disinfection.

Water purification is achieved by its protection with the help of subsequent filtration through grainy material of different dispersion. For coagulation of colloid admixtures and absorption of painted substances contained in water, electrolytes – sulfates of aluminium and iron – are added in it.

The disinfection of water is provided by its chlorinating or ozonization.

Degassing – removal of cut-in gases from water – is achieved by a chemical method at which those gases are taken in by chemical reagents.

A demineralization is used in those productions, where especially hard requirements are put to water on cleanness, for example, at the production of semiconductor materials, chemically clean reagents, pharmaceutical preparations. The demineralization of water is achieved by the method of ionic exchange, distillation and electrodialysis.

The method of ionic exchange is based on the property of some solids (ion-exchangers) to take in from solution ions in an exchange on the equivalent amount of other ions of the same sign. Ion-exchangers are subdivided into cationites and anionites.

Presently in the conditions of automatic checking of technological water quality many factors get out as criteria of optimization – technological, economic, structural ones, etc. At producing of expensive products the productivity can be the criterion of optimization: the higher it is, the higher degree of optimization of the mode of operations of technological process is in chemical industry. In the conditions of the creation of new information-measuring checking systems economic criteria are used more often in a unit cost: the lower it is, the nearer to the optimal mode is the process [5].

The most convenient decision of the perfection of IMCS for the optimal management (measuring and adjusting) of water quality checking is the application of flow-injection method as a hardware in «adviser» mode of operator [6–7].

The complication of the most technological processes of chemical production results in that for realization of automatic checking at different stages of production informative-measuring checking systems (IMCS) are usually required (fig. 1), which produce the calculation of values of optimization criterion on the basis of measuring of technological parameters and the calculation of values of managed influences that provide the optimization of process [8].

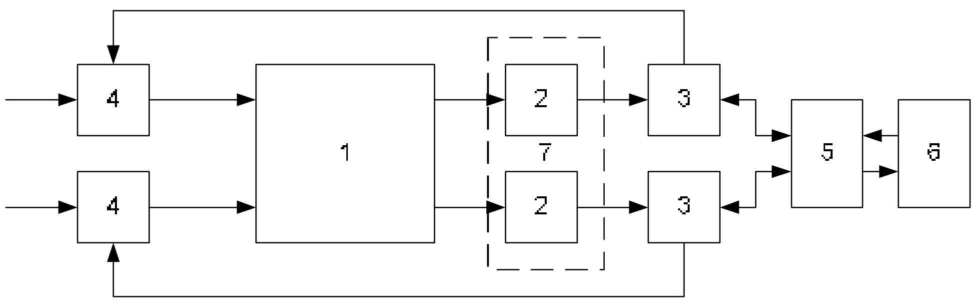

Fig. 1. Information-measuring control system: 1 – check (technological process) object; 2 – measuring sensors; 3 – regulators of measureable parameters; 4 – metering devices hardware; 5 – computer; 6 – operator; 7 – measuring module consisting of a few detectors and ancillaries

Thus, **the purpose** of this work is the perfection of IMCS hardware on the basis of application of criteria of optimization at the development of ancillaries of measuring module.

The task of the control of multicomponent mixtures composition is especially actual, therefore in the last years ionometric methods of analysis get all wider development with the use of flow-injection method [9].

To basic requirements the next parameters of regulative organs (pumping system) are pulled out:

- continuous flow of solutions of carrier and reagents through analytical module and detector corresponding to volume relationships with the fixed speed;
- providing of strict constancy of speed and evenness of stream, including the moments of input of test and passing by it through a detector;
- the support of range of speed is 0,4–3,0 mls/of mines;
- on possibility of subzero working resistance, not more than 0,1 MPa;
- miniature, manufacturability, low cost, convenience in exploitation, possibility of work under control of a computer.

These requirements are answered by peristaltic and electromagnetic pumps. The lacks of peristaltic pumps it is been origin of pulsations [8], necessity of the use of flexible tubes from inert and mechanically strong materials, overheat of reducing gear at long works (automatic mode), rollup and tightening of tubes in opening of reducing gear. For removing of peristaltic pump pulsations the author offers to place before the pump of smoothed device that is silicon tube with the length 100–200 mm [10]. An electromagnetic pump does not have these defects and that is why the author uses it for IMCS development.

The constructions of electromagnetic pumps are presented in fig. 2.

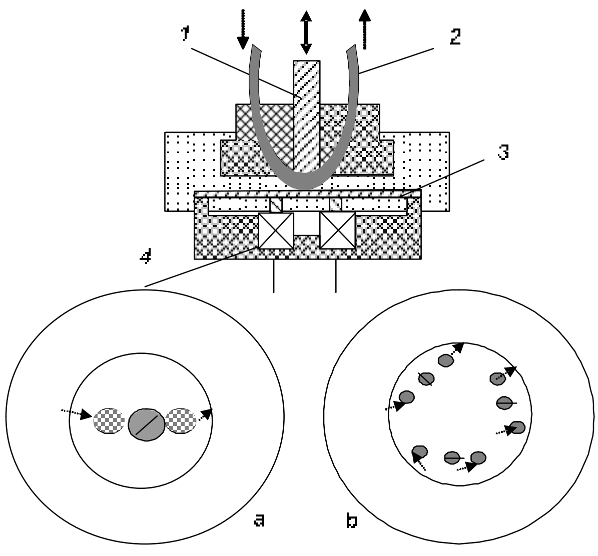

Fig. 2. Constructions of electromagnetic membrane pumps: a) one-channel, b) three-channel of "Lemon" type: 1 – regulative screw; 2 – flexible tube (silicon); nut; 3 – membrane made from ferromagnetic material; 4 – spools of inductance with winding from the thin wire set on magnitude

As a criterion of optimization of electromagnetic pump construction the following parameters: frequency, tension of feed, gap of tube, variable resistance and temporal stability of work have been chosen.

An electromagnetic pump is a permanent magnet, between the pole tips of which the membrane is placed. At the transmission of electric vibrations an alternating current flows in the spools of pump, that creates the variable magnetic field. This magnetic field changes a magnetic stream flowing through the coils of the puttee winded on magnitude. At the change of magnetic field a magnetic resistance of the system, that operates on the membrane of pump and compels it to hesitate, changes. A regulative screw from ferromagnetic material pins an elastic tube against a membrane. A permanent magnet executes the role of closing valve, i.e. in the pinned kind a liquid does not flow through a pump. Regulative spiral conducts adjusting of gap that in proportion relates to the expenses of pump. Due to the difference of hydraulic resistances on an entrance and exit of a pump the pumping-over of liquid passes through the pump.

In fig. 3–7 many optimization parameters of basic parameters of electromagnetic pump are presented.

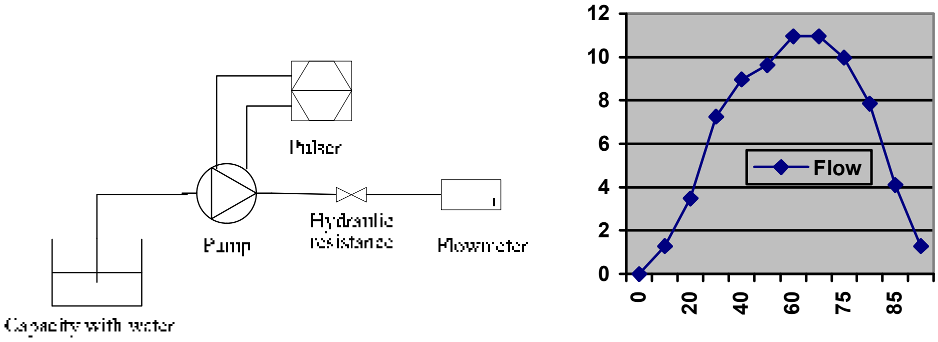

Fig. 3. The chart of setting and dependence of pump serve from the frequency of feed at permanent tension of feed of U=5 V

Measuring the pump serve we conduct at permanent tension of feed of U=5 V by the increase of frequency and middle of the got measuring. As a result of measuring the most optimal value of frequency is f=45–65 Hz.

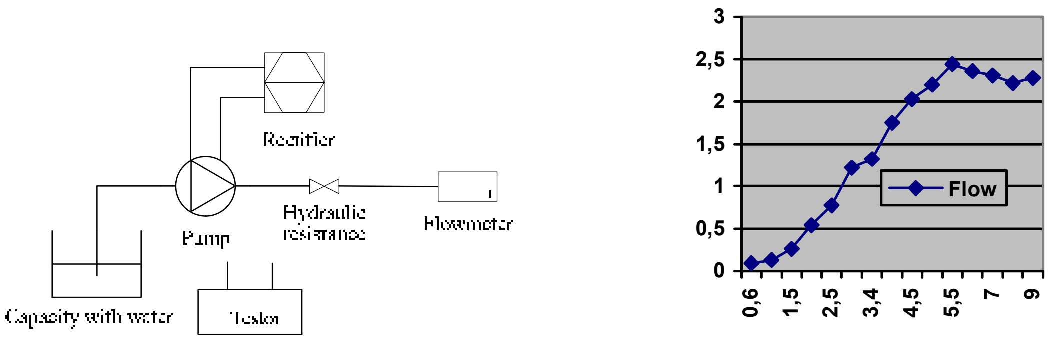

Fig. 4. The chart of setting and dependence of pump serve from the tension of feed at permanent frequency of feed of f=50 Hz

Measuring the pump serve we conduct at permanent frequency of feed of f=50 Hz by the increase of tension of feed and middle of received measuring. As a result of measuring the most optimal tension of feed is U= 5 V.

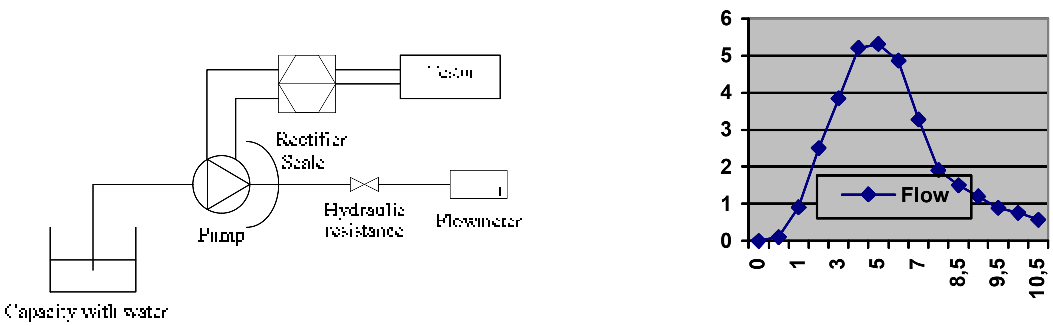

Fig. 5. The chart of setting and dependence of pump serve from the gap of tube at permanent tension of feed of U=5 V

We set tension of feed of U=5 V and collate tester tension. Then we connect tester to the rectifier. We choose 0 on the scale of pump and measure an expense; by middle we choose an optimal gap for calibration of expense of pump.

To calibrate a capillary (scale) together with hydraulic variable resistance we connect to the flowmeter. We set tension of feed of U=5 V. We collate tester tension. On a pump we propose the working gap of capillary on a scale.

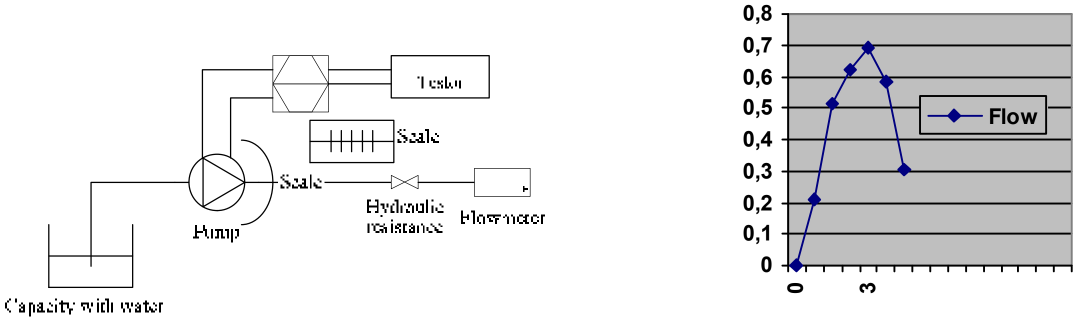

Fig. 6. The chart of setting and dependence of pump serve from variable resistance at permanent tension of feed of U=5 V

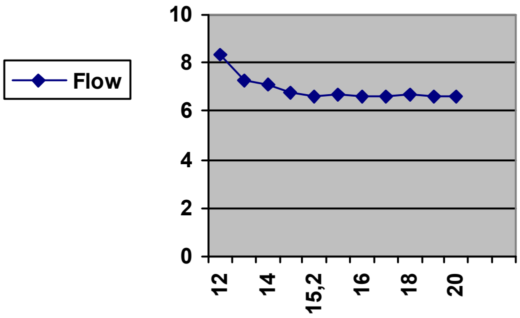

Fig. 7. The stability of pump serve at the tension of feed of U=5 V in time

We set the optimal parameters of construction of pump of U=5 V, f=50 Hz and optimal gap. We produce the middle measuring of expense in time.

Conclusions:

1. The flow diagram of informative-measuring checking of chemical-technological processes parameters system is worked out with the use of flow-injection analysis.

2. The construction is worked out of one- and three-channel electromagnetic pump.

3. Options are worked out and an active experiment is conducted on many optimization parameters of the choice of electromagnetic pump parameters.

4. At development miniature flow-injection IMCS it is possible to use miniature types of metering faucets-devices of co-planar type or to use the construction of pump of "Lemon» type, worked out by the author, that can execute the role of metering pump-device.

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СОВЕРШЕНСТВОВАНИЕ АППАРАТНОГО ОБЕСПЕЧЕНИЯ ИНФОРМАЦИОННО-ИЗМЕРИТЕЛЬНЫХ СИСТЕМ КОНТРОЛЯ ПАРАМЕТРОВ ХИМИКО-ТЕХНОЛОГИЧЕСКИХ ПРОЦЕССОВ С ИСПОЛЬЗОВАНИЕМ ПРОТОЧНО-ИНЖЕКЦИОННОГО МЕТОДА

Работа посвящена совершенствованию аппаратного обеспечения информационно-измерительных систем контроля параметров химико-технологических процессов с использованием проточно-инжекционного метода. Описан способ беспрерывной прокачки растворов и реагентов через аналитический модуль и детектор в соответствующих объемных отношениях с фиксированной скоростью с помощью электромагнитного насоса. Проведена оптимизация параметров конструкции и выбраны оптимальные условия работы электромагнитного насоса.

Ключевые слова: *химико-технологический процесс, технологическая вода, электромагнитный насос, оптимизация параметров, проточно-инжекционный анализ.*