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ISSUES OF DEVELOPMENT OF AN AUTOMATED CONTROL SYSTEM OF OXYGEN PRODUCTION PROCESS

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ABSTRACT

The article presents the results of studying the influence of such factors as results of automation of the oxygen production process based on pressure swing adsorption. The implementation of technological process control provides for a two-level structure using modern microcontrollers.

Introduction

Compressed air, previously purified from gangue and droplets, is fed to one of the 5 zeolite-filled adsorbers at a pressure of 0.6 MPa using a filter and a ehumidifier. In this case, the nitrogen present in the air is selectively absorbed through the zeolite, and oxygen is released from the other (upper) part of the adsorber. Once the adsorption layer is processed (saturated), the initial air transfer is automatically transferred to another adsorber. The processed adsorbend regenerates at the expense of the pressure in the adrosber to atmospheric pressure and at the expense of the reverse product.

Research methods. The rapid development of the industry of our Republic during the years of independence has led to a sharp increase in demand for clean and concentrated gases. Today, there is a significant variety of methods for separating and purifying gases, but the most effective, economically feasible and having a number of operational advantages is the technology of short-cycle heatless adsorption [1].

Installations for the adsorption separation of gas mixtures are capable of absorbing a significant range of various substances, including poisonous ones, which are not capable of separating carbon filters and systems with temperature regeneration. In industrial production, systems are successfully used to remove carbon dioxide, carbon monoxide, methane, ethane, oil vapors and nitrous oxide; they are also used to separate air into oxygen and nitrogen. They are capable of operating continuously for many years without degradation. Despite the widespread and promising nature of the method of short-cycle heatless adsorption, this method of separating gas mixtures has not been fully investigated. It is known that the solubility of gases in boiling water drops to zero, therefore, the closer the created vacuum at the boiling point of water, the higher the possibility of the degassing effect. In order for water to flow freely into the tank in the presence of a vacuum in the degasser, the degasser is placed at a height above the receiving tank so that the pressure of the column of water in the outlet pipeline exceeds the vacuum value in the degasser.

To reduce this height, it is possible to suck water from the degasser with a pump.
The cross-sectional area of the degasser is calculated from the irrigation density of the packing 50 m^3\m^{2}h. f = $\frac{q}{50}$ m.

The capacity of the device that creates a vacuum in the degasser is determined by the formula obtained from the Cliperon equation:

$$V_{sm} = \frac{G_{kd}(273+t)}{A*P_к};\ m^3$$

Where V_{sm} - the volume of the vapor-gas mixture sucked out from the degasser, m^3

G_k- weight of oxygen sucked out of the degasser (taking into account oxygen sucked in from the atmosphere through the non-density of the vacuum system) in kg / h.

A - coefficient. taken when removing oxygen 377, when removing carbon dioxide 520, G_{kd} - weight of oxygen removed from water in kg / hour

G_{kd} - 1,312*$C_{к.в.}$ where

$C_{k.v..}$= $\frac{q_h(C_{in}-C_o)}{1000}$; kg\h.

$P_к$- partial equilibrium oxygen pressure at a given water temperature corresponding to a given final oxygen concentration [2].

The volume of the vapor-gas mixture calculated by the formula corresponds to the temperature and pressure that take place in a vacuum degasser. The performance of vacuum pumps in catalogs usually refers to a temperature of 00 and a pressure of 1 ta. In order to bring the volume of gas calculated earlier to the conditions adopted in the catalogs, you can use the laws of Boyle-Mariotte and Gay-Lussac, according to which

$$\frac{VP}{1+0.00366t_0} = \frac{V_0P_0}{1+0.00366t_0}$$

$$V_0 = \frac{VP}{1+0.00366t}$$

V_0- the volume of the vapor-gas mixture at t = 00 and P_0 = 1 atm, m^3 / hour,

V - the volume of the vapor-gas mixture found earlier, m^3 / hour. (according to form 1), P-the pressure of the vapor-gas mixture in the degasser at a temperature

Knowing the initial content of free carbon dioxide in water, and having determined from the nomogram the CO_2 concentration that corresponds to pH = 7.5, you can find the amount of CO_2 that must be removed from the water as the difference between the initial and optimal concentrations corresponding to the pH value of 7, five . In addition, the amount of CO_2 that is formed during the hydrolysis of ferrous bicarbonate must be removed. The presence of this carbon dioxide in water can prevent the pH from increasing to the required limit. The amount of CO_2 released during the hydrolysis of iron, according to the stoichiometric calculation, is 1.57 mg per 1 mg of iron contained in the source water.

C_y = 1,57*C_f + (C_b – $C_{f.}$)

C- the amount of free carbon dioxide CO2, which must be removed from the water, mg / l;

F = $\frac{G}{K_a * \Delta C_{av}}$;

Where F- surface area of the packing,
K- coefficient of desorption, m / hour.

ΔC_{av}- average driving force of the desorption process, kg / m^3

G - the amount of free carbon dioxide to be removed kg / hour.

$$G = \frac{q_h(C_{in.} - C_{out.})}{1000}, \quad kg / h. ;$$

Therefore, it is very important to build a control system for the process of KBA, built on the basis of modern software and hardware [3].

At the same time, special requirements for functionality and flexibility are imposed on the projected automated control system for the adsorption separation of gas mixtures using the method. The fulfillment of these requirements cannot be ensured without the use of modern technical means of automation, multifunctional programmable controllers, and the use of SCADA systems. At present, in some enterprises of the chemical industry of our Republic, the adsorption air separation unit is not fully automated, the valves are controlled according to a rigid program using a programmable timer. In addition, the unit is equipped with local pressure gauges for pressure control. The current level of development of technical means of automation can provide various possibilities for increasing the efficiency of the process of adsorption separation of gas mixtures. Since a quick payback is important to justify the use of automated control, a good knowledge of production technology is a mandatory requirement. Lack of process knowledge simply means that the payback period of the system increases due to the costs of empirical model development [4].

Provision of personnel with sufficient, reliable and timely information about the progress of the technological process and the state of equipment for operational management is achieved through:

-operative and highly efficient monitoring and control over the course of the technological process;

-application of modern technical means and control methods;

- accurate, reliable automatic registration of the technological process, which ultimately ensures the improvement of technological discipline;

-Operational computational processing of the results of the functioning of technological units.

The implementation of management provides for a two-tier structure. The control structure is understood as a set of parts of an automatic system, into which it can be divided according to a certain criterion, as well as the ways of transmission of influences between them. The lower control level is formed by programmable controllers, the main tasks of which are to obtain information about the control object from primary measuring transducers; transformation of information into digital form and transfer of information to the upper level of management, control and regulation in order to work out the instructions set by the upper level of management [5].

The upper control level assumes the presence of a PC compatible computer and an operator console implemented on it using one of the SCADA systems (Supervisory Control and Data Acquisition). These programs make it possible to provide two-way communication in real time with the object of control and monitoring, visualization of information on the monitor screen in any form convenient for the operator, control of emergency situations, organization of remote access, storage and processing of information. It should be noted that when developing an automation project, it is necessary to resolve the issues of choosing a management structure. The choice of the control structure of the object of automation has a significant impact on the efficiency of its work, reducing the relative cost of the control system, its reliability [6].

When designing structural schemes of management and control, we first of all took into account the administrative and operational management structure that exists at the production enterprises of our Republic. In the block diagram of management and control, the features of the technological nature of this production are displayed, as well as the technical means used in the creation of local automation systems. The automated oxygen production control system carries out information, computing and control functions [7].

The lower level is made up of controllers, the second is the operator's console, which can be represented by a workstation or an industrial computer. The level of controllers in such a system collects signals from sensors installed at the control object; preliminary signal processing; the implementation of control algorithms and the formation of control signals to the actuators of the control object; transmission and reception of information from the industrial network.

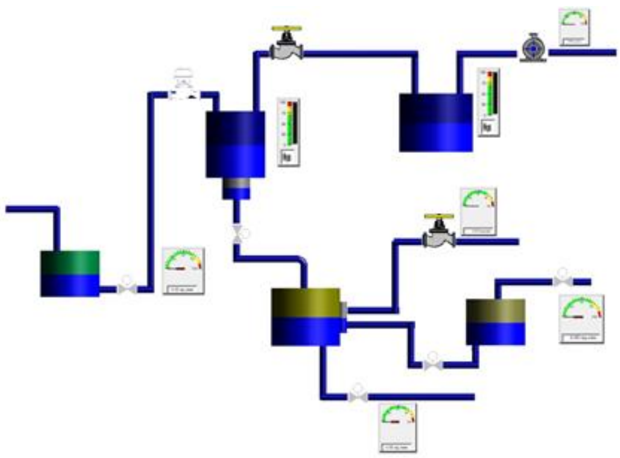

Figure1. Reflection of the technological process in the SCADA system

The operator's console generates network requests to the lower-level controllers, receives from them operational information about the progress of the technological process, displays the progress of the technological process on the monitor screen in a convenient form for the operator, provides long-term storage of dynamic information about the process, corrects the necessary parameters of control algorithms and settings regulators in controllers of the lower level. When creating software and hardware complexes, the software packages for measuring information at the operator's display points, called SCADA programs, have become widespread. In our work, a Russian-made SCADA-master dispatch control system was chosen, which allows high-quality control of the technological process and workstations of computer systems [8]. The operator's workstation operates under the operating system of the Windows family (Windows 2000 / XP / 7/8) by Microsoft. To solve communication problems (for example, when the SCADA system and controllers interact), the OPC technology developed by Microsoft, which has now become an industry standard, is provided.

Conclusion. The obtained results of experimental studies show that the need to remove oxygen from water is associated with the fight against corrosion of pipes and equipment in contact with water. Most often, the removal of dissolved oxygen from water is required for hot water supply systems and heat power engineering.

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