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SPECIFICITY OF USING A GROUP OF WELLS

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СПЕЦИФИКА ИСПОЛЬЗОВАНИЯ ГРУППЫ СКВАЖИН

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ABSTRACT

Nowadays, due to several positive indicators of the underground water, it is useful, safe and recommended using in the water supply system. Water wells and their efficient operation ensure the reliability and stability of the entire water supply system. When using alone or group wells, their operation has some individual or groups causes, which has different calculations, and the justification of this order is a very important factor. The following article is devoted to the specific calculation of the group wells and their interaction indicators.

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АННОТАЦИЯ

В настоящее время, благодаря ряду положительных показателей подземных вод, они полезны, безопасны и рекомендованы к использованию в системе водоснабжения. Водозаборные скважины и их эффективная эксплуатация обеспечивают надежность и стабильность всей системы водоснабжения. При использовании одиночных или групповых колодцев их работа имеет какие-то индивидуальные или групповые причины, что имеет разные расчеты, и обоснование такого порядка является очень важным фактором. Следующая статья посвящена конкретному расчету групповых скважин и показателей их взаимодействия.

Keywords: ground water, water well, well capacity, filters, water table, drawdown, depression line, well influence radius.

Ключевые слова: подземные воды, водозаборная скважина, мощность скважины, фильтры, уровень грунтовых вод, депрессия, депрессионная линия, радиус влияния скважины.

Method of research, analysis and study of the problem. Well flow rate and its radius of influence. It is known that ground water depends on the depth of their occurrence, the source of saturation and the type of structure that takes water from them to the consumer, and it is recommended to use them in the water supply system due to a number of positive indicators. One of the main factors in this case is the type of well and its flow rate. The flow rate of a well is its water yield, and this indicator varies depending on the filtration of the aquifer, its throughput and the characteristics of the water entering the well, that is, on how far the well can draw water. These indicators are the main factors in ensuring well performance and affect its reliable and continuous operation during well operation. Groundwater wells and their efficient operation ensure the reliability and sustainability of the entire water supply system. When using wells, their operation individually or in groups causes different calculations, and the rationale for this order is a very important factor. Below we will focus on individual wells, the order of their operation, such indicators as flow rate and hydraulic calculation.

The main purpose of the hydraulic calculation of wells is:

- determination of debit and analysis of factors influencing its change;
- to determine the decrease in the static water level in the well during its operation;
- calculation of the distance between wells operating in the same reservoir, and their interaction;
- consists in assessing the impact of the well on the environment or the natural environment on the well.

We know that when water is pumped out of the ground, the static level of water in the well changes, as a result of which there is a change in the flow rate of water entering the well and the indicators of its flow path. First, let's dwell on a limited decrease in the static water level in the well - S_{ch}. The water flow Q, determined at the request of the consumer, i.e., specified in the project assignment, is determined as the water flow required by the consumer - Q_t. Why is there a limitation in the S_{ch} indicator? Because it is not allowed to fall below the level of the pump, and through this limitation the throughput and stability of the well is estimated. In the calculations, the initial values of S_{ch} are found according to the following expressions:

a) Dropdown of water level for wells operating in a free-flowing aquifers,

$$S_{ch} \approx (0,5...0,7)h - h_N - \Delta h_f, m \quad (1);$$

b) Dropdown for wells in the pressure-bearing aquifers,

$$S_{ch} \approx -(0,3...0,5)m + H - H_N - \Delta H_f, m \quad (2);$$

Where: *h* and *H* are the natural height and pressure of water in the non-pressured and pressured layers, m;

h_n and H_n - distance from the dynamic water table to the lowest point of the pump, m;

Δh_f and ΔH_f - pressure loss of water flow from the reservoir, its value is determined depending on the resistance of rocks around the filter and the well to the water flow. *m* –a thickness of the pressured water layer, m;

The calculation of artesian and other vertical wells operating separately can be carried out using the following calculation images (Fig. 1). On the diagram you can see the geometric and hydraulic dimensions of some of the above indicators.

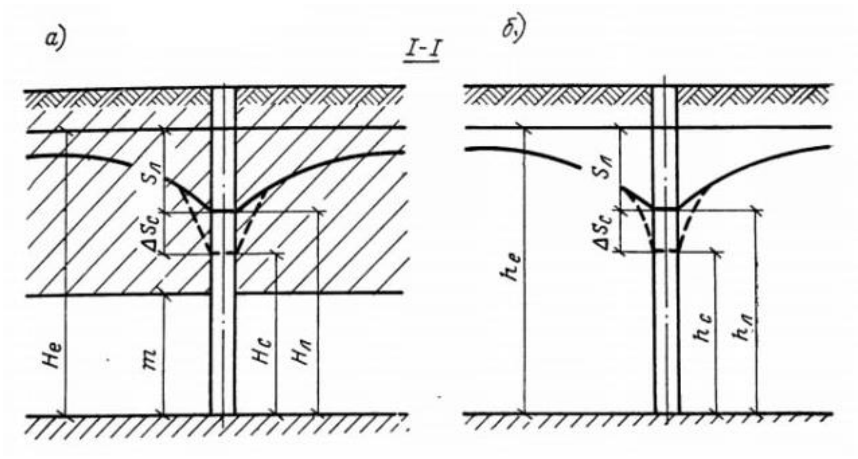

Figure 1. Scheme for calculation of vertical wells

The well flow rate is determined depending on the main parameters of the aquifer and the details of the well. Wells may be completed or incomplete, depending on the level of drilling. The thickness of the aquifer can be large or small, it can be confined or unconfined, and the movement of groundwater in the aquifer can be stable or unstable. The above indicators are important in determining the throughput of wells, and they must be taken into account. Now we will analyze special cases in determining the well flow rate [1,5,6].

The water supply of a completed well operating in a reservoir with stable water movement, or their flow rate is determined by the Dupuy expression:

a) for wells operating in a free-flowing aquifers,

$$Q = \frac{2.73 \cdot k \cdot m \cdot s}{\lg \frac{R}{r}}, m^3/sut. \qquad (3);$$

b) for wells in the pressure-bearing aquifers,

$$Q = \frac{1{,}36 \cdot k \cdot s(2h_s - S)}{\lg \frac{R}{r}} \qquad (4);$$

where h_s - is the natural water height in the free-flowing layer, m;

k - is the permeability coefficient of the aquifer, m/day;

m - is the thickness of the aquifer, m;

s - reduction of the static water level in the well, m;

r - well radius, m;

R - well impact or radius of influence, m;

$$R = 10 \cdot S \cdot \sqrt{k}\ , \text{m.} \qquad (5);$$

Depending on the properties of the rocks that make up the aquifer, in the calculations it is possible to determine the radius of influence of wells according to [2]. It can be seen from formula (5) that this index of wells, i.e. radius of influence depends on what factors. Now let's focus on the analysis of how this indicator changes when the wells are operated as a group well and how to control it.

After determining the flow rate of one well, we determine the number of wells necessary to meet the water demand/need of the consumer:

$$n_i = \frac{Q_T}{Q_i}, \qquad (6)$$

where Q_T - is the water consumption required by the consumer, m3/day.

The total number of wells is equal to the sum of operating and reserve wells.

$$N = n_i + n_z \qquad (7)$$

where n_i - working wells;

n_z - reserve wells.

The required number of reserve wells is determined depending on the number of active wells, as well as the level of performance and reliability corresponding to the category of water consumer. Obviously, the total number of wells has increased. The way they are located is very important, the distance between them can lead to a change in well flow rates. It also depends on the layer of water in which they operate.

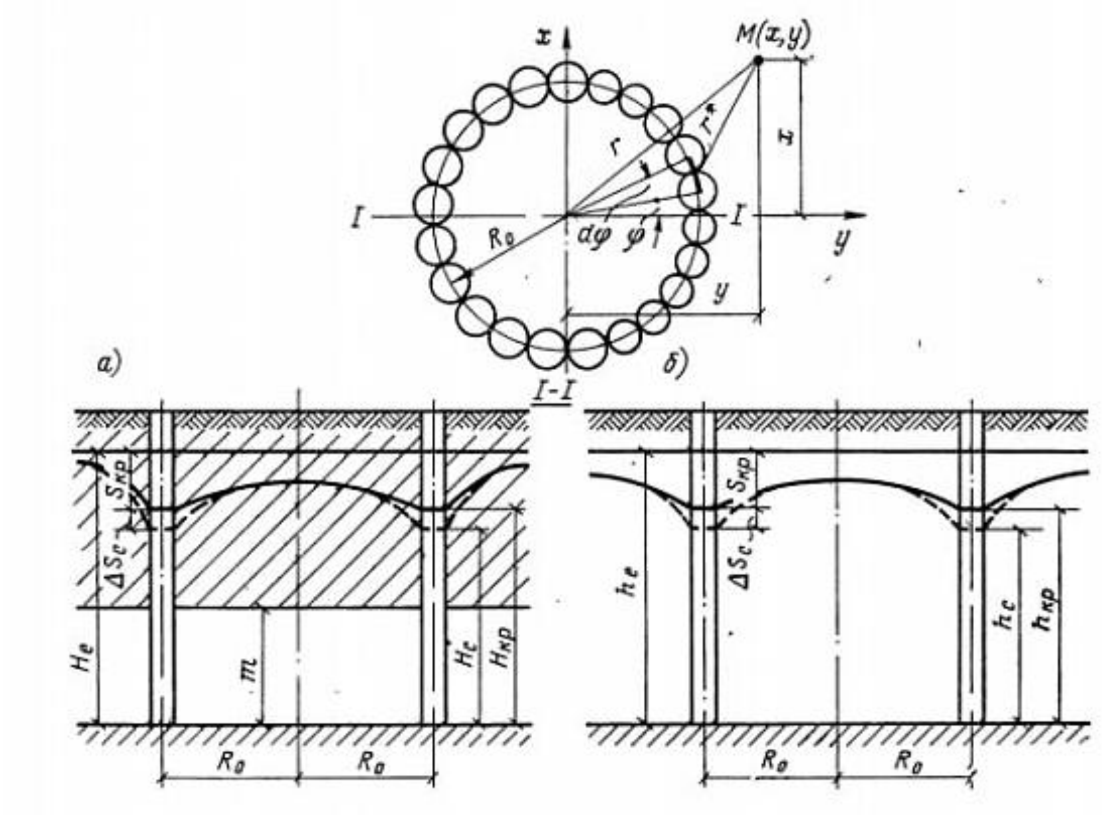

Figure 2. Scheme of wells in an annular array in a pressured (a) and non-pressured (b) reservoir

Considering that wells are considered to be working for one aquifer, when placing them, it is necessary to pay attention to the radius of influence - *R*. If these are interacting wells, then calculations are carried out using special expressions from *[3,5,8]*. Today, a group of wells is used to meet consuming water demand with groundwater. Water wells and their efficient operation ensure the reliability and sustainability of the entire water supply system. When calculating water intake structures consisting of a large number of wells, groups of wells interacting to each other, a method called generalized systems is often used. To begin with, let's talk about the radius of influence of the well and on what factors it depends.

Justification of the order of operation of a group of wells and their location

If a large number of wells are combined into one enlarged water intake facility, for example, vertical drainage wells, galleries or drinking water supply wells we call it a operating group water wells. Their calculation and parameters are different. At the same time, the influence of wells located close to each other is assessed not only at points remote from water supply facilities, but also at the exact locations of wells. Here they are also generalized, and this provision is the basis for calling water bodies generalized systems *[4,5,9]*. It should be taken into account that the decrease in the level of groundwater, which occurs under the influence of generalized systems consisting of the group of wells, depends on the decrease in the level inside the wells. Therefore, in a single well, the decrease is relatively smaller than in a group of wells, since in the case of a group of wells, the most deformed sections of the drawdown water level near each well are excluded. But according to the method of filtration resistance, it is possible to separately determine the additional drop in the water level in the wells. Then the total decrease in S is represented by the following sum:

$$S = S_{\omega} + \Delta S_q \ , \qquad (8)$$

in this case, S_{ω}-is a decrease in the water level that occurs under the action of a generalized system;

ΔS_q - additional level dropdown in the well.

Accordingly, the completely dimensionless resistance is expressed as:

$$\kappa = \kappa_{\omega} + \Delta\kappa_q, \qquad (9)$$

where κ_{ω} - is a value that characterizes the external resistance, which depends on the territorial dimensions of the wells connected to each other, the conditions at the boundaries of the wet layer, the permeability coefficient and the continuity of the well medium;

$\Delta\kappa_q$ - additional resistance (internal resistance), determined depending on the distribution of wells inside the q-system.

Below are solutions for generalized well systems with finite and unlimited sizes, infinite zebra stripes, circular and rectilinear (gallery) representations of bounded areas. First, general expressions are given for determining $S\omega$ and ω, and then for all systems of dependencies, on the basis of which it is possible to calculate the additional decrease in the well ΔSq and, accordingly, the additional resistance $\Delta\kappa_q$.

Conclusion and recommendations:

- The well flow rate is determined depending on the main indicators of the aquifer and the details of the well and may be completed or incomplete according to the degree of drilling. The results obtained are greatly influenced by pressure and non-confinement aquifers and groundwater in them, stable and unstable movement of water in the aquifer;
- When determining the well yield, the reservoir and groundwater yields are important and must be taken into account depending on the location.
- When using wells, their operation individually or in groups causes different calculations, and the rationale for this order is a very important factor.
- It should be taken into account that the decrease in the level of groundwater, which occurs under the influence of generalized systems consisting of a group of wells, depends on the decrease in the level inside the wells.

Research on a group of wells and their joint work, as well as on improving their efficiency, “Water supply, waste water and water resources protection” Department of Samarkand State Architectural and Civil Engineering university and at the UZWATER National Centre. Researches in this field are going on.

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