IMPROVING THE EFFICIENCY OF AGRICULTURAL WATER SUPPLY TO AGRICULTURAL CONSUMERS IN KAZAKHSTAN IN MARKET CONDITIONS

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Abstract: *Examined and shown ways to improve water supply to agro-industrial complex consumers agribusiness in Kazakhstan to irrigate pastures and irrigation in market conditions. There are given the theoretical foundations of the most progressive method of restoring the production rate of underground water source - a well by the use of compressed air and airlift technology, which can be recommended for practical application. They are purpose for definition of the main parameters of the process: the need to over-pressure compressed air supply compressor, power consumption and efficiency.*

Keywords: irrigation, airlift technology

1. Introduction

In Kazakhstan, in a market economy the priority of rural development, including irrigation of pastures and irrigation of crops in irrigated areas, is not possible without the proper functioning of water systems and autonomous water systems for drinking water quality assured villages of farmers and other consumer agro-industrial complex. Water problem villages and pastures will facilitate the adoption in 2003. Government's "Water Code of the Republic of Kazakhstan" and approved by the branch program "Drinking water" [1, 2, 3].

The Republic of Kazakhstan has good conditions for the production of crops and livestock products using irrigated land and natural grassland, the area of the latter is 183 million hectares, of which the Ministry of Agriculture - 154.4 million hectares.

The main producers of crops and livestock production in the Republic of Kazakhstan are agricultural formation, including farmers and farms, of which there are more than 170 thousand.

Drinking water supply to agricultural consumers are both due to groundwater - Mining and tube wells in the amount of 69.8% and surface water - rivers, canals, lakes, springs, water-filled items for about 30%.

When keeping pasture stock-breeding the most accessible types of water supply, low-cost, are the above-ground water sources, but they are not always pollution free and require purification plants for improvement of the water quality, in addition they are not enough to satisfy all consumers.

2. State of the problem

At present, the prevailing economic conditions, the number of livestock farmers and farms are concentrated around settlements and open water sources. This increases the load on the limited area of pastures (30 million hectares), 50% of which in varying degrees of degraded.

The problem of water supply to agricultural consumers should be pursued in conjunction rational use of water resources, conservation of grassland and has no adverse effect on the ecology of the environment. Daily demand for potable water use in Kazakhstan is about 1350 m^3, or 26% of the total demand for the Republic.

Promising market environment is centralized water supply by the group and the local water supply, which is now covered in Kazakhstan, 45.8% of rural users, and the rest have their own independent water supply due to the organization of services for the mechanization of underground water supply (75%) and surface (25%), water sources.

The main water-lifting equipment supply are centrifugal pumps domestic and foreign, for the conditions of pasture irrigation - Cord belt and water-pump, submersible pumps, and airlift pumping stations.

Improving the efficiency of agricultural water users in the market environment can be achieved through the use of water-lifting equipment of the new generation with the use of energy-saving technologies on the basis of domestic and foreign alternative development.

Currently, 54.2% of the Republic of Kazakhstan agricultural consumers have their autonomous agro-industrial complex water supply due to the organization of services for the mechanization of water, which are carried out mainly by groundwater - tubular and open wells (75%).

It requires a proper state of the main water sources, watering plants and water-lifting equipment.

However, their maintenance and repair at a low level due to lack of production of a single set of machines for this purpose, which leads to the degradation of water sources, reduced water quality, reduce their service life and decrease the reliability of water-lifting equipment.

To increase the effectiveness of independent water supply must be maintained in the desired state of the main water sources, including wells, wells and other water intakes produce replace outdated and worn water-lifting equipment to the new most effective, based on the new resource-saving technologies water lift.

Therefore needed in this area is monitored throughout the country, to create databases of the major water sources, to give suggestions to the development of new resource- and energy-saving technologies and equipment supply.

An important factor in maintaining the necessary condition of underground water sources is the timely recovery of their production rate. Below we consider the theoretical foundations of the most progressive method of restoring production rate of underground water source on the example of the well [4].

3. Airlift pumping method

When restoring the well production is widespread use of compressed air as an energy source in the major processes: removal of sediment light category density (loose soil), pumping contaminated water from the well to its full clarification, while using the most effective way to lift airlift as water mixture with a suspension of purified soil.

The technological process of lifting method airlift water wells with a suspension of purified soil (Fig. 1) at the steady work will be a continuous supply of compressed air to air wire sleeve, dropped below the water level and fixed at a certain depth. The resulting mixture of water, air and soil suspension for well casing is fed up and discharge duct sealing tip - on the surface of the well.

Technological process of this scheme is theoretically not fully understood. Below we describe the basic equation of the ongoing process of lifting air mixture with a suspension of purified soil - analytical dependence between the main process parameters: the excess of required pressure of the compressed air supply system P_{exc}, volume weight of lifted mixture γ_{mix}, depth air supply hose H_i, lift height mixture H, loss of pressure in the air ΔP and hydraulic ΔH lifting system, compressed air consumption (supply compressor) W_H and airlift supply the water with a suspension of purified soil Q.

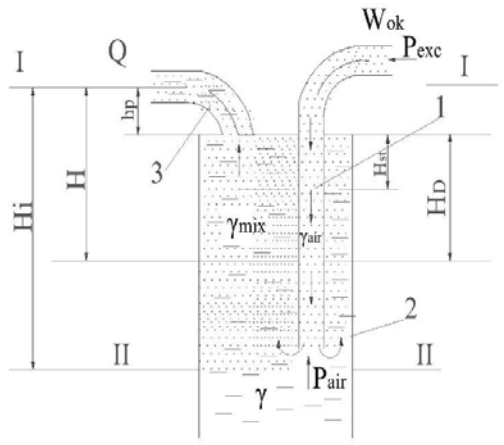

Fig. 1 *Sketch of an airlift pump station*
1 - air supply hose clamp;
2 - well;
3 - vent pipe.

4. Mathematical description

To determine this dependence used Bernoulli equation for section I-I and II-II wells on the output of compressed air from the air supply hose, the latter taken as a datum:

(1) $P_{exc} + \frac{v_{air1}^2}{2g} - \gamma_{air} + \gamma_{air} \cdot H_i = P_{air} + \frac{v_{air2}^2}{2g}\gamma_{air} + \Delta P$;

(2) $P_{air} + \frac{v_{mix2}^2}{2g}\gamma_{mix} = \gamma_{mix} \cdot H_i + \frac{v_{mix1}^2}{2g}\gamma_{mix} + P_{res} + \Delta H \cdot \gamma_{mix}$,

where P_{exc} - excess air pressure in the supply system, Pa; v_{air1}, v_{air2}, v_{mix1}, v_{mix2} - speed of the compressed air and of the lifted mixture adopted sections, m/s:

(3) $v_{air_{1,2}} = \frac{4W_{H_{1,2}}}{\pi \cdot d^2_{pipe_{1,2}}}$;

(4) $v_{mix_{1,2}} = \frac{4Q_{mix}}{\pi \cdot d^2_{pipe_{1,2}}} = \frac{4\left(Q + W_{H_{1,2}}\right)}{\pi \cdot d^2_{pipe_{1,2}}}$,

where W_H - compressed air flow (flow compressor discharge) in section 1 and 2, m^3/s; $d_{pipe_{1,2}}$ - internal diameters of pipes in sections 1 and 2 (in section 2 conditional), m:

(5) $d_{pipe_2} = \sqrt{D^2_{well} - d^2_{out}}$,

where D_{well} - internal diameter of well casing, m; d^2_{out} - outer diameter air supply hose, m; Q_{mix}, Q - general feed airlift installation water mixture and purified water with a suspension of soil, m^3/s; γ_{air}, γ_{mix} - volume weight of the supplied compressed air and raised water mixture with a suspension of purified soil N/m^3; H_i - depth air supply hose into the well, m; ΔP, ΔH - loss of pressure in the pneumatic and hydraulic lift system mixture, Pa and m; P_{air} - overpressure in section II-II wells, Pa:

(6) $P_{air} = \gamma\left(H_i - H\right)$,

where H - water lifting height, m:

(7) $H = H_D - h_p$,

where H_D - dynamic water level in the well, m; h_p - height of the tip (the mouth) of the well to spout diverter pipe, m; γ - volume weight of water in the well, N/m^3; P_{res} - residual pressure lifted mixture drain connection, Pa.

5. Solution and analysis of the results

Substituting the value P_{air} from equation (2) into (1), and considering that the rate of the compressed air hose length changes slightly, i.e. $v_{air_1} \cong v_{air_2}$ and substituting the value $v_{mix_{1,2}}$ in (4) and (5), and solving for P_{exc}, we get the basic equation of the ongoing process of lifting the mixture:

(8) $P_{exc} = \gamma_{mix}\left[H_i + \frac{8\left(Q + W_{H_1}\right)^2}{\pi \cdot g \cdot d^2_{pipe_1}} - \frac{8\left(Q + W_{H_2}\right)^2}{\pi \cdot g\left(D^2_{well} - d^2_{out}\right)} + \Delta H\right] + \Delta P - \gamma_{air} \cdot H_i + P_{res}$

Excessive air pressure in the system without hydraulic losses is determined by (1), by substituting P_{air} from (6):

(9) $P_{exc} = \left(H_i - H\right)\gamma + \Delta P - \gamma_{air} \cdot H_i$.

Starting a suit of excessive air pressure is determined by the formula

(10) $P_{exc.s} = \left(H_i - H_{st}\right)\gamma + \Delta P - \gamma_{air} \cdot H_i$,

where H_{st} - static water level in the well, m.

Air flow (flow compressor suction) is calculated by the formula:

(11) $W_{ok} = Q\left(1 + \frac{P_{air}}{P_{exc}}\right)\gamma \cdot H \cdot P_{air}^{-1} \cdot \eta_{PS}^{-1}$,

where η_{PS} - efficiency of airlift pump system installation (based on experimental data η_{PS} = 0,7).

Executed theoretical basics of using compressed air in the recovery work over tried out in a mobile unit designed for work over ARS-300, which was used by airlift pumping unit for cleaning wells of sediment density and light category of pumping contaminated water to its full clarification.

6. Conclusions

1. Analysis is presented of the state and the ways to improve the effectiveness of the water supply to agricultural consumers of agro-industrial complex in Kazakhstan in respect of pasture watering and irrigation of land in market conditions.

2. There are given the theoretical foundations of the most progressive method of restoring the production rate of underground water source - a well by the use of compressed air and airlift technology, which can be recommended for practical application. They are purpose for definition of the main parameters of the process: the need to over-pressure compressed air supply compressor, power consumption and efficiency.

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