Water wells: sustainable usage and rehabilitation technology

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Abstract. Uzbekistan is one of the most water resources limited regions and it needs better sustainable water management. The global ecological problem as the Aral Sea disaster makes it more urgent not only for one nation but also for the all CentralAsian region. Region needs to be developed by following SDG and the same time to save water resources. The balance of the ground water resources in the region is environmentally safe and enough by quantity and also hydrologically. It is due to the use of huge number of the water wells as artesian and also drainage wells. At the UZWATER National center of SamSACU the studies on the clogging deposits as the chemically and mineralogically multicomponent complex composition particles and their removal/declogging rehabilitation of the water wells are carried out. A rehabilitation technology effective for the region with dry and hot climate and environmentally safe water wells by using complex reagents such as oxyethylidenediphosphonic acid and nitrilotrimethylphosphonic acid in combination with carbon dioxide will help to remove of the clogging deposits and a stable filtration process and work of the water wells.

1 Introduction

Increasing the number of the population and industrial enterprises as consumers leads to increasing in their demand for water and, accordingly, the number, capacity and costs of water wells increase. In order to supply by water of consumers, in most cases, additional wells are built, the cost of which is much higher than prolongation of the old ones. This article is devoted to the water wells rehabilitation technology by using complex acids and following SDGs in the region of Uzbekistan. Operation of the water wells in the condition of poor groundwater quality, in high water rigidity and climate change are the most causes for the result of the salt depositions, filter corrosion in the pores and on the surface of the water well filters as well as near filter zones. It leads to decreasing in the productivity of wells.

2 Analysis

The main reason for this crisis is water resources mismanagement and it has been affected to Amudarya and the Sirdarya rivers. Uzbekistan's drinking water mainly comes from ground water sources and it consists 85- 90 % of the general water budget of the country. Nowadays

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ground water has been using in the rural economy as the agricultural irrigation system. It helps to save more surface waters. Very important moment is how to balance economic development of the region and a natural resource which follows sustainability rules. Countries in Central Asia share existing water resources and the same time share the water issues in the region. As a region is multinational so, agreements on the water resources using and management is required. Nowadays Aral Sea basin and surrounding territories have huge ecological disaster related to the water management and using. Statistics show that in early 20th century on the region was 7-8 million people and irrigation was done on the land of about 3.5 million hectares. Irrigation style, tools and network system also was on the different level. Society is developing and population of the region has increased 7 times and irrigated lands have more than doubled (7.5-7.9 million hectares). Aral Sea needs 60 cubic km per year which could keep the sea surface of the Aral Sea in normal condition. The water flow to the Aral Sea has been a sharp decrease and by 2002 was less than one cubic kilometer per year. Geographical location and climatic changes say that ground waters could be used for domestic, industrial and agricultural water supply system and it could be one of the best environmental solutions. As it needs thousands of water wells and their normal operational life time will be very important. This article is about the water well operating issues and their rehabilitation for a prolongation of their life time. The main question is how to sustain of the water well using and effective operation. It is complicated issue because of sharp climate change in the region as well as with the water resources limitation. There are some specific water shortage and climate change problems. For improving water supply system efficiency at all, following SDG rules in the region, offered alternative water sources using and reusing, watershed management. To improve current water situation there is a need for the new effective and water saving technologies.

3 Results and discussion

Changing a water situation needs some new sustainable approaches to solve water problems in the region. We offer one of the sustainable water resources managements by using innovative water well rehabilitation technology as combined with reagent and impulsive influence to the clogging deposits. In this article we offer an alternative approach to safe surface waters in the region by using ground water technologies. If we analyse a water demand and water resources availability in the region [4] it shows:

Table 1. Water formation and water using statistics in CA countries.

	Country	Area, km^3	Population, 12.08.2020	Water formation		Water use	
				km^3/year	%	km^3/year	%
1.	Kazakhstan	2724900	18802492	2.46	2.1	10.51	9.24
2.	Kyrgyzstan	199900	6535950	29.409	25.1	6.5	5.71
3.	Tajikistan	143100	9562558	50.583	43.4	14.3	12.57
4.	Turkmenistan	488100	6041812	1.549	1.2	19.34	17.0
5.	Uzbekistan	447100	34227246	11.223	9.6	59.2	52.04
	Total CA		74470052	94.890		109.85	
6.	Afghanistan	647500	39034417	21.593	18.6	3.9	3.42

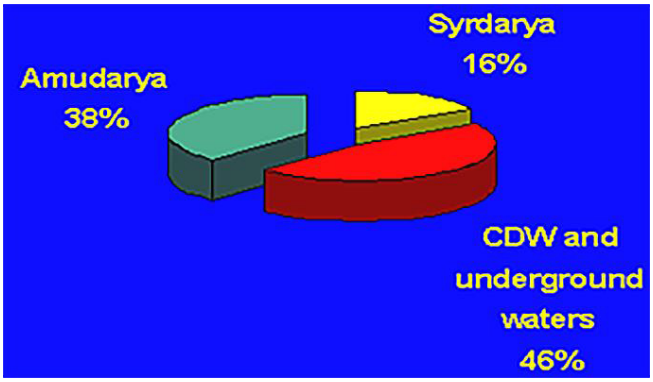

Fig. 1. Water resources availability in Uzbekistan.

Statistics show that a big water resources reserve in the region available as the ground waters but it is related with operation of the thousands of water wells. During maintenance and operation water wells lose their capacity because of clogging issues. Water wells' operating practice shows that if a well has lost more than 25% of its original capacity rate for some or another reasons, regeneration is expedient. Water well rehabilitation and prolongation of their life time is very urgent issue in the CA region. As it mentioned, region is specific by climate, by water resources limitation and by water using frequency. Particularly, we offer a new developed water well rehabilitation technology for a CA regions' specific conditions. The long-term effective operation of wells depends on the quality indicators of underground water and the mode of use of the well, mainly the high hardness and level of mineralization, as well as the lack of use of the well in a stable mode, the formation of salts and corrosion products on the surface of the well filter and in the holes in the pre-filter area has a negative effect on the stable operation of the well. The above factors serve as an accelerator of the clogging process, which leads to a decrease in the flow rate of the well. Selection and studies of chemically complex and mineralogical multi-component sediments and effective reagents for their destruction, which are the main reason for the decrease in well discharge, will help to restore the stable discharge of wells. Studies on the restoration of the water discharge wells using the complex of selective influincing reagents and hydrodynamic action to destroy dissolved and weakened colmatant (clogging deposits) in natural conditions were conducted, to confirm the reliability of the laboratory experiments' results on the rehabilitation of the artesian wells. These studies are devoted to the use of reagents with a selective effect for the destruction and removal of settling sediments in wells and the results of laboratory analyzes to restore the discharge of wells by using pulsating hydrodynamic flow in natural conditions. The results of laboratory studies on declogging of water wells were carried out under the natural conditions in the wells with reduced discharge in Kiziltepa district of Navai region. These are areas with a high concentration of hardness salts and mineralization of underground water.

Offered a new well rehabilitation technology allows to prolongate a stable life time of the existing using water wells and recover their capacity. Water well operation and maintenance in the region shows that if water wells lose their productivity because of ground waters' hardness and unproper maintenance. If a water well has lost more than 25% of its original capacity for any reasons, rehabilitation/regeneration is expedient. It shows that one of the reasons for losing of well capacity is a clogging of the well filter and near filter zones' porous by salt deposits and corrosion products. Water well inspection by using CCTV [5] can show that almost all filter halls are filled by deposits (Figure 3).

Fig. 2. Clogged filter porous by salt sediments and corrosion products (Photo by Abror Gadaev during the CCTV inspection of the water well).

Clogging of the well filters is a multifactor and complex physical and chemical and also hydro geological process. Detailed investigation of all factors can allow us correctly determine a problem and to develop appropriate method of water well capacity recovery. Existing methods for the water well rehabilitation can't facilitate fully removal of clogging deposits from the filters and the near filter zones. If a mechanical treatment of filters (cleaning with metal spars, scraper devices, swabbing, etc.) clogging deposits used then hard deposits can be just broken only from the filter surface and water well columns. There is possibility to use chemical treatment of wells by introducing reagents. It can allow to remove of salt deposits from the filter surface, porous and in the filter zones however, mentioned methods do not always guarantee the desired effect, since the permeability of the reactant solutions are negligible in the salts clogging of the filters and in the near filter zone with dense precipitates. Using the impulsive methods can be effective only at the beginning of operation as the salt crystallization can be intensified by the increasing of broken salt deposits' surface. At the same time, broken/destroyed and dispersed depositions can fill out porous again and be as disturber to complete removal of them during the washing process. Dispersed salt deposits can intensify the process of secondary clogging process in the beginning of well operation. In addition, the application of this method is limited by the strength characteristics of the well elements as columns and filters. Using combined methods as reagent and impulsive can provide better effect of the well production recovery because a combination of chemical and impulsive technology techniques can compensate for the disadvantages. As the research results show that a clogging deposits' removal from the filter surface/porous and near filter zones is improved by using a specific complex reagents and carbon dioxide. However, it has the specific requirements as of the working elements of water intake structures fails to achieve the desired result due to complications arising in the recovery of well productivity. As each method is applicable in certain hydro geological and mechanical conditions. In this regard, researches and investigations on the new and more effective methods of cleaning filters and near well filter space from sediments is urgently needed. It can improve of existing methods and technical equipment for unclogging and ensuring stable operation of water wells.

One of the effective and recommended methods of cleaning water wells and near filter zone from salt deposits, corrosion products and biological fouling is the combined method by using complex reagents with selective influence (RSI) [1-3] characteristics and solid carbon dioxide. In the practice of the water wells rehabilitation with high effect of filter cleaning and sub filter zones is achieved at cyclic pressing of reagent solutions beyond the well contour. Melting, grinding, washing (removal) of the clogging deposits occurs during the whole process. At the same time, according to the method of cyclic compression of the

reagent outside the contour of the well filter, the dissolution of the clogging deposits mainly occurs in the third stage. In laboratory conditions, the degree of dissolution of clogging deposits' samples was determined depending on the duration of processing in the solution of nithrilothremethilphosphoric (NTP) and oxiethilidendiphosphoric (OEDP) acids. NTP and OEDP are complex specific asids called complexones [2]. Studies were conducted under natural conditions on the dissolution of colmatant in wells with a solution with a rational ratio of reagent concentration. The temperature of the solution is constantly maintained in the range of t = 8-20 ° C.in the researches, mainly experiments were conducted on decolmatation of filters and zones near the filter, depending on the intensity of salt deposition, the level of mineralization, and the hardness of underground water. X-ray structural microprobe analysis, as well as thermal, diffractometric and chemical analyzes [6] were carried out to determine the mineralogical composition of the chemically preserved and structurally intact mineral composition, as well as the structure of the complex colmatant.

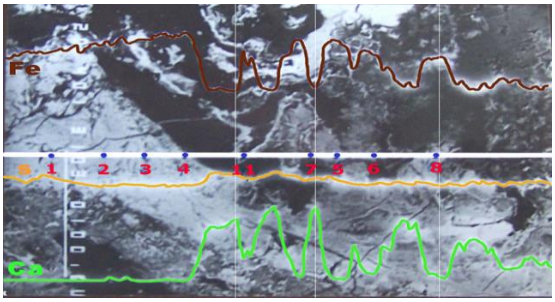

Fig. 3. X-ray structural microscope analysis of the water well clogging deposit in Kiziltepa, Navoiy region, Uzbekistan.

The layered structure of the complex colmatant was established, the evolution of salt deposition and their easy removal was analyzed. It should be noted that physical modeling of an artesian well with all parameters in the laboratory is very difficult.in order to take into account all the parameters of the well, it is necessary to conduct research in natural conditions, that is, in existing wells. To do this, first of all, it is necessary to set parameters such as the rate of flow reduction due to compaction and the relative flow rate of the well, which was done by us. To calculate the required concentration and ratio of selective complex acids, the static water level in the well and the volume of water in the well are needed. We set the operating pressure to squeeze the required volume of solution beyond the well filter boundary. The laboratory results were re-checked in field conditions where natural requirements were preserved and the results were confirmed in the presence of representatives of the organization using the well. Initially, technical mechanisms and structures were developed to seal the well selected for field research and to create the necessary pressure in it, as well as to control the cyclic process and the important recycling process in the processing of the well.

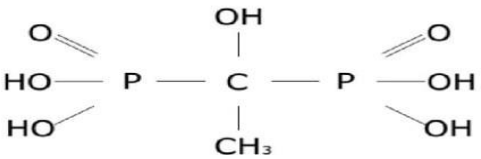

Fig. 4. Structural formula of oxyethylidenediphosphonic acid.

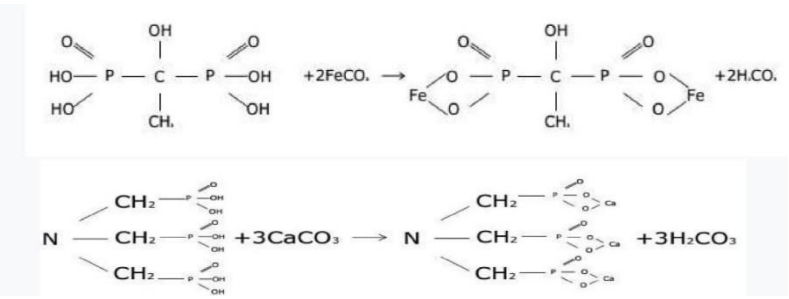

Fig. 5. Structural formulas of reactions of the oxyethylidenediphosphonic and nitrilotrimethylphosphonic acids with carbonates of Fe and Ca.

In the well, there is a blockage of salt deposits, corrosion products and sand particles in the ways of groundwater flow into the well. The inner walls of the well underwent mechanical treatment several times, and the last reconstruction works were not completed, and a sharp decrease in flow rate was observed.

Developed the water wells' capacity rehabilitation and restoring method by using RSI and impulsive influence for the salt depositions removal and it is one of the effective approaches and offered technology is environmentally safe [7]. As it mentioned above along using methods do not always guarantee for the better effect. Clogging deposits are destroyed and dispersed by using impulsive affect and by offered combined technology can be complete removal of clogging deposits and by aft treatment washing it can be finished completely. In addition, the separately application of each method can be limited by the strength characteristics of the well elements (filters) and some dissolving issues. Application of combined method provides better effect of well production recovery. A combination of impulsive method with the reagent method compensates for the disadvantages alone using methods. Researches on the new efficient methods of filters and near well filter space permeability and improving cleaning from clogging deposits can be a key point for the improvement of existing ecological conditions. It is related to reuse huge number of the water wells as artesian and drainage wells as well. At the UZWATER National center of SamSACU carried out the studies on the clogging deposits as the chemically and mineralogically multicomponent complex composition particles and their removal/declogging rehabilitation of the water wells. Also developed effective for the region with dry and hot climate and environmentally safe water wells' rehabilitation technology by using complex reagents as OEDP and NTP in combination with carbon dioxide which will help to remove of the clogging deposits and a stable filtration process and work of the water wells [1].

Cleaning filters and near filter zone from salt deposits, corrosion products and biological fouling by using complex reagents as RSI and solid carbon dioxide is one of the promising combined and more effective methods. Water wells recovery with a high effect of filter cleaning and sub filter zones can be achieved by cyclic pressing of reagent solutions beyond the well contour. Compressed air or solid carbon dioxide is used to press solutions of reagents into the formation.

4 Conclusions and recommendations

Water situation in the regions can be improved by increasing water wells' rehabilitation.

Water well recovery can prolongate their capable life time.

Using methods of water well rehabilitation needs to be justified for each local condition.

The water well capacity rehabilitation by using combined methods shows promising positive results.

As the most respectful method for restoring productivity of drinking water wells by cleaning filters and near filter zones from complicated and multicomponent clogging deposits recommended a combined method by using solid carbon dioxide together with RSI.

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