

ANNOTATION

Dissertation for the degree of Doctor of Philosophy PhD in the educational program
8D07208 – "Geology and exploration of mineral deposits"
Borash Ardak Rabbimuly on the topic: "**Development of technical and technological
means for the development of productive formations in hydrogeological wells**"

The relevance of the work: There is a noticeable shortage of water resources in the Republic of Kazakhstan, which is a consequence of the natural features of the territory and climate.

The volume of annual water consumption in Kazakhstan averaged 22.5 km³, of which 95% is provided by groundwater. According to the Concept of the State Program for Water Resources Management in Kazakhstan for 2020-2030, by 2040 water, consumption will increase by 56% and water shortage will amount to about 12 billion m³.

Water supply is provided by the following sources: surface water, desalinated seawater, Volga water and groundwater.

The variety of development methods is caused by the fact that they show different effectiveness in different geological conditions. There is no universal way to develop aquifers. Therefore, a thorough analysis of the geological conditions of a particular groundwater deposit and the choice of the optimal method of development for these conditions *is an urgent task*, the solution of which is of great practical importance.

The purpose of the dissertation is the scientific substantiation and development of effective technological means for the development of aquifers when drilling wells in the conditions of the Tonirekshin field on the Mangystau peninsula.

Research objectives:

- to investigate the geological features of the aquifers of the Tonirekshin groundwater field;
- to consider the existing methods of developing water intake wells with the establishment of their advantages, disadvantages and areas of effective application;
- to choose the optimal method of development, taking into account the properties of the Tonirekshin field aquifers;
- to improve the technical means and technology that will allow to achieve the highest quality development of wells.

The subject of the study is the technology for the development of water intake wells at the Tonirekshin groundwater field.

Research methods:

- investigation of the specific features of the Tonirekshin groundwater field and typification of drilling conditions for water intake wells at the field;
- a critical analysis of existing methods of developing aquifers and increasing the flow rate of wells;
- the choice of optimal methods of well development in relation to the conditions of the Tonirekshin basin of groundwater;
- a critical analysis of modern technical means for the implosion method of aquifer development;
- development of an improved device for implosion impact on aquifers;
- scientific substantiation of the operating parameters of the improved device for implosion impact on aquifers.

The main statements submitted for defense:

1. The maximum implosion effect that can be exerted on the productive horizon is limited by the strength characteristics of the production casing, directly proportional to the thickness of the casing wall and inversely proportional to the density of the drilling fluid.

2. The implosion effect on the aquifer when using the developed device can be increased using a composite production casing or a casing of reduced diameter.

3. With an increase in the diameter of the inlet valve disc of the implosion device, its operating parameters change as follows: the required length of the drill string to create an implosion effect and the total area of the holes in the partition under the valve disc increases, the flow rate and pressure loss decreases when the reservoir water flow passes through the valve openings.

Scientific novelty of the work:

For the first time, for the geological and technical conditions of the Tonerekshin groundwater field, using the method of expert assessments, the choice of the optimal method for the development of water intake wells has been scientifically justified, ensuring the decolmation of the downhole zone and the maximum flow rate of high-quality water for household and drinking water supply. A new method of implosion impact application for the development of water intake wells is proposed and a mathematical description of its functioning is given. For this method, the problem of collapse casing strings by differential pressure arising from the creation of intervals necessary for the implosion effect of unfilled liquid in them has been investigated. It has been shown that in order to increase the implosion effect, it is necessary to increase the wall thickness of the production casing, reduce its diameter or reduce the density of the drilling fluid.

Justification of the novelty and importance of the results obtained:

The novelty and importance of the results obtained is confirmed by the issuance of a patent for the invention of the Republic of Kazakhstan for a device for intensifying the flow of reservoir fluid into the well, which allows to repeatedly reduce the complexity of the device and the number of elements included in it, by eliminating the need for a tubing casing, a wellhead seal, as well as compressor treatment of the well.

The practical value of the work: The results of the work can be applied in the activities of public and private organizations engaged in drilling water wells, as well as scientific and design organizations involved in drilling and development of wells. The implementation of the developed implosion impact method will provide a solution to the problem of drinking water supply in the region.

Compliance with the directions of scientific development or government programs: The dissertation solves the problem of increasing the utilization rate of groundwater reserves of the Tonirekshin groundwater field. Its content corresponds to the State programs "Drinking Water" (2003-2010) and "Ak-Bulak" (2011-2020), as well as the State Program for the Development of Regions (2020-2025), as well as priority areas approved by the Higher Scientific and Technical Commission under the Government of the Republic of Kazakhstan on the priority "Rational use of natural resources, including hydrocarbon raw materials, water resources, geology, processing, new materials and technologies, safe products and structures"

The author's personal contribution lies in the fact that the basic calculations and theoretical justification of the developed method of mastering, as well as the idea contained in the received patent for the invention, were obtained and developed personally by the applicant. The task statement and discussion of the results were carried out jointly with scientific consultants.

Reliability of the results: The reliability of theoretical scientific statements, conclusions and recommendations is confirmed by the fact that they are based on the well-known laws of hydraulics and computational mathematics and are confirmed by the practice of developing wells with hydraulic pulse methods of excitation of shock waves in the aquifer interval.

Description of the main research results: Based on the results of the performed studies, the following main conclusions can be drawn:

1. A critical analysis of the geological and hydrogeological Tonirekshin groundwater field was carried out. The analysis showed that the groundwater of the Alb-Cenomanian aquifer complex is recognized as the most promising for use in economic needs. In most cases, aquifers are represented by sands, mainly fine- and fine-grained. The exception is the deposits of the Maastrich complex, where the water is located in fractured chalk. All these rocks have low permeability. The thickness of individual layers of aquifer sands ranges from 5 to 40 m, and their total capacity averages 60-65 m. The filtration coefficient varies from 2.1 to 7.8 m/day. The flow rate of wells ranged from 4.4 to 45 l/s at depressions of 14-37 m and a specific flow rate of 0.3-1 l/s/m. The average flow rate was 27 l/s.

2. A critical analysis of the results of exploration work carried out earlier at the field was carried out. Hydrogeological surveys were previously carried out at the site: core drilling, experimental work, routine observations, geophysical studies in wells and laboratory studies. The well development process included degrading of the near-well zone of the aquifer, causing self-flow and bringing the flow rate to the maximum possible values. This work was carried out by an airlift method using a compressor. The presented results raise questions, which are primarily related to the very large difference in the hypsometric level of groundwater, filtration coefficients, aquifer capacity and flow rates for wells drilled in a relatively small area of 10 km². This primarily indicates the imperfection of the technology of drilling and development of wells on the site.

3. Based on the analysis of the geological and technical conditions of the field and previously carried out exploration work, the requirements for the development of water intake wells in relation to the conditions of the Tonirekshin basin of groundwater were formulated. As a result of a comparative analysis of existing progressive methods of well development by the method of expert assessments, it was found that the implosion method meets the formulated requirements to the greatest extent for the studied conditions.

4. It has been established that the implosion effect not only affects the aquifer, increasing its permeability, but also has an effect on the casing strings, which can lead to their crumpling and violation of the integrity of the casing. Thus, it is very important to choose the right parameters of the implosion effect in order to maximize its positive effect and prevent the development of negative phenomena.

5. As a result of the analysis of patent literature sources, it was found that the most important disadvantage of most devices for creating an implosion effect is the dependence of the operation of the inlet valve on the condition of the packer, separating the areas of high and low pressure. Well-known devices are characterized by complexity and unreliability of operation.

A critical analysis of the known devices allowed us to propose a new simple device for creating an implosion effect in the development of water intake wells, devoid of all the above disadvantages. A patent of the Republic of Kazakhstan has been obtained for this device.

The essence of the invention consists in the fact that the filter part of the casing is separated from its upstream part from the outside by a packer, and inside by a partition

mounted on pins with a spring-loaded shut-off valve; there is a chute, the valve of which is equipped with a lift limiter and is located above the end of the chute at a distance that ensures, when installed on the partition, the opening of the chute valve shut-off valve when eliminating excessive load. The upper part of the well has a diameter larger than the sub-packer, and the packer is located between the formed ledge and the disk mounted on the casing, or the ledge of a single casing consisting of pipes of larger and smaller diameters.

6. The problem of collapse casing strings by differential pressure arising from the creation of intervals necessary for the implosion effect of unfilled liquid in them has been studied. The permissible height of the empty space in the casing is determined, which ensures the creation of the maximum implosion effect and prevents the casing from collapsing. It directly depends on the thickness of the casing wall and vice versa on the density of the drilling fluid. The amount of solution required to top up the casing to achieve these results has been determined. It increases with a decrease in the allowable empty space in the casing.

7. The weight reduction of casing under the influence of the Archimedean force, due to the presence of empty intervals in them, has been studied. It was revealed that with an increase in the length of the unfilled interval, the buoyant force acting on the casing increases significantly, reducing the actual weight of the casing in the well.

8. In relation to the conditions of the Tonirekshin field, an optimal well design has been proposed, including the proposed device for creating an implosion effect. The critical dimensions of the empty intervals for all wall thicknesses of the casing pipes included in the well design are calculated. It was found that the amount of reduction in the weight of the casing in the well due to the Archimedean force for field conditions is 43-47%, depending on the geometric dimensions of the casing. The Archimedean force increases with increasing pipe wall thickness. Reducing the weight of the casing reduces the required power of the winch, which allows drilling wells using lighter drilling rigs.

9. As a result of the study of the interaction of the bailer with the inlet valve of the developed device, the following was established. To open the valve with a bailer, its weight must exceed the force generated by the differential pressure of the drilling fluid on the inlet valve. If this weight turns out to be insufficient, then the bailer should be weighted with drill pipes, the required length of which depends on the density of the drilling fluid, the density of the drill pipe material and the required amount of weighting. To reduce the pressure drop on the intake valve, it is necessary to strive to increase the total area of its openings, which is limited by the geometric dimensions of the valve. As the valve diameter increases, the pressure drop decreases. To achieve a repeated implosion effect, it is necessary to bail out the water that entered the well after the previous exposure. The number of trips required for this depends on the inner diameter of the casing, the outer diameter and wall thickness of the bailer, as well as the length of the bailer.

10. Due to the received results, it is possible to achieve the maximum implosion effect without the risk of damage to the casing through repeated exposure to the productive formation. This is explained by the fact that repeated exposure to the productive formation ensures effective removal of the clogging material from the formation and cleaning of the productive horizon to a much greater depth compared with a single exposure.

11. The above provisions are illustrated by an example of calculation for specific conditions of the Tonirekshin field, which made it possible to choose the optimal diameter of the inlet valve, the required length of drill pipes to weigh down the bailer, as well as the number of flights of the bailer before re-implosion.

12. Assessment of the scientific level of the work performed in comparison with the best achievements in this field. The research carried out and the results obtained correspond to the best achievements in the field of development of water intake wells.

Approbation of work and publications:

The main provisions of the dissertation are published in 7 printed works in scientific specialized publications (including 2 that are indexed in the scientometric database Scopus), 2 – in the proceedings of international conferences, 2 - an article recommended by the Committee for Quality Assurance in the Field of Science and Higher Education of the Republic of Kazakhstan and developed within the framework of the tasks of the dissertation, A patent for inventions was obtained from the National Institute of Intellectual Property of the Republic of Kazakhstan.

Scope and structure of the work

The dissertation consists of an introduction, 4 sections, general conclusions and recommendations, contains 23 figures, 20 tables, 67 formulas, a list of references from 72 sources.

Gratitude.

In conclusion, I consider it my duty to express my gratitude to the scientific consultants for constructive and valuable professional advice and recommendations to the Doctor of Technical Sciences, Professor B.T. Ratov, as well as the Doctor of Technical Sciences, Professor Yu.A. Nifontov. Throughout the entire period of work, the author felt constant attention and support from the head of the Department of Science and Research, PhD Syrlybekkyzy S., Head of the Department of Ecology and Geologists, PhD, Associate Professor Nurbayeva F.K., PhD Koibakova S.E., Associate Professor Kozhakhmet K.A. and Dean of the Faculty of Engineering, PhD, Professor Gusmanova A.G. NAO of the Caspian University of Technology and Engineering named after Sh. Yesenov.

The author expresses special gratitude for valuable consultations and advice on improving the structure and content of the dissertation to the entire teaching staff of the Department of Ecology and Geologists and other colleagues.