Advanced device for cleaning drain wells

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Abstract. The article presents cleaning technologies and considers an improved device for cleaning drainage wells, which allows to increase the productivity and quality of cleaning drainage wells, reduce labor costs, and water consumption. The device is simple, reliable, and highly maintainable, allowing you to operate it in the mode of economy and consumption of a large volume of water. The proposed device received a copyright certificate for the invention. A cable system is provided in this device, and a ruff head is stretched inside the drainage pipe, which has the ability to deviate and rotate along the longitudinal axis of the drainage pipe, the ruff is pulled by winches through adjustable and fixed blocks, and the mounting frames are installed in inspection wells and fixed with bolts and successively reinstalled from one well to another. Theoretical prerequisites have been developed for determining the maximum force in the closing, hoisting rope, the required power for closing the jaws and lifting the bucket, the diameters of the corresponding drums and ropes.

1. Introduction

In recent years, water scarcity has become a limiting factor in the development of agriculture in Uzbekistan. In a significant part of the irrigated lands of the republic, soil salinization, a high level of groundwater occurrence, loss of agrobiodiversity and other undesirable phenomena occur, and as a result, all this affects the development of agriculture and other sectors of the economy [1, 2].

The length of horizontal closed drains in the republic is about 39,000 km, of which 11.7 thousand km are in unsatisfactory condition. There are four inspection wells for every kilometer of closed drains, which implies that about 97500 wells need to be cleaned and about 21.5 thousand m3 of sediment removed in a year [3].

During the operation of closed horizontal drains, at insufficient outflow speeds, they are silted up and periodic cleaning is required to support their normal operation. Depending on the degree of siltation and its density, a maximum of two wells can be cleaned in one work shift. However, it should be noted that at present, drainage wells are practically not cleaned, and if carried out, they are carried out manually. The current situation can be commented on for only one reason - the lack of devices due to their physical deterioration [4, 5, 6].

It is known that the social well-being of the rural population is associated with a reliable supply of water for irrigation, as well as an improvement in the land reclamation state. The good technical condition of the irrigation network, the effectiveness of drainage systems contribute to a reduction in filtering from canals and irrigation fields and the associated negative consequences. In this aspect, the consensus of improving the drainage well cleaning device is a priority and a very urgent task.

The purpose of the study is to increase the productivity and quality of cleaning drainage wells, reduce labor costs and water consumption, prepare recommendations for its implementation in production.

IOP Conf. Series: Materials Science and Engineering **883** (2020) 012181 doi:10.1088/1757-899X/883/1/012181

2. Materials and Methods

The use of the device requires high operational reliability and the consumption of a large amount of water during the cleaning of drainage wells. In this regard, we analyze the closest analogs and their shortcomings [7, 8]. Theoretical studies to calculate the main parameters of the device are performed using the general laws of mechanics [9, 10].

3. Results and Discussion

Horizontal closed drains are cleaned using the PDT-125 drainer, which is a complex of units of two class 30 kN tractors (DT-75M) and includes a main pump station, a trailer with a drum, an auxiliary pump station and a tank. The number of attendants is four people, including two tractor minders [7]. The technological process of this method of cleaning the drainage includes several stages:

1st stage - a site is prepared by a bulldozer at the control and viewing well for the installation of a drain washer;

2nd stage - the cavity of the drainage pipe is exposed to a length of 0.5 ... 0.7 m to enter the wash head;

3rd stage - the pump is turned on and the worker, located at the bottom of the well, gradually pushes the sleeve into the drain, and the other worker, as the reaction head moves inside the tubular line, unwinds the sleeve from the drum;

4th stage - the pulp removed from the pipe cavity is pumped out by the auxiliary pumping station through the intake hose with a filter to the surface from the bottom of the well.

At the end of the flushing of the drains in one direction (about 125 m), the main pump station with a trailer is reset to the next position, opposite the flushing line, etc. A significant drawback of this method of cleaning the drainage is the complexity and the need to use expensive imported reclamation machines, special hoses and pumping equipment, the use of manual labor and the consumption of large quantities of water. Until recently, a device was used to clean drainage wells, which included a pressure head conduit, a slurry line, and a hydraulic ripper (Figure 1) [8].

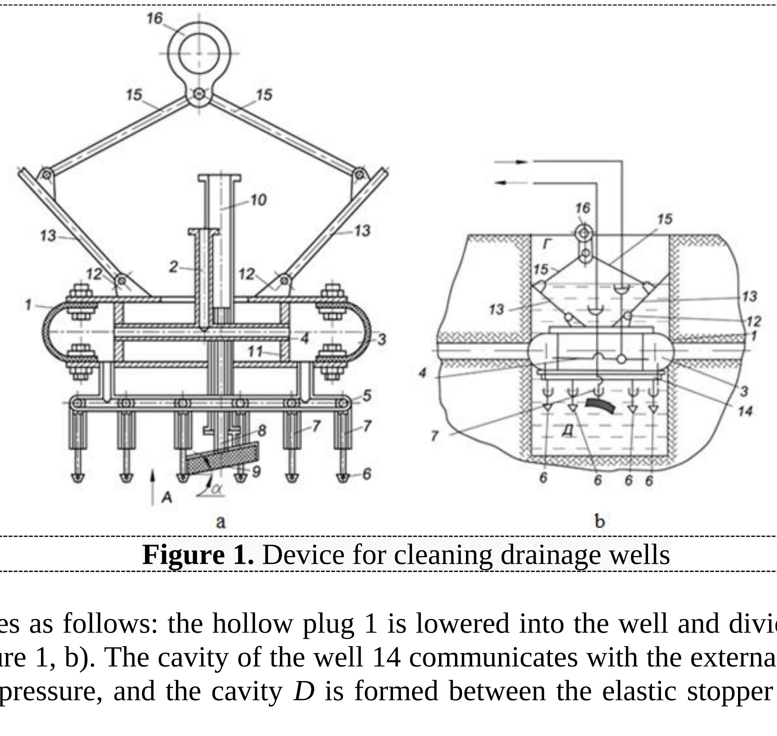

Figure 1. Device for cleaning drainage wells

The device operates as follows: the hollow plug 1 is lowered into the well and divided into two cavities *G* and *D* (Figure 1, b). The cavity of the well 14 communicates with the external environment, i.e. with atmospheric pressure, and the cavity *D* is formed between the elastic stopper 1 and the applied layer. Water supply 2 supplies water under pressure to the cavity 3 of the elastic plug 1 (Figure 1 a). Under the influence of excess water pressure, the elastic plug 1 expands, sealing the container *D* from the external environment. From the cavity 3, water enters the collector 5 and is distributed among the nozzles 6. Water flows from nozzles 6, eroding the surface layer and turning it into a pulp. The water flowing out of the nozzles 6 creates pressure in the cavity D and squeezes the pulp through the slurry line 8 from the well. As the spreading layer is eroded, the nozzles 6 drop lower under the action of water pressure, eroding the spreading layer. The erosion continues until the outflow of light water from the slurry line 8. The water supply to the cavity 3 is stopped, the plug 1 depressurizes the container D, into which water flows from the part of the well. Then the plug 1 is removed from the well and moved to the next.

A significant disadvantage of this device is the need and consumption of a large amount of water during the cleaning of drainage wells, and the presence of a hydraulic ripper does not contribute to the erosion of solid sediment. To increase the productivity and quality of cleaning drainage wells, reduce labor costs and water consumption, it is necessary to modernize it. This goal is achieved in that an improved device for cleaning drainage wells is equipped with a grab, which includes a suspension system, a locking mechanism, a housing, jaws for capturing inert materials, made in the form of valves, each of which is connected by a flexible connection with a rope for closing the load and the rope for opening the valves during unloading of the grab (Figure 2) [11].

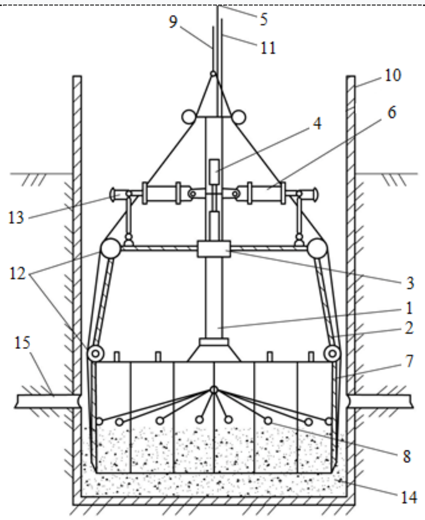

Fig. 2. Advanced cleaning device drainage wells

The operation of the upgraded device is as follows: in the drainage well 10 below the drainage line (pipe) 15, a cleaning device is lowered to the surface of the applied soil 14. Cylinders 6 mechanism, using the support-hinged tabs 13, is fixed in the well 10, then the cylinder 4 of the grab 2 is pressed into the applied soil 14 to the height of the wings 7. When the shutters 7 are closed, at the same time due to the action of the cylinder 4, the grapple body 2 is lowered and the support 3 is moved along the rod 1 to the stop. The closure of the flaps occurs through flexible connections 8 connected by a loading cable 5. Thus, the volume of the applied soil is taken along the height of the flaps. The loading grab is lifted from the drainage well by the lifting rope 11. The soil is unloaded using the unloading rope 9 to the soil surface or the body of the dump truck. Then, the sediment extraction cycle is repeated [11].

To calculate the main parameters of the device, it is necessary to determine the forces necessary S_3 to provide the required power S_K, for lifting N_3 and lifting $N_П$ the bucket, to ensure compliance with the corresponding drums and ropes.

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In the calculation, we assume that the hoisting rope at this moment makes sense (Figure 3).

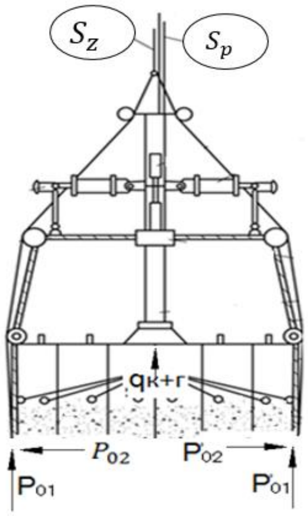

Figure 3. To the calculation of the main parameters of an improved device for cleaning drainage wells Then the horizontal P_{02} and P'_{02}, and the normal P_{01} and P'_{01} components of the soil resistance to digging, as well as the mass of the grab q_K act on the bucket.

From the condition of equilibrium of forces we have:

$$q_z - S_z = P_{01} + P'_{01} ; P_{02} + P'_{02} = 0 ; P_{02} = \frac{S_z D_b}{2l} \qquad (1)$$

where l is the path of movement of the cutting edge in the process of scooping up the soil, *m*;
D_b is the diameter of the pulley blocks, *m*.
The ratio $\frac{P_{01}}{P_{02}}$ for the grab is taken equal to 0.3 ... 0.6.

By the condition of providing a deepening of the grab bucket into the material, they usually take: $q_k = q_g$.
where q_k is the mass of the grab, *kg*;
q_g is grab capacity, m^3.
The force in the closing rope varies from zero to the value:

$$S_3 = (q_k + q_g) \qquad (2)$$

The filled grapple rises on the hoisting and closing ropes. At the same time, the design of the winch should provide an even distribution of forces between the ropes, i.e.:

$$S_z \approx S_p \approx 0{,}5(q_k + q_g) \qquad (3)$$

taking into account the short duration of the maximum efforts, the following are taken:

$$S_k = 0{,}6(q_k + q_g) \qquad (4)$$

The multiplicity of the closing tackle is chosen to take into account the conditions for ensuring the necessary horizontal force P_{02}.
The power required to close the jaws can be determined from the expression:

$$N_z = \frac{S_z \vartheta_z}{\eta_z} \qquad (5)$$

Where υ_z is jaw closure rate, accepted (0,3-0,7) м/с;
η_z is the coefficient of a performance locking mechanism.
Capacity, the need to lift the grab bucket:

$$N_p = \frac{S_p \vartheta_p}{\eta_p} \qquad (6)$$

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where ϑ_p is the lifting speed of the grab bucket, *m/s* (assuming equal to υ_p -1.0 ... 1.3 *m/s* with an excavator weight of 5-10 t);
η_p is the efficiency of the lifting mechanism.

4. Conclusions

During operation, the siltation of closed horizontal drains occurs, which is the reason for the loss of their performance and one of the factors in the deterioration of the land reclamation state.

The disadvantage of existing devices, including the use of expensive imported reclamation machines and other special equipment, is a limiting factor in their use for cleaning closed horizontal drains.

The effectiveness of an improved device for cleaning drainage wells consists in the fact that for the phased removal of sediment from an enclosed space, a mechanism is provided for feeding and fixing the body of the grab as it is immersed in captured sediments, which in turn will reduce labor costs and water consumption, as well as increase productivity and quality of cleaning drainage wells from sediment.

References

[1] Mamutov R A 2015 Integrated water resources management and water conservation plan in the Zarafshan river basin *Presentation of the Project of the Ministry of Agriculture of Uzbekistan and UNDP* –Tashkent p 7
[2] Shirokova Yu, Morozov A 1991 Ways to improve irrigation and drainage systems in Uzbekistan –Tashkent p 156
[3] Lee A, Usmanov T, Botirov Sh 2019 A modernized device for cleaning drainage wells *Science Education and Innovation for the AIC Status Problems and Prospects Collection of scientific reports of the International scientific-practical conference* Tashkent pp 163-166
[4] Usmonov T, Ibragimova H, L Babazhanov and Lee A 2016 On the modernization of technology for cleaning concrete trays *Young scientist* **5** pp 259-263
[5] Usmonov T, Ibragimova H, Babazhanov L and Lee A 2016 On the modernization of technology for cleaning concrete trays *Young scientist* **5** pp 259-263
[6] Usmonov T, Dzhuraev N and Lee A 2018 The working body of the tray cleaner Modern ecological state of the environment and scientific and practical aspects of rational nature management. *Collection of scientific articles of the III International Scientific and Practical Internet Conference* pp 99–110
[7] Vasiliev B A, Gantman V B and Commissars V V 1980 Reclamation machines *Ed I.I Measure*–M Kolos p 351
[8] Kondratiev V N, Raikevich N G 1983 A device for cleaning viewing drainage wells A S USSR **11** p 4
[9] Handbook of elementary mathematics, mechanics and physics –M *Akalis*-1995 p 215
[10] Korn G, Korn T 1990 Handbook of mathematics for scientists and engineers *Science* p 720
[11] Lee A, Usmanov T and Sharipov Z 2019 A method of cleaning horizontal closed drainage from sediment *Invention* p 5