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The Performance Of The Dredger With The Movement Of The Bucket According To Strict Guidelines

Kodirjon Shavazov[1], Parakhat Berdimuratov[1], Xamzat Abdulmajidov[2], Normurod Telovov[1], Nurbek Murtazayev[3] and Nuriddin Razikov[1]

[1]Tashkent Institute of Irrigation and Agricultural Mechanization Engineers, Tashkent, Uzbekistan
[2]Russian State Agrarian University named after K.A.Timiryazev, Russia, Moscow
[3]Karshi Engineering Economic Institute, Karshi, Uzbekistan

Abstract – The article presents mathematical models for determining the performance of the channel cleaner PP-303, a feature of which is the rectilinear movement of the bucket along rigid guides along the bottom along the axis of the cleaned channel. The studies were carried out on the basis of experimental and calculated data. The object of research is the network of reclamation channels of the drainage system, and the working equipment of the channel cleaning machine is the subject of research. Productivity, which is the amount of production produced by the machine per unit of time, can be of three types: theoretical, technical and operational, determined taking into account the design parameters of the working equipment. When working with channel diggers, their performance directly depends on the main parameter - the depth of the channel under construction, in the case of cleaning channels with channel cleaning machines, this parameter cannot be considered as the main one. This is due to the fact that sediments and siltation accumulated on the bottom and slopes of the channels during the operation of the reclamation system are extremely unevenly distributed along the length of the channel. The greatest concentration and amount of sediment and siltation is observed mainly at the mouth of the channels, at the junctions of channels of different levels, at the junctions of the drainage with the drainage channel. The most significant parameter in this case is the thickness of the chips removed by the working body with a bucket from the bottom and slopes of the channel. In addition, the performance of the channel cleaner, as a batch machine, is affected by the design of the working equipment itself, the main element of which is a bucket capable of moving in a straight line along rigid guides with different speeds. With obvious high performance values of continuous channel cleaning machines, the PP-303 channel cleaner showed quite high values of technical and operational characteristics.

Keywords – ***Reclamation Systems, Drainage Channels, Irrigation Systems, Performance Of Channel Cleaners, Cleaning Of Channels, Sediments, Siltation, Vegetation In Channels.***

I. INTRODUCTION

In the Republic of Uzbekistan, targeted research works are being conducted aimed at creating resource-saving technologies for tillage [1-27], sowing [25-26], harvesting [27] and processing [28-29] of agricultural crops, field planning and reclamation work [30-39] to increase the yield of agricultural crops and new samples of technical means for their implementation, developing scientific and technical bases for improvement that ensure resource-saving of existing machines.

The quality of the reclamation system depends directly on the condition of the reclamation channels, on the quality and frequency of their cleaning and repairs. The operation of reclamation channels involves carrying out their current and major repairs, in addition, at reclamation enterprises, it is necessary to carry out thorough maintenance of channels to ensure the quality of the entire system.

Corresponding Author: Kodirjon Shavazov

The modern market of channel cleaning machines does not have such a variety, number and standard sizes of machines that were produced in the USSR from 1960 to 1980. Currently, for cleaning and repairing channels of reclamation systems, instead of using special channel cleaning machines, general construction excavators are often used, adapted for cleaning operations with widened buckets. Meliorators have to solve the difficult task of cleaning channels in the face of a shortage of special machines and the choice of general construction excavators with re-equipment of working equipment.

In Soviet times, the territory of the RSFSR various factories produced analog oiliest with different types of work with active working bodies, with passive working bodies working on suntans scheme in-ear, and cars driving through the bream clean channel. The choice of a specific channel cleaning machine depends on the type of channel, its purpose and its geometric parameters. Most channels of both drainage and irrigation systems have a trapezoidal profile. On reclamation systems, there are also channels of a parabolic profile, the shape of which is as close as possible to the shape of natural channels-drainers, i.e. rivers. However, cleaning such channels with conventional bucket channel cleaners or single-bucket general construction excavators while maintaining the original profile is a difficult task. Maintaining the original design profile that provides the required throughput during operation is the main task of reclamation plants [30, 31, 32].

Drainage channels of the reclamation system can be made in an earthen body or in an embankment with the fixing of the bottom and slopes. Cleaning of channels with a fixed bottom causes certain difficulties when using single-bucket general construction excavators, which consist in the destruction of the fixing elements. In this case, a channel cleaner with a rectangular bucket on rigid guides is most suitable for cleaning the bottom of the channel. This version of the bucket in the design of this machine moves along the bottom, along the axis of the channel, without destroying the fastening elements (fascines, boards, etc.) and cleans only the bottom of the channel. On reclamation channels of a large length, it is difficult from an economic point of view to secure the bottom and slopes of the channels, so the channels are made in an earthen body. In this case, the channel can be cleaned with a trapezoidal bucket on rigid guides, which will clean not only the bottom of the channel, but also the slopes.

II. Methods

The work was performed using a mathematical modeling package to determine the performance of the PP-303 channel cleaner in various operating conditions using a rectangular and trapezoidal bucket.

Channel cleaner PP-303 is designed for the annual routine maintenance of reclamation channels of the regulatory network. The channel cleaner can clean the bottom of channels with both reinforced and non-reinforced slopes with a width of 0.4 m along the bottom and a depth of up to 3.5 m. The channel cleaner equipment is mounted on a crawler tractor of traction class 3.0-DT-75B (Fig. 1). The hydraulic system of the base tractor is used to control the channel cleaner, which is carried out from the driver's cab. The channel cleaner PP-30 has a working body of the "plough" type, made in the form of a guide beam, along which the bucket moves. The guide beam has a welded structure, is made of two channels No. 14, is equipped with two end height-adjustable supports. The beam is mounted on two telescopic arms, which are pivotally mounted on transverse bars located in front and behind the base tractor [33, 34, 35].

Figure 1. Channel cleaner PP-303 in the working position (set of soil)

The cycle of the dredger consists of the following series of operations: lowering tough rails with a bucket at the bottom of the channel and install them on the support; the movement of the bucket on rails with the removal of the chips of a certain thickness on

the length of the rigid guides; up tough rails with the filled bucket; the reverse movement of the bucket on the rails with simultaneous unloading of the moving car to the next position at a distance equal to the displacement of the bucket on the hard rails. The theoretical performance of a channel cleaner as a batch machine can be determined by the formula [36, 37, 38]:

$$P_T = 60qn = \frac{3600q}{t_s}.$$

where P_T – is the theoretical performance of the dredger, m^3/h; the q – capacity of the bucket, or the amount of sediment and siltation remote from the bottom of the channel in a single cycle, m^3; n – design-the calculated number of cycles performed by the dredger per minute; t_s – theoretical duration of one cycle, p.

Theoretical duration of one cycle analog oiliest machine: $t_s=t_1+t_2+t_3+t_4$; where t_1, t_2, t_3, t_4 – duration operations, lowering the bucket to the bottom of the movement of the bucket (digging), lifting the bucket with soil (sediment), the discharge of the bucket.

The capacity of the bucket used for cleaning the channel with a fixed bottom is determined by the formula:

$$q = bhlk_N k_p.$$

where b – is the width of the bucket corresponding to the width of the channel at the bottom, m; h – is the height of a ladle, m; l – is the length of the bucket, m; k_N – filling ratio of the ladle, k_N=0,8-1,1; k_p – coefficient of loosening developed soils, siltation or sediment k_p=1,0-1,2 depending on the type and condition of the developed environment.

The capacity of the trapezoidal bucket used for cleaning the channel with an unfixed bottom is determined by the formula:

$$q = \frac{a+b}{2} hlk_N k_p.$$

where a – is the bucket width at the top, m.

The range of changes in the value of the bucket filling coefficient is explained by the fact that the bucket, depending on the selected chip thickness, may not be completely filled or vice versa with a "slide". The range of changes in the loosening coefficient is explained by the nature and condition of sediments, the presence of water at the bottom of the channel.

Obviously, from the above mentioned, the performance of the dredger is affected by the lowering speed of the rigid guide with bucket on the bottom of the channel and install them on the support; the speed of the bucket on rails with the removal of the chips of a certain thickness on the length of the rigid guides; the lifting speed of the hard rails with the filled bucket; the speed of the backward movement of the bucket on the rails with simultaneous unloading; the speed of the moving car to the next position at a distance equal to the displacement of the bucket on the hard rails.

Figure 2. Discharge of sediment from the bucket to the ground receiving device-slip.

To determine the technical performance on the route of the channel, sections with a length of 100 mi were marked up and the time of their passage was measured with a stopwatch. The number of cycles in the control area was determined by the number of

piles of ejected sediment, after which the actual length of the working stroke of the bucket was estimated. The average actual bucket stroke length was 4.7-4.9 m for channels up to 1.2 m deep and 4.3-4.5 m for channels up to 3 m deep.

III. Results and Discussion

From the conducted studies, it can be seen that the performance of the PP-303 channel cleaner is influenced by such factors as the duration of all cycle operations, the condition and nature of the developed soils, sediments and silting, and the thickness of the chips.

The channel cleaner PP-303 based on the tractor DT-75 or other analog is a workable machine that meets its purpose. The technical-operational and technical-economic indicators obtained as a result of the tests are quite acceptable. The main advantage of this machine in comparison with other types of channel cleaners is the high quality of the work performed, the relatively high productivity for batch machines and the ability to clean channels with a reinforced bottom. According to its parameters, the channel cleaner is able to clean the bottom of channels up to 2.5 m deep when laying slopes of 1:1.5; that is, it can be used to clean more than 70% of all drainage channels in the zone of excessive moisture [39].

The channel cleaner is characterized by a simple design combined with sufficient strength, rigidity and reliability of the technological process. The advantages of the technological process include:

- ability to work in a wide range of ground conditions: on peat and mineral soils, including stony inclusions and buried wood;

- ability to work when the channel is overgrown with vegetation, as well as on channels, as well as on channels both with and without water;

- unloading of the soil is carried out on the bream of the channel (on the lane of the base car) without getting it on the slopes of the channel;

- the hitch of the channel cleaner does not reduce the mobility of the base machine;

- high-quality planning of the channel bottom is carried out regardless of the state of the berm and the position of the base machine on it;

- the work can also be carried out in adhering soils, since the bucket is discharged forcibly;

- the presence of replaceable buckets allows you to clean channels with different widths along the bottom with the greatest efficiency.

IV. Conclusions

An increase in the performance of the PP-303 channel cleaner can be achieved by making the following changes and additions to the machine design:

- increase the velocity of the bucket when set and idle and the lifting speed of the working body due to the installation of pumps with a larger supply, making it is possible to increase the performance of the dredger in half;

- restriction of possible movements of the working body in the horizontal plane when unloading the soil;

- improving the conditions for unloading the bucket by changing the design of the bucket attachment to the traverse;

- provision for the cleaning of loose channels, the release of replaceable buckets with a trapezoidal profile.

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