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C O N T E N T S

Development in the educational process and research and production activity of modern technologies and technical means of field irrigation

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Summary. *The main condition for the effective use of existing reclamation systems in Ukraine is to increase the productivity of reclaimed lands along with improving their ecological condition. This is emphasized in a number of state documents, namely: Presidential Decrees, Resolutions of the Verkhovna Rada, Laws of Ukraine. One of the main reasons for the weak dynamics of the revival of the domestic reclamation complex is the lack of qualified management and technological staff in the infrastructure that provides reclamation agriculture. Therefore, in the educational process these issues are given more and more attention. Reclamation agriculture is considered by scientists as a complex technology for sustainable development of production in the agricultural sector of the economy.*

There is a systematic approach to the development of modern technologies and technical means of irrigation for the sustainable development of agricultural production, obtaining quality products, preserving the fertility of lands, fauna and flora that inhabit it with important conceptual tasks of the educational process and research and production activities. Current strategic issues include: the formation of water policy in Ukraine in view of the availability of water resources and the development of adaptation measures in the context of climate change; development of conceptual bases of restoration and development of irrigation and drainage in Ukraine. And also - water resources of Ukraine and modern methods of research of aquatic ecosystems; scientific bases of formation of sustainable bioenergy agroecosystems; system of laboratory diagnostics of water-physical properties of soils; scientific and methodological bases of organization and conduct of ecological and reclamation monitoring; water and ecological risks of transformation of reclaimed lands and ways of their minimization; information technologies in scientific research in the field of agricultural reclamation, etc. Important issues in the development of modern technologies and technical means of irrigation also include: conceptual principles of irrigation management; features of designing irrigation systems; method of setting watering dates - the basis of irrigation regimes; use of the method "Penman-Monteith" for irrigation management; irrigation management based on phytomonitoring; use of remote sensing data for irrigation control; Irrigation management information system "Irrigation online"; operation of irrigation systems; technologies of repair and restoration works on hydraulic structures of irrigation systems, etc.

KEYWORDS: *DEVELOPMENT, WATER RESOURCES, DESIGN, SOIL PROTECTION, RESEARCH, PRODUCTION ACTIVITY, MODERN TECHNOLOGIES, TECHNICAL MEANS, FIELD IRRIGATION*

1. Introduction

The formation of water policy [1] water supply and adaptation measures in the context of climate change are important issues of reclamation measures in agro-industrial production. As you know, land reclamation is the science of ways and methods of land improvement in order to increase their fertility and create optimal conditions for growth and development of crops [2]. In this regard, it is necessary to reconsider the conceptual principles of irrigation systems management, some restoration and development of technical means of water regime optimization, to increase the quality of agro-industrial production, professionally competent agro-engineering personnel. The developed pedagogical technology of training of professional agroengineering personnel should provide continuity of educational process in the study of soil and water resources, their protection and preservation [3].

2. Prerequisites and means for solving the problem

Modern technologies of training future agricultural engineers [4] involve the study of problematic issues of soil and water resources. As noted in throughout the study period, students systematically study these topical issues. In lectures students receive information about the general theoretical features of the use of soil and water resources in agro-industrial production, and in practical and laboratory classes they study the mechanical and technological properties of soils, interaction with them of working machines, features of irrigation systems design. In the process of formation of professional competencies in the project activities of future agricultural engineers, during the research to optimize the parameters of the sprinkler positional action DDN-70 studied agrochemical, mechanical and other characteristics of agricultural materials. According to special methods, the main parameters of the sprinkler were calculated - irrigation radius Rd, nozzle pressure P, nozzle diameter d, watering time at one position t, distance between positions b and C - depending on soil moisture, type and phase of plant development [5]. In the educational process, the purpose of research is to expand and deepen the knowledge of future agricultural engineers on the basics of theory, calculation and design of agricultural machinery, the formation of competencies on the interaction of working bodies with soil, irrigation systems and more. The purpose of the course and diploma design of work on agricultural machinery is the technological development of the design of the machine or its components or improvement of existing mechanization for irrigation, etc.

Future agricultural engineers [6, 7, 8]. should have a general understanding of erosion processes and prevent them from occurring. For example, soil erosion is the separation and movement of the upper most fertile soil layers from one place to another under the influence of water or wind. The process of water erosion consists of three steps: 1) separation of soil particles; 2) soil transfer – movement of soil particles from the site of erosion; 3) deposition of soil particles in a new place. Water erosion is appearing mostly when the effect of rain is exacerbated by the action of water flows: rain drops are separated by soil particles, and their flows are swept away.

Many scientific conferences have addressed the issue of soil and water protection. For example, at the II International Scientific Conference "Protection of Soils and Water Resources", the report was presented − «The main components of studies and research of conserving soils and water in technologies of agroengineers training" [Pr.The main]. This report partially discloses the scientific and methodological bases for soil and water exploration by future specialists in agroengineering in higher education institutions. Innovative pedagogical technology of development of project activity is developed in the form of a method of a consistent cross study of the material based on the objective relationship of disciplines and provides a qualitatively higher level of formation of professional competencies of agroengineers on the basis of preservation and even multiplication of natural resources. The report of states that the current issues of soil science are devoted to many works by well-known scholars, for example, P. Zaicka, M. Manojlovič, R. Meissner and others. A particularly important scientific and production problem is the optimization of the nutrient and water regimes of the soil on the slopes. A number of scientific works are devoted to the features of soil preparation for sowing crops on sloping lands, optimization and management of technological processes in these conditions.

The role of science in the educational process is growing significantly. Classical, practically oriented, as well as the most modern developments of scientists in the form of didactic materials are covered in textbooks, manuals, methodological developments and are used in the educational process of agricultural engineering.

It is worth to mention that due to the considerable scientific contribution of scientists, agroengineering pedagogical science and educational practice have great achievements. Significant contribution to the development of the theory and methods of vocational education were done by I. Bendera, V. Duganets, V. Man`ko and other.

These accents of scientific problems are prerequisites for solving urgent problems of soil and water conservation in pedagogical technologies for the formation of professional competencies of future agricultural engineers in higher educational institutions.

3. *Results and discussion*

The development of theoretical preconditions for some technological processes of agro-industrial production and the functioning of technical systems contributed to the optimization of the parameters of special agricultural machines. In addition, the results of scientific research have shown that the high quality of the educational process is achieved when future agricultural engineers conduct in-depth theoretical calculations of machines, participate in experimental laboratory and field research. Here is an example of the use in scientific and technical activities and technologies of preparation of agricultural engineers for innovative design activities of the elements of the algorithm of the theory and calculation of nozzles and devices of sprinklers and installations.

In fig. 1 shows a scheme of a deflector nozzle used in sprinklers and installations.

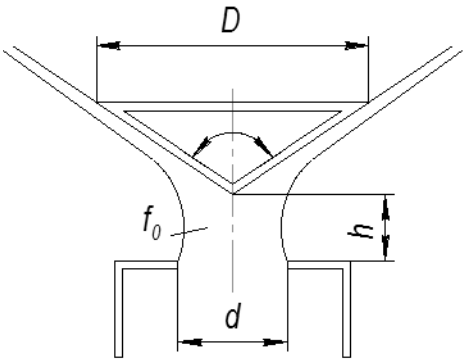

Fig. 1. The scheme of the deflector nozzle

Usually take the following ratios: $h = d$; $D = 2d$; $2\theta = 120^0$ (Fig.1).

Irrigation radius R can be determined by the following formula:

$$R = \frac{H}{0{,}43 + 0{,}0014\frac{H}{d}}, \quad (1)$$

where H – pressure in front of the nozzle hole.

(Fig. 2) there is their simplicity

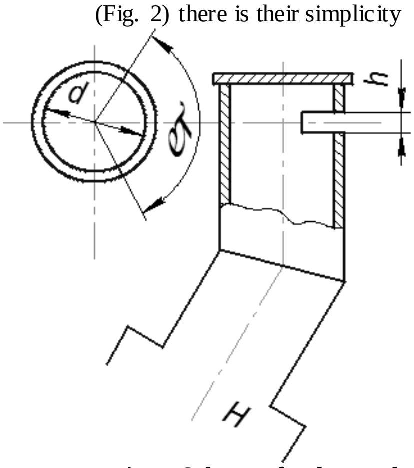

Fig. 2. Scheme of a slot nozzle

Such a nozzle can be obtained by sawing on any pipe. Spray torch angle φ_p determined from this ratio:

$$\varphi_p = (0{,}7\text{–}0{,}9)\varphi.$$

Smaller values of the numerical coefficient correspond to smaller values of the angle φ. The radius of the irrigated sector is determined by the formula:

$$R = \frac{H}{1{,}15 + 0{,}0003\frac{H}{h}}. \quad (2)$$

The recommended ratio of the length of the slit to its width 1:5, 1:10. The irrigated area has the shape of a sector with an angle φ_p. Approximately at a distance 1/5R from the nozzle irrigation does not occur.

Medium-jet sprinklers are used on most modern sprinklers and installations. Their designs are mostly the same type, although they have some significant differences.

The principle of operation is approximately as follows. The jet flowing from the barrel meets on the way a rotary deflector and a reflective blade. The front end of the rocker arm is pushed to the side, and the rocker arm is turned. When leaving the jet, the deflector rotates relative to the rocker arm. The rocker arm, twisting the spring, rotates at an angle of about 90°, then under the action of the spring returns to the previous position.

After reaching the initial position, the rocker strikes the tide on the barrel with its tide and turns it at an angle of 2–5° in the course of movement. The jet at this point hits the back of the deflector and returns it to its original position. Then the front end of the rocker is pushed out of the jet again and the process is repeated.

The barrel performs a continuous rotation. The jet irrigates the circular area. The design can work without a chopping blade. In this case, more precise adjustment of the position of the deflector relative to the jet is required.

With the conditional replacement of the action of the jet on the curved rotary deflector and the blade by the action of only one blade located on the middle radius, according to Fig. 3, a) and b) the value of the angular velocity of the rocker arm after the deflector exits the jet will be

$$\omega = 2\sqrt{\frac{pfr\varphi \sin\alpha}{J_к}}, \quad (3)$$

where $J_к$ – the moment of inertia of the rocker arm;

φ – the angle of rotation of the rocker arm at which the jet affects the deflector,

$$\varphi = (2\text{–}3)\varphi_т;$$

p – pressure in front of the nozzle.

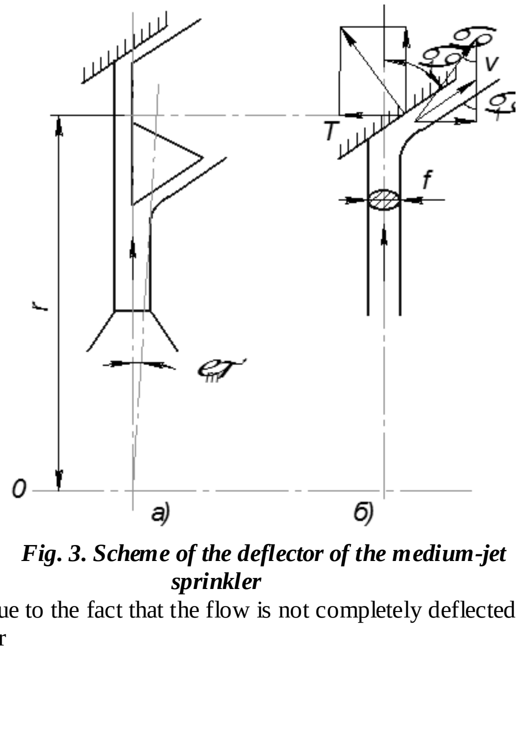

Fig. 3. Scheme of the deflector of the medium-jet sprinkler

Due to the fact that the flow is not completely deflected by the deflector

$$\alpha = (0{,}7 \div 0{,}8)\alpha_1 \quad (4)$$

The maximum angle of rotation of the rocker arm

$$\varphi_{max} = \frac{2pfr\sin\alpha}{M_n}, \quad (5)$$

where M_n − the average value of the moment created by the spring during the rotation of the rocker arm.

The angle of rotation of the device in one stroke of the rocker arm

$$\psi_a = \frac{8pfr\varphi\sin\alpha}{M_T}\left[\frac{me^2}{J_к} + \cos^2\theta\right]\cos^2\theta, \quad (6)$$

where M_T − the moment of friction which brakes rotation of the device and is equal to the sum of moments of friction in the bearing and a rubber cuff.

The full travel time of the rocker arm in both directions

$$t = 4\frac{\sqrt{J_к pfr\varphi\sin\alpha}}{M_n}. \quad (7)$$

Long-jet sprinklers are used in cases when it is possible and expedient to create a pressure of 4-6 atm in the pipes.

Common devices with worm or toothed mechanisms of rotation, which are driven by a small turbine, which rotates under the action of the energy of the main jet, which is formed by the device with a turbine drive.

Mechanisms are often introduced into the structure to provide the apparatus of reverse rotation within the sector of the irrigation circle in the sector in a given direction. The angle of the sector is usually adjustable.

The jet of water flowing from the nozzle rotates the turbine. On the axis of the turbine is a worm that rotates the worm gear. The gear through the shaft transmits rotation to the worm connected to the worm gear. There is an eccentric finger on the axis of the gear, which makes the frame swing. The ratchet mechanism consisting of two hinged rods, a spring and a dog is established on a frame. Under the action of a compressed spring, the dog is pushed away from the stationary gear on one side, due to which a slow intermittent rotation of the sprinkler around the vertical axis is carried out. The fixed gear has a series of protruding fingers. At an emphasis of a shank of a dog in one of them its position changes, its other party starts to work and the direction of rotation of the device changes. Thus it is possible to carry out watering on sector. The number of revolutions of the turbine per minute is determined by the formula:

$$n_T = \frac{60u}{\pi D}, \quad (8)$$

where u − circular velocity of the ends blades m / s;

D − diameter of the turbine at the ends of small blades, m

The circular speed of the ends of the blades can be determined by the formula

$$u = k_0 v, \quad (9)$$

where k_0 − wheel speed ratio, k_0 = 0,7–0,8;

v − fluid velocity in the jet, m / s.

The velocity of the liquid in the jet is determined by the formula

$$v = \varphi\sqrt{2gH}, \quad (10)$$

where φ − speed factor, φ = 0,97;

g − free fall acceleration g = 9,8 м/с^2;

H − pressure in front of the nozzle, m of water column

The number of revolutions of the long-jet sprinkler is equal to:

$$n_a = \frac{n_T}{i}, \quad (11)$$

where i − the total gear ratio between the turbine and the body of the apparatus.

The range of the jet for medium and long-jet nozzles can be determined by one of the following empirical formulas:

$$R = 0{,}42H + 1000d \quad (12)$$

or

$$R = \frac{H}{0{,}5 + 0{,}25\frac{H}{d}}. \quad (13)$$

The formulas are valid for the angle of inclination of the jet to the horizon of 30°, ie for the angle corresponding to the longest range and the ratio

$$\frac{H}{d} \geq 800, \quad (14)$$

where H − pressure in front of the nozzle, m of water column;

d − jet diameter, m

The range of the jet can also be determined using the experimental graph shown in Fig. 4. For different diameters of the jets, a series of curves is constructed that determine the relationship between H and R. The decay of the jet into droplets is determined by the ratio H / d.

The range of the jet, defined on the graph (Fig. 4), can be obtained only with a properly designed barrel and non-rotating sprinkler.

The range of the jet during the rotation of the apparatus around the vertical axis with a speed of 0.3−1 per minute decreases by 10-15% compared to the range of the jet without rotation of the apparatus. The rational shape of the trunk is shown in Fig. 5. A larger angle of inclination to the horizon is selected at a pressure of 1.5−3 at, a smaller - at a pressure of more than 6-8 at. Essential for the formation of the initial section of the jet is a sedative 1, which consists of a series of partitions parallel to the axis of the barrel, dividing its living section into a number of narrow channels.

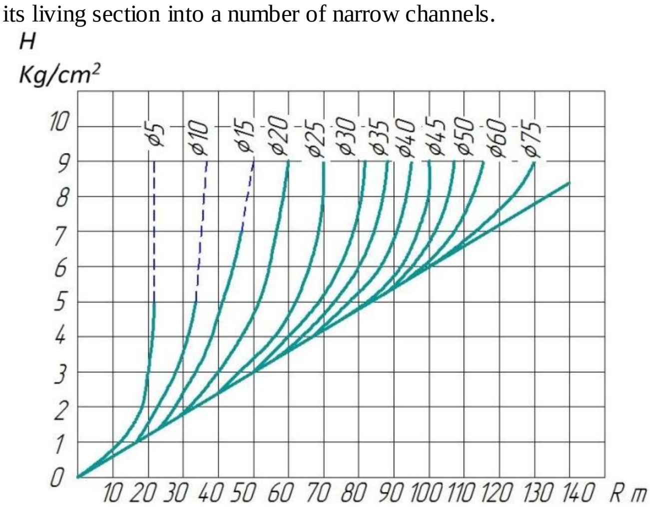

Fig. 4. Schedule to determine the range of the jet

The length of the cells of the sedative should be 12-15 times greater than their width. The diameters of the barrel and the silencer should be 3-4 times larger than the diameter of the nozzle. It is necessary to install ribs 2 in the knee, which prevent the occurrence of transverse circulation of velocity in the flow. In medium-jet and some long-jet barrels, the cone 3 is not placed, and the nozzle 4 is located directly behind the output end of the sedative. The rational shape of the nozzle is shown in Fig. 6, a.

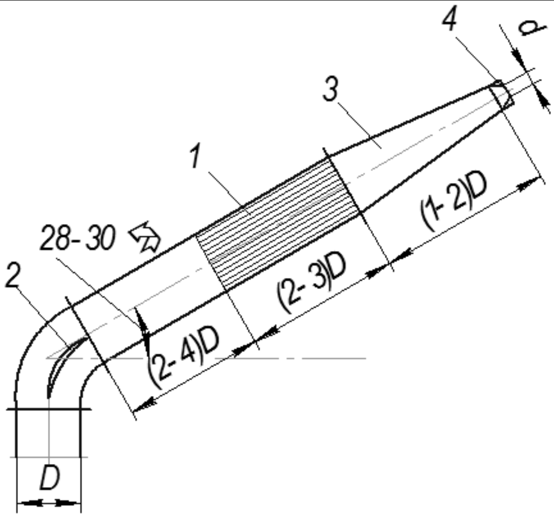

Fig. 5. The scheme of a long-jet trunk:
1 - sedative; 2 - rib; 3 - cone; 4 - nozzle.

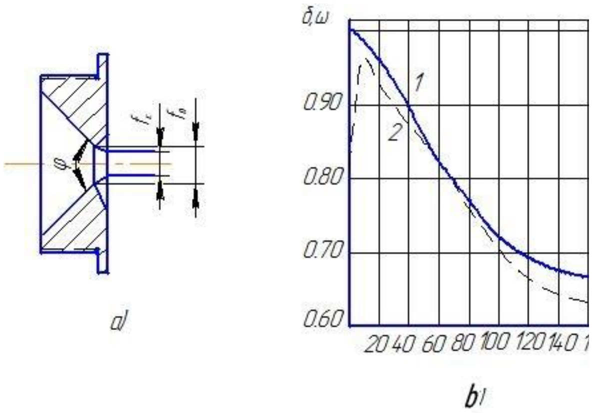

Fig. 6. Rational shape of the nozzle

Water consumption through such a nozzle is determined by the formula:

$$Q = \delta f_0 \sqrt{2gH}\,, \qquad (15)$$

where δ – flow rate, which is determined depending on the angle of conicity of the nozzle φ on curve 2 (Fig. 6, b).

Curve 1 gives the value of the compression ratio ε of the jet:

$$\omega = \frac{f_c}{f_0}\,. \qquad (16)$$

This factor determines the diameter of the nozzle required to create the desired jet.

5. Conclusions

As a result of conducted all the scientific research work and using the fundamental mathematical analysis we can get the theoretical basis which will help to improve the development of the educational process and research and production activity of modern technologies and technical means of field irrigation.

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