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THE PROBLEM OF DETERMINING THE SHAPES OF WATER DISTRIBUTION CHANNELS THAT DO NOT CREATE CAVITATION AND ACCUMULATION ZONES

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Keywords: channel, boundary condition, compaction area, velocity, water flow, compression coefficient, speed.

Abstrakt: The article proposes a solution to the problem of fluid flow in the channel, taking into account the zones of rotation and cavitation. Systematic calculations of the stationary properties of the flows and cavities for the cavitation flow in the channel are also given.

The irrigation system of the Kashkadarya region consists of main canals and cascades of pumping stations that lift water. The cascade of pumping stations receives water mainly from unconcreted rivers. The river waters consist of a lot of sand and silt.

In places where the flow speed is slightly reduced (areas of accumulation), small particles settle intensively and narrow the length of the consumer channel, making it difficult to pass water. For example, 10-15 million cubic meters of silt settles from the Amudarya to the Karshi main canal every year, making it difficult to transfer water. Therefore, finding the non-accumulating shape of the consumer channel using hydrodynamic methods plays an important role in the design of concrete-free dam culverts. The solution to this problem is also applied to the distribution of pipelines.

The problem of determining the shape of water distribution channels that do not create cavitation and stagnant zones is brought to the problem of water transfer from the main channel to the auxiliary channel. The problem of determining the boundary of the part of the consumer channel adjacent to the main channel that does not create stagnant zones plays an important role in the rational distribution of water to consumers. In this chapter, the problem of regulating the movement of liquids in water distribution channels was studied based on the theory of flow (jet) in cases of changing flow rates.

During the pressure and pressureless movement of water in the canals, stagnant or cavitation zones are formed in the water distribution sections, which prevent the smooth flow of water and, therefore, the correct measurement of water consumption. Such sections, especially when water is taken from rivers into the canals, cause erosion of non-concrete banks and filling of the consumer channel with silt. For example, these processes are observed in the water distribution sections from the Amudarya to the Karshi main main canal, and from the Karshi main canal to the district canals. Therefore, it is very important to optimize the boundary shapes of the consumer channel (bringing the stagnant and cavitation zones to a form that does not form) when designing new canals and renovating existing ones. With this in mind, below we will determine the exact shape of the consumer channel supplied with water from the main channel using the flow theory method [23,29,32,36,38]. This, as we noted above, plays an important role in hydraulic engineering projects.

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To do this, we consider the process of water distribution from a channel $\alpha\pi$ $(\alpha > 0)$ of width H to a consumer channel located at an angle (Figure 1).

We assume that the flow potential is incompressible. As observed in real flows, a free boundary DE is formed at the entrance of water to the consumer channel. Since the pressure along this boundary is equal to atmospheric pressure, the fluid velocity at the boundary is constant, which we denote by V_k. The unknown boundary CM, which connects the main and consumer channels and does not create a stagnation zone, is also determined in the process of solving the problem. The V_C velocity on this boundary is also constant, which we denote by (Figure 1).

Also, during the solution of the problem, we assume that the boundaries DE and CM take the form of a straight line after point M. This is also observed in the real flow in the channels. (In the Karshi, Nishon, Mirishkor channels of the Kashkadarya region).

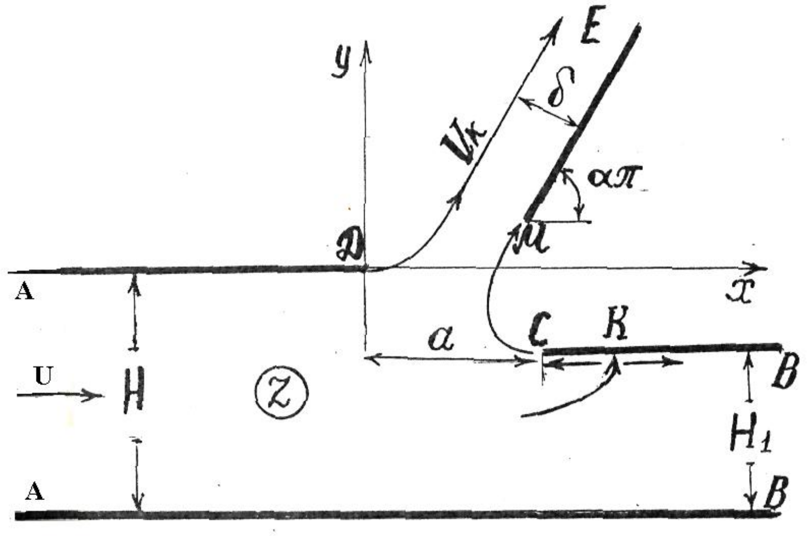

Figure 1. Scheme of unconfined water distribution in the canal.

$\frac{H_1}{H}$, $\alpha\pi$, $\frac{U}{V_k}$ The parameters are known in advance.

BB is the width of the H_1 channel in the section; U- is the water velocity in the main channel.

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In the process of solving the problem, the goal is $\kappa = \frac{\delta}{\alpha}$ to determine the boundary forms of the DE and CM curves, as well as the flow coefficient. δ - the width of the consumer channel at point E, α - the abscissa of point C.

We will begin to solve this problem using the Zhukovsky method. The so-called Zhukovsky function is given by

$$\omega = \ln \frac{V_k dz}{dw_0} = \ln \frac{V_k}{V_0} + i\theta \qquad (1)$$

let's look at the function. Here is V_0 -the fluid velocity modulus;

θ - tezlikning ox o'qi bilan tashkil qilgan burchagi.

θ - the angle formed by the velocity with the ox.

Along the DE border $V_0 = V_k$, because it was $\ln \frac{V_k}{V_0} = 0$. On the other hand

θ DE across from changes to $\alpha\pi$. Figure 2 depicts the state of the physical plane when it is projected conformally onto the ω-plane.

So, as shown in Figure 2, θ - DE bo'ylab 0- dan $i\alpha\pi$ -gacha o'zgaradi. θ - It varies from 0 to $i\alpha\pi$ along DE.

Along DA, AB, BK, the abstract part of ω remains unchanged and is equal to zero. Along KC and ME, the abstract part of ω remains unchanged again, but this time it is equal to π and $\alpha\pi$ respectively.

Along the SM, ω the real part of changes from $\ln \frac{V_k}{V_c}$, to and the abstract part π from to $\alpha\pi$.

When passing through the point K, ω the real part of changes to infinity, and θ the value of changes by leaps. Thus, ω the domain of the function forms a pentagon, as depicted in Figure 2.

By comparing Figures 1 and 2, we obtain ω the following result by means of a conformal reflection of and to the upper half-plane [complex calculations are described in paper 5 in the list of published literature on the topic]:

$$\omega = C_1 \int_0^u \sqrt{\frac{\xi - m}{\xi(\xi - C)}} \frac{d\xi}{(\xi - k)} + C_2 \qquad (2)$$

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We determine from C_1 the C_2 following conditions,

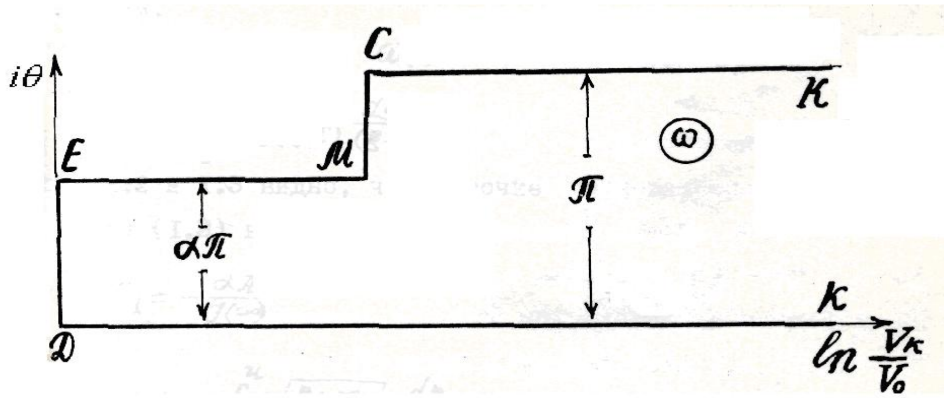

Figure 2. ω **the domain of variation of a function.**

That is, at point $\omega(0) = 0$ D, from here $C_2 = 0$.

$$\omega = C_1 \int_0^u \sqrt{\frac{\xi - m}{\xi(\xi - C)}} \frac{d\xi}{(\xi - k)} \qquad (3)$$

It can be seen from Figures 1 and 2 that at point E $\omega = i\alpha\pi$. Then, from formula (3), we determine:

$$C_1 = -\frac{\alpha\pi}{J(\quad)}$$

Here

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$$J(u) = \int_0^u \sqrt{\frac{\xi + m}{\xi(\xi + C)}} \frac{d\xi}{(\xi + k)}$$

so,

$$\omega(u) = -\frac{\alpha\pi}{J(\quad)} \int_0^u \sqrt{\frac{\xi - m}{\xi(\xi - C)}} \frac{d\xi}{(\xi - k)} \qquad (4)$$

When moving from DK to KC, $\omega = i\pi$. Figure 2.

$$J(\quad) = \alpha\pi \sqrt{\frac{m - k}{k(c - k)}}$$

It can be seen from (1) and (4) that

$$\frac{1}{V_k} \frac{dw}{dz} = EXP \frac{\alpha\pi}{J(\quad)} \int_0^u \sqrt{\frac{\xi - m}{\xi(\xi - C)}} \frac{d\xi}{(\xi - k)}$$

(5)

The speed value is determined from the formula.

$$\frac{U}{V_k} = EXP -\frac{\alpha\pi}{J(\quad)} \int_0^1 \sqrt{\frac{m - \xi}{\xi(C - \xi)}} \frac{d\xi}{(k - \xi)} \qquad (6)$$

At the CM boundary of the channel:

So,

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$$\frac{V_c}{V_k} = EXP\ \frac{\alpha\pi}{J(\ \ )}\int_0^C \sqrt{\frac{m-\xi}{\xi(C-\xi)}}\frac{d\xi}{(\xi-k)} \qquad (7)$$

$w(z) = \varphi_0 + i\psi_0$ reflects the complex potential flow field conformally to the $\{0 \quad \psi \quad Q\}$ field

$$w(u) = \frac{q_E}{(b-1)\pi}\ (k-1)\ln\frac{u-1}{k-1} - (k-b)\ln\frac{u-b}{k-b}\ + iq_B \qquad (8)$$

Here $q_E = \delta V_k$ и $q_B -$ are the fluid flows in sections EE and VV, respectively.

Differentiating (8), we obtain the following.

$$\frac{dw}{du} = \frac{q_E}{\pi}\frac{(u-k)}{(u-1)(u-b)} \qquad (9)$$

The fluid flow in the VV section is determined by the passage of $w\ (u)$ through the point $u = b$.

$$q_B = -\int_{u=B} \frac{dw_0}{du}\ du \quad \text{yoki} \quad \frac{q_B}{q_E} = \frac{k-b}{b-1} \qquad (10)$$

As can be seen from Figure 1,

$$Q = q_B + q_E \qquad (11)$$

Let's move on to the physical plane of the flow using formula 1:

$$Z(u) = \frac{1}{V_R} \quad e^{\omega} \frac{d\omega_0}{du} du \, . \qquad (12)$$

If we put (4) into (2),

$$Z(u) = \frac{q_E}{\pi V_k} \int_0^u \frac{(u-k)}{(u-1)(u-b)} EXP \left(-\frac{\alpha\pi}{J(\;)} \int_0^u \sqrt{\frac{\xi - m}{\xi(\xi - C)}} \frac{d\xi}{(\xi - k)} \right) du \qquad (13)$$

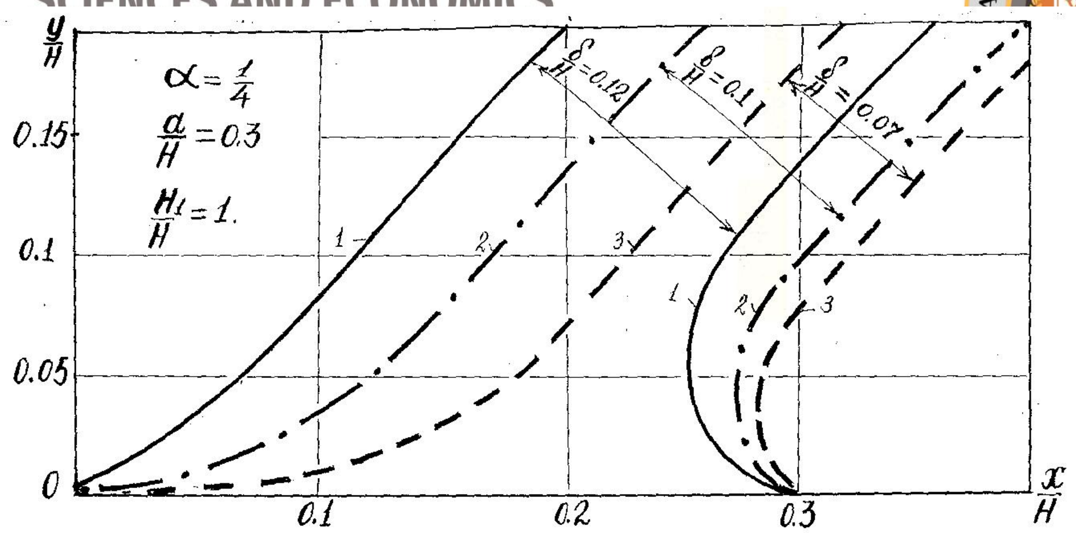
Separating the abstract and real parts of expression (13), we determine the boundary, that is, the free DE boundary:

$$x(u) = \frac{q_E}{\pi V_k} \int_0^{-u} \frac{(u+k)}{(u+1)(u+b)} Cos \left(\frac{\alpha\pi}{J(\;)} J(-u) \right) du$$

$$y(u) = \frac{q_E}{\pi V_K} \int_C^{-u} \frac{(u+k)}{(u+1)(u+b)} Sin \left(\frac{\alpha\pi}{J(\;)} J(-u) \right) du \qquad (14)$$

The obtained relations fully represent the solution of the problem. The latter system was calculated using Newton's numerical method, depending on the known geometric values of the channel and different flow velocities. Below, in Figures 3 and 4, the shapes of the consumer channel that do not form a convolutional field are determined for different values of $\frac{U}{V_k}$ and α.

Calculations and numerous experiments have shown that the flow is compressed in the consumer channel and eventually takes on the shortest δ value. The narrowing of the flow is explained by the fact that the fluid moves along the walls AD and KC and, reaching the beginning of the consumer channel, compresses δ without changing the width.



\Figure 3. Views of the shape of the consumer channel providing a smooth flow for different values of $\frac{\alpha}{H}=0{,}3, \alpha=\frac{1}{4}$ and $\frac{U}{V_k}$.

$$1-\frac{U}{V_k}=0{,}2;\ \ 2-\frac{U}{V_k}=0{,}43;\ \ 3-\frac{U}{V_k}=0{,}66$$

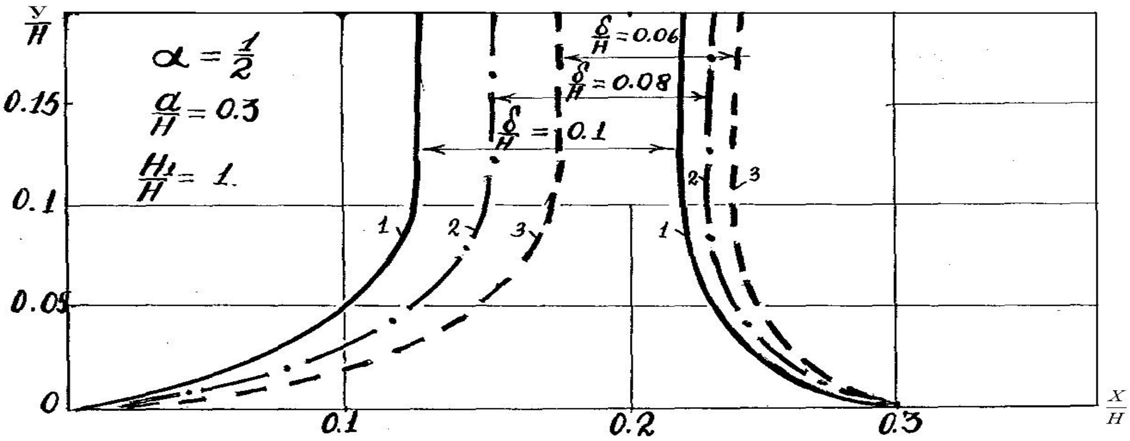


Figure 4. Representations of the shape of the consumer channel providing a smooth flow for different values of $\frac{\alpha}{H}=0{,}3, \alpha=\frac{1}{2}$ and- $\frac{U}{V_k}$.

$$1-\frac{U}{V_k}=0{,}2;\ \ 2-\frac{U}{V_k}=0{,}43;\ \ 3-\frac{U}{V_k}=0{,}66$$

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The described physical processes and the flow pattern are well illustrated in Figures 3 and 4. Calculations show that as the flow velocity from the main channel increases, point M approaches point S, leading to the formation of turbulent fields along the channel walls. This is also confirmed by observed experiments.

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