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MODELING OF COLLECTOR WATER DISCHARGE INTO THE WATER COURSE IN THE FERGANA VALLEY MODELING OF COLLECTOR WATER DISCHARGE INTO THE WATER COURSE IN THE FERGANA VALLEY

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Abstract. *"Modeling of discharges of collector waters into the watercourse of the Ferghana Valley" The process of discharges for a watercourse is considered, starting from a certain distance from the inlet, a concentrated liquid over the entire cross section of the channel experiences a retarding action of viscosity forces, a change in the concentration of the liquid occurs, both along the cross section and along the length of the channel .*

In the following, the main attention will be paid to the consideration of the flow and the change in concentration in a channel with a circular cross section that is constant along the length. There are no internal sources in the main channel. The value of the concentration coefficient and analytical calculation are given.

Keywords: *Collector, liquid, Reynolds number, turbulent motion, concentration rate, the frictional stress, laminar isothermal motion, factor*

МОДЕЛИРОВАНИЕ КОЛЛЕКЦИОННОГО СТОКА ВОДОТОКА В ФЕРГАНСКОЙ ДОЛИНЕ МОДЕЛИРОВАНИЕ КОЛЛЕКТОРНОГО СТОКА ВОДОТОКА В ФЕРГАНСКОЙ ДОЛИНЕ

Аннотация. *«Моделирование сбросов коллекторных вод в водоток Ферганской долины» Рассмотрен процесс сбросов для водотока, начиная с определенного расстояния от входа, концентрированная жидкость по всему сечению русла испытывает тормозящее действие силами вязкости происходит изменение концентрации жидкости, как по сечению, так и по длине канала.*

В дальнейшем основное внимание будет уделено рассмотрению течения и изменения концентрации в канале с постоянным по длине круглым поперечным сечением. В основном канале нет внутренних источников. Приведены значение коэффициента концентрации и аналитический расчет.

Ключевые слова: *коллектор, жидкость, число Рейнольдса, турбулентное движение, скорость концентрации, напряжение трения, ламинарное изотермическое движение, фактор.*

INTRODUCTION

Collector water is used to save irrigated water. The norm of irrigated waters in relation to salinity is 5 mg/l. To achieve this, about 23 m3/s of water is discharged or brought in from the route of the canals terminated by the node of structures on the North-Baghdad collector to desalinize the drainage water of this collector and then use them for irrigation. The discharge process for a watercourse is more complex than the process of flushing the surface with an unrestricted flow. The cross section of the pipe has finite dimensions. As a result, starting from a certain distance from the inlet, the concentrated liquid over the entire cross section of the channel experiences the retarding action of viscous forces, and the concentration of the liquid changes both along the cross section and along the length of the channel. In the following, we will focus on the consideration of the flow and the change in concentration in a channel with a circular cross section that is constant along the length. There are no internal sources in the main channel.

Fluid flow can be laminar or turbulent. The flow regime in pipes is judged by the value of the Reynolds number [4,7]

$$\text{Re} = \frac{\overline{\vartheta} d}{\nu}$$

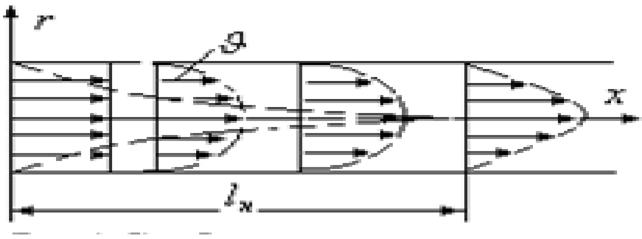
where $\overline{\vartheta}$ - average fluid velocity; d - inner diameter of the pipe. If a $\text{Re} < \text{Re}_{кр} \approx 2000$, the flow is laminar. Meaning $\text{Re}_{кр} = 2000$ is the lower critical value of the Reynolds number. At $\text{Re} > 2000$ the flow after a single perturbation no longer returns to the laminar flow regime.

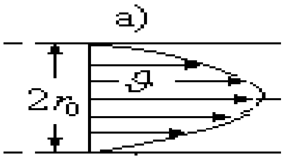
A developed turbulent flow in technical pipes is established at

$\text{Re} > \text{Re}_{кр2} \approx 10^4$.

MATERIALS AND METHODS

Current at $\text{Re} = 2 \cdot 10^3 - 10^4$ called transitional. It also corresponds to the transitional regime of recoil salt.

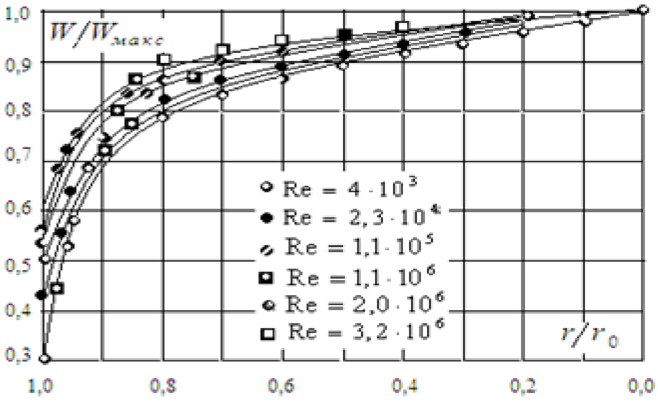




area of stabilization. If concentrated saline liquid enters the pipe from a large volume, the velocity distribution in the initial section is considered uniform (Fig. 1), then a boundary layer is formed near the walls, the thickness of which gradually increases. In sufficiently long pipes, at some distance from the inlet, the boundary layer fills the entire cross section. In the distance counted from the inlet to the cross section corresponding to the boundary layer merging, the concentration stabilizes ($x \geq l_н$) and it does not depend on the velocity distribution at the input ($x = 0$), but the distribution of the concentration rate as for $x < l_н$, so with $x \geq l_н$ may depend on the process of salt exchange.

The initial section is observed both in laminar and turbulent flow. However, when $\text{Re} > \text{Re}_{кр1}$ the flow in the initial section can develop in a peculiar way. A laminar flow pattern may exist in the front of the channel. The resulting laminar boundary layer, upon reaching the critical thickness, passes into a turbulent one. The thickness of the latter grows rapidly until it fills the entire section of the pipe. The zone of the initial section at the place of change in the flow concentration regime is characterized by the displacement of motion. A change in the concentration of the flow regime can also occur outside the initial section.

At $\mathrm{Re} \geq 5 \cdot 10^4$ A turbulent boundary layer develops almost from the very beginning. If a concentrated liquid flows from a large volume into a channel with a sharp edge at the inlet, then vortices are formed at the beginning of the channel, leading to a rapid destruction of the laminar boundary layer.



Picture 3
Velocity distribution in a round pipe at various Reynolds numbers

The length of the initial section and its fraction, occupied by the laminar and turbulent boundary layers, respectively, depend on the number , the degree of flow turbulence at the inlet, and a number of other factors. Many factors are interrelated.

If the flow is stable ($x > l_н$), the concentration velocity over the flow cross section during laminar isothermal motion are distributed along a parabola [3,6,7] (rice.2, *a):*

$$\vartheta_x = \vartheta_{макс}\left[1 - \left(\frac{r}{r_0}\right)^2\right]$$

where r_0 — pipe radius; $\vartheta_{макс}$ - concentration velocity on the pipe axis (at $r = 0$).

The average concentration rate in this case is equal to half the maximum:

$$\overline{\vartheta} = \frac{1}{2}\vartheta_{макс}.$$

During turbulent motion, almost the entire section of the pipe is filled with a turbulently flowing more concentrated saline liquid. At the wall, a viscous sublayer is formed. At large numbers, the thickness of the sublayer is an insignificant part of the pipe diameter. With a stabilized turbulent flow, the liquid concentration in the pipes is distributed over the cross section, it has the form of a truncated parabola (Fig. 2, b) with a maximum on the pipe axis. The velocity changes most sharply near the wall.

The distribution of velocities in the turbulent part of the flow can be described using the universal logarithmic law[1]:

$$\frac{\overline{\vartheta}_x}{\vartheta_*} = \frac{1}{\chi}\ln y_* + \eta$$

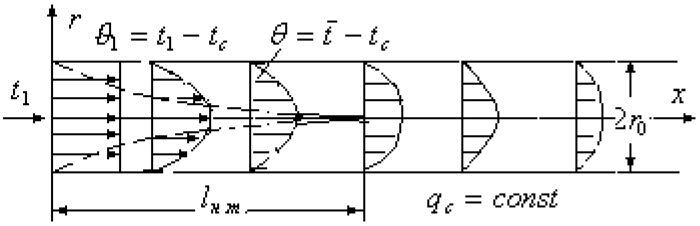
where $\vartheta_* = \sqrt{\frac{s_c}{\rho}}$; $y_* = \frac{\vartheta_* y}{\nu}$; $y = r_0 - r$ (picture.2). According to the data of a number of studies for a turbulent core ($y_* \geq 30$), $\chi = 0{,}4$ $\eta = 5{,}5$ for the region intermediate between the turbulent core and the viscous sublayer ($y_* \approx 5 - 30, \frac{1}{\chi} = 5{,}0$ и $\eta = 3{,}05$. Within the viscous sublayer ($y_* \approx 0 - 5$) a linear speed change is assumed.

$$\frac{\overline{\vartheta}_x}{\vartheta_*} = y_* \text{ или } \overline{\vartheta}_x = \frac{s_c}{\mu} y$$

RESULTS

The frictional stress on the wall is a function of the Reynolds number. This gives rise to the dependence of the distribution of the concentration velocity over the cross section on . The larger the Reynolds number, the sharper the concentration rate changes near the wall and less sharply in the central part of the flow, i.e. velocity diagram becomes more filled (picture. 3).

As a result, the ratio of the average velocity over the pipe section to the maximum ($r = 0$) will depend on the Reynolds number.



Picture 1
Stabilization of the velocity distribution during the movement of fluid in a pipe

It has been experimentally obtained that the value of this quantity varies slightly and is equal to 0.8–0.9.

The above information about the distribution of the concentration velocity in a turbulent flow, first of all, corresponds to concentrated flows or flows with practically no variability in the physical properties of the liquid.

Area of concentration stabilization. As the concentrated liquid moves along the pipe, an increase or decrease in the concentration of near-wall layers is observed if the liquid concentration is different from the concentration of the incoming liquid.

The recoil salt coefficient decreases in the laminar flow section and increases with its destruction. Then the concentration stabilizes during turbulent flow. [2,5]

The length of the initial section of the recoil salt depends on a large number of factors, for example, on the liquid concentration coefficient, the presence of stabilization, the Reynolds number, the concentration distribution at the inlet, etc.

DISCUSSION

The theory shows that in the case of a laminar fluid flow with constant physical parameters and a homogeneous concentration at the inlet in the case $C_c = const$

$$\frac{l_{н.т}}{d} = 0{,}055 Pe$$

and in case $q_c = const$

$$\frac{l_{\text{н.м}}}{d} = 0{,}07Pe$$

CONCLUSION

These equations correspond to a preliminarily stabilized concentration flow. In laminar flow, the Reynolds number can reach a value of approximately 2000. At the same time, for gases in which $\Pr \approx 1$ ($Pe = \mathrm{Re}\Pr$), the estimated length of the initial stabilization section reaches about a hundred diameters. For very viscous liquids ($\Pr > 1$) meaning $l_{\text{н.м}}$ can vary from several hundred to several tens of thousands of diameters. In the latter case, salt exchange almost always occurs within the initial region. According to numerous experimental data in turbulent flow $l_{\text{н.м}} = (10 - 15)d$. Pipe concentration change factor. Let us determine the average pipe concentration factor if $l > l_{\text{н.м}}$, где l - pipe length. Let on the site $\alpha = \alpha(x) = \alpha_{\text{н.м}}$, $0 \le x < l_{\text{н.м}}$ and at $x \ge l_{\text{н.м}}$ $\alpha = \alpha_\infty = const$. [1,6

$$\bar{\alpha} = \frac{\bar{q}_c}{\Delta\bar{t}} = \frac{\int_0^{l} \alpha \Delta t dx}{\int_0^{l} \Delta t dx} = \frac{\int_0^{l_{\text{н.м.}}} \alpha_{\text{н.м}} \Delta t + \int_0^{l_{\text{н.м}}} \alpha_\infty \Delta t dx}{\int_0^{l_{\text{н.м}}} \Delta t dx + \int_0^{l_{\text{н.м.}}} \Delta t}$$

Integrals ranging from 0 to $l_{\text{н.м}}$ can be represented as follows:

$$\int_0^{l_{\text{н.м}}} \alpha_{\text{н.м.}} \Delta t dx = \bar{q}_{\text{н.м.}} l_{\text{н.м.}} \qquad \int_0^{l_{\text{н.м}}} \Delta t dx = \Delta\bar{t}_{\text{н.м.}} l_{\text{н.м.}}$$

Substituting the values of the integrals into equation (a), we obtain

$$\bar{\alpha} = \frac{\bar{\alpha}_{\text{н.м.}} + \dfrac{\alpha_\infty}{\Delta\bar{t}_{\text{н.м}} l_{\text{н.м.}}} \displaystyle\int_{l_{\text{н.м.}}}^{l} \Delta t dx}{1 + \dfrac{1}{\Delta\bar{t}_{\text{н.м.}} l_{\text{н.м}}} \displaystyle\int_{l_{\text{н.м.}}}^{l} \Delta t dx} \tag{1}$$

or

$$\frac{\bar{\alpha}}{\alpha_\infty} = \frac{\dfrac{\alpha_{\text{н.м.}}}{\alpha_\infty} + \varphi(l)}{1 + \varphi(l)}$$

where

$$\varphi(l) = \frac{1}{\Delta t_{\text{н.м.}} l_{\text{н.м.}}} \int_{l_{\text{н.м.}}}^{l} \Delta t dx = \frac{\Delta\bar{t}_\infty}{\Delta t_{\text{н.м.}}} \cdot \frac{l - l_{\text{н.м.}}}{l_{\text{н.м.}}}$$

$\Delta\bar{t}_\infty$, $\Delta\bar{t}_{\text{н.м.}}$ — respectively, the average temperature differences in the areas $(l_{\text{н.м.}}, l)$and $(0, l_{\text{н.м.}})$

If

$$\Delta \bar{t}_{\infty}, \approx \Delta t_{н.т.}, \text{ то } \varphi(l) = \frac{l - l_{н.т.}}{l_{н.т.}}.$$

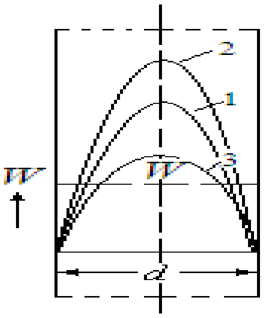
Substituting into equation (1) this value of the function

we get: $\varphi(l)$, Substituting into equation (1) this value of the function

we get:

$$\frac{\bar{\alpha}}{\alpha_{\infty}} = 1 + \frac{l_{н.т}}{l}\left(\frac{\bar{\alpha}_{н.т.}}{\alpha_{\infty}} - 1\right) \qquad (2)$$

From equation (2) it follows that in long pipes $(l \succ\succ l_{н.т.})\ \bar{\alpha} \to \alpha_{\infty}$, i.e. for large l values $\bar{\alpha}$ and α_{∞} practically match. For example, if $\frac{\bar{\alpha}_{н.т.}}{\alpha_{\infty}} = 1{,}3$, then, with an accuracy of 3%, the average recoil salt coefficient α will be equal to local α_{∞} at $l = 10 l_{н.т.} = \bar{l}_{н.т.}$



Velocity distribution over the pipe section in the viscous flow of droplet liquids
1-isometric flow
2-liquid cooling
3-liquid heating

Pipe length at which, with a sufficient degree of accuracy, it can be assumed that the average concentration coefficient equal to the exchange salt coefficient at a stabilized concentration $l_{н.т.}$, Pipe length at which, with a sufficient degree of accuracy, it can be assumed that the average concentration coefficient equal to the exchange salt coefficient at a stabilized concentration $\bar{\alpha}$ Pipe length at which, with a sufficient degree of accuracy, it can be concentration coefficient equal to the exchange salt coefficient at a stabilized concentration α_{∞} ,commonly used in practical calculations of average recoil salt. Obviously, is a conditional calculated value, the value of which depends either on the accuracy of the analytical calculation, or on the accuracy of the experimental data. $l_{н.т.}$ commonly used in practical calculations of average recoil salt. Obviously, is a conditional calculated value, the value of which depends either on the accuracy of the analytical calculation, or on the accuracy of the experimental data.

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