So, the formula (4) has been obtained by us from the equation (1), on the basis of the study of the maximum function C_1. Then, it is checked by the immediate formulation in (3) at $H = r$).

The initial moment (e.g. the reading) time $\tau = 0$ in the sub–model (1) is taken from the start moment of the mechanism actuation of the clearance, and in the sub–model (2) – from the origin moment of the instantaneous linear source of the instant sand particles. Accordingly, x – the distance from the continuously operating impurities source, and τ – the time, which is required to be transferred the turbulent flow, having originated the linear instantaneous source at the distance x.

The sub–model 2 is based on the equation of the diffusion transport of the particles, having presented in the following form:

$$\frac{\partial C_2}{\partial \tau} = \frac{\partial}{\partial z}\left(D\frac{\partial C_2}{\partial z} - C_2\omega_z \right) + q, \qquad (5)$$

where ω_z – the speed of the downwelling vertical flow.

In the general case, $q \neq$ const. So, the dependence of q on τ can be obtained, on the basis of the sub – model 1.

The results of the numerical implementation of the model are allowed to be got the estimates of the magnitude:

$$C = C_1(z) + C_2(x, y), \qquad (6)$$

at the time moment τ_{max} depending on the model parameters V, W, D, which, in their turn, are depended on the operating principle and the design parameters of the addition of the wells sand reduction mechanism with the turbulent jets using, having generated, on the basis of the ejection.

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THE VALVE OPENING CONTROL TIME CALCULATION

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Having neglected the membrane mass with the rod and the locking – regulatory body, at moving up, the shut – off and regulating body for the Δh motion, is described by the following equation [1]:

$$\omega_K \frac{dH}{dt} = \mu_{VL}\omega_{VL}\sqrt{2gH} - \mu_{SL}(h)\omega_{SL}\sqrt{2gH_K}, (1)$$

where: $\omega_C dh$ – the volume part of the over – membrane chamber with the dh height, having filled with the water during dt; μ_{VL}, ω_{VL} – the flow rate coefficient and the inlet section of the calibrated hole; $\mu_{SL}(h)$, ω_{SL} – the flow rate coefficient and the input section of the branch hole; H_C – the head in the over – membrane chamber; $H = H_{IN} - Hc$ – the head outflow through the calibrated hole; H_{IN} – the head at the inlet of the calibrated hole.

Since the system dynamics is studied at the slight movement of the locking – regulatory body (Δh), then in order to be simplified, we linearize the non – linear equation (1). For the linearization, we'll introduce the variables deviation from the non – initial values. So, we'll denote:

$$h = h_o + \Delta h;\ H = H_o + \Delta H.$$

So, the non – linear function

$$Q_{SL} = \mu_{SL}(h)\omega_{SL}\sqrt{2gH_K}$$

we present in the following form:

$$Q_{SL} = Q(h_O; H_O) + \left(\frac{\partial Q}{\partial h}\right)\Bigg|_{h=h_0} \Delta h + \left(\frac{\partial Q}{\partial H}\right)\Bigg|_{H=H_0} \cdot \Delta H + D_2(\Delta h; \Delta H); \qquad (2)$$

where D (Δh; ΔH) – is the non – linear one, having contained the Δh and ΔH product and their degrees, which are over the first one. Because of the small deviation values Δh and ΔH, the non – linear part of the series can be neglected, and, thus, to be replaced the non – linear function by its linear approximation:

$$Q_{SL} = Q(h_0; H_0) + \left(\frac{\partial Q}{\partial h}\right)\Bigg|_{h=h_0} \cdot \Delta h + \left(\frac{\partial Q}{\partial H}\right)\Bigg|_{H=H_0} \cdot \Delta H. \qquad (3)$$

Having given, that Q (h_0; H_0) is equal to $Q_{VL} = \mu_{BL,} \omega_{BL} \sqrt{2gH}$ and substituted (3) into (1), we'll yield the following:

$$\omega_K \frac{dH}{dt} = \left(\frac{\partial Q}{\partial h}\right)\bigg|_{h=h_0} \cdot \Delta h + \left(\frac{\partial Q}{\partial H}\right)\bigg|_{H=H_0} \cdot \Delta H. \quad (4)$$

Having given, that

$$\frac{dH}{dt} = \frac{d(H - H_0)}{dt} = \frac{d\Delta H}{dt},$$

we'll yield the following:

$$\omega_K \frac{d\Delta H}{dt} = \left(\frac{\partial Q}{\partial h}\right)\bigg|_{h=h_0} \cdot \Delta h + \left(\frac{\partial Q}{\partial H}\right)\bigg|_{H=H_0} \cdot \Delta H. (5)$$

So, the resulting equation of the transient regime (e.g. the dynamics) in the coordinates' increments, we'll give the dimensionless form, by means of the h and H relative deviations introducing:

$$x_{INPUT} = \frac{\Delta h}{h_H};$$

$$x_{OUT} = \frac{\Delta H}{H_H}, \quad (6)$$

where h_H and H_H – are some constant baseline values of the water level and the moving (in our case, the head in the over – membrane chamber).

Having substituted the Δh and ΔH values, we'll get the following:

$$\omega_K h_H \frac{dx_{HX}}{dt} - h\left(\frac{\partial Q}{\partial h}\right)\bigg|_{H=H_0, h=h_0} \cdot x_{INPUT} = H_H + \left(\frac{\partial Q}{\partial H}\right)\bigg|_{H=H_0, h=h_0} \cdot x_{OUT}. \quad (7)$$

For the dimensionless receiving of all the equation terms, we'll divide it by the coefficient x_{IN} and then, having taken the Laplace transforms (e.g. the entries in the pictures, or in the operator form), we'll obtain the dynamics equation, in the following form:

$$(T \cdot p - 1)\, x_{INPUT} = Kx_{OUT}, \quad (8)$$

where $T = \dfrac{\omega}{\left(\frac{\partial Q}{\partial h}\right)\Big|_{H=H_0}^{h=h_0}}$ – the time constant, having obtained from the equation (7), by means of dividing by the coefficient at $x_{INPUT;}$

$$K = \frac{H_H \left(\frac{\partial Q}{\partial H}\right)\Big|_{H=H_0}^{h=h_0}}{h_H \left(\frac{\partial Q}{\partial h}\right)\Big|_{H=H_0}^{h=h_0}}$$ – is the transfer coefficient;

p – the symbol (e.g. the operator) of the differentiation.

The characteristic equation of the equation (8) will have the following form:

$$T \cdot p - l = 0, \quad (9)$$

whence

$$p = \frac{l}{T}; \quad (10)$$

$$\frac{\partial Q}{\partial h}\bigg|_{h=h_0,\, H=H_0}$$

Thus, from the equation (10), it is clear, that the check valve operation will be stable, if p has the negative real part. So, the time constant T, in this case, must be the negative one, i.e. the denominator $\left(\frac{\partial Q}{\partial h}\right)$ will be less than zero, in other words, it is presented itself the decreasing function.

Indeed, at the h increase, the flow rate through the calibrated hole is decreased. Thus, here, there is always observed the $\left(\frac{\partial Q}{\partial h}\right) < 0$ inequality.

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THE TECHNOLOGICAL PROCESS RESEARCH FOR WELLS' OPERATION

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It is necessary to be considered the various factors research challenge at the wells' protection process from their sanding up, for the theoretical researches confirmation.