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MODELLING OF WATER TREATMENT IN THE HORISONTAL SETTLER WITH PERFORATED PLATES

Introduction. It is well known that the horizontal settlers are very often used in the water treatment. Today the different forms of the settlers are used at the treatment plants. But the engineers face the problem of computational methods deficit. Designers need the reliable information about the efficiency of the settler which have comprehensive geometrical form and work in different conditions. To obtain this information the CFD models are most convenient.

Literature review. The process of the waste waters purification in settlers is calculated very often using the empirical models. These models do not take into account the geometrical form of the horizontal settlers and the peculiarities of the sedimentation process. [3, 5, 6]. Therefore, it is important to develop CFD models having more capabilities to simulate the process of the waste waters treatment in settlers and which do not need much computational time for running and allow to take into account the geometrical form of settlers [1,2].

The objective. The main objective of this paper is the development of the effective CFD model which allows to compute the mass transfer in horizontal settler with perforated plates.

Modeling equations. To simulate the process of the water purification in the horizontal settler the transport equation (1) is used [1, 2]:

$$\frac{\partial C}{\partial t}+\frac{\partial uC}{\partial x}+\frac{\partial (v-w_s)C}{\partial y}+\sigma C = \\ =\frac{\partial}{\partial x}\left(\mu_x\frac{\partial C}{\partial x}\right)+\frac{\partial}{\partial y}\left(\mu_y\frac{\partial C}{\partial y}\right), \qquad (1)$$

where C is the concentration; u, v, are the velocity components in x, y direction respectively; w_s – is the speed of the gravity fallout; σ is the parameter taking into account the process of flocculation and decay; μ_x , μ_y are the coefficients of turbulent diffusion in x, y direction respectively; x_i , y_i are the Cartesian coordinates.

The transport equation is used with the following boundary conditions [1, 2, 4]:

– inlet boundary: $C|_{inlet} = C_E$, where C_E is the known concentration (in the case study of this paper it is dimensionless and equal to C_E =100);

– outlet boundary: in numerical model the condition C(i+1,j)=C(i,j) is used. Here, C(i+1,j) is the concentration at the last computational cell which corresponds to the outlet boundary (this boundary condition means that we neglect the process of diffusion at this plane).

Fluid Dynamic Model. To simulate the flow in the horizontal settler the model of potential flow is used. The choice of this model is explained by low computational time for running this model of invisid flow. In this case the governing equation is [7]

$$\frac{\partial^2 P}{\partial x^2}+\frac{\partial^2 P}{\partial y^2}=0,$$

where P is the potential of flow. The components of the water flow inside the settler are calculated as follows [7]

$$u=\frac{\partial P}{\partial x}, v=\frac{\partial P}{\partial y}$$

The boundary conditions for Laplas equation are discussed in [2].

Numerical integration of the modeling equations. To solve the fluid dynamic equation of potential flow Libman method is used. The numerical integration of the mass transfer equation is carried out using four steps change – triangle implicit difference scheme [1,8]. On the basis of the developed numerical model the code was created using FORTRAN language.

Results. The developed computer model was used to compute water purification in the horizontal settler with perforated plates which are used to increase the efficiency of the settler (Fig.1). It is clear from this figure that the computational domain has the comprehensive geometrical form from the modeling point of view. Dimensions of the computational region are 20m×11m; diffusion coefficient is 0,7 m2/h, w_s=0.001m/s. In Fig. 2 the concentration field in the settler is presented. Every number in Fig.2 represents percentage from the concentration at inlet plate.

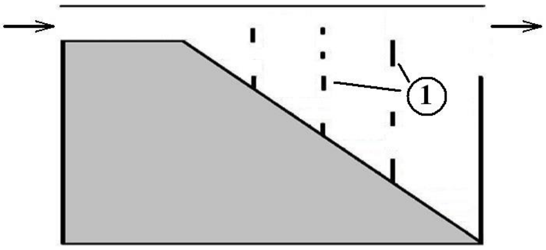

Fig.1. Sketch of the horizontal settler with perforated plates (1)

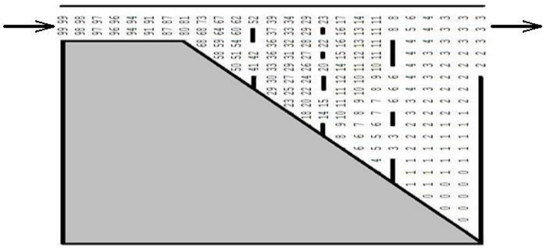

Fig.2. Concentration of contamination in the horizontal settler

We can see from Fig.2, that the concentration at the exit plane is about 2 -3% from the initial concentration at the inlet plane. The concentration near the first perforated plate is about 50%, at the bottom and it is equal to 18% near the second perforated plate. In the last, fourth part of the settler (the domain between the third perforated plate and exit plane) the concentration field is almost uniform. As we see from Fig. 2, the intensive fallout takes place in the region near the perforated plates.

The computational time to solve the problem was about 7 sec. It means that the developed computational model can be used to predict very quickly the concentration field in the settler having comprehensive geometrical form. In future the 3-D CFD model is proposed to be developed.

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НАПРАВЛЕНИЯ УСОВЕРШЕНСТВОВАНИЯ РАБОТЫ ЗАКРЫТЫХ ЦИРКУЛЯЦИОННЫХ ОКИСЛИТЕЛЬНЫХ КАНАЛОВ

Повышение эффективности работы канализационных очистных сооружений в современных условиях чрезвычайно важно как в Украине, так и во всем мире. Поступление неочищенных или недостаточно очищенных сточных вод в природные водоемы представляет опасность для окружающей среды.

Для механической и биологической очистки хозяйственно-бытовых и близких к ним по составу производственных сточных вод на существующих канализационных очистных сооружениях используются закрытые циркуляционные окислительные каналы. Закрытые циркуляционные окислительные каналы эксплуатируются на существующих канализационных очистных сооружениях, в районах со среднегодовой температурой ниже +6ºС, при этом не требуется первичного отстаивания сточных вод, что значительно упрощает технологическую схему очистной установки [1-3].

Проведенный анализ существующего положения очистки хозяйственно-бытовых сточных вод в закрытых цирку-