MATHEMATICAL MODELLING OF DYNAMICS OF RIVER POLLUTION PROCESSES

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The paper is focus on two mathematical models to describe processes of river water pollution by point sources.

The first model [1] bases on the partitioning of the river on small elementary areas (clusters). In that case, the only one pollution source is taking into account and only one function of water quality indicators is considered as changeable, but all the hydrological characteristics of the cluster are considered as unchangeable. This mathematical model is defined by the system of linear differential nonunion equations. The system of linear differential nonunion equations is developed for each cluster.

On the next step, solutions to satisfy the earlier defined condition are

searching, taking into consideration the positivity and monotonic of the solution. The time-period of pollution processes in each previous cluster depends on the time-period of the pollution processes in the following cluster. At that case, the solution for one and two-cluster models describes by elementary functions.

The second model of river water pollution processes bases on the compartment model with retarded argument [2,3]. This model is described by the system of regular equations. The differential equation of the compartment model of total mixing [3] can be determined as follow (1):

$$\frac{d(V\vec{C}^*)}{dt} = Q_{inf}\vec{C}_{inf} - Q\vec{C}^* + VR^*(\vec{C}^*, P^*), \qquad (1)$$

where $\vec{C}^*$ is a vector of the concentration of the pollutant in the compartment (averaged by volume in the compartment); $\vec{C}_{inf}$ – is a vector of the concentration of the pollutant, that comes from the point source and inflow into the compartment; Q_{inf} -- is a water volume, that inflow in the compartment; Q – is a water volume, what outflow from the compartment; V – is a volume of the compartment; R*(C*, P*) – is a vector of pollutants transformation as the result of chemical, biological and other kind of transformation.

In the research, only solutions of differential equations defined by entry data of proposed models are considered [4].

The proposed model was investigated with computer algebra system *Mathematica* (version 6.0).

References

1 Мокін, В. Б. Математичне моделювання процесів забруднення та очищення річкових вод : автореф. дис. ... канд. тех. наук / В. Б. Мокін, Вінниця, 1999.– 19 с.

2 Golovanov, I. Modelling of strategies of water reservoir management under impact of accidental radioactive contamination / I. Golovanov, V. Sizonenko, M. Zheleznyak // Proceedings of international conference on aspects of conflicts in reservoir development & management, city university, London, 1996. / City University. -- London, 1996. – P. 433–442.

3 Сизоненко, В. П. Метод та засоби прогнозування розповсюдження радіоактивних забруднень в проточних поверхневих водоймищах з урахуванням режимів роботи АЭС і ГЕС : автореф. дис. … канд. тех. наук / В. П. Сизоненко, Київ, 2008. – 18 с.

4 Chichurin, A. Mathematical Modelling of the River Pollution by Emergent Pollutants / A. Chichurin, Y. Vystavna // Computer Algebra Systems in Teaching and Research (Mathematical Physics and Modeling in Economics, Finance and Education). / WSFiZ. – Siedle, , 2009. – P. 26–29.