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Approaches to the simulation of microbiological wastewater treatment using cellular automata

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Abstract

The article discusses an approach to modeling microbiological wastewater treatment using simulation modeling by cellular automata. A model of the evolution of one type of microorganisms in a nutrient medium has been built and its research has been conducted by means of a numerical experiment. Non-colony-prone microorganisms and having the same scale in all dimensions were taken as model microorganisms. Nutrient medium is adopted single-component and having a uniform initial distribution. The influence of the size of the cellular automaton field and the characteristics of the division of bacteria on the parameters and behavior of the system was investigated. It was determined that, when using periodic boundary conditions, the scale of the field, when its size is more than 20×20 cells, does not affect the evolution of the system. The bacterial reproduction rate affects both the appearance of the concentration curves of bacteria and the nutrient component, as well as the internal parameters of the model, such as the average return of bacteria and the supply of nutrients accumulated by bacteria. The rate of decrease in the concentration of the nutrient increases until the maximum concentration of bacteria is reached, then there is an inflection point and then the decrease in the concentration of the nutrient medium is approximately exponential. The advantages/disadvantages of this approach and its applicability to specific phenomena and technological processes are given, which, in addition to microbiological water treatment, include the processes of biodegradation of toxic substances, industrial and food waste, the death of microorganisms upon contact with a toxic substance. The source code of the program that implements the simulator model is written in Python and is freely available.

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