Biofouling on water intakes and fight against them

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Abstract. Relevance of the research is caused by high costs of maintenance for Dreissena removal from water inlets of a water intake system. In this regard, the article is directed to the development of the technology and the technological scheme of biofouling prevention on water intakes. The main approach to this problem research is the development of the technology and the technological scheme of biofouling prevention on water intakes.

1. Introduction

Pipelines on water intakes (especially on the regulated sources) are subject to internal fouling by hydrobionts most of which are often Dreissena mollusks. Fouling often happens to be considerable. It leads to critical losses of pressure in the water intake soaking-up system and threat of pump stations laying-off. Driyssena larvae seldom move independently in the water supply system, generally under the water flow influence.

The Dreissena layer on internal walls of pipelines reaches 7...10 cm, and the mass of fouling up to 7 kg/m². At such fouling the hydraulic resistance of pipelines significantly increases. It attracts additional expenses of the electric power on water supply. In this regard fight with Dreissena on the operating water intakes is to be considered not only as an instrument for ensuring of uninterrupted water supply, but also as a measure of economy of the electric power. So it is seen to be important to prevent entry of hydrobionts in water intakes.

The scale of annual expenses for fight against Dreissena is impressive. According to the experts of the U. S. Congress additional costs of maintenance for Dreissena removal were more than 3 billion dollars in 1993-99. On average, a total of 376,000 $ is spent on protection against biofouling of one power station in the United States, and 822,000 $ for a nuclear power plant.

2. Formulation of the problem.

Small microorganisms (fungi and bacteria) begin the process of new surfaces colonization. They cover very quickly all available surfaces of pipelines, forming a thin film similar to a transparent gel. Biofilm reduces the efficiency of heat transfer process and promotes large microorganisms (mollusks and algae) attachment.

Weak tendrils of larvae cannot be fixed on the walls of the tubes without biofilm and will be carried away outside by water flow.

As it is known, the bacterial membrane is semipermeable.

If you electrically "charge" the bacteria flowing through the pipe-line, then the water molecules align themselves around it, forming several ordered layers of pure (on the molecular level) water (Figure 1) around the bacterium.
Figure 1 – Scheme of a bacteria "charging", where water molecules are polarly aligned

There is osmotic pressure that makes water molecules penetrate the membrane into the bacterium from all sides. It instantly leads to rupture of its membrane.

3. **Discussion of the results**

Internal surfaces of the pipelines are proposed to impart a weak positive charge. Due to the attraction of water molecules to charged surfaces, several stable layers are formed from identically oriented water molecules (Fig. 2).

Figure 2 – Scheme of microbial fixation preventing on the walls of pipes

The proposed scheme of preventing water fouling is shown in Figure 3.
Thus, several layers of pure (on the molecular level) water are created on the surfaces of the pipelines. They represent a stable barrier to fungi and bacteria, which prevents the microorganisms from fixing on the surface.

Consequently, suppressing the bacteria themselves and not allowing them to fixate on the walls of the pipelines, biofilm formation is prevented. Protector provides protection of anode fracture of the pipeline.

Similar to bacteria and particles of pollution, the Dreissena larvae and other microorganisms are also electrically charged. As a result, the larva cells begin to experience a high external osmotic pressure and, as already shown above, they will be surrounded by pure water layers (Figure 4).

As a result, the larvae metabolic processes will be disturbed. The cell, trying to stabilize the internal pressure, will continuously eject its cytoplasm into external environment, receiving only pure water instead of nutrients.

At the same time, some of the cells immediately die of osmotic pressure drop, while others cannot normally function.

4. **Conclusion.**

Physical ways to prevent fouling by Dreissena appear to be promising because of their non-reagency and safety for the environment.

The required DC power for processing will be about 1 kW at a current density of 0.5 A/dm².
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