TECHNICAL AND ECONOMICAL CONCEPTS IN USING THE WASTEWATER TRANSPORT PIPES AS A PRE-TREATMENT METHOD

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Numerous examples show that the dispersion and mass transfer of gas into a liquid mass are two important coefficients. This study considers a circular pipe through witch a homogenous fluid (clean water) flows and we will study the oxygen mass transfer from gas into liquid along the transport pipe. This method has an important impact over reduction the design costs of wastewater treatment plants.

Keywords: wastewater treatment, oxygen dispersion, modelling, simulation.

1. Introduction

The aim of this paper is to implement a modern technology for wastewater pre-treatment in main sewer, using alternating aerobic/anaerobic zones, so that organic and nutrients loadings decrease, relieving wastewater treatment loadings. The unpleasant smells disappear and also the possibility of toxic gases release.

Also in the future, this solution may be used in the aeration of natural streams for improving water quality and for stopping the unpleasant effects of eutrophication process. This method may be applied for the treatment of agriculture waters before they reached the natural streams.

In addition to water, soils are also conveyed in channels. Regardless of their origin and performance, these solids are referred to collectively as sediment.

The sediment in alluvial channels consists of mineral and organic matter. The organic sediment originates from a wide variety of wastes discharged mostly through the sewers of major settlements into the steams. Since the appearance of wastes, that is, of organic sediment, is irregular, being limited to certain occasions, and their movement is of a random character, studies concerned with sediment transportation in streams focus their attention exclusively on the mineral matter.

Most sediment transported in alluvial channels are of natural-mineral origin. The laws governing their movement apply, however, to the movement of other solid granular material as well. This circumstance is exploited in laboratory experiments where granulated coal, glass or even synthetic material is used to

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study the transportation and movement of a wide variety of granular materials is designed with due consideration to the laws governing the movement of natural sediments.

In early hydraulic engineering, sediment transported streams gave rise to numerous difficulties, but the full significance of sediment transportation in alluvial channels was not realized.

The interest devoted to sediment transportation in streams increased with the projects in hydraulic engineering becoming more ambitious and with the methods and procedures of water management becoming increasingly sophisticated.

The problems of sediment transportation are of a highly complex character. The origin of sediment is difficult to trace, since large areas and many aspects of human activity are involved. The phenomenon responsible for the appearance of sediment is erosion, so that the relevant problems are consequence for agricultural and forest areas alike as well as for the safety and continuous existence of human settlements and wide variety of structures.

The sediment, once born, may be set into motion by a suitable transporting medium, and this movement, just like the origin, may give rise to a variety of problems. Numerous transporting media are conceivable, but the present considerations will be restricted to water. Over the headwater reaches of rivers large boulders may also be transported, especially at times of floods, and the hydraulic engineering structures there may be severely damaged or even destroyed thereby.

On the other hand, the problems caused by the fine suspended sediment may prove equally serious. Reference is only made here to industrial and communal water supply, were once of the gravest problems is the removal of suspended particles.

Problems are encountered finally when the sediment is deposited either temporarily or permanently. The deposit sediment may cause unwanted silting in streams, while at times of floods it may cause serious damages within the flood bed and in human settlements alike. In many instants the operation of reservoirs may be jeopardized by settling sediment and, where rivers discharge into major streams, even the recipient may be gradually filled.

Urban area and industrial activities generate, depending on the processes, different pollutants which are discharged in sewage network and transported by wastewater. The ending goal of wastewater treatment is protection of environment by obtaining treated water according to legislation limits.

The costs of wastewater treatment lead to high prices paid by population and economic agents. Researchers try to find new solutions for advanced wastewater treatment. Generally the wastewater treatment and sludge handling capacities are overrun in many towns. A modern solution, identified in last years is use of sewage network as pre-treatment wastewater treatment.

During wastewater flow in sewer there are mass transfer and reaction between constituents. Because of continuous flow of organic matter there are chemical and biochemical processes:

- ✓ suspension biomass grow and it decompose organic matter; for intensifying this process air is injected in water into main sewer;
- ✓ on the pipe walls there is biological film that is aerated or not and it decompose organic matter;
- ✓ there are sedimentation processes that create deposits in which biological processes appear for decompose organic matter
- ✓ there are mass transfer processes – for example oxygen in water- next to biological film and processes of release gases due to biological processes
- ✓ suspension loading of wastewater varies because of sedimentation and deposits entrainment at high flowrates
- ✓ there are interactions between wastewater, biological film on the wall and gaseous medium at the upper part of sewer
- ✓ the biological film detached from the wall is entrained by wastewater and this process will intensify biological processes

2. Mathematical modelling of oxygen dispersion wastewater transport pipe's

We consider a circular pipe thru witch flows a homogen fluid (clean water). We study the oxygen transfer from the air into the liquid masse thru wastewater transport pipes.

For the FlexPDE modelling we have used the experimental dates for the retention hydraulical time, dates acquire from the experimental installation existed in the Laboratory of Poliphasic Fluids and wastewater treatment, from the faculty of Power Engineering, University Politehnica of Bucharest. Thru this model we determine the dissolve oxygen concentration thru linear pipe. Pipe geometry: 1.2 metres length, 0.5 water height into the pipe.

The simplified schema for the FlexPDE models is presented in Figure 1.

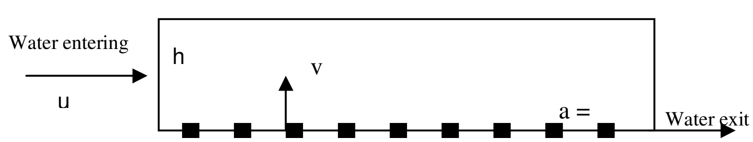

Fig. 1. Hidrotransport pipe installation for poliphasic mixt used in numerical modelling.

We observe the oxygen variation transferred from the gas into water. We consider for the numerical modelling in FlexPDE the next equation:

$$\frac{\partial C}{\partial t}-\frac{\partial^2 C}{\partial x^2}-\frac{\partial^2 C}{\partial y^2}-u\frac{\partial C}{\partial x}-w\frac{\partial C}{\partial y}-k_2(C_S-C)-kC^2-k_1L-D_1\frac{u}{a}=0 \tag{1}$$

This program is used to resolve the derivate partial equations by finite method element.

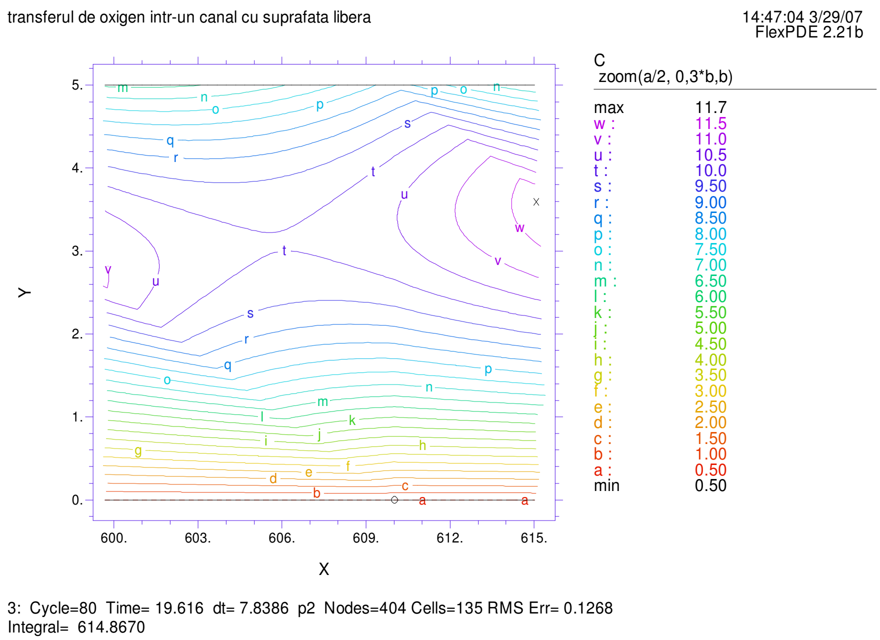

Fig. 2. FlexPDE numerical modelling, for different parameters (molecular diffusivity D, pipe longer a, aeration coefficient k_1, oxygenation coefficient k_2)

After the modelling in FlexPDE we observed:

- ✓ It is necessary to make an intense aeration, at lower oxygen coefficient k_2, the mathematical model is stopped and the maximum value in these point of oxygen concentration is around 2 mgO_2/l. For values of $k_2 > 1000$ the modelling has a positive end and the values are close to saturation concentration.
- ✓ The oxygen concentration repartition is different in rapport with pipe's length. At higher values of pipe's length there is a stabilization of the model, so this solution can be used for long wastewater transport pipes.

3. Conclusions

Economic impact - From technical and economical the proposed solution should: relauching the commercial society that manufacture equipment in wastewater treatment field; reducing power consumption and increasing wastewater treatment efficiency; specialising some commercial societies in manufacturing and maintenance of pre-treatment equipment in main sewer.

Social impact - Regarding social impact the proposed solution has in view: introducing on the market of wastewater pre-treatment system in main sewer which will increase wastewater treatment efficiency, environment protection and implicit human health; realizing of the project will assure jobs for personnel and will create new jobs at beneficiaries.

Environmental impact - The proposed solution will contribute at reducing impact on the environment because of using new technology for wastewater treatment.

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