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STUDY REGARDING THE SIMULATION OF THE FLOW OF A FLUID THROUGH PIPES INTENDED FOR THE DOMESTIC WATER NETWORK, AND THE CAUSES OF THEIR DEGRADATION

Beatrice Daniela TUDOR, Dumitra STERIAN
"Dunarea de Jos" University of Galati, Romania
e-mail: beatrice.tudor@ugal.ro

ABSTRACT

A public water supply and sanitation system refers to the infrastructure and services needed to provide drinking water, and to collect and treat wastewater, in a community or geographic area. It has the role of ensuring access to safe drinking water and correctly managing liquid waste generated by the population and industry.

The paper makes a simulation, with the help of the SolidWorks program, of the flow of liquids through the pipes, and analyses the causes of the degradation of the pipes, intended for the domestic water network.

KEYWORDS: simulation, flow, degradation, program

1. General information on the water supply system

A water supply system is an important component of the hydrotechnical system, and has the role of providing drinking water, or water for other purposes, in a certain area or populated centre. It is made up of a number of elements, including:

- Raw water capture- involves the process of collecting raw water from a natural source, such as a river, lake or well. Raw water can be taken by various methods, such as surface abstraction, or through wells drilled into subsurface layers.

- Stage I pumping (if applicable): If the raw water source is at a lower level than the treatment plant or distribution network, a pumping station may be required to raise the water to the desired level.

- Supply pipes: these are pipes through which raw water is transported from the source to the treatment plant. The supply pipes are designed to ensure a continuous and efficient flow of water.

- Water treatment plant: this is a specialized installation, where raw water is treated and corrected, depending on the quality imposed on the consumer. The treatment processes can include sedimentation, filtration, disinfection operations to ensure the quality of drinking water.

The analyses to determine the values of the physico-chemical and bacteriological indicators of the water are carried out by the Drinking Water Laboratory, within the Quality Laboratory Service of the company, a laboratory that is registered with the Ministry of Health, in the Laboratory Register, which performs quality control monitoring drinking water.

- Reservoirs: these are constructions or containers, used to store the volume of water required for various purposes. The tanks provide a water reserve for emergency situations, to compensate for hourly consumption and to ensure the water required for firefighting.

- Second-stage pumping station (if applicable): If the water pressure in the distribution network is not sufficient, an additional pumping station may be required to ensure the necessary pressure in the network. In some cases, the pressure can be ensured by gravity, without the need for additional pumping stations.

- Distribution network: This consists of an extensive system of pipes and branches, which carry treated water from the treatment plant to consumers such as households, public or industrial buildings. The distribution network is designed to ensure the supply of drinking water, at the appropriate pressure and in sufficient quantity, at all points of consumption [7].

2. Simulation of fluid flow through pipes

When water moves along a pipe, the density differences can cause two phases to be distributed, in several different configurations, which can affect the operating conditions, for example: the angle of the

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pipe, and the phase velocities, which determine the distribution phases in pipelines.

A flow that is unstable and complicated, can cause damage to the pipes, but also to the circuit, due to the speed of the liquid flow.

More or less deposits can remain on the pipes, which can lead to the appearance of extreme variation over time in the cross-sections of the pipes. Phase differences, and pressure, as well as flow rates, lead to destabilization of mass transfer processes [1, 3].

At the same time, flow interruptions can cause vibrations and pressure drops, along the entire length of the pipe, causing damage to the pipe supports, as well as corrosion of the pipes, in the lower part.

The simulation of flow in pipes or rings is very important, and has wide applicability in various industries, such as chemical processes, and petroleum industries, pipeline engineering, power plants, biomedical engineering. Simulation applications are also used in engineering, micro-scale fluid dynamics studies, in food processing industries, in geothermal flows and in the extrusion of molten plastic materials.

These simulations are also used in sludge flow (water-solid) and sludge flow (water-air), with applications in various industries, aiming to reduce environmental pollution.

This type of multiphase flow occurs frequently in horizontal pipes and channels.

The liquid-solid simulation has found its applicability to slurry flows, the transport of raw materials, waste and sludge, which are in solid form, their valorisation, and in extractive metallurgy and mining factories, coal processing plants, fluidized beds, oil industries and many more [2].

The sludge transport system helps to reduce air pollution, noise, save energy consumption, and better protection from an ecological point of view.

Computational fluid dynamics (CFD) is a programming and calculation method applied to study the behavior of two-phase flows.

The modeling of two-phase flows is time-consuming and very difficult, due to the involvement of advanced physics and mathematical calculations.

The flow simulation was carried out with the help of the SolidWorks program.

SolidWorks is a computer-aided design (CAD) software used primarily in the field of engineering and industrial design. This software is known for its advanced 3D modeling and simulation features.

The program helps us to create and use three-dimensional models in the virtual environment. The program has a wide range of tools and functions. This gives us options for solid modeling, surface modeling, assembly, animation, simulation and automatic drawing generation.

It uses a feature-based approach to 3D modeling, allowing objects to be created and edited by adding, modifying, or removing specific features. This provides precise control over the geometry.

With the help of integrated simulation functions, it allows testing and validation of models before manufacturing. The simulation program enables structural strength analysis, fluid flow simulations, thermal simulations and more. Simulations provide important information to optimize the design and identify potential problems, before production [4].

We used this program because it can simulate problems related to damage to equipment, installations and operational problems with equipment such as pipelines.

Phase distribution is a key component in the design of engineering structures due to its impact on various parameters such as flow load and pressure drop.

To study the flow mode, it is important to know both the system distribution and the flow regime under different boundary conditions.

The deposits during the flow move at a higher speed than the liquid, and can initiate strong vibrations, causing equipment damage.

Deposition frequency, which is defined as the number of coalesced particles that flow over a given point in a pipeline in a given period of time, is an important factor in determining operational capacity.

The program can simulate difficulties such as pipeline vibration and instability, wellhead pressure fluctuations, and flooding of downstream facilities. High frequency of deposits can cause pipe corrosion [5].

If the concentration of pipe vibrations is high, it can be caused by an unstable flow regime, changes in flow direction, or inadequate pipe diameter.

Severe pipe vibrations can affect their operation, and this can lead to unsafe and even dangerous conditions. Until now, the studies have mainly referred to the vibration of pipes due to mechanical causes, as sources of vibrations and not deposits.

The cause of fluid vibrations in pipelines has been studied using various theoretical methods.

The first stage of the simulation consisted in the creation of the object to be tested and analysed, namely the pipe (Fig. 1).

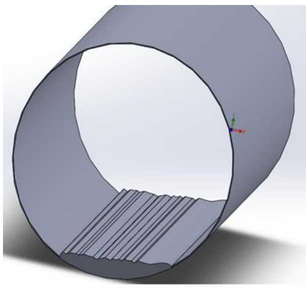

Fig. 1. *Pipe with the waste*

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For the simulation, we made a pipe with a diameter similar to that of the domestic water installation.

At the bottom of the image, depositions were simulated. I watched the impact of oxide deposits, from the lower part of the pipes.

The second part of the simulation consists in presenting the variation of the velocity of a fluid, in a parallel plane, which almost reaches the maximum diameter. The program shows us a maximum speed of 9m/s in the middle part of the pipe, where the fluid passes. Towards the side walls of the pipe, the maximum velocity of the fluid is approximately 4 m/s (Fig. 2).

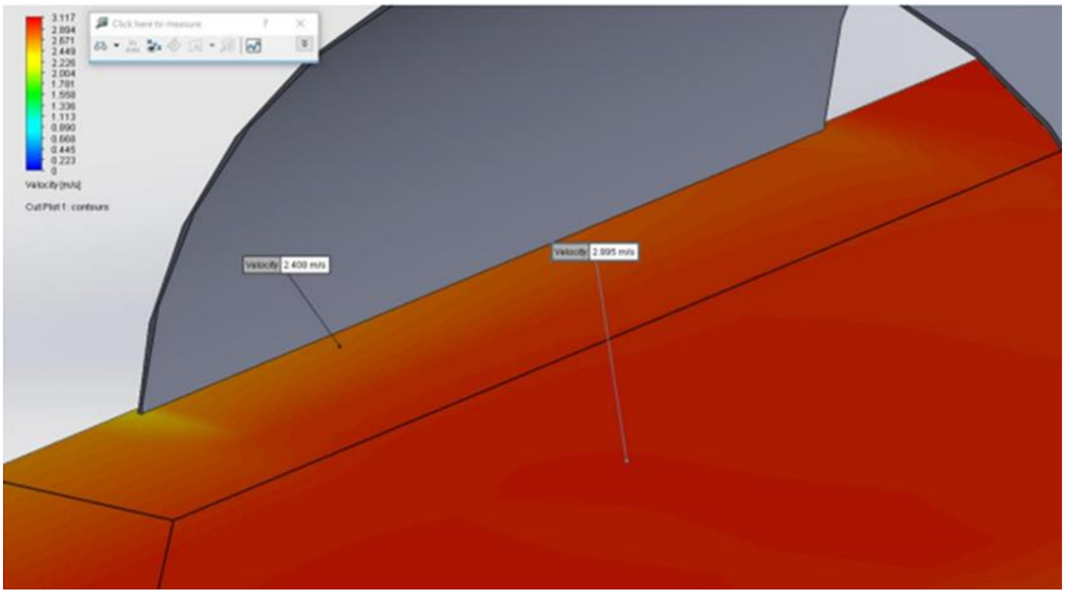

***Fig. 2.** Variation of fluid velocity in a pipe*

At the bottom of the pipe, where the deposits are located, a very large decrease in the flow velocity can be observed, which can reach up to 0.8 m/s. In this case, the pressure will be higher, which will facilitate the transport of deposits from the bottom, if they will have smaller dimensions [6].

In the captured images from the simulation program (Fig. 3), you can see the distribution of the speed of the fluid, in the time of simulation.

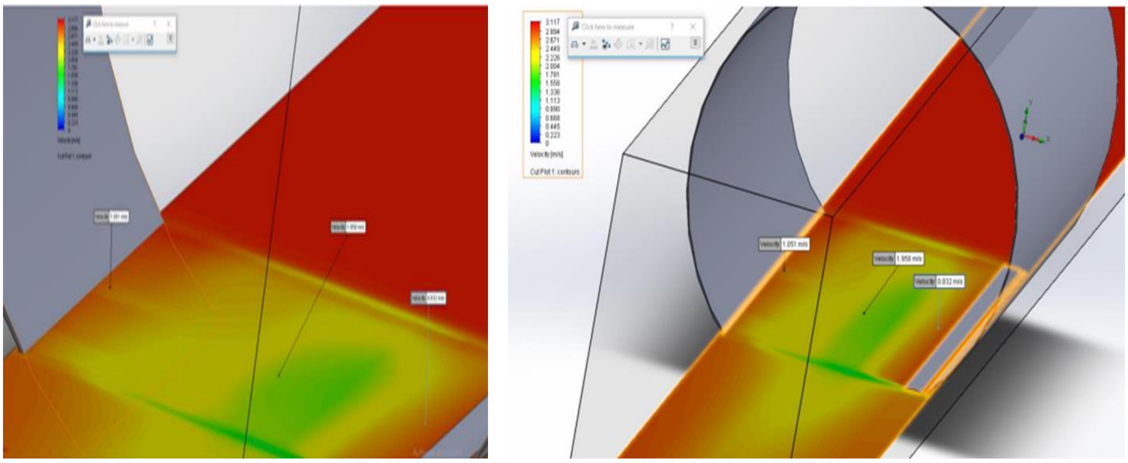

***Fig. 3.** Fluid velocity distribution*

Following the simulations, it turned out that if the pressure drops to approximately 8 %, we will have a higher consumption for water transport in the network, due to the low pressure in the pipe (Fig. 4).

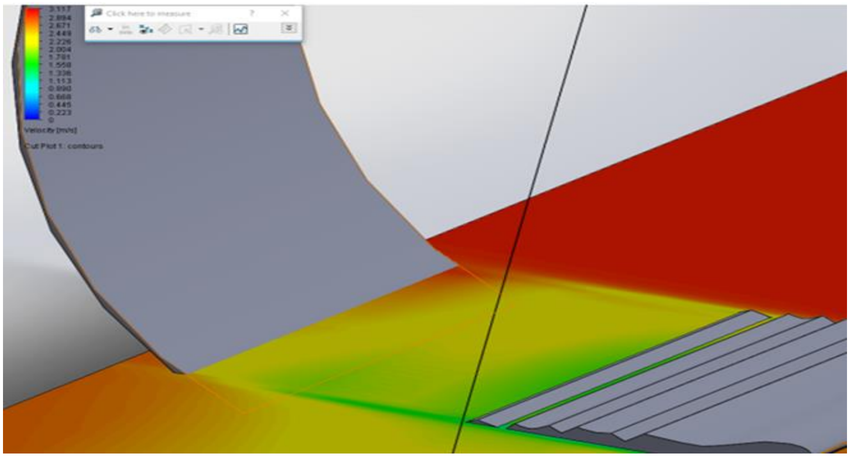

Fig. 4. *Low pressure in the pipeline*

3. Conclusions

The flow simulation was carried out with the help of the SolidWorks program.

The deposits during the flow move at a higher speed than the liquid, and can initiate strong vibrations, causing equipment damage.

The simulation consists in presenting the variation of the speed when a fluid flows, in a parallel plane, which reaches almost the maximum diameter.

Following the simulations, it turned out that if the pressure drops to approximately 8 %, a higher consumption will be induced for water transport, in the household water transport network.

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