

## ABSTRACT

For the last month, I have been working on a long project called BEI (Bureau d'Etudes Industrielles) with another ENSEEIHT student, Sarah Balland. The subject of the project is the « Modelling of Oxidation ditches in Wastewater treatment » and it was given to us by the industrial societies DEGREMONT and ITT. This study is part of a bigger project called O<sub>2</sub> STAR with groups together two public partners (INSA Toulouse and IMFT) and two private ones (ITT Flygt and Degremont). During our project we have been supported by two supervisors, A.Cocx from the INSA and D.Legendre from the ENSEEIHT. They were here to give us the main objectives of the project and to advice us in our work.

The water-treatment plants we study are based on the principle of activated muds. It is a mode of purification by free cultures. The purification by activated muds consists in mixing waste water with a bacteria rich mixture to degrade the dissolved organic matter. The aeration is very important to allow the bacteria activity and the degradation of these muds. The aeration process is achieved by gaz injectors arranged in a grid shape at the bottom of the tank, and liquid flowing over it. Those injectors generate small bubbles, wich rise into the tank and tranfert oxygen to the water before reaching the surface.

The general objective of our study is to create a simple tool to predict the oxygenation capacity of oxidation ditches. This tool must include several geometrical aspects and it should anable the user to obtain quickly, reliable results about the oxydation capacity over a large range of ditches.

At the begining of our project, we first thought about work distribution, both temporaly and between us. We decided to work together most of the time because our personal skills are complementary. Sarah has already done a practice on oxidation tanks in Sweeden, as a consequence, she is well informed on the industrial context and she masters the governing parameters of the problem. As far as I am concerned, I have been studiing two-phase flow for the last two semesters and I have good skills in this topic.

We have achieved several steps in order to cary out our project. We first made a bibliografic search so as to be aware of the past advancements about oxidation ditches and use them. We mainly studied a thesis titled « Oxygen transfer prediction in aeration tanks using CFD » written by Y. Fayolle in 2007, in which we found many information about oxdiation process. Secondly we wrote the governing equation of the flow without bubbles in the tank using the equation of momentum conservation. This equation enables to determine the longitudinal velocity of the water in the tank considering several parameters (tank length, height, roughness of the tank walls, caracteristics of the mixers).

Then we established the governing equations of the bubbles movment in one section of the ditch, considering the spiral flow phenomenon. This phenomenon is due to the upward movment of the bubbles which creates an ascending movement of the liquid cause by the drag. The water then goes back down preferentially in the parts of the tank without diffusers and thus showing a weak gas rate, i.e., in this case, along the tank walls. The spiral flow penomenon, by generating an upward fluid movement, accelerates the ascendant velocity of the bubbles and makes their residence time decrease, thus reducing the oxygen transfer to the water. This mechanism is therefore essential to

determine the oxidation capacity of the ditch.

Finally we evaluated the oxygen transfer between the air bubbles and the water to be treated. When we obtained the whole set of equations, we used the software Matlab to implement them. MATLAB stands for "Matrix Laboratory" and is a numerical computing environment and programming language. Developed by The MathWorks, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms and creation of user interfaces. The Matlab program we wrote requires a set of information from the user, such as the size of the tank and the air flow through the injectors. It gives as results the velocities of the two phases, the gas rate and the oxidation capacity of the tank both in a file and as graphic results. Those data are useful for the industrialists to characterize the oxidation capacity of the aeration tank they plan to build, and to inform their potential clients.

The trend of our results seems good even though we have not managed to use our program on an existing tank to validate them. Nevertheless we have compared the data we obtain with Sarah's data from her practice in a waste water treatment industry, and this with several fixed parameters. The results appear to be relatively similar. We can thus consider that our program gives reliable results and can be used further.

Throughout the project, we contacted our school supervisor D.Legendre to inform him with our results and ask him the main directions of advance we had to follow. We talked with him and asked for information when we faced technical problems.

In order to obtain satisfactory results for our work, we had to realize various hypotheses to simplify the problem. Some points could be reviewed to improve the program such as a more complete modeling of the spiral flow, especially the presence of bubbles in the downward part of the airlift; a more detailed study of the pressure losses due to the diffuser grids; a modeling of the spiral flow in the liquid flow direction; the influence of the mixers on the flow roughness.

As a conclusion, I must say that this long project was very enriching for me, both scientifically and personally. From a scientific point of view, I had to use my skills in two-phase flow and that enabled me to strengthen them. I learned a lot about simplifying governing flow equations by choosing the most important ones between all the flow parameters. I also improved my knowledge of Matlab programming, as well as post-treatment of the results. From a personal point of view, I learned to work in autonomy and to organize intelligently my time. I got to know where to search a solution in order to solve a technical problem when I had to face one. This project also led me to group work, with the many benefits and compromises it induces.