DHI SOLUTION

# OPTIMISING INDUSTRIAL DESIGN AND OPERATION

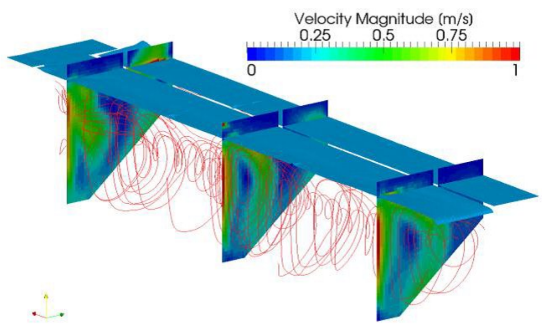
## IMPROVED HYDRAULIC SOLUTIONS WITH COMPUTATIONAL FLUID DYNAMICS (CFD)

The design and optimal operation of many industrial process units require information about the motions of liquids and gases, combined with chemical/biological processes, particle motions and physico-chemical relations. In order to facilitate a successfully optimal design, it is necessary to possess reliable knowledge about all these aspects. We can offer numerical models – based on Computational Fluid Dynamics (CFD) – that cover all these features. We have more than 30 years of experience in such detailed modelling studies. Moreover, we work in close dialogue with our clients and can customise our solutions to meet their specific needs.

In order to assess and optimise the design of industrial process units, we use CFD to model the following:

### LIQUID AND GAS MOTION

CFD modelling is considered the most exact numerical modelling tool for the analysis of flow problems. The important role of numerical simulations in the engineering design process is well-recognised. Numerical testing provides valuable information as it is conducted under controlled environmental conditions. Also, the data that it provides is many orders of magnitude higher than any complex physical model test.




*CFD simulation, stream lines and magnitude of velocity in a aerated sand and grease trap*

A key feature of CFD modelling is that it provides a complete insight into the physics of the investigated problem. Results of the model are not limited to a few measuring points, but they present a complete picture of the hydrodynamic performance, incorporating space and time variation.

## SUMMARY

### CLIENT

Any corporate body dealing with liquids and gases, such as:

- water utilities
- chemical industry
- supplier to the industry
- mining companies
- aquaculture industry

### CHALLENGE

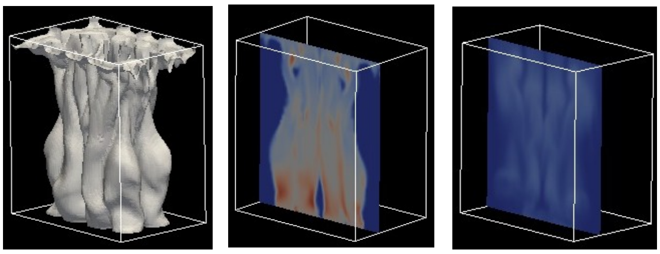
- Cost-ineffective design of industrial process units
- Lack of accurate models integrating all aspects (hydrodynamic, chemical, biological and physical) of industrial processes

### SOLUTION

Application of combined knowledge (hydrodynamic, chemical, biological and physical) in advanced Computational Fluid Dynamics (CFD) models

### VALUE

- improved performance of new constructions, leading to efficient industrial process units
- reduced costs—optimised designs save resources and energy
- time-efficiency—prior modelling eliminates on-site trial and error
- detailed insight—CFD analysis leads to understanding of bio-physico-chemical flows



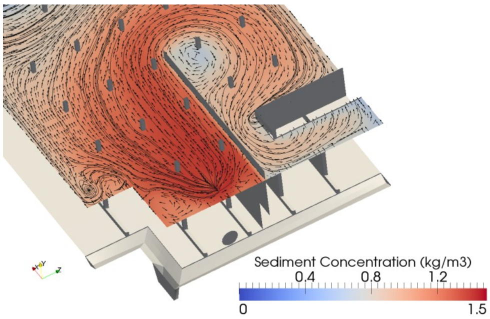
*Two-phase CFD simulation of the raise of air phase from 6 diffusors. Left figure show contour of the air phase, middle figure concentration of oxygen in the air and the right concentration of oxygen in the water*

## AERATION

Oxygen concentration is the driving force in many industrial process units. A common method of transferring oxygen to the unit is by aeration. Transfer of oxygen from the air to the liquid phase depends on several aspects such as:

- concentration of the air
- bubble size distribution
- Pressure

With CFD, we can model the variation in oxygen transfer as function of time and location. The analysis may include the assessment of bubble size distribution and estimation of breakup and coalescence between different bubble fractions.




*Calculation of sediment in a retention basin*

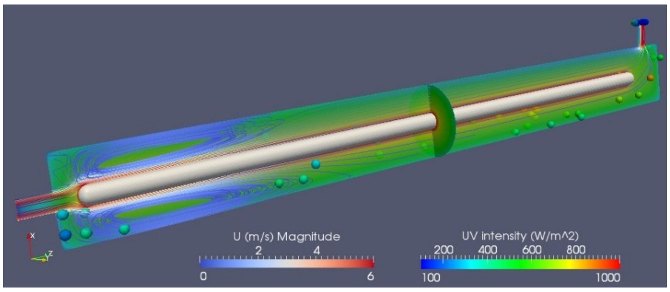
## SEDIMENT TRANSPORT

Sediment transport models can be coupled with the advanced hydrodynamic description, where transport of the sediment is calculated on the basis of an advection-dispersion model. Transport models may be based on a cohesive or non-cohesive approach and include hindered settling. Combining these models allows us to assess streamlines of the flow paths, sediment concentration contours and the quantity of sedimentation within the process unit.  It also helps us test various designs (such as, assessing the effectiveness of the given design with respect to the settling efficiency of the tank). Our services can help verify designs for a particular site during the design phase or optimise existing installations.

*Model of a secondary settling tank requires advance modeling like viscous effects (plastic behaviors), hindered settling, in order to captures the formation of a sludge blanket*

## PHYSICAL AND CHEMICAL ASPECTS

When modelling systems in the water industry, it is essential to integrate physical and chemical aspects of the water into the models. This helps us to take the hydrodynamic characteristics into account. For example, equations describing viscosity are integrated in the models to describe fluid dynamic conditions in highly viscous or non-Newtonian fluids. Another example could be the integration of the density properties of the fluid as a function of concentration or the sediment settling properties as functions of sediment concentration.




*Results of a process model, killing of biological organism by UW light. The model is based on a particle tracing model, particles conveyed by the flow and the accumulated dosis of UW lighting is calculated for the individual particles.*

## BIOLOGICAL/CHEMICAL MODELLING PROCESSES

One of the targets of models of industrial process units is to describe the distributed characteristics of a population of microorganisms (it could be growth, products or death). A major challenge in modelling these biological processes is that a complete description of all phenomena that occur in an industrial process unit may result in models that are too complex. It is important to limit the complexity of these models to a bare minimum. We have the requisite experience in doing just that. We work on models for a wide range of applications – from wastewater treatment plants to fermentation tanks. We can also tailor our approach to any given problem.

Contact: Lars Yde - lay@dhigroup.com
For more information visit: www.dhigroup.com