COMPUTATIONAL FLUID DYNAMICS (CFD) STUDY OF THE BIOLOGICAL REACTOR OF THE WASTEWATER TREATMENT PLANT OF ROLDÁN, LO FERRO AND BALSICAS (SPAIN)

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Abstract The hydrodynamic study of a biological reactor allows the detection of dead zones or preferential flow paths that reflect hydrodynamic deficiencies in its operation. The purpose of this study is to evaluate the hydrodynamic behavior, for the design flow, of a biological reactor type A2O of the Roldán, Lo Ferro and Balsicas Wastewater Treatment Plant. The FLOW-3D software has been selected to analyze the three-dimensional operation of the anaerobic chamber for an inlet flow of 2,750 m^3/day. The influence of the turbulence model and the mesh size in the hydraulic retention time have been investigated.

Keywords: Wastewater Treatment Plant (WWTP), biological reactor, hydrodynamic, Computational Fluid Dynamics (CFD).

Methods

A three-dimensional numerical model has been developed in FLOW-3D for the anaerobic chamber of a biological reactor. The main characteristics are:

Structured mesh:

- Different mesh sizes (0.6 m, 0.5 m, 0.4 m)
- Nested mesh blocks in the bottom orifices and in the inlet (mesh size of 0.1 m)

Boundary conditions:

- Inlet: constant flow condition of 0.032 m^3/s.
- Outlet: hydrostatic pressure considering the fluid elevation at 5.49 m.

Turbulence models:

- *k-ε* model.
- Re-Normalisation Group (RNG) *k-ε* model.
- The laminar flow behavior has been also analyzed.

Numerical probes:

- One probe in each bottom orifice

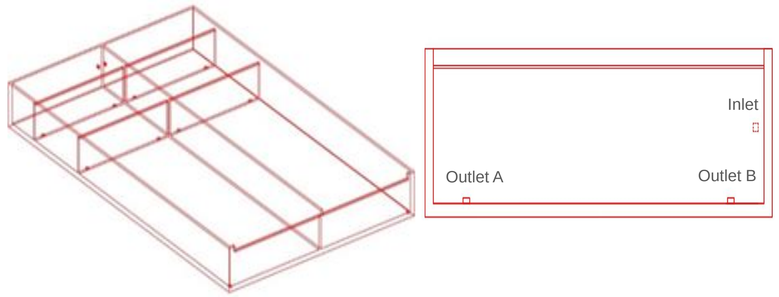

Figure 1: 3D view (left) and front view (right) of the biological rector.

Results

•The reduction of the mesh size tends to diminish the Hydraulic Retention Time (HRT) in the probe A and to increase it in the probe B.

•The RNG *k-ε* tends to obtain the larger retention times in the outlet B, while the laminar flow cases obtain the higher HRT for the finer meshes in probe A.

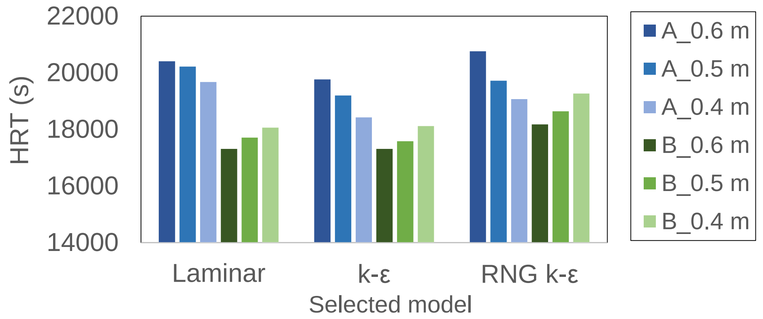

Figure 2: Hydraulic retention time in the probes as a function of the mesh size and the turbulence model.

•Differences between mesh sizes of 0.5 and 0.4 m are smaller than 5% in all the cases.

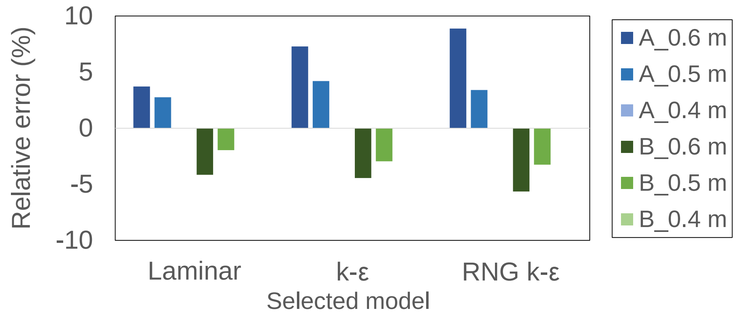

Figure 3: Relative error with respect to the finest mesh.

Similar retention time distributions may be observed for the *k-ε* model and the RNG *k-ε* models, with a large dead zone in the vicinity of the outlet B due to the recirculation of the flow.

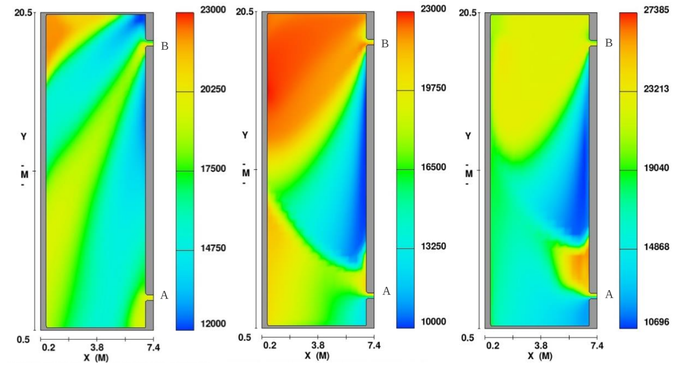

Figure 4: Hydraulic retention time for a horizontal plane located at the bottom outlets level with mesh size of 0.4 m: laminar model (left), *k-ε* model (center), RNG *k-ε* model (right).

Conclusions

Studying the hydrodynamics of a biological reactor is essential to improve the efficiency of the purification process. However, those results need to be validated against measurements in prototype and/or in a scaled model.

Bibliography

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