*Desalination and Water Treatment*
www.deswater.com

doi: 10.5004/dwt.2021.27708

237 (2021) 1–17
October

# Experimental and numerical studies on predicting and improving the full-scale wastewater treatment plant hydrodynamics

Rahim Şibil[a,*], Egemen Aras[b], Murat Kankal[c]

[a]*Department of Civil Engineering, Faculty of Engineering and Natural Sciences, University of Gümüşhane, Gümüşhane 29100, Turkey, email: rahimsibil@gumushane.edu.tr*
[b]*Department of Civil Engineering, Faculty of Engineering and Natural Sciences, University of Bursa Technical, Bursa, Turkey, email: egemen.aras@btu.edu.tr*
[c]*Department of Civil Engineering, Faculty of Engineering, University of Bursa Uludağ, Bursa 16059, Turkey, email: mkankal@uludag.edu.tr*

Received 27 January 2021; Accepted 12 August 2021

**ABSTRACT**

This paper presents the results of both experimental and numerical studies on biological wastewater treatment plant (WWTP), oxidation ditches (OD) hydrodynamics to design and develop the desired flow conditions of the WWTP. Computational fluid dynamics (CFD) models were developed using CFD software, ANSYS Fluent (V13) with the three-dimensional, steady, incompressible flow based on the Reynolds-Averaged Navier-Stokes equations for flow field calculations in the combined ODs. Also, three different turbulence models [standard $k$–ε (ske), renormalization group $k$–ε (RNG), and realizable $k$–ε (real)] were performed for a comparative study. The numerical model was verified based on the experimental data in the relative errors for ske, RNG, and real 13%, 17%, and 18%, respectively. According to the parametric studies, the hydrodynamic characteristics of the existing WWTP were investigated. The maximum wastewater velocity occurred at the inlet and outlet, affecting the flow field in ODs. Moreover, the water velocity decreased as it moved away from the inlet and outlet locations at vertical and horizontal. It can also be noted that there was no homogeneous flow field distribution in ODs. Because the current OD model needs improvement hydrodynamically, a new original OD geometry was presented to eliminate the hydraulic weakness of existing WWTP by CFD analysis. The new original geometry provides a more homogeneous flow field in ODs that mean it will also help treatment efficiency and energy saving according to the operating principles of this facility.

*Keywords:* Computational fluid dynamics modeling; Oxidation ditch; Turbulence modeling; Acoustic Doppler Velocimeter

* Corresponding author.