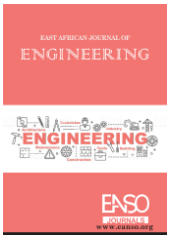
Article DOI: https://doi.org/10.37284/eaje.3.1.357



East African Journal of Engineering
eaje.eanso.org
Volume 3, Issue 1, 2021
Print ISSN: 2707-5389 | Online ISSN: 2707-5397
Title DOI: https://doi.org/10.37284/2707-5397

EAST AFRICAN NATURE & SCIENCE ORGANIZATION

Original Article

Modelling the Influence of Evaporation on Residual Chlorine in Water Storage Tanks Using CFD.

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Article DOI: https://doi.org/10.37284/eaje.3.1.357

Publication Date:

08 July 2021

Keywords:

Chlorine Decay, Water Treatment, CFD, OpenFoam, Evaporation.

ABSTRACT

Water storage tanks are usually utilized in water distribution systems (WDS) to meet the water demand fluctuations. Chlorine is the most common disinfectant used to disinfect water supplies. However, variations in the rate of chlorine decay in these storage tanks are one of the greatest limiting factors in ensuring adequate water treatment process and giving guarantee to its efficiency. These variations could be due to some inadequately tested mechanisms of chlorine reactions in bulk fluid, chlorine reactions with storage tank walls, and natural evaporation. This study presents Computational Fluid Dynamics (CFD) modelling approach to assess the influence of evaporation on residual chlorine in water storage tanks. Findings indicate that an increase in the evaporation rate accelerates the rate at which residual chlorine is lost. It is concluded that temperature is the main factor influencing evaporation, which in turn causes the disappearance of residual chlorine within the water storage tanks.

APA CITATION

Tulirinya, J., Awichi, R. O., Mbabazi, F. K., & Nagulama, M. (2021). Modelling the Influence of Evaporation on Residual Chlorine in Water Storage Tanks Using CFD. *East African Journal of Engineering*, *3*(1), 33-49. https://doi.org/10.37284/eaje.3.1.357

CHICAGO CITATION

Tulirinya, John, Richard O. Awichi, Fulgensia. Kamugisha Mbabazi, & Moses Nagulama. 2021. "Modelling the Influence of Evaporation on Residual Chlorine in Water Storage Tanks Using CFD". *East African Journal of Engineering* 3 (1), 33-49. https://doi.org/10.37284/eaje.3.1.357.

HARVARD CITATION

Tulirinya, J., Awichi, R. O., Mbabazi, F. K., and Nagulama, M. (2021) "Modelling the Influence of Evaporation on Residual Chlorine in Water Storage Tanks Using CFD", *East African Journal of Engineering*, 3(1), pp. 33-49. doi: 10.37284/eaje.3.1.357.

IEEE CITATION

J., Tulirinya., R. O. Awichi., F. K. Mbabazi., & Nagulama, M. "Modelling the Influence of Evaporation on Residual Chlorine in Water Storage Tanks Using CFD," *EAJE*, vol. 3, no. 1, pp. 33-49, Jul. 2021.

Article DOI: https://doi.org/10.37284/eaje.3.1.357

α	Phase fraction	
ρ	Density	$[kgm^{-3}]$
κ	Curvature	
k	Thermal conductivity	$[Wm^{-1}K^{-1}]$
$\mu;$	Fluid viscosity	$[m^2s^{-1}]$
$\dot{m}_e$	Rate of evaporation	$[s^{-1}]$
$\eta;$	First-order decay constant	$[s^{-1}]$
$\eta_{b;}$	bulk decay rate constant	$[s^{-1}]$
$\eta_{w;}$	wall decay rate constant	$[s^{-1}]$
$c_{p;}$	Specific heat capacity	$[Jmol^{-1}K^{-1}]$

REFERENCES

AWWARF, D. (1996). *W2 tz w. Internal corrosion of water distribution Systems, 1, 900–996*.

Batchelor, G. K. (1967). An introduction to fluid dynamics. 1967. Cambridge: UP xviii 615.

Brackbill, J. U., Kothe, D. B. & Zemach, C. (1992). A continuum method for modeling surface tension. *Journal of Computational Physics*, *100*(2), 335–354.

Chambers, A. (1995). *Booktalk*. Thimble Press.

Clasen, T. & Edmondson, P. (2006). Sodium dichloroisocyanurate (nadcc) tablets as an alternative to sodium hypochlorite for the routine treatment of drinking water at the household level. *International journal of hygiene and environmental health*, *209*(2), 173–181.

Hua, F., West, J., Barker, R. & Forster, C. (1999). Modelling of chlorine decay in municipal water supplies. *Water Research*, *33*(12), 2735–2746.

Jasak, H. (1996). Error analysis and estimation for the finite volume method with applications to fluid flows. Doctorate Thesis. Department of Mechanical Engineering Imperial College of Science, Technology and Medicine

Koutsoyiannis, D. (2012). Clausius–clapeyron equation and saturation vapour pressure: simple theory reconciled with practice. *European Journal of Physics*, *33*(2), 295–300.

Noh, Y., Kim, S.-H., Choi, S.-U. & Park, J. (2016). A review study on major factors influencing chlorine disappearances in water storage tanks. *Journal of Korean Society of Disaster and Security*, *9*(2), 63–75.

Persad, A. H. & Ward, C. A. (2016). Expressions for the evaporation and condensation coefficients in the hertz-knudsen relation. *Chemical Reviews*, *116*(14), 7727–7767.

Pickford, J. (1996). Reaching the unreached: challenges for the 21st century. *Proceedings of the 22nd WEDC Conference*, New Delhi, India, 9-13 September 1996. Water, Engineering and Development Centre, Loughborough University.

Powell, J. C., Hallam, N. B., West, J. R., Forster, C. F. & Simms, J. (2000). Factors which control

Article DOI: https://doi.org/10.37284/eaje.3.1.357

bulk chlorine decay rates. *Water Research, 34*(1), 117–126.

Rossman, L. A., Clark, R. M. & Grayman, W. M. (1994). Modeling chlorine residuals in drinking-water distribution systems. *Journal of Environmental Engineering, 120*(4), 803– 820.

Sun, D., Xu, J. & Chen, Q. (2014). Modeling of the evaporation and condensation phase change problems with fluent. *Numerical Heat Transfer, Part B: Fundamentals, 66*(4), 326– 342.

Vyzikas, T., Nilsson, H. & Andric, J. (2015). *Cfd with opensource software*. pp. 5–32.

