Hydraulic and Water Quality Modeling of Water Distribution System using EPANET-an open source package

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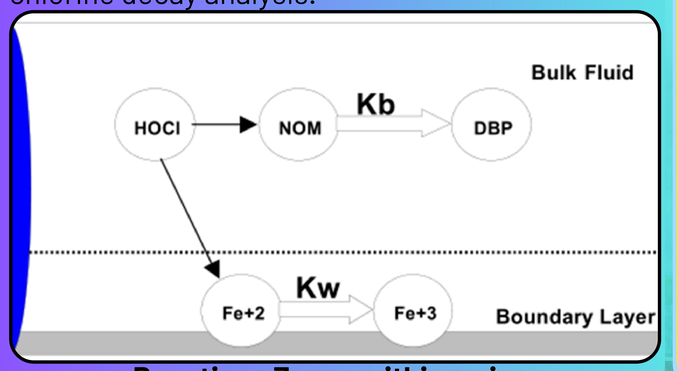
Abstract

This study outlines the learning experiences during an internship at IIT Kanpur, focusing on the project "Hydraulic and Water Quality Modeling of Water Distribution Systems Using EPANET." Water distribution systems (WDS) are vital for delivering clean water efficiently. Using EPANET 2.2, both single and extended period hydraulic analyses were conducted. The project addressed intermittent WDS modeling with EPANET-IWS, focusing on consumer adaptation to intermittent water supply (IWS). Simulations were performed on real-world rural WDS from Kerala, India, analyzing mean volume deficits at consumer nodes. Additionally, the study included quality analysis, emphasizing chlorine dosing at the source.

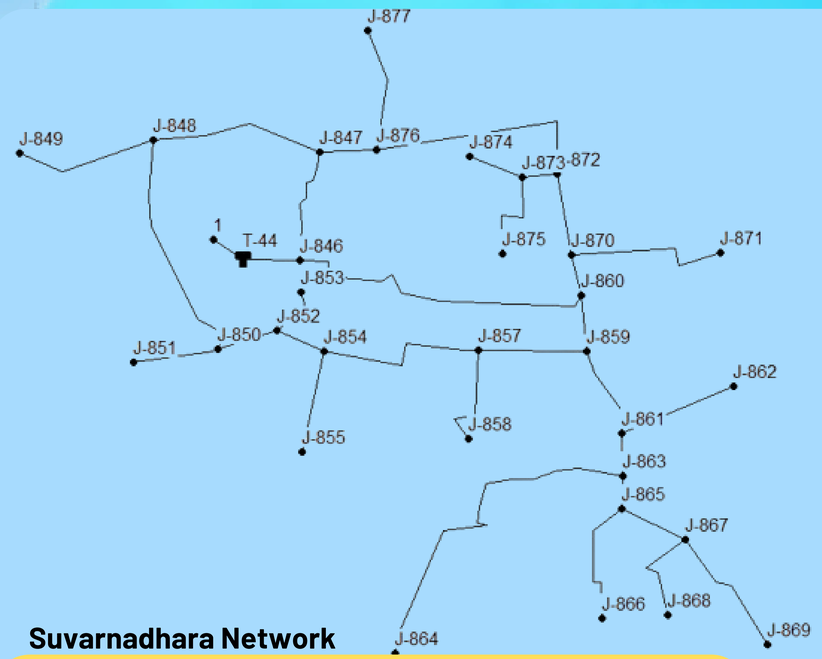
Objectives

- Model intermittent water distribution systems using the EPyT toolkit.
- Simulate real-world scenarios and perform hydraulic analysis and mean volume deficit at different consumer nodes.
- Perform water quality analysis, focusing on chlorine decay modeling.

The study done on the Suvarnadhara network, a real-world WDS in Kerela, India focus on conducting hydraulic analysis and modeling intermittent operation of WDS to perform chlorine decay analysis.



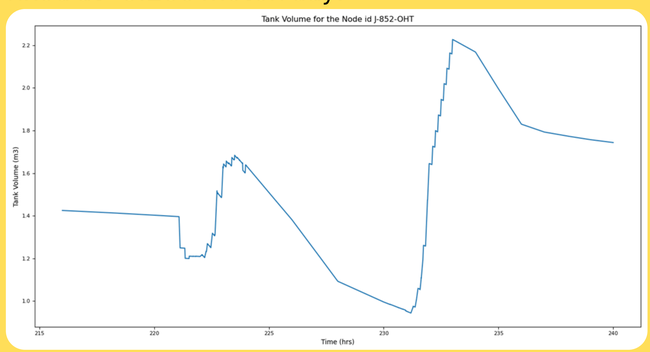
Reactions Zones within a pipe



Suvarnadhara Network

Methodology

Suvarnadhara Network: A newly designed rural WDS in Kerala, India, serving 1500 consumers across 375 houses. It includes 31 nodes, 1 tank, 1 open well, and 35 pipes. The network has two demand patterns and a controlled pumping schedule to manage limited water supply. Hydraulic analysis was conducted using EPANET-IWS to evaluate system performance. For this network, modifications included adding pseudo nodes, artificial overhead tanks, and pseudo pipes to represent consumer points and flow control valves. Water Quality analysis was done by setting the chlorine concentration of 1 mg/L at open source well. The analysis incorporated 20 different bulk coefficients. The wall coefficient was fixed at -0.209 meter/day.



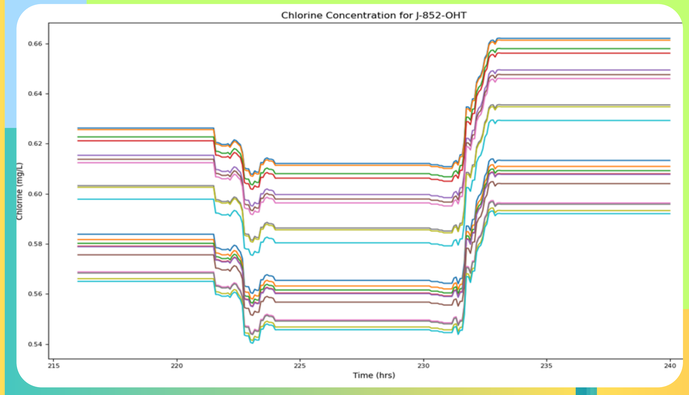
Tank Volume

Results

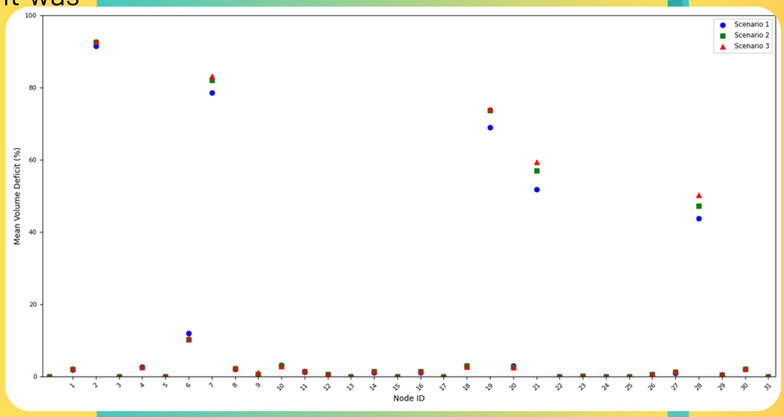
The hydraulic analysis indicates that Scenario 1, with the pump starting at midnight, results in lower mean volume deficits, suggesting better water distribution. The higher deficits at nodes 2, 7, 19, 21, and 28 are likely due to their greater distance from the main tank (T-44). Node J-852 was analyzed, showing spikes in tank volume and chlorine concentration after pump operations at 6 am and 3 pm. Figure shows that chlorine dosage varied from 0.54 mg/L to 0.66 mg/L, with tank volume fluctuations reflecting consumer water usage patterns.

Conclusion

This study conducted an extensive hydraulic and water quality analysis of the Suvarnadhara network, revealing critical insights into the performance and behavior of the system under various scenarios. The Suvarnadhara network, under IWS operation interesting dynamics were observed in the tank volume and chlorine concentration over time. This study illustrated the dynamic nature of chlorine concentration as water fills the tanks. The findings of this study underscore the importance of considering operational schedules and their impact on water quality when managing WDS.



Chlorine Concentration



Mean Volume Deficit

References

1)Abhijith et al (2023). Analyzing the role of consumer behavior in copingwith intermittent supply in water distribution systems. Journal of Hydroinformatics, 25(5), 1766

2)Abhijith, G. R., & Mohan, S. (2020). Random walk particle tracking embedded cellular automata model for predicting temporospatial variations of chlorine in water distribution systems.

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