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Review Article

Water loss from urban water supply networks and the factors affecting it

Seyed Hamid Alavi

Water Engineering and Hydraulic Structure, Faculty of Civil and Environmental Engineering, Tarbiat Modares University, Tehran, Iran.

**Corresponding Author email:* Seyedhamidalavi@modares.ac.ir

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Extended Abstract

Introduction

Water loss in urban water distribution systems is a significant issue, particularly in regions with scarce water resources. Annual water losses cause substantial damage to water resources, infrastructure, and the environment, while also imposing financial burdens on water distribution companies. Leakage, a major component of water loss, results from aging infrastructure, soil stress, traffic loads, pressure fluctuations, improper installation, and inadequate backfilling. By examining factors influencing leakage, such as pressure, pipe material, soil characteristics, and temperature, the occurrence and volume of leaks can be managed effectively. This study explores the fundamentals of water loss, its types, causes, and methods for calculating leakage, with a focus on optimizing pressure and soil conditions to minimize water loss.

Materials and Method

The study reviews existing research and experimental data to analyze the factors influencing leakage in water distribution systems. Key parameters such as pressure, pipe material, soil type, and temperature are evaluated to understand their impact on leakage rates. The relationship between pressure and leakage is examined using the orifice equation and the FAVAD (Fixed and Variable Area Discharge) theory. Experimental and field studies are referenced to validate the findings, particularly focusing on the variability of the leakage exponent (α) and its dependence on pipe material and crack geometry. Soil characteristics, including grain size distribution and hydraulic conductivity, are also analyzed to assess their influence on leakage.

Results and Discussion

The results indicate that pressure is a critical factor influencing leakage, with the leakage exponent (α) ranging from 0.5 to 2.79, often exceeding the theoretical value of 0.5. This variability is attributed to differences in pipe material, crack geometry, and soil conditions. Studies show that reducing pressure through pressure management techniques, such as pressure-reducing valves, can significantly decrease leakage rates. Temperature also plays a role, as higher temperatures reduce the viscosity of water and increase leakage rates, particularly in thermoplastic

pipes like HDPE. Pipe material significantly affects leakage behavior, with corroded steel pipes exhibiting higher leakage exponents due to reduced material integrity. Soil characteristics, particularly grain size (D50) and hydraulic conductivity, influence leakage rates, with coarser soils allowing higher leakage compared to finer soils.

Conclusion

The study concludes that effective leakage management requires a comprehensive understanding of the factors influencing leakage, including pressure, pipe material, soil characteristics, and temperature. Pressure management emerges as a cost-effective strategy for reducing leakage, while selecting appropriate pipe materials and optimizing soil backfill can further minimize water loss. Future research should focus on the impact of temperature on the viscoelastic properties of pipes, the role of soluble soils in pipe degradation, and leakage behavior at pipe joints. Addressing these factors will contribute to more sustainable and efficient water distribution systems, particularly in water-scarce regions.

Keywords: leakage management, leakage flow, Water supply network, Pressure, Crack