

Distribusi air bersih yang andal dan aman merupakan salah satu tantangan utama yang dihadapi Perumda PDAM Tirtamarta Kota Yogyakarta, khususnya dalam pengelolaan usia air (*water age*) pada jaringan pipa distribusi. Usia air yang tinggi pada sistem distribusi tidak hanya berpotensi menyebabkan penurunan kualitas air, seperti menurunnya konsentrasi sisa klorin dan meningkatnya pertumbuhan mikroorganisme, tetapi juga dapat meningkatkan risiko kesehatan bagi pelanggan akibat terbentuknya produk sampingan disinfektan maupun kontaminasi logam berat. Penelitian ini bertujuan untuk menganalisis sebaran nilai usia air pada jaringan distribusi PDAM Tirtamarta, mengevaluasi kinerja usia air eksisting, serta menyelidiki hubungan usia air terhadap parameter kualitas air pada keran pelanggan.

Simulasi dan pemodelan dilakukan secara terintegrasi berbasis GIS menggunakan perangkat lunak EPANET 2.2 yang dikombinasikan dengan QGIS melalui fitur *plugin* QEPANET, sehingga mampu memvisualisasikan dan memetakan sebaran usia air secara spasial di jaringan distribusi. Analisis penelitian ini memanfaatkan data sekunder yang meliputi karakteristik teknis jaringan pipa, data operasional sistem distribusi, serta hasil pengukuran kualitas air pada beberapa titik sampling pelanggan.

Hasil simulasi menunjukkan sebaran usia air yang bervariasi pada tiap zona, dengan rerata usia air tertinggi mencapai 17,20 jam pada *node* terjauh dari reservoir. Namun, seluruh nilai usia air masih tergolong *short* berdasarkan kriteria United States Environmental Protection Agency (US EPA). Penilaian kinerja sistem distribusi menunjukkan kategori *good performance*, dengan lebih dari 95,63% *nodes* dapat menjaga usia air pada kategori tersebut selama 24 jam. Meski demikian, ditemukan kandungan besi terlarut (Fe) melebihi baku mutu meski tidak berkorelasi signifikan dengan usia air. Hal ini kemungkinan besar diakibatkan oleh korosi pipa distribusi yang sudah tua sehingga diperlukan validasi dan evaluasi operasional lebih lanjut serta perumusan standar batas aman usia air pada jaringan distribusi sebagai upaya menjaga kualitas air di masa mendatang.

Kata kunci: EPANET 2.2, jaringan distribusi, kualitas air, QGIS, usia air

Reliable and safe clean water distribution remains one of the main challenges faced by Perumda PDAM Tirtamarta, Yogyakarta City, particularly in managing water age within the distribution pipe network. High water age in the distribution system not only has the potential to decrease water quality—such as reducing residual chlorine concentrations and increasing microorganism growth—but can also elevate health risks for customers due to the formation of disinfection by-products and heavy metal contamination. This study aims to analyze the spatial distribution of water age values in the PDAM Tirtamarta distribution network, evaluate the existing water age performance, and investigate the relationship between water age and water quality parameters at customer taps.

Integrated simulation and modeling were conducted based on GIS using EPANET 2.2 software, combined with QGIS through the QEPANET plugin feature, enabling the spatial visualization and mapping of water age distribution across the distribution network. The analysis utilized secondary data, including technical characteristics of the pipeline network, operational data of the distribution system, and water quality measurements at several customer sampling points.

The simulation results showed a varied distribution of water age in each zone, with the highest water age reaching 17,20 hours at the node farthest from the reservoir (JBD230). However, all water age values are still considered short according to United States Environmental Protection Agency (US EPA) criteria. The performance assessment of the distribution system also indicated a "good performance" category, with more than 95.63% of nodes maintaining water age within this category for 24 hours. However, anomalies were found in the relationship between water age and chlorine residual parameters that were not entirely in line with the hypothesis, so further validation and operational evaluation were needed, as well as the formulation of safe water age limit standards in the distribution network as an effort to maintain water quality in the future.

Keywords: distribution network, EPANET 2.2, QGIS, water age, water quality