INTISARI

Peningkatan efisiensi operasional turbin uap dalam pengaturan beban merupakan tantangan utama di sektor energi, terutama karena kompleksitas dan sifat non-linear antarparameter operasi. Pendekatan konvensional sering kali tidak mampu memodelkan hubungan tersebut secara akurat, sehingga diperlukan metode prediktif yang lebih adaptif dan presisi tinggi. Penelitian ini bertujuan mengembangkan model prediksi pembangkitan daya listrik turbin uap dengan konfigurasi *reheat-regenerative combined cycle* menggunakan Jaringan Syaraf Tiruan (*Artificial Neural Network*, ANN). Tahapan diawali dengan *preprocessing* data historis, termasuk penanganan data kosong dan *outlier* menggunakan metode *K-Means Clustering* dan *Grubbs Test*, serta *feature selection* berbasis *Principal Component Analysis* (PCA). Dalam hal ini, PCA digunakan untuk mengevaluasi kontribusi relatif setiap fitur terhadap *principal components*, dan dipilih 13 fitur dari 49 fitur asli berdasarkan bobot *eigenvector* tertinggi pada komponen-komponen yang menjelaskan 95% variasi data guna mempertahankan parameter fisis termodinamika turbin uap. Model ANN dikembangkan melalui skema *grid search* untuk mengevaluasi kombinasi terbaik dari algoritma pelatihan, fungsi aktivasi, serta konfigurasi *hidden layer* dan jumlah neuron. Hasil pengujian menunjukkan bahwa model optimal diperoleh dengan algoritma *Bayesian Regularization*, fungsi aktivasi *tangent sigmoid*, dan lima *hidden layer* dengan konfigurasi neuron 22–18–14–10–6. Model ini menghasilkan nilai MSE sebesar 0,00177, RMSE sebesar 0,04203, dan R^2 sebesar 0,9985, yang menunjukkan akurasi prediksi sangat tinggi dan potensi implementasi yang kuat dalam mendukung optimasi pembangkitan daya di PLTU Banjarsari.

Kata kunci: Pembangkitan Daya Listrik, Turbin Uap, Jaringan Syaraf Tiruan

ABSTRACT

Improving the operational efficiency of steam turbines in load management remains a key challenge in the energy sector, primarily due to the complexity and non-linear interactions among operational parameters. Conventional approaches often fail to accurately model these relationships, necessitating more adaptive and high-precision predictive methods. This study aims to develop a predictive model for steam turbine electric power generation with a reheat-regenerative combined cycle configuration using an Artificial Neural Network (ANN). The research process began with comprehensive preprocessing of historical data, including handling of missing values and outlier detection using K-Means Clustering and the Grubbs Test. Feature selection was then performed using Principal Component Analysis (PCA), where the contribution of each original feature to the principal components was evaluated. A total of 13 key features were selected from the initial 49 based on the highest eigenvector coefficients associated with components that collectively explained 95% of the data variance, ensuring the preservation of the steam turbine's thermodynamic parameters. The ANN model was optimized using a grid search approach to identify the best combination of training algorithm, activation function, hidden layer structure, and neuron count. The optimal model utilized the Bayesian Regularization training algorithm, tangent sigmoid activation function, and a five-layer architecture with neurons configured as 22–18–14–10–6. This model achieved an MSE of 0.00177, RMSE of 0.04203, and an R^2 of 0.9985, demonstrating excellent predictive performance and strong potential for application in supporting power generation optimization at the Banjarsari *steam power plant.*

Key words: *Electric Power Generation*, *Steam Turbine*, *Artificial Neural Network*