

ABSTRAK

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Program Studi : Teknik Industri
Judul : Optimasi Prediksi Total Spray Reheat pada Pembangkit Listrik Tenaga Uap Menggunakan Pendekatan Machine Learning Berbasis Hyperparameter Tuning
Dosen Pembimbing : Ir. Mega Bagus Herlambang, S.T., M.T., Ph.D., IPM., ASEAN Eng

Penelitian ini bertujuan untuk mengoptimalkan prediksi Total Spray Reheat pada sistem reheater Pembangkit Listrik Tenaga Uap (PLTU) menggunakan pendekatan machine learning berbasis hyperparameter tuning. Dataset operasional PLTU sebanyak 354 baris, mencakup variabel seperti Generator Load, Temp 1st Stage Superheat, Slagging Index, dan suhu reheater (TEMP RHTR TE0-TE9), digunakan untuk melatih 12 model regresi: Linear Regression, Ridge, Lasso, ElasticNet, Decision Tree, Random Forest, Gradient Boosting, AdaBoost, SVR, KNN, XGBoost, dan LightGBM. Data diolah melalui praproses, termasuk pengkodean variabel kategorikal, penskalaan fitur dengan StandardScaler, dan pembagian data (80% latih, 20% uji). Model dioptimalkan menggunakan GridSearchCV dengan validasi silang 5-lipat dan dievaluasi berdasarkan metrik Mean Squared Error (MSE), R-squared (R^2), dan Mean Absolute Error (MAE). Hasil menunjukkan SVR sebagai model terbaik dengan Test MSE 29.38, Test R^2 0.84, dan Test MAE 3.76 ton/jam, diikuti oleh XGBoost dengan Test MSE 31.52, Test R^2 0.83, dan Test MAE 3.78 ton/jam. Analisis kepentingan fitur mengidentifikasi Temp 1st Stage Superheat dan Generator Load sebagai variabel utama. Penelitian ini mendukung pengendalian reheater yang lebih presisi, meningkatkan efisiensi termal hingga 4%, mengurangi emisi CO₂ hingga 2%, dan memberikan rekomendasi untuk integrasi model ke sistem kontrol PLTU guna operasi yang lebih efisien dan ramah lingkungan.

Kata Kunci: Total Spray Reheat, PLTU, Machine Learning, Hyperparameter Tuning, Efisiensi Termal, Emisi CO₂

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Menyutujui

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ABSTRACT

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This study aims to optimize the prediction of Total Spray Reheat in the reheater system of a Steam Power Plant (PLTU) using a machine learning approach based on hyperparameter tuning. PLTU operational dataset of 354 rows, including variables such as Generator Load, Temp 1st Stage Superheat, Slagging Index, and reheater temperature (TEMP RHTR TE0-TE9), is used to train 12 regression models: Linear Regression, Ridge, Lasso, ElasticNet, Decision Tree, Random Forest, Gradient Boosting, AdaBoost, SVR, KNN, XGBoost, and LightGBM. Data are processed through preprocessing, including categorical variable encoding, feature scaling with StandardScaler, and data splitting (80% training, 20% testing). The models are optimized using GridSearchCV with 5-fold cross-validation and evaluated based on the Mean Squared Error (MSE), R-squared (R^2), and Mean Absolute Error (MAE) metrics. The results showed SVR as the best model with a Test MSE of 29.38, a Test R^2 of 0.84, and a Test MAE of 3.76 tons/hour, followed by XGBoost with a Test MSE of 31.52, a Test R^2 of 0.83, and a Test MAE of 3.78 tons/hour. Feature importance analysis identified 1st Stage Superheat Temp and Generator Load as key variables. This research supports more precise reheater control, increases thermal efficiency by 4%, reduces CO₂ emissions by up to 2%, and provides recommendations for model integration into the control system of a coal-fired power plant (PLTU) for more efficient and environmentally friendly operation.

Keywords: Total Spray Reheat, Coal-fired Power Plant, Machine Learning, Hyperparameter Tuning, Thermal Efficiency, CO₂ Emissions

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