

RINGKASAN

PERANCANGAN SISTEM MONITORING NILAI EFISIENSI TURBIN UAP BERBASIS HMI MENGGUNAKAN STANDAR IAPWS-IF97 TERINTEGRASI DENGAN PROTOKOL MQTT

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Efisiensi turbin uap merupakan indikator utama kinerja pembangkit listrik tenaga panas bumi karena berpengaruh langsung terhadap konversi energi panas menjadi energi listrik. Pada sistem Distributed Control System (DCS) PT Pertamina Geothermal Energy Area Karaha, efisiensi turbin ditampilkan melalui modul GPADCS. Namun, terdapat perbedaan antara nilai efisiensi tersebut dan hasil perhitungan manual berbasis standar termodinamika internasional IAPWS-IF97, sehingga diperlukan proses validasi tambahan untuk memperoleh gambaran kinerja turbin yang lebih akurat.

Penelitian ini menggunakan data operasional turbin uap yang diperoleh dari sistem GPADCS dalam bentuk data historis berformat Microsoft Excel. Data tersebut dihitung ulang menggunakan metode IAPWS-IF97 dengan bantuan bahasa pemrograman Python untuk memastikan konsistensi dan akurasi perhitungan. Hasil perhitungan kemudian diintegrasikan menggunakan protokol MQTT dan ditampilkan pada sistem Human Machine Interface (HMI) berbasis Streamlit secara periodik, sehingga proses pemantauan dapat dilakukan secara mendekati real-time.

Hasil penelitian menunjukkan bahwa sistem yang dikembangkan mampu menampilkan efisiensi turbin dari GPADCS dan hasil perhitungan manual secara bersamaan serta menghitung deviasi efisiensi sebagai parameter validasi. Rentang deviasi 5%–10% ditetapkan sebagai kondisi ideal, sedangkan deviasi di luar rentang tersebut dikategorikan tidak ideal. Selain itu, integrasi basis data MySQL memungkinkan penyimpanan data historis untuk evaluasi kinerja turbin berbasis waktu. Sistem ini berfungsi sebagai pendukung monitoring yang independen tanpa memengaruhi sistem kontrol utama pembangkit.

Kata kunci : Efisiensi Turbin Uap, MQTT, GPADCS, IAPWS-IF97, *Real-Time Monitoring*,

SUMMARY

DESIGN OF A STEAM TURBINE EFFICIENCY MONITORING SYSTEM BASED ON HMI USING THE IAPWS-IF97 STANDARD INTEGRATED WITH THE MQTT PROTOCOL

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Steam turbine efficiency is a key performance indicator of geothermal power plants, as it directly affects the conversion of thermal energy into electrical energy. In the Distributed Control System (DCS) of PT Pertamina Geothermal Energy Area Karaha, turbine efficiency is displayed through the GPADCS module. However, discrepancies were identified between the efficiency values provided by GPADCS and manual calculations based on the international thermodynamic standard IAPWS-IF97, indicating the need for an additional validation process to obtain a more accurate representation of actual turbine performance.

This study utilizes operational data of a steam turbine obtained from the GPADCS system in the form of historical data formatted in Microsoft Excel. The data are recalculated using the IAPWS-IF97 method with the assistance of Python programming to ensure calculation consistency and accuracy. The calculated results are then integrated using the Message Queuing Telemetry Transport (MQTT) protocol and periodically displayed on a Streamlit-based Human Machine Interface (HMI), enabling near real-time monitoring.

The results show that the developed system is capable of simultaneously displaying turbine efficiency from GPADCS and manual calculation results, as well as computing efficiency deviation as a validation parameter. A deviation range of 5%–10% is defined as the ideal condition, while deviations outside this range are classified as non-ideal. Furthermore, integration with a MySQL database enables historical data storage for time-based turbine performance evaluation. The system functions as an independent monitoring support tool without affecting the main control system of the power plant.

Keywords : Steam Turbine Efficiency, MQTT, GPADCS, IAPWS-IF97, Real-Time Monitoring