ABSTRAK

GINI MURSITO, ST. Pengaruh Fluktuasi Beban Termal Terhadap Konsumsi Listrik *Chiller* 1, 2, 3 Dan 4 Pada Ciputra World 1 Jakarta. Dibimbing oleh PROF. DR. DR. H. AMINULLAH ASSAGAF, SE., MS., MM., M.AK dan HAKIMUL BATIH, S.T., M.T., PH.D.

Operasional *centralized chiller plant* Ciputra World 1 Jakarta menyerap 20% beban kelistrikan tahunan kawasan (±69 juta kWh) yang ekuivalen dengan produksi 20 juta TRh. Dalam tata kelola kawasan komersial terpadu, deviasi efisiensi termomekanis sekecil apa pun akan secara langsung membebani Anggaran Belanja Operasional (OPEX). Penelitian ini mengevaluasi dampak fluktuasi beban termal terhadap efisiensi energi empat unit kompresor sentrifugal York 1.800 TR. Pemodelan regresi linier berkonstanta ($Y = \beta_0 + \beta_1 X$) diterapkan untuk mengorelasikan kapasitas pendinginan harian (X, dalam TRh) terhadap konsumsi daya kelistrikan aktif (Y, dalam kWh) selama 366 hari, guna mengekstraksi daya statis minimum (β_0) dan sensitivitas daya marjinal (β_1). Hasil analisis membuktikan signifikansi pengaruh beban termal terhadap konsumsi daya ($p < 0{,}001$; R^2 86,9%–92,8%). Karakteristik operasional spesifik terekstraksi melalui persamaan regresi: *Chiller* 1 ($Y = 1.102{,}69 + 0{,}584X$), *Chiller* 2 ($Y = 906{,}22 + 0{,}605X$), *Chiller* 3 ($Y = 1.600{,}70 + 0{,}549X$), dan *Chiller* 4 ($Y = 1.051{,}40 + 0{,}599X$). Komparasi empiris terhadap batas desain ideal AHRI 550/590 (0,6220 kW/TR) mendeteksi tingkat degradasi mekanis yang memicu kerugian *Cost of Poor Performance* (CoPP) asimetris. *Chiller* 4 mengalami degradasi terparah (0,6598 kW/TR) dengan kerugian Rp169.147.763,07, disusul *Chiller* 2 (0,6528 kW/TR; Rp168.217.719,44), *Chiller* 1 (0,6437 kW/TR; Rp111.793.335,65), dan *Chiller* 3 (0,6417 kW/TR; Rp87.576.998,46). Total defisit konversi daya ini memproyeksikan kerugian absolut sebesar Rp536.735.816,61 per tahun. Matriks empiris ini memvalidasi urgensi eksekusi *major overhaul* pada unit kritis dan restrukturisasi jadwal operasi (*chiller staging*) sebagai instrumen mitigasi OPEX utilitas kawasan.

Kata Kunci: *Chiller Plant, Efisiensi Energi, Regresi Linier, Cost of Poor Performance, Chiller Staging.*

ABSTRACT

GINI MURSITO, ST. The Effect of Thermal Load Fluctuations on the Electricity Consumption of Chillers 1, 2, 3, and 4 at Ciputra World 1 Jakarta. Supervised by PROF. DR. DR. H. AMINULLAH ASSAGAF, SE., MS., MM., M.AK and HAKIMUL BATIH, S.T., M.T., PH.D.

The centralized chiller plant operations at Ciputra World 1 Jakarta consume 20% of the facility's annual electrical load (±69 million kWh), equivalent to a cooling production of 20 million TRh. Within the governance of an integrated commercial development, even microscopic deviations in thermomechanical efficiency directly inflate the Operational Expenditure (OPEX). This study evaluates the impact of thermal load fluctuations on the energy efficiency of four 1,800 TR York centrifugal compressors. A constant-inclusive linear regression model ($Y = \beta_0 + \beta_1 X$) was applied to correlate daily cooling capacity (X, in TRh) against active electrical power consumption (Y, in kWh) over a 366-day window, extracting the minimum static power (β_0) and marginal power sensitivity (β_1). Statistical analysis proves the absolute significance of thermal load impact on power consumption ($p < 0.001$; R^2 86.9%–92.8%). Specific operational characteristics were extracted through the regression equations: Chiller 1 ($Y = 1{,}102.69 + 0.584X$), Chiller 2 ($Y = 906.22 + 0.605X$), Chiller 3 ($Y = 1{,}600.70 + 0.549X$), and Chiller 4 ($Y = 1{,}051.40 + 0.599X$). Empirical comparison against the AHRI 550/590 ideal design boundary (0.6220 kW/TR) detected mechanical degradation triggering asymmetrical Cost of Poor Performance (CoPP) losses. Chiller 4 suffered the most severe degradation (0.6598 kW/TR) with a loss of IDR 169,147,763.07, followed by Chiller 2 (0.6528 kW/TR; IDR 168,217,719.44), Chiller 1 (0.6437 kW/TR; IDR 111,793,335.65), and Chiller 3 (0.6417 kW/TR; IDR 87,576,998.46). This total power conversion deficit projects an absolute loss of IDR 536,735,816.61 annually. This empirical matrix validates the urgency of executing major overhauls on critical units and restructuring operational schedules (*chiller staging*) as an OPEX mitigation instrument.

Keywords: Centralized Chiller Plant, Energy Efficiency, Linear Regression, Cost of Poor Performance, Chiller Staging.