ABSTRAK

ANALISIS PENGARUH *RPM WATER PUMP* DAN DAYA *HEATER* TERHADAP PENCAPAIAN TEMPERATUR IDEAL SIMULATOR *COOLING SYSTEM*

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Sistem pendingin mesin berfungsi menjaga temperatur kerja mesin agar tetap berada pada rentang ideal 82–93°C demi performa dan keandalan yang optimal. Penelitian ini bertujuan untuk menganalisis pengaruh variasi kecepatan putaran *water pump* (RPM) dan daya *heater* terhadap perubahan temperatur *coolant*, serta menentukan kombinasi parameter yang paling efektif dalam mencapai temperatur kerja ideal pada alat *simulator cooling system*. Metode penelitian yang digunakan adalah eksperimental dengan pendekatan *full factorial* 3×3, menggunakan tiga variasi kecepatan putaran *water pump* (900 RPM, 1800 RPM, dan 2800 RPM) dan tiga variasi daya *heater* (2000 Watt, 3000 Watt, dan 5000 Watt), dengan fluida pendingin berupa campuran *Ethylene Glycol*. Parameter yang dianalisis meliputi temperatur *inlet* dan *outlet radiator*, selisih temperatur (ΔT), efektivitas *radiator* (ε), laju aliran massa *coolant*, dan laju perpindahan panas ($\dot{Q}$). Analisis statistik dilakukan menggunakan uji *Two-Way ANOVA with Replication* pada tingkat kepercayaan 95%. Hasil penelitian menunjukkan bahwa daya *heater* berpengaruh signifikan terhadap perubahan temperatur *coolant* (F = 10,1891; p-value = 0,000079), sedangkan variasi RPM *water pump* dan interaksi keduanya tidak memberikan pengaruh yang signifikan secara statistik. Secara eksperimental, putaran 1800 RPM menghasilkan distribusi panas yang paling optimal dengan nilai ΔT tertinggi sebesar 16,28–17,33°C dan efektivitas *radiator* yang paling baik. Temperatur kerja ideal hanya berhasil dicapai pada kombinasi 1800 RPM dan daya *heater* 5000 Watt, yaitu sebesar 82,6°C pada menit ke-13 dan 82,7°C pada menit ke-15. Kombinasi ini juga menghasilkan laju perpindahan panas sebesar 16,17 kJ/s dengan laju aliran massa *coolant* sebesar 0,280 kg/s. Dengan demikian, kombinasi putaran *water pump* 1800 RPM dan daya *heater* 5000 Watt ditetapkan sebagai kondisi operasi yang paling efektif pada alat *simulator cooling system*.

Kata Kunci: *Cooling system*, *water pump*, *heater*, temperatur *coolant*, efektivitas *radiator*

ABSTRACT

ANALYSIS OF THE EFFECTS OF *WATER PUMP* RPM AND *HEATER* POWER ON ACHIEVING THE IDEAL TEMPERATURE IN A *COOLING SYSTEM* SIMULATOR

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The *engine Cooling System* functions to maintain the *engine*'s operating temperature within the ideal range of 82–93°C to ensure optimal performance and reliability. This study aims to analyze the effect of *water pump* rotational speed (RPM) and *heater* power variations on *coolant* temperature changes, as well as to determine the most effective parameter combination for achieving the ideal working temperature on a *Cooling System* simulator. The research method used was experimental with a 3×3 full factorial approach, employing three variations of *water pump* rotational speed (900 RPM, 1800 RPM, and 2800 RPM) and three variations of *heater* power (2000 Watts, 3000 Watts, and 5000 Watts), using a Ethylene Glycol mixture as the cooling fluid. The parameters analyzed included *radiator* inlet and outlet temperatures, temperature difference (ΔT), *radiator* effectiveness (ε), *coolant* mass flow rate, and heat transfer rate ($\dot{Q}$). Statistical analysis was performed using Two-Way ANOVA with Replication at a 95% confidence level.The results showed that *heater* power had a significant effect on *coolant* temperature changes (F = 10.1891; p-value = 0.000079), whereas *water pump* RPM variation and the interaction between both factors did not show statistically significant effects. Experimentally, the 1800 RPM speed produced the most optimal heat distribution, with the highest ΔT value of 16.28–17.33°C and the best *radiator* effectiveness. The ideal working temperature was only achieved at the combination of 1800 RPM and 5000 Watts *heater* power, reaching 82.6°C at the 13th minute and 82.7°C at the 15th minute. This combination also produced a heat transfer rate of 16.17 kJ/s with a *coolant* mass flow rate of 0.280 kg/s. Therefore, the combination of 1800 RPM *water pump* speed and 5000 Watts *heater* power was determined as the most effective operating condition on the *Cooling System* simulator.

Kata Kunci: *Cooling system*, *water pump*, *heater*, *coolant* temperature, *radiator* effectiveness.