RANCANG BANGUN *COOLING BOX* PORTABEL BERBASIS PELTIER DENGAN *FUZZY LOGIC* DAN DAYA BATERAI UNTUK EFISIENSI ENERGI DAN PENGAWETAN MAKANAN

SKRIPSI

Diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar Sarjana Pendidikan pada Program Studi Pendidikan Teknik Otomasi Industri dan Robotika, Fakultas Pendidikan Teknik dan Industri, Universitas Pendidikan Indonesia

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HALAMAN HAK CIPTA

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ABSTRAK

Makanan merupakan kebutuhan pokok yang harus dijaga kualitas dan keamanannya. Penurunan mutu dapat terjadi akibat aktivitas mikroorganisme dan kondisi penyimpanan yang tidak stabil. Pendinginan merupakan metode pengawetan yang umum digunakan karena mampu memperlambat pertumbuhan mikroorganisme tanpa merusak kandungan gizi. Sistem pendingin konvensional umumnya menggunakan refrigeran seperti HCFC dan HFC yang memiliki efisiensi termal tinggi, namun berdampak negatif terhadap lingkungan, seperti perusakan lapisan ozon dan potensi pemanasan global. Teknologi Peltier menjadi salah satu solusi karena tidak menggunakan bahan kimia dan ramah lingkungan, meskipun efisiensinya yang masih rendah (COP < 1). Oleh karena itu, metode *fuzzy logic* diterapkan untuk meningkatkan efisiensi energi dan kestabilan temperatur. Penelitian ini bertujuan untuk merancang dan membangun *cooling box* portabel berbasis Peltier dengan kontrol fuzzy logic dan sumber daya baterai. Penelitian ini menggunakan metode *Research and Development* (R&D) dengan pendekatan eksperimental. Hasil menunjukkan bahwa nilai COP meningkat dari 0,846 menjadi 1,14 dengan tingkat akurasi 99,47% dan selisih temperatur 0,1°C dari set point. Sistem memiliki *delay time* sebesar 299 detik, *rise time* selama 872 detik, *settling time* tercapai pada detik ke-1.681 dan *peak time* tercapai pada detik ke-1.985. Sistem dengan kendali *fuzzy logi*c mampu beroperasi selama 6.029 detik (± 100 menit), lebih lama 1,81 kali dibandingkan sistem tanpa kendali fuzzy logic yang mampu beroperasi selama 3.335 detik (±56 menit), dengan selisih waktu sebesar 2.694 detik (±45 menit). Peningkatan ini menunjukkan bahwa pemilihan desain fisik, isolasi termal yang tepat serta penerapan *fuzzy logic* mampu meningkatkan efisiensi energi sistem, mempercepat pendinginan dan menjaga kestabilan temperatur di dalam box.

Kata Kunci: *Cooling Box* Portabel, Peltier, *Fuzzy Logic*, Efisiensi Energi, Pengawetan Makanan

ABSTRACT

Food is a primary necessity that must be maintained in terms of quality and safety. Quality degradation can occur due to microbial activity and unstable storage conditions. Cooling is a commonly used preservation method because it can slow down microbial growth without damaging nutritional content. Conventional cooling systems generally use refrigerants such as HCFCs and HFCs, which have high thermal efficiency but negatively impact the environment, including ozone layer depletion and global warming potential. Peltier technology offers an alternative solution because it does not use chemical substances and is environmentally friendly, although its efficiency remains relatively low (COP < 1). Therefore, fuzzy logic control is applied to improve energy efficiency and temperature stability. This study aims to design and develop a portable cooling box based on Peltier modules with fuzzy logic control and battery power supply. The research employed the Research and Development (R&D) method with an experimental approach. The results show that the COP value increased from 0.846 to 1.14, with an accuracy of 99.47% and a temperature deviation of only 0.1°C from the set point. The system achieved a delay time of 299 seconds, a rise time of 872 seconds, a settling time at 1,681 seconds, and a peak time at 1,985 seconds. The fuzzy logic-controlled system operated for 6,029 seconds (±100 minutes), which is 1.81 times longer compared to the system without fuzzy logic control that operated for 3,335 seconds (±56 minutes), with a time difference of 2,694 seconds (±45 minutes). This improvement indicates that the selection of physical design, appropriate thermal insulation, and the application of fuzzy logic can enhance the system's energy efficiency, accelerate cooling, and maintain temperature stability inside the box.

Keywords: *Portable Cooling Box, Peltier, Fuzzy Logic, Energy Efficiency, Food Preservation*

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