INTISARI

Pertumbuhan kendaraan di perkotaan meningkatkan konsumsi bahan bakar dan emisi, nilai konsumsi bahan bakar semakin tinggi pada lalu lintas *stop-and-go*. Meskipun EV dan HEV telah banyak dikembangkan, keterbatasan pasar dan infrastruktur masih menjadi kendala. Penelitian ini mengkaji *Flywheel Energy Recovery System* (FERS) sebagai solusi alternatif untuk meningkatkan efisiensi bahan bakar dan mengurangi polutan pada mobil bensin perkotaan. Tujuan penelitian ini adalah merancang implementasi FERS, menganalisis potensi penghematan energi, dan mengevaluasi efisiensi FERS menggunakan data siklus mengemudi WLTC.

Metodologi penelitian ini menggunakan studi literatur, pengumpulan spesifikasi lima mobil populer Indonesia, pemodelan dinamika kendaraan untuk menentukan rasio pengereman FERS. Perhitungan karakteristik pengereman ideal dan minimum (sesuai regulasi ECE) dilakukan. Data siklus WLTC Class 2 (LOW, MEDIUM, HIGH) digunakan untuk simulasi. Potensi daya pengereman yang dapat dibangkitkan kembali oleh FERS dihitung dengan menentukan porsi dan rasio FERS pada kurva pengereman, dengan asumsi FERS diaplikasikan pada roda depan untuk pemulihan energi maksimal.

Hasil menunjukkan FERS dapat dirancang dengan sistem dual CVT dan empat fase operasi (*Charging, Flying, Boosting,* dan *Depleted State*). Desain *flywheel* disesuaikan dengan spesifikasi kendaraan. FERS terbukti meningkatkan efisiensi energi, terutama dalam kondisi *stop-and-go* WLTC. Simulasi menunjukkan potensi pemulihan energi signifikan (1.072 kJ pada mode LOW) dan efisiensi pemulihan tertinggi pada mode LOW (61%),

Kata kunci: ***Flywheel Energy Recovery System, WLTC, distribusi pengereman***.

ABSTRACT

The growth of vehicles in urban areas increases fuel consumption and emissions, exacerbated by stop-and-go traffic. Although EVs and HEVs have been widely developed, market limitations and infrastructure remain obstacles. This research examines the Flywheel Energy Recovery System (FERS) as an alternative solution to improve fuel efficiency and reduce pollutants in urban gasoline cars. The objective of this study is to design the implementation of FERS, analyze its energy saving potential, and evaluate its efficiency using WLTC driving cycle data.

The methodology includes a literature review, collection of specifications for five popular Indonesian cars, and vehicle dynamics modeling to determine FERS braking ratios. Calculations for ideal and minimum braking characteristics (according to ECE regulations) were performed. WLTC Class 2 cycle data (LOW, MEDIUM, HIGH) were used for realistic simulations. The potential for regenerative braking power by FERS was calculated by determining the FERS portion and ratio on the braking curve, assuming FERS is applied to the front wheels for maximum energy recovery.

Results show that FERS can be designed with a dual CVT system and four operating phases (Charging, Flying, Boosting, and Depleted State). The flywheel design is tailored to vehicle specifications. FERS is proven to increase energy efficiency, especially in WLTC stop-and-go conditions. Simulations indicate significant energy recovery potential (e.g., 1,072 kJ in LOW mode) and the highest recovery efficiency in LOW mode (61%), confirming the relevance of WLTC for optimal FERS control strategies.

Keywords: **Flywheel Energy Recovery System, WLTC, braking force distribution**.