FUEL ECONOMY COMPARATIVE ANALYSIS OF CONVENTIONAL AND ULTRACAPACITORS-BASED, PARALLEL HYBRID ELECTRIC POWERTRAINS FOR A TRANSIT BUS

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ABSTRACT: Due to Internal Combustion Engines' (ICE) significant share in global energy demand, primarily through the transportation sector, great efforts are invested in research for solutions that will increase the fuel economy of ICE-powered vehicles. The main objective of the study presented in this paper has been to perform a comparative study of a conventional and a parallel hybrid electric transit bus employing an ultracapacitors-based energy accumulator. A high-fidelity simulation model of the vehicle has been designed in the AMESim multi-domain system analysis software. The conventional powertrain model has been calibrated using data obtained during an acquisition experiment conducted in real-world traffic conditions on a transit bus. This data also served as the basis for defining the driving cycle on which the numerical analyses will be conducted. A simple, sub-optimal control law has been implemented in the hybrid powertrain simulation model. Also, an advanced energy management law based on Dynamic Programming has been derived to assess the ultimate fuel economy improvement potential of the hybrid solution and to make design decisions. Initial study shows that considerable fuel consumption reduction in excess of 30% could be achieved by implementing a regenerative hybrid system employing an ultracapacitor-based accumulator.

KEY WORDS: Simulation, Transit Bus, Ultracapacitors, Dynamic Programming, Internal Combustion Engines

KOMPARATIVNA ANALIZA POTROŠNJE GORIVA KONVENCIONALNOG I HIBRIDNOG GRADSKOG AUTOBUSA SA PARALELNIM HIBRIDNIM POGONSKIM SISTEMOM

REZIME: Usled značajnog udela motora SUS u globalnoj potrošnji energije, prevashodno putem transportnog sektora, veliki istraživački napori ulažu se u povećanje energetske efikasnosti vozila. U radu su prikazani rezultati komparativne analize potrošnje goriva konvencionalnog i gradskog autobusa sa hibridnim pogonskim sistemom koji koristi ultrakondenzatore za skladištenje energije. Za potrebe ovog istraživanja realizovan je simulacioni model u AMESim okruženju. Model konvencionalnog pogonskog sistema kalibrisan je prema podacima dobijenim u toku eksperimenta na gradskom autobusu u realnim eksploatacionim uslovima. Podaci dobijeni akvizicijom poslužili su i za definisanje relevantnog voznog ciklusa koji je korišćen za numeričke analize opisane u radu. Prikazani su rezultati simulacije dobijeni korišćenjem jednostavnog zakona upravljanja radom hibridnog sistema. Takođe, u radu su prikazani metodologija i rezultati rešavanja optimalnog kontrolnog problema metodom dinamičkog programiranja. Prikazane su vrednosti maksimalno moguće uštede u potrošnji goriva kao i optimalnih projektnih parametara na osnovu izvedenog rešenja optimalnog upravljanja radom hibridnog sistema.

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Zaključak jeste da su implementacijom hibridnog pogonskog sistema na bazi ultrakondenzatora moguće uštede u potrošnji goriva i do 30%.

KLJUČNE REČI: simulacija, gradski autobus, ultrakondenzatori, dinamičko programiranje, motori SUS