ABSTRACT

This research proposes a new methodology for designing parallel shaft gearbox in passenger cars, aimed to reduce gear-shifting effort, embedding eco-design; comprising fuel economy and greenhouse gas emission as its attributes. It is a two-step design methodology; devising a neoteric shifting strategy for gear clusters selection for merging of gear ratios and refashioning gearbox architectures, compatible for intra-gear shifting. This study considers an orthodox Dual Clutch Transmission (DCT) as a reference model, on which configurational modifications are implemented through spatial rearrangement of gears, derived following the functioning pattern of shift strategy. Three shifting strategies are propounded here; Type-I through Type-III, which has been the basis for designing compatible gearbox architectures. Two architectural configurations are based on Type I and Type II shifting strategies, involving two clutches. While, two other architectural variants are configured; one with three clutches and the other with two in the case of the third (Type III) shifting strategy. Modified gear-shifting sequences and algorithms are designed to mitigate manual interference in shifting, leading to reduced shift frequency, while not compromising on the merits of using multiple gear ratios. Further, to select shift compatible gearbox, a design screening approach is adopted to ascertain the optimal ones out of several model layout alternatives created through full factorial of robust design technique. The resultant layout-based information is utilized to develop the CAD model, rendered through SolidWorks software, due to its expedient functionalities. The designed CAD models have subsequently been fielded for visualization of gear-shifting to verify the efficacy of gear engagement and disengagement operations, utilizing MSC ADAMS software. Besides visualization of virtual models, the mathematical models of the shifting strategy as well as the gearbox architectures, developed in MATLAB Simulink environment, are tested for fuel economy and emission, employing standard driving cycles, namely, 'Highway Fuel Efficiency Test (HWFET)' and 'National European Driving Cycle (NEDC)'. Test result values have been compared with the standard vehicle performance data, retrieved from the ADVISOR software. The results show that the design reduces the shifting effort by more than 46%, improves fuel economy well above of 4.6-8.7% and also, the border line overall improvement in emission is observed.

Keywords: Parallel Shaft Gearbox, Gear- Shifting Strategy, Gearbox Architecture, Dual Clutch Transmission, MATLAB Simulink and Ecodesign.

Ecodesign of the Parallel Shaft Architecture in Passenger Car Gearbox with an Embedded Effort-Reducing Strategy for Gear-Shifting

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