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TECHNICAL PAPER

A new methodology to determine typical driving cycles for the design of vehicles power trains

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Abstract Driving cycles currently available cannot be used for the eco-design of vehicles power trains because those cycles do not describe local driving patterns. The main difficulty in obtaining a representative driving cycle is the lack of a repeatable and reproducible methodology to ensure that the resulting cycle is representative of local conditions. We developed a methodology to address this need, based on simultaneous data of speed, altitude, fuel consumption and tail pipe emissions. The methodology consists of three steps: (i) route selection; (ii) obtaining a representative sample of real cycles from vehicles driven in the region of interest; (iii) identification of the typical driving cycle as the one out of the real cycles sampled, whose characteristic parameters have the minimum weighted differences with respect to the average values of all cycles sampled. This method does not require the measurement of fuel consumption nor the emission of pollutants. However, by following this method, a vehicle that reproduces the resulting cycle exhibits a fuel consumption, and tailpipe emissions similar to the average of these variables shown by the entire population of vehicles with the same technology being driven in that region. We applied it to a fleet of 15 buses of the same technology covering the same routes over 8 months, in an area of high altitude with flat and hilly terrain. Measured fuel consumption and tailpipe emissions for the resulting driving cycle were within the 4% of difference with respect to the average values of all cycles sampled.

Keywords Driving pattern · Fuel consumption · Vehicular emissions · Eco-design · Design for energy efficiency

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1 Introduction

A typical driving cycle (TDC) is a time series of speeds representing the average driving pattern of drivers in a given region. Implicitly, it describes the average workload cycle demanded to the vehicle engine by drivers in that region. Therefore, a TDC has important applications, such as vehicle powertrain design, determination of fuel consumption, and determination of vehicle tail pipe emissions [1,2].

- Vehicle powertrain design: the expected driving cycle of a vehicle defines the external dynamic loads that the engine must supply. To size the engine and appropriate transmission ratios requires knowledge of the vehicle's work cycle. Not knowing the expected driving pattern of the vehicle means designing a powertrain for any condition, leading to overdesign and higher fuel consumption.
- Determination of fuel consumption: Vehicle buyers expect the manufacturer to specify a vehicle's specific fuel consumption (SFC), in liters per kilometers or miles per gallon, obtained experimentally by repeatable procedures with results that can be replicated. However, fuel consumption depends on how the vehicle is driven. Automakers use a single arbitrary driving cycle as a basis for comparison. But the value obtained does not predict the driver's actual fuel consumption, which depends on the local average driving pattern.

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