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Influence of the automotive Start/Stop system on noise emission: Experimental study

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ABSTRACT

One of the most common environmental impacts of road transportation is the traffic noise. Linked to this, Start/Stop is a technology which has demonstrated to save fuel by powering off the engine when the vehicle is stopped, such as in front of a traffic light, and restarting the engine instantly when the driver pushes back the pedal brake to proceed. The technology helps also to reduce the CO_2 emission, playing a key role in a way to accomplish stringent emission norms for vehicle manufacturer. However, we are not sure whether it reduces the noise emission and how much? Thus, the main aim of this work is to assess the engine noise emissions of a vehicle incorporating a Start/Stop system in urban traffic, and compare it with those radiated by the mean traffic stream. Experimental results demonstrate that there are no contributions of the Start/Stop system to reduce meaningfully the engine noise in urban traffic.

The theoretical model is included to estimate the noise contribution in far field, as a part of a methodology of acoustics measurements for automotive vehicles.

1. Introduction

Reducing fuel consumption has become a priority for vehicle manufacturers, forced by the pressure of the worldwide authorities and environmental considerations, such as climate change [1]. A device which claims to reduce fuel consumption is the Start/Stop system (S/S in the following), which powers off the engine at stops as long as they accomplish certain conditions and re-start automatically when the driver needs to resume the trip. This automatic S/S system is increasingly common in American cars in recent years [1].

In an urban driving cycle, consisting of a route of 7 km and 12 stops of 15 s each, the S/S system reduced fuel consumption of a vehicle by up to 8% [2]. For example a diesel vehicle equipped with a S/S system running along two representative urban circuits (5.1 and 8.7 km) radiated to atmosphere a 20% less CO_2, in average, in comparison with a similar vehicle without the S/S system [3].

Therefore, whilst the S/S system gets a substantial reduction of fuel consumption and CO_2 emission, there are scarce published data that demonstrate whether it produces any beneficial effect on noise emission. Traffic noise is the most extensive cause of environmental health problems in the world. For instance, about 210 million of EU citizens, over 44% of the EU population, are regularly exposed to road traffic noise which is above the level considered as healthy by the World Health Organization (WHO) considers to pose a serious risk to health [4]. In urban environment, the number of people exposed to road noise is at least 5 times greater than all other sources (railways, airports, and industry) [5]. Reducing emission noise from vehicles is therefore a public health imperative. It is also far cheaper than the cost of in mission noise control techniques, such as noise barriers, insulation and quiet surfaces. The costs of these noise control techniques per person protected are, on average, between 8 and 120 times more expensive than those for making vehicles quieter [6].

Nowadays the vehicle fleet is increasingly growing in urban environment, so that a sustainable acoustic environment has turned out to be a key issue and a technological challenge [7]. Many efforts have been made by traffic managers and vehicle manufacturers to reduce the road traffic noise. Most developed countries have established noise limits which cannot be exceeded. At the same time, noise emission limits of individual vehicles have decreased by 8–11 dB in the last 35 years [8]. However, community surveys indicate that noise annoyance in urban environments has maintained more or less constant along the last years [7]. It is argued that the significant reduction of noise emission limits of individual cars has been neutralized by the increase of the vehicle fleet.

Thus, the aim of this work is to elucidate whether the S/S system has any beneficial effect in the reduction of vehicle noise

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Table 1
Vehicle specifications.

Body style	Compact Hatchback
Engine	Intercooled Turbo Premium Unleaded I-3
Size	1.5 L
Cylinders	3
Max power	136 HP @ 4500 rpm
Max torque	120 N m @ 1250 rpm
Transmission	6 SP automatic
Drive	FWD
Gear final ration	3.42
Fuel consumption city combined	4.5 L/100 km

emission. This is carried out by measuring the engine noise emitted by a vehicle with an S/S system in an urban circuit, and comparing it with the average engine noise radiated by the same vehicle driven by a set of 3 drivers along the same circuit with the S/S system switched off. Ibarra et al. [9] proposed an on-board measurement system able to quantify the contribution of single vehicles to the road traffic noise. This system was based on the assessment of the engine and rolling noises by two microphones located inside the engine hood and close to one of the wheels, respectively [10]. This measurement system will be used here to measure just the contribution of the S/S system to the overall engine noise emission of a vehicle in an urban circuit. An analytical far field extrapolation model will be use to estimate the contribution in this situation [11].

The equipment and measurement system, as well as the complete test procedure, are described in detail in Section 2. The results from the measurements are summarized in Section 3. The predictions of far filed noise are analyzed in Section 4. Finally, the main conclusions of this study are outlined in Section 5.

According to the report "Towards the road collapse" [12], the vehicle fleet has increased considerably in Mexico, and some estimates suggest that by 2030 the vehicle fleet in the country will be about 70,192,669 vehicles. Of these, private car will be the largest category. Furthermore, according to the Mexican Association of Industry Automotive (AMIA), Mexico belongs to the club 15 countries with sales of automobiles, 86% grouped together marketing world . The INEGI reports that in 2013 are recorded over 4 and a half million cars, only in Mexico City [13].

Also, the market ratio of diesel and gasoline engines in Mexico is 5% and 95%, respectively, so that it looks rational to choose a

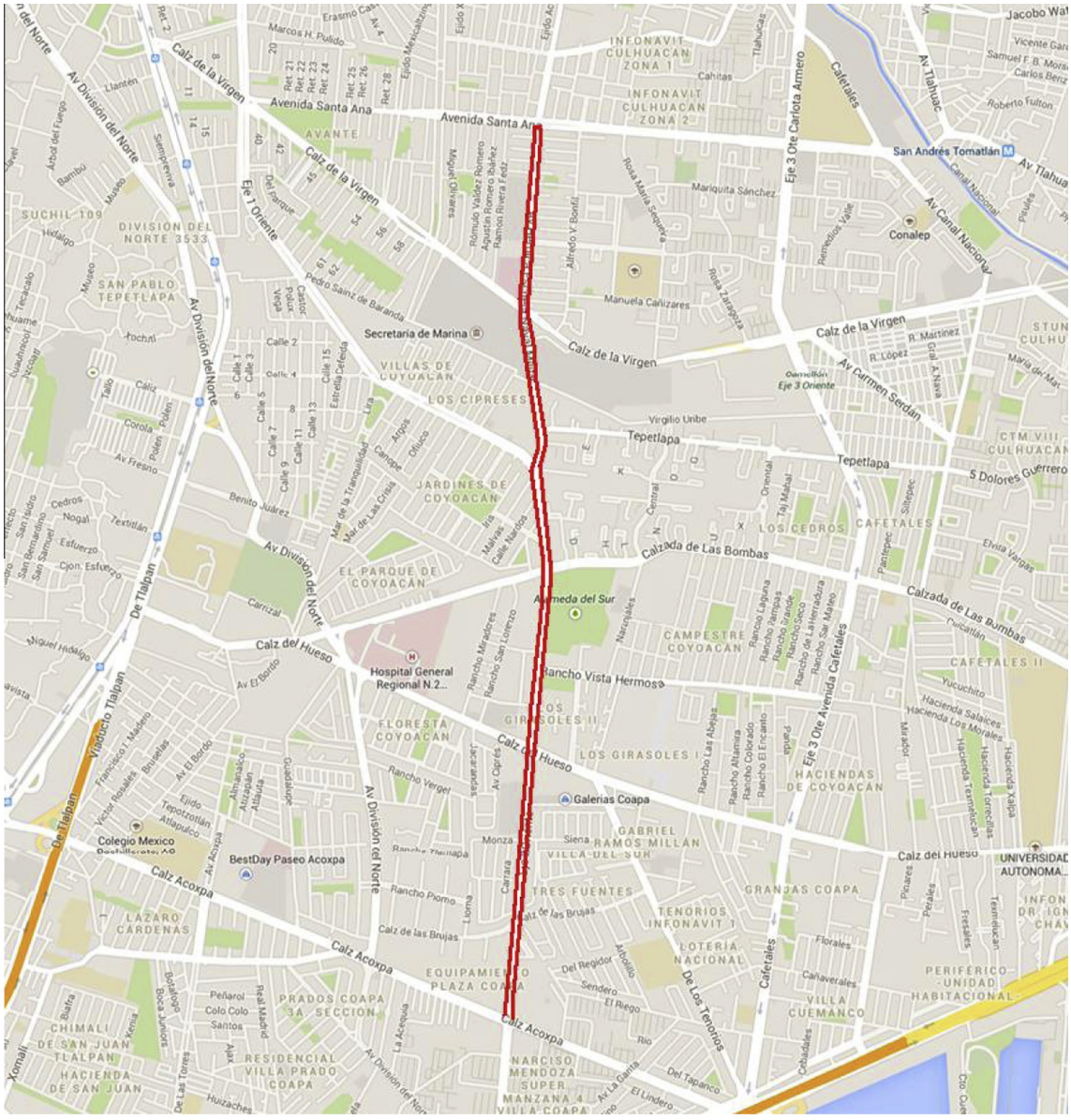

Fig. 1. Urban circuit map.

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