Identification of Influence of Vehicle Age and Accumulated Mileage on Tailpipe Emission–A Review

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Abstract

Concerns regarding the sustainability of the environment and the quality of air are becoming more prevalent as a result of the heavy reliance on fossil fuels to meet the ever-rising global energy demand. The transport sector contributes significantly to this demand growth and to the consequential global emission inventories with the rapid acceleration of global urbanization and corresponding growth in vehicle population. Pollutants produced by vehicle exhaust cause numerous environmental and health issues. Vehicle parameters, fuel parameters, vehicle operating conditions, and environmental factors are known to influence vehicle emission levels. It is expected that the engine gradually wears out and emits higher emissions as the vehicle ages and its mileage grows. In addition, due to the degradation of the engine controls, the catalyst, and possibly the particle filter, vehicle exhaust emissions tend to rise with vehicle age. The technology change also significantly affects the exhaust emission level because modern engines are different from those made in the past and must adhere to stricter emission regulations. Despite this complex influence that vehicle age and millage have on emissions, only very little research has been done to investigate the matter. The aim of this review is to identify the state-of-the-art of research studies conducted to investigate the influence of vehicle age and accumulated mileage on tailpipe emissions of different vehicle categories. Therefore, this paper presents a critical review and a synthesis of empirical studies from both developed and developing countries such as Oregon, Switzerland, Indonesia, India and China, investigating the impact of vehicle age and accumulated mileage on exhaust emissions across different vehicle categories and research purposes. Most of the studies use inspection and maintenance data for their regions for this analysis. While some studies have directly assessed the impact of these two parameters on tailpipe emissions, others have examined the relationship between them to develop vehicle failure probability models, considering emission violations. Additionally, certain studies have aimed to develop emission factors. The results of the studies commonly show a direct influence of vehicle age and accumulated mileage on tailpipe emission constituents, mainly CO, HC, and NOx for all the selected vehicle categories. These emissions tend to increase as both vehicle age and accumulated mileage increase, however, following different trends. Some studies have observed linear relationships of change in emission constituents with these parameters, while others demonstrate logarithmic or polynomial regression trends. Similar patterns have been observed in the studies for both CO and HC emission changes with vehicle age and accumulated mileage. However, one study, which evaluated the test results for bus accumulated mileage only for a 2-year span, doesn't show any clear upward or downward trend of emissions change with vehicle mileage, but only a decrease in fuel economy. Additionally, another study reveals higher emissions during idle test conditions compared to fast idle, following similar trend lines for both CO and HC change with respect to both vehicle age and accumulated mileage of different models of petrol Maruti passenger cars. In addition, one of the studies highlights that vehicles having engine sizes smaller than 2000 cc, older than ten years and odometer reading over 100,000 miles would significantly increase the

probability of identifying high polluting vehicles. Further, it shows that the increase in exhaust emissions is greater in non-passenger vehicles than in passenger cars. Compared to technological changes in vehicles, one study shows that Euro 2, 3, and 4 vehicles demonstrate emission improvements and show a linear increase in emissions with vehicle age. Nevertheless, Euro 1 vehicles still show the lowest level of stable emissions with respect to the vehicle age. In contrast, another study reveals emission improvements in Euro 1, 2, 3, and 4 vehicles in sequence, following linear emissions change with respect to the vehicle age. These findings demonstrate how newer vehicle technology has improved emissions compared to older ones. In conclusion, this review confirms that vehicle age and accumulated mileage have a direct influence on exhaust emissions, and the emissions increase as both vehicle age and accumulated mileage grow. However, due to the variation in factors such as vehicle category, emission test data, tested region, and conditions across different studies, it will not be possible to establish a common trend for emission changes or directly apply the findings to make required policy decisions to control emissions for other regions. Nevertheless, these results encourage us to carry out high-quality research in these domains to gain a better understanding of the local priorities and, consequently, design the necessary emission reduction strategies appropriate for the country. Thus, these factors must be considered for future studies.

Keywords: *Accumulated mileage, Air quality, CO, Vehicle age, HC, Health issues, NOx, Tailpipe emissions*

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