

# Real-world Vehicle Emissions in Mexico

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## Abstract

Real-world emissions are much higher in several parts of the world without evident reason. This work aims to investigate for those differences in Mexico in the way that findings can be extrapolated to other countries. We identified three fields that have not been thoroughly covered in the literature: i) Inspection and Maintenance (I/M) programs, ii) air-conditioning systems (A/C), and iii) regional-based conditions such as fuel-quality, altitude, and model-year technologies.

First, we must understand that I/M programs, which are absent in many countries, were created to identify highly polluting vehicles and force them to undergo mechanical maintenance. In this context, a methodology, based on a single measurement campaign using a Remote-Sensing Device (RSD), is presented in this work to assess the reduction in vehicles emissions obtained from implementing I/M programs. As a case study, an RSD campaign was carried out in Monterrey's Metropolitan Area, Mexico. Approximately 0.4% of the vehicles registered in this region were sampled under similar conditions to those found in I/M programs. The results suggested that 39% of the vehicles would not comply with the current national regulations. Following a conservative scenario, the implementation of a vehicle I/M program in this urban center has the potential of reducing the current mass emissions of HC, CO and NO in approximately 69%, 42% and 28%, respectively.

Second, to determine A/C impact on the real fuel consumption, light-duty passenger vehicles were monitored under their normal driving conditions in a 5-month campaign. We obtained, second-by-second, simultaneous measurements of the vehicle's fuel consumption, speed, position, engine speed and load, and the A/C operational state (on/off). The results obtained showed that the added Specific-Fuel-Consumption (SFC, L/100 km) due to the A/C peaked at low vehicle speeds (<10 km/h) with values up to 17.6 L/100 km. This increment reduces with vehicle speed, being (on average) 8.2 L/100 km for low speeds (<50 km/h) and 1.3 L/100 km for higher speeds. However, when observing this increment in terms of fuel consumption rate, those differences remained approximately constant at 0.9 L/h. Results showed that the SFC metric is naturally influenced by the vehicle's speed, hiding the real effect of the A/C fuel consumption. Therefore, we suggested to report the A/C added fuel consumption using the fuel consumption rate metric, which showed no clear relationship with vehicle speed. Additionally, we found that the A/C added load to the engine forces it to operate in regions of better efficiencies.

And third, to identify the effect of regional based conditions, results from RSD measurements obtained in four different locations within Mexico and the US were compared. Results show that fuel formulation, altitude, and vehicle age were not significant factors in the Mexico-US emissions discrepancy. It was mainly due to the notable presence of one outdated vehicle technology in Mexico. In the Mexico-City, this single vehicle technology raises the overall CO, HC, and NO emissions by 16%, 12%, and 29%, respectively.

## Keywords

Real World Emissions, Remote Sensing, I/M programs, air-conditioning, gross polluters.

## Biographies

**Antonio E. Mogro** is an automotive engineer graduated with distinction from the University of the Armed Forces ESPE, in Ecuador. He has a master's degree graduated as an honor student in automotive engineering from the Tecnológico de Monterrey. Currently, he is a PhD candidate from the Tecnológico de Monterrey where he works as an academic researcher focusing on real world vehicle emissions. He has 6+ years of experience in research centers, 12+ years in academia, 10+ research projects and 9+ working/published articles.

**José Ignacio Huertas** is a full-time professor of the Mechanical Engineering Department at Tecnológico de Monterrey. Researcher of the Energy and Climate Change Research Group. He belongs to the Mexican System of researchers (SNI) level 2, and to the Mexican Academy of Science. He has published 3 books, more than 50 indexed papers, has 2 patents conferred, has graduated 8 PhD and 89 MSc students, and has completed more than 90 research projects financed by private companies and governmental institutions in Colombia, Mexico, Spain, France, and USA. Areas of interest: Energy, Combustion, Vehicular emissions, Air pollution and Smart mobility