Study of Air Pollutions Caused by Exhaust Gases Emitted from Gasoline Vehicles in Erbil City

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Abstract: The environmental pollution caused by exhaust gas during parking in Erbil City’s Periodic Vehicle Inspection (PVI) was studied. The purpose of this research is to measure vehicle exhaust emissions from Erbil (PVI) gasoline vehicles. Tested the carbon monoxide (CO), carbon dioxide (CO2), oxygen (O2) and hydrocarbon (HC) emissions of gasoline vehicles. The statistical results show that there are significant differences between emission rates based on vehicle characteristics (such as fuel type, model year, engine fuel supply system, and regular maintenance). In addition, these factors will also affect the emission level test results based on the Iraqi vehicle emission standards. In addition, the emissions of these exhaust gases also depend on factors such as engine combustion design and operating conditions, fuel grade, lubricants, local road conditions and other factors, and continue to affect the concentration of pollutants emitted by vehicles (such as carbon dioxide and unburned hydrocarbons) These pollutants are very toxic to the human body and cause environmental pollution. Accurate estimates of pollutant emissions are needed to ensure proper design and implementation of air quality plans. Emission factors (EFs) are empirical functions between pollutant emissions and their activities. In this review article, in connection with the development of EFs found in emission models used to generate emission inventories, techniques for measuring emissions from road vehicles are studied. The emission measurement technologies covered include those most widely used for road vehicle emission data collection, namely chassis and engine dynamometer measurements, remote sensing, road tunnel research, and portable emission measurement systems (PEMS). The main advantages and disadvantages of each method with regard to emission modeling are presented. It also reviews ways in which EF can be derived from test data, with a clear distinction between data obtained under controlled conditions (engine and chassis dynamometer measurements using standard driving cycles) and measurements under real conditions.

Keywords: gasoline vehicles; exhaust fumes; extremely dangerous air pollution.

1. Introduction

The use of a vehicle is a great convenience for the individual, but society pays a very high price for it - especially in crowded cities, where there are more cars than in smaller cities. Motor vehicles are a source of air pollution in cities with various environmental problems. Air pollution is becoming more international. Currently, most pollutants are released into the atmosphere from the combustion of fossil fuels in power plants and factories (stationary sources) and in motor vehicles (mobile sources). In modern cities, such as the Irbid headquarters, motor vehicles can be a major source of air pollution. The main pollutants emitted by gasoline cars are carbon monoxide (CO) and hydrocarbons (HC). Carbon monoxide (CO), which is a colorless, odorless, toxic gas produced as a result of incomplete combustion of organic compounds [1]. The primary health effect of carbon monoxide is that it reduces the oxygen carrying capacity of the blood. At atmospheric concentrations, CO can affect the functions
of the brain, lungs, heart and exercise capacity, all of which are sensitive to blood oxygen levels. Exposure to high levels of CO is also associated with low birth weight in babies. Hydrocarbons (HC), which are formed when unburned or partially burned fuel is emitted from the engine as exhaust gas and when the fuel is vaporized directly into the atmosphere. HC contains many toxic compounds that cause cancer and other adverse health effects. This study will focus on measuring the vehicle exhaust emissions that are emitted from the exhaust of petrol vehicles in the city of Erbil. In order to determine whether the difference in the average exhaust emissions from different groups of vehicle characteristics (such as model year (MY), manufacturer, engine capacity, emission test result based on Iraqi standards, maintenance and fuel type) is statistically significant [2]. The specific emissions of products released with the exhaust gas during engine start-up and heating were assessed by measuring the concentrations of pollutants in the exhaust gas composition. Dangerous emissions are mainly caused by the engine warming up at idle and the vehicle movement when parked. We assume that emissions from engines of cars entering external car parks are minimal, therefore we do not take them into account [3]. These gasoline exhaust emissions are consequently influenced by the fuel type, age of the vehicle, vehicle model, engine size, fuel type and delivery system, catalytic converter, vehicle maintenance and road network, and country of origin [4]. The use of acetone and wet methanol as a premium fuel blend is expected to improve engine performance and reduce emissions [5]. Measured car exhaust emissions from gasoline vehicle exhaust in the Irbid Directorate. One thousand gasoline vehicles have been tested for carbon monoxide (CO), carbon dioxide (CO2), oxygen (O2) and hydrocarbons (HC) emissions. The statistical results show that there are significant differences between the emissions based on vehicle characteristics such as fuel type, model year, engine fuel system and regular maintenance. In addition, these factors influence the outcome of an emission test based on Jordanian vehicle emission standards [6].

Hamed M. J., and Yousif. A. A. [7] Research and statistics were conducted to outline the environmental impact of the following pollution sources, with emphasis on qualitative and quantitative treatment of this problem. I-The pollution caused by the increase in the number of vehicles in Erbil City indicates that the traffic volume has increased by a certain amount (from 2006 to 2011) in 6 years, an average of 10.87 times. Compared with other pollutants, this led to a large amount of carbon dioxide emissions. In 2011, the total daily carbon dioxide emissions reached an astonishing 2,813 tons. Our research also shows that the number of other pollutants has also increased at the following rates: 10.0 times that of CO, and the daily total in 2011 reached 163.68 tons. 10.1 times of HC, the daily total in 2011 reached 10.4 times of 19.38 tons of NOx, the daily total in 2011 reached 12.94 tons; 11.8 times of the mass pellets, the daily total in 2011 reached 1.311 tons, and the daily total of CO2 was 11.0 Times, the daily total in 2011 reached 2813 tons. II-Pollution caused by the increase in the number of generators in Erbil, which shows that in the 10 years between 2003 and 2012, the number of second-hand generators increased by 76.1%, of which the number of second-hand generators increased from 2003 The number of units in the year rose from 1,458 to 2,568 in 2012, Pollutant emissions have increased by the following percentages: CO2 was 76.3%, and the total in 2012 was 1024 tons. NOx is 75.7%, and the total amount in 2012 was 181 tons. SO2 is 78.4%, so the total in 2012 reached 91 tons. Draws some conclusions and makes appropriate recommendations.

Perez, P.J. and Nogueria, T. [8] In order to calculate pollutant emission factors (EFs), in 2011, the air pollutant measurement of hybrid fleets, heavy and light vehicles (HDV and LDV) in two tunnels in the São Paulo metropolitan area was studied. Carbon dioxide, carbon monoxide (CO), nitrogen oxides (NOx) and particulate matter (PM2.5) were measured. High concentrations associated with high-density traffic, especially during workdays. EF is seriously affected by the load of pollutants, so the ratio of total vehicle flow to HDV. The EF value of HDV is 3.6 and 9.2 g km⁻¹ for CO and NOx (LDV is 5.8 and 0.3 g km⁻¹). In order to determine the EF estimate, parameters such as air speed, cross-sectional area and tunnel length, as well as vehicles passing in an hour interval, are considered.

2. Methodology

In this study, a random sample of gasoline vehicles was used to measure exhaust emissions using an exhaust gas analyzer. The exhaust emission is measured according to the user guide of the exhaust gas analyzer. The probe of the analyzer is placed in the tail pipe of the vehicle at idling speed, and it is
stably read in a short time (CO, CO2, O2 and HC). The picture shows the sample, which was taken from two privately certified vehicle test stations in Erbil (PVI).

![Exhaust gas checker](image)

**Figure 1.** Method of taking data

3. **Exhaust Gas Exhaust System**

   The exhaust gas checker is a testing device that measures the chemical composition of exhaust gas (measures the emissions from combustion in the engine). This device is a valuable tool for diagnosing faults. Install the probe (sensor) pipe at the outlet of the exhaust pipe. Through engine operation and exhaust emissions, the device can display the amount of pollutants and gases that constitute vehicle exhaust. Technicians can use these results to identify and judge the state of the engine and other engine systems. The exhaust gas analyzer in the engine system is a diagnostic tool that can be identified in the following ways:

   - Carburetor problem or injection system
   - Mechanical problems of the engine
   - Vinegar leak
   - Ignition system problem
   - Problems with the crankcase ventilation PCV system
   - Filter clogged (air filter)
   - Disable air injection system
   - Problems in the evaporation control system Computer control problems
   - Catalysis box

4. **Exhaust gas analyzers**:

   1. A device that can measure two kinds of exhaust gas: measuring the amount of HC and CO. With the development of automobiles, many pollution control systems have been added to automobiles to reduce carbon monoxide and hydrocarbon emissions, so that the pollutants in these exhaust gases do not indicate the operating conditions of the engine. Exhaust gas analyzer manufacturers have added the measurement of the other two gases in the exhaust gas composition, namely oxygen and carbon dioxide, which have little effect on the work of pollutants, so their readings can be used to judge the condition of the engine.

   2. A device capable of measuring 4 kinds of exhaust gas (using 4 measuring methods): measuring the amount of HC and CO and CO2 and O2. Although oxygen and carbon dioxide are not toxic gases and are not considered pollutants, their ratio to exhaust gas can provide valuable information about combustion Efficiency and engine system.
3- Equipment for measuring the quantity of five kinds of waste gas: The measuring equipment is shown in figure 2, and the technical data is shown in figure 3.

![Figure 2. MAHA device MET6.1](image)

![Figure 3. Technical data of MAHA device](image)

5. The Permissible Range Of Gases Leads To Gasoline Engines

The "Europe" emission standards are set by the European Commission. They greatly help reduce pollution. Many cities use these euro standards to shut out older, more polluting vehicles. These are often referred to as low emission zones. Every 4 to 5 years, new European standards will ensure that the emissions of vehicles sold are reduced. The following table lists the timing of these standards by vehicle type. This only provides guidance on the emission standards of each vehicle (depending on the time of its manufacture) based on the guidelines. All dates listed in the table 1 refer to the approval of the new model (that is, the new model that has not been produced before). All vehicles must meet the standards within one year after the following dates before they can be sold. RDE is "Real World Driving Emissions". It is a test designed to ensure the reduction of vehicle emissions in the real world, not just in a test laboratory. The vehicle will travel outdoors and on real roads according to random acceleration and deceleration patterns. New models must meet the requirements from September 2017 and will be tightened in September 2019. EEV emission standards are between 5 and 6 euros.

| Table 1. Euro standard and type of vehicles |
|------------------------------------------|
|                | Euro 1 | Euro 2 | Euro 3 | Euro 4 | Euro 5 | Euro 6 |
| Passenger cars | July 1992 | Jan 1996 | Jan 2000 | Jan 2005 | Sept 2009 | Sept 2014 | Sept 2017 |
| Light commercial vehicles (N1-I) ≤1305kg | Oct 1994 | Jan 1998 | Jan 2000 | Jan 2005 | Sept 2010 | Sept 2014 | Sept 2017 |
| Light commercial vehicles (all others) | Oct 1994 | Jan 1998 | Jan 2001 | Jan 2006 | Sept 2010 | Sept 2015 | Sept 2017 |
| Trucks and buses | 1992 | 1995 | 1999 | 2005 | 2008 | 2013 | Sept 2017 |
| Motorcycles | 2000 | 2004 | 2007 | 2016 | 2020|
| Mopeds | 2000 | 2002 | 2017 | 2020 |
6. Vehicle Euro Standards

Table 2. Euro emission limits

| Euro 1 emission limits: | Euro 2 emission limits: | Euro 3 emission limits: |
|------------------------|------------------------|------------------------|
| CO – 2.72 g/km         | CO – 2.2 g/km          | CO – 2.3 g/km          |
| HC+ NOx – 0.97 g/km    | HC+ NOx – 0.5 g/km     | HC – 0.20 g/km         |
|                        |                        | NOx – 0.15             |

| Euro 4 emission limits: | Euro 5 emission limits: | Euro 6 emission limits: |
|------------------------|------------------------|------------------------|
| CO – 1.0 g/km          | CO – 1.0 g/km          | CO – 1.0 g/km          |
| HC – 0.10 g/km         | HC – 0.10 g/km         | HC – 0.10 g/km         |
| NOx – 0.08             | NOx – 0.06 g/km        | NOx – 0.06 g/km        |

7. Results and Discussions

Collect data from the PVI Center in Erbil City: Send the selected vehicles below to PVI (Emission Test) for testing. Initially, the vehicle is subject to a minimum checklist, such as an exhaust leak check, and if there is any exhaust leak, it must be corrected. The test procedures for different years are based on the general emission test procedures applicable to vehicles of that category and model. Table 3 shows the test cycles of different types of vehicles. In this chapter, some tables are shown that indicate how to collect and collect data. The tables also indicate the ratio of carbon monoxide to meter (KM) and gas HC. The relationship between the meter (KM) and the type and model of the car. In order to obtain accurate results in our research, we chose a (normal) type of fuel. After considering the relationship between cars and natural gas CO, I studied cars and natural gas HC, as well as cars and production years in meters (km), and Toyota, Hyundai and Nissan brands that have both HC and CO gas. The car shows us from the mentioned relationship:

Figure 4 clearly shows the difference in hydrocarbon gas between all types of vehicles. This shows that the condition of the engine, the type of fuel, the type of oil and the follow-up measures for regular maintenance directly affect the amount of gas produced by the engine. One of the main reasons for this situation is that poor mixture (carburetor or fuel injection), incorrect ignition timing (distributor, computer problems, need to adjust the process) and engine problems (low pressure) (gas leakage, piston rings, Burner problem) valve, damaged cylinder head).

Figure 5 shows the obvious difference in carbon monoxide between all types of vehicles. This indicates that the condition of the engine, fuel type, oil type and regular maintenance follow-up have a direct impact on the amount of gas produced by the engine. One of the main reasons for increasing this gas is a problem in the pollutant control system (that is, a problem in the pollutant control system leads to an increase in carbon monoxide), a problem in the ignition timing (a larger spark is provided-damages the ignition system ) Improper adjustment of no-load speed (slow speed) (wrong carburetor or injection system setting).

Figure 6 shows the obvious difference in hydrocarbon gas. As shown in the figure, the number of kilometers does not affect the gas ratio. For example, in the picture 4.5, the gas in compartment 20 is less than the gas in compartment 3, despite the use of compartment 3. The volume is less than the 20th car. As mentioned in the first two points, the reason for the increase in gasoline volume depends on the condition of the engine and regular maintenance (if the condition is not good), so increase the proportion of gas produced by the engine.

Figure 7 shows the relationship between the meter (KM) and carbon monoxide, and shows the same reason for increasing this gas. We concluded that the usage time of the car does not affect the amount of gas. The percentage of gas produced by the engine and the percentage of gas restricted by the factory vary from company to company. The low gas ratio indicates the condition of the natural engine.
and also the use of fuel and high-quality oil. But their high percentages indicate that many of the above-mentioned reasons have caused damage to human health and also affected the environment. Figure 8 shows the difference in hydrocarbon gas between all types of vehicles. This shows that the state of the engine and the type of vehicle directly affect the amount of gas produced by the engine.

**Table 3. Method of data collection**

| No. | Type of vehicle | Model | En.size (cc) | NO.cyl. | km or mile | fuel type | HC ppm | CO2% | O2% | CO% |
|-----|----------------|-------|--------------|---------|-----------|-----------|--------|------|-----|-----|
| 1   | INFINITI       | 2018  | 3000         | 6       | 13000 M   | SUPER     | 120    | 16.18 | 0.32 | 0.08 |
| 2   | HYUNDAI        | 2014  | 1600         | 4       | 65000 M   | NORMAL    | 265    | 14.37 | 2.42 | 0.13 |
| 3   | HYUNDAI        | 2017  | 2000         | 4       | 18679 M   | NORMAL    | 132    | 15.09 | 0.68 | 0.9  |
| 4   | RENAULT        | 2016  | 1400         | 4       | 5000 M    | SUPER     | 10     | 16.36 | 0.08 | 0.01 |
| 5   | FORD           | 2017  | 2500         | 4       | 46390 M   | NORMAL    | 0      | 15.24 | 1.32 | 0    |
| 6   | TOYOTA         | 2017  | 2400         | 4       | 2500 M    | NORMAL    | 175    | 14.66 | 0.92 | 0.86 |
| 7   | FORD           | 2017  | 2400         | 4       | 16543 M   | NORMAL    | 0      | 15.4  | 0.19 | 0    |
| 8   | HYUNDAI        | 2016  | 2000         | 4       | 79658 M   | NORMAL    | 143    | 15.68 | 0.21 | 0.73 |
| 9   | TOYOTA         | 2017  | 3500         | 6       | 24800 M   | NORMAL    | 56     | 16.24 | 0.12 | 0.03 |
| 10  | FORD           | 2017  | 2500         | 4       | 34500 M   | NORMAL    | 81     | 15.77 | 0.32 | 0.21 |
| 11  | KIA            | 2016  | 1600         | 4       | 60549 KM  | NORMAL    | 11     | 15.8  | 0.57 | 0.01 |
| 12  | NISSAN         | 2016  | 1800         | 4       | 72000 KM  | NORMAL    | 5      | 15.84 | 0.07 | 0.01 |
| 13  | CHEVROLE       | 2017  | 3500         | 6       | 31000 KM  | NORMAL    | 2      | 15.53 | 0.66 | 0.01 |
| 14  | NISSAN         | 2017  | 1800         | 4       | 47243 M   | NORMAL    | 0      | 15.97 | 0.06 | 0.01 |
| 15  | JEEP           | 2017  | 2400         | 4       | 23411 KM  | NORMAL    | 22     | 15.34 | 0.71 | 0.06 |
| 16  | HYUNDAI        | 2017  | 2000         | 4       | 495 M     | NORMAL    | 218    | 15.06 | 0.06 | 0.49 |

**Figure 4. Relation between Vehicles types of and HC Gas**
Figure 5. Relation between Vehicles types and CO Gas

Figure 6. Relation between distance traveled by the vehicle in kilometers and HC Gas

Figure 7. Relation between distance traveled by the vehicle in kilometers and CO
8. Conclusion
- This research and analysis provides important information to help better understand exhaust emissions; the levels of "CO, HC, CO2 and O2" for different model years are "new technologies" from 2014 to 2018.
- Using ERBIL (PVI) exhaust gas analyzer data collected from November 2018 to April 2019. Perform implementation to determine whether different sets of vehicle characteristics (such as model year (MY), manufacturer, engine capacity, emission level test results based on IRAQS standards, maintenance and fuel type) are statistically significant.
- Test results show that there is statistical significance between the emission level and vehicle characteristics (fuel type and model year), and there is no statistical evidence that different emission levels are affected by frequent maintenance.
- Test results related to IRAQ vehicle emission standards. However, in order to reduce emissions levels in the Republic of Iraq, we recommend that drivers “based on this research” start using unleaded gasoline.
- By using unleaded fuel, emission levels will be reduced, which will have a positive impact on our health and the environment.
- Vehicle exhaust pollutants are unburned hydrocarbons (HC), carbon monoxide (CO) and carbon dioxide (CO2) that are emitted by gasoline fuel. The fluctuation range depends on the fuel type, engine size and number of cylinders.
- Oxygen (O2) is one of vehicle exhaust emissions, mainly emitted by older gasoline vehicles.
- Too many old cars are imported into the country, resulting in high levels of pollutants, exceeding the highest level recommended by the World Health Organization (WHO).
- These exhaust gases play an important role in air pollution related to vehicles, and carbon dioxide (a greenhouse gas) contributes to climate change.
- When the carbon in gasoline is not completely burned, gasoline vehicles emit carbon monoxide.
- The hydrocarbons emitted by gasoline vehicles are toxic compounds of hydrogen and carbon.
In the case of the introduction of lean and rich mixtures, the exhaust gas emissions generated in this state are more than that of the stoichiometric mixture.

9. Recommendation
1. Supply unleaded gasoline to gas stations so that everyone can use it.
2. In addition, we encourage the government to support this fuel type by lowering prices so that most
car users can purchase.

3. The conclusion drawn from our analysis is that people are encouraged to start using the new technologies available in modern vehicles.

4. In addition to keeping the catalytic converter in the vehicle, this is an anti-pollution device that converts exhaust emissions such as carbon dioxide and nitrogen oxides into normal atmospheric gases such as nitrogen and water.

5. In Iraq, most car users remove catalytic converters from their cars. In addition, in order to reduce gas emissions, we encourage car users to start effective frequent inspections and maintenance.

6. There is an urgent need to use the stoichiometric equation to adapt the exhaust emission measurement value to the stoichiometry of gasoline combustion.

7. The scope of research should also be expanded to use local material precursors to purchase cheaper chemical exhaust gas emission adsorbents/absorbents.

8. Therefore, it is necessary to apply advanced statistical tools such as multivariate analysis or PCA to test the correlation and important trends and patterns of exhaust emissions.

9. The government should reduce the life of imported cars from eight to three years from the date of import.

10. The government should establish minimum emission control standards for pollutants, conduct regular impromptu inspections on all road vehicles, and impose heavy penalties on vehicles that fail emission tests.

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