

Modeling of Lead Emissions in Palestine

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Introduction

- The fuel consumption in the Palestinian Territories used for the transport sector (Gasoline and Diesel) reached 980 KCM distributed as follows:
 - Gaza Strip: 215 KCM
 - West Bank: 765 KCM.
- The fuel consumption of the power plant at 140 MW capacity reaches 170 KCM of diesel oil.
- Switching to Natural Gas instead, the consumption is expected to reach 250 MCM of natural gas.

Introduction, Continued

- The Transport sector in Palestine is expected to face a growing demand for mobility in the near future.
- Accordingly, a growing demand on fuel is therefore expected to increase sharply in the Palestinian Territories.
- Road transport accounts for more than half of the overall energy consumed in the Palestinian Territories, which makes the transport sector a target field for energy and environmental research.

Background

- The major air pollutants are:
 - Carbon monoxide (CO),
 - Nitrogen oxides (NO_x),
 - Particulate matter (PM),
 - Sulphur dioxide (SO₂),
 - Volatile Organic Compounds (VOCs) such as benzene and lead compounds. Lead is emitted in the atmosphere in two forms by petrol vehicles; firstly as particulate product of combustion and secondly as a volatile lead alkyl which is found in unburned petrol.

WHO guideline for airborne lead

- The concentration of air pollutants is normally in such a level that the convenient units are micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) or part per million (PPM).
- The World Health Organization (WHO) guideline for airborne lead is **0.5 $\mu\text{g}/\text{m}^3$** .

Specification of Fuel

The American Standard ASTM D439 for petrol:

| | | |
|--------------|---------------------|----------------------|
| Unleaded | 0.07 grams / gallon | 0.0185 grams / liter |
| Low lead | 0.5 grams / gallon | 0.13 grams / liter |
| Conventional | 4.2 grams / gallon | 1.11 grams / liter |

According to (*DOE, 1996*):

- The quantity of TEL added to petrol must not exceed 0.15 g/l
- 70% of this additive becomes in the form of airborne lead.

Background about Gaza Strip

● **Geographic and Demographic Context**

- The area of the Gaza Strip is densely populated with an estimated population of 1.2 million persons. The population density in the Gaza Strip is higher than the densely populated Egyptian Nile valley and delta.
- Gaza city is the main city in the Gaza Strip. The population of Gaza city is estimated at 335,000 residents. Gaza city has a high population density (2112 persons/km²).
- More than 50% of the population in Gaza city are less than 14 years old which means that in the near future more transport is needed.
- The population of Gaza city will be doubling within less than 15 years.
- All development projects including transport projects should take this situation into consideration.

Meteorological Context

- The average daily mean temperature ranges from 24°C in summer (May-August) to 15 °C in winter (November- February).
- The daily relative humidity fluctuates between 62.5% in the daytime and 83.4% at night in the summer, and between 51.6% and 81.3% respectively in winter.
- The monthly average wind speed for Gaza is 3 m/s.

Economic Context

- The economic situation in Gaza city is generally below the average income of the other cities in the Palestinian Territories. The situation has become even worse since the beginning of the uprising.
- The Gross National Product (GNP) per capita is about 600 \$ (1987 base data). This is almost 50% of the GNP per capita of the West Bank.
- A recent survey showed substantial high potential for the economic development in Palestine.

Road Traffic Context

- By the end of year 2000, the official number of vehicles totaled 49000 vehicles in the Gaza Strip and 75000 vehicles in the West Bank.
- Private cars using petrol were 37000 vehicles in the Gaza Strip and 53000 in the West Bank.
- There is a 17% annual rate of increase in private vehicle ownership in the Gaza Strip.
- The monthly average consumption of fuel oil in the WBG reached 22 million liters.
- The market share of unleaded petrol was approximately 2% of the total gasoline consumed in the WBG for 1995. This share should arise using cost incentives and policy measures.

Road Network of Gaza City

- Three major roads carry traffic in the east west direction. The major streets are laid out in a compact configuration with no adequate circulation schemes.
- Carriageway widths in Gaza city are generally 10-20 meters, with many streets having smaller widths.
- Parked vehicles at either side of the road limit the effective width of the carriageway.
- Most roads in the city of Gaza are badly pot holed from natural wear and tear of traffic and lack of maintenance.
- The use of carriage ways by pedestrians causes drivers to reduce speed and hence causes traffic congestion and increases the potential of direct exposure to vehicle generated air pollution

Calculation of Lead Concentration Levels From Road Traffic

$$\text{Lead Pollution } (\mu\text{g}/\text{m}^3) = \{(L_f * V * T) / W\} - 1.75$$

where:

- L_f : represents the annual average lead content of fuels (g/l)
- V : represents the mean spot speed of cars using the carriageway (km/h)
- T : represents the average daily flow of petrol engine vehicles (thousand vehicles/day)
- w : represents the monthly average wind speed (m/s).

Values used for the case study

| | |
|------------|-------------------------|
| Lf: | 0.15 g/l |
| V: | 20 km/h |
| T: | 5 k vehicles/day |
| W: | 3 m/s |

Results of the model's application

- Using the above values show that lead pollution was found in the order of **3.25 $\mu\text{g}/\text{m}^3$**
- This is almost **six** times higher than the WHO annual average of lead concentration ($0.5\mu\text{g}/\text{m}^3$).
- A similar situation can be detected in some parts of Cairo city as lead concentrations are **five to six** times as high as the global norms set by the World Health Organization (*World Bank, 1996*).

Recommendations

- An immediate study is to be launched to determine which categories of vehicles not designed to the latest standards justify retrofitting with catalysts or particulate traps
- More stringent standards be applied in the emissions element of the annual exhaust emissions test, and that this element becomes obligatory for all cars a year after registration
- The differential duty which favors unleaded petrol should be retained and that the government should collaborate with the oil industry and the vehicle manufacturers to develop specifications for cleaner fuels, i.e. Compressed Natural Gas and Liquefied Petroleum Gas, and should consider incentives to operators of fleets of heavy vehicles in urban areas to use natural gas powered vehicles

Recommendations, Continued

In order to control and limit the amount of emissions of lead from petrol vehicles in Palestine, the following considerations and measures can be adopted towards reducing the emissions from existing vehicles:

- Wide utilization of particulate traps, i.e. lead traps to replace the current silencer exhaust systems.
- The Ministry of Transport should mandate the exhaust emissions test for exhaust emissions as a requirement for vehicle licensing every year.
- Increasing the public awareness to choosing quality fuel coupled with fiscal incentives should also be encouraged by the Palestinian Authority in order to raise the market share of unleaded petrol.

End Note

- Through proper application of the above-mentioned recommended measures, the environment can be preserved, a better air quality can be reached, public health can be maintained and protected, and the foreseen sustainable development in Palestine can be achieved.