

Emission Facts

Average Annual Emissions and Fuel Consumption for Gasoline-Fueled Passenger Cars and Light Trucks

The amount of pollution that a vehicle emits and the rate at which it consumes fuel are dependent on many factors. The U.S. Environmental Protection Agency (EPA) has developed and refined a series of computer models that estimate, for different types of highway vehicles, the fleetwide in-use average emissions as a function of many variables. This fact sheet is one of a series on highway vehicle emission factors. It presents average annual emissions and fuel consumption for gasoline-fueled light-duty vehicles (passenger cars) and light-duty trucks (pickup trucks, sport-utility vehicles, and the like).

Introduction

There are a number of factors that affect the rate at which any vehicle emits air pollutants. Some of the most important are the vehicle type/size (passenger cars, light-duty trucks, heavy-duty trucks, urban and school buses, motorcycles), vehicle age and accumulated mileage, fuel used (gasoline, diesel, others), ambient weather conditions (temperature, precipitation, wind), the maintenance condition of the vehicle (well maintained, in need of maintenance, presence and condition of pollution control equipment), and how the vehicle is driven (e.g., long cruising at highway speeds, stop-and-go urban congestion, typical urban mixed driving).

Abbreviations and Acronyms Used

CO:	Carbon monoxide; a regulated pollutant
CO₂:	Carbon dioxide; the primary byproduct of all fossil fuel combustion
FTP:	Federal Test Procedure; the primary test used in certifying vehicle compliance with emission standards
g:	gram(s)
g/mi:	grams per mile
GHG:	Greenhouse gas(es); gases, such as CO ₂ , that accumulate in the atmosphere and are thought to contribute to anthropogenic climate change
HC:	Hydrocarbons; molecules formed of hydrogen and carbon that constitute gasoline, diesel, and other petroleum-based fuels; also a regulated pollutant
NOx:	Nitrogen oxides; also a regulated pollutant
PM₁₀:	Particulate matter under 10 microns diameter; also a regulated pollutant
PM_{2.5}:	Particulate matter under 2.5 microns diameter, sometimes referred to as “fine particulate”
ppm:	parts per million
psi:	pounds per square inch
RVP:	Reid vapor pressure; a standardized method for expressing the volatility, or tendency to evaporate, of gasoline
SUV:	Sport-utility vehicle; a subset of all light-duty trucks; examples include most Daimler-Chrysler Jeep models, Ford Escape, Ford Explorer, GMC Yukon, etc.
VMT:	Vehicle miles traveled

The most current version of the computer model used by EPA to estimate average in-use emissions from highway vehicles is MOBILE6.2. EPA, the States, and others use this model to estimate total emissions of pollutants generated by highway vehicles in various geographic areas and over specific time periods. The emission rates (also commonly termed emission factors) and annual emissions presented for gasoline-fueled passenger cars and light-duty trucks in this fact sheet are based on national average data representing the in-use fleet as of July 1, 2005. These estimates use national averages for most of the variables that affect emission rates, as discussed in greater detail in the following section, and are based on average summertime weather conditions. These estimates are suitable for use in obtaining first-order approximations of vehicle emissions.

Discussion

The emission rates for hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM₁₀, particulate 10 microns diameter and smaller; and PM_{2.5}, particulate 2.5 microns diameter and smaller, sometimes referred to as “fine particulate”) presented in the following tables are from the most recent version of the MOBILE6.2 highway vehicle emission factor model. They assume an average, properly maintained vehicle on the road in July 2005, operating on typical gasoline on a warm summer day (72-92°F). Emission rates can be higher in very hot weather (especially HC) or very cold weather (especially CO).

MOBILE6.2 allows the modeler to specify values for a number of different parameters that affect average in-use emission rates. This permits more accurate emission estimates to be made that are specific to a geographic area and time period. For this emission factors presented in this fact sheet, national average values are assumed for these parameters. National data are used for registration distributions by age (what fraction of all vehicles of each specific type, in use today, are of the current model year, one to two years old, two to three years old, and so forth) and annual mileage accumulation rates by age (newer vehicles tend to be driven more miles per year than do older vehicles). Some of the other primary assumptions made in developing these emission factors are:

- Ambient temperature: 72 to 92 °F diurnal range (warm summer day)
- Nominal gasoline volatility: 9.0 psi RVP
- Weathered fuel volatility: 8.6 psi RVP
- Gasoline sulfur content: 92 ppm
- I/M program: No
- Reformulated gasoline: No

The calculations for “Annual Emissions and Fuel Consumption” are based on average annual passenger car mileage of 12,000 miles and average annual light-duty truck mileage of 15,000 miles. Fuel consumption is based on estimated fleetwide average in-use fuel economy, 24.0 miles per gallon (mpg) for passenger cars and 17.3 mpg for light trucks. These values are also from the MOBILE6.2 model.

These emission factors and fuel consumption rates are for gasoline-fueled passenger cars and light-duty trucks only. Diesel cars represent less than 0.5 percent of all cars on the road in the United States as of 2005, and diesel light trucks represent less than 2 percent of all light-duty trucks on the road. In general, diesel vehicles (relative to gasoline vehicles of similar size and age) will have lower emissions of HC and CO, and higher emissions of NO_x and particulate matter. Diesel fuel economy tends to be better than that of similar gasoline-fueled vehicles, meaning total fuel consumption and CO₂ emissions per vehicle per year tend to be lower.

Changes from Previous Versions of this Fact Sheet

The emission factors presented below are not directly comparable to those used in previous versions of this fact sheet due to the extensive changes made to the MOBILE model in order to better represent real-world driving. In earlier versions, the emission factors were based on an average travel speed of 19.6 mph. This is the average speed of the Federal Test Procedure (FTP), which is the basis for certification of new vehicles to applicable emission standards. The FTP is considered to be reasonably representative of overall traffic in urbanized areas; it includes stops and starts, idling time, accelerations and decelerations, and short cruising stretches. However, it does not include any acceleration or deceleration rates greater than 3.4 mph per second (mph/s), nor does it include any travel at speeds greater than 60 mph.

The emission factors produced by MOBILE6.2 and used in this fact sheet are based on national average data on the fraction of total vehicle miles traveled (VMT) accrued on each of four major roadway types, and national average traffic speeds associated with each of these facility types. The four roadway types are limited access highways (freeways, expressways), ramps (entrance and exit ramps to and from limited access highways), arterials (primary surface roadways), and local and collector roads (local streets and minor surface roadways).

These emission factors account for the fact that a single value of average speed is not adequate for the characterization of real-world driving patterns. For example, driving patterns associated with an average speed of 40 mph on a limited access highway are not the same as driving patterns associated with an average speed of 40 mph on an arterial route; in the first case, 40 mph implies heavy traffic with some congestion and varying speeds, while in the latter case 40 mph represents near free-flow conditions. The emission factors developed for the four roadway types include much sharper acceleration and deceleration rates (up to 6.9 mph/s), which result in significantly higher emission rates for short periods of time, and higher maximum speeds (up to 75 mph on limited access highways).

Thus, these emission factors differ from those that would have been estimated using previous versions of the MOBILE model, which assumed a single driving pattern with an average speed of 19.6 mph, no accelerations or decelerations exceeding 3.4 mph/s, and no driving over 60 mph. These newer emission factors are much closer to being representative of observed real world driving patterns and speeds, and thus more accurately represent emissions in use.

Additional information about the development of the MOBILE6.2 highway vehicle emission factor model, including technical reports on the development of driving patterns and VMT fractions by roadway type as well as on the numerous other updates, revisions, and refinements included in the latest model, can be found on the MOBILE modeling page of the Office of Transportation and Air Quality Web site at:

www.epa.gov/otaq/m6.htm

Average Emissions and Fuel Consumption for Passenger Cars¹

Pollutant/Fuel	Emission and Fuel Consumption Rates (per mile driven)	Calculation	Annual Emissions and Fuel Consumption
Hydrocarbons (HC)	1.36 grams (g)	1.36 g/mi * 12,000 mi/yr * 1 lb/454g	36.0 lb
Carbon monoxide (CO)	12.4 g	12.4 g/mi * 12,000 mi/yr * 1 lb/454 g	328 lb
Nitrogen oxides (NOx)	0.95 g	0.95 g * 12,000 mi/yr * 1 lb/454 g	25.1 lb
Particulate matter (PM ₁₀)	0.0052 g	0.0052 g * 12,000 mi/yr * 1 lb/454 g	0.14 lb
Particulate matter (PM _{2.5})	0.0049 g	0.0049 g * 12,000 mi/yr * 1 lb/454 g	0.13 lb
Carbon dioxide (CO ₂)	369 g	369 g/mi * 12,000 mi/yr * 1 lb/454 g	9760 lb
Gasoline consumption	0.0417 gallons (gal)	(12,000 mi/yr) / (24.0 mi/gal)	500 gal

* See Endnotes

Average Emissions and Fuel Consumption for Light-Duty Trucks² (most pick-up trucks, SUVs, etc.)

Pollutant/Fuel	Emission and Fuel Consumption Rates (per mile driven)	Calculations	Annual Emissions and Fuel Consumption
Hydrocarbons (HC)	1.61 grams (g)	1.617 g/mi * 15,000 mi/yr * 1 lb/454 g	53.2 lb
Carbon monoxide (CO)	15.7 g	15.7 g/mi * 15,000 mi/yr * 1 lb/454 g	519 lb
Nitrogen oxides (NOx)	1.22 g	1.22 g * 15,000 mi/yr * 1 lb/454 g	40.3 lb
Particulate matter (PM ₁₀)	0.0065 g	0.0065 g * 15,000 mi/yr * 1 lb/454 g	0.21 lb
Particulate matter (PM _{2.5})	0.0060 g	0.0060 g * 15,000 mi/yr * 1 lb/454 g	0.20 lb
Carbon dioxide (CO ₂)	511 g	511 g/mi * 15,000 mi/yr * 1 lb/454 g	16,900 lb
Gasoline Consumption	0.0578 gallons (gal)	(15,000 mi/yr) / (17.3 mi/gal)	867 gal

* See Endnotes

For More Information

Additional documents on the following topics related to this fact sheet can be accessed on the Office of Transportation and Air Quality's Web site. See:

Modeling and estimating vehicle emissions: www.epa.gov/otaq/models.htm

Vehicle fuel economy: www.epa.gov/otaq/mpg.htm
www.fueleconomy.gov/

Improving fuel economy and reducing emissions: www.epa.gov/otaq/consumer.htm

Finding the "greenest" vehicle: www.epa.gov/greenvehicles

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Endnotes

1. Figures presented above are averages only. Individual vehicles can differ substantially in terms of both annual miles traveled and pollution emitted per mile from values indicated here. Values shown may differ slightly from original sources due to rounding.
2. These emission factors and fuel consumption rates are averages for the entire in-use fleet as of July 2005. Newer vehicles generally emit less pollution and use less gasoline, while older vehicles generally emit more pollution and use more gasoline. This is due to several factors, including the increasing stringency of emission standards over time and the deterioration (degradation) in the performance of emission control technology (e.g., catalytic converters) with increasing age and accumulated mileage.

3. Carbon dioxide (CO₂), while not regulated as an air pollutant, is the transportation sector's primary contribution to climate change. Carbon dioxide emissions are essentially proportional to fuel consumption (and inversely proportional to fuel economy) – each 1% increase (or decrease) in fuel consumption results in a corresponding 1% increase (or decrease) in carbon dioxide emissions. About 19.4 lb CO₂ is produced for every gallon of gasoline combusted. Passenger cars and light-duty trucks also emit small amounts of other greenhouse gases (GHGs); thus, total GHG emissions from these vehicles are slightly greater than the CO₂ emission totals shown in this fact sheet.

- 4 All of the emission estimates provided in this document are consistent, in terms of assumptions made and modeling methodology, with those provided in the other fact sheets in this series: “Idling Vehicle Emissions” (EPA420-F-05-023), “Average In-Use Emission Factors for Urban Buses and School Buses” (EPA420-F-05-024), and “Average In-Use Emissions from Heavy-Duty Trucks” (EPA420-F-05-025).