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 a series of computer models that estimate the average emissions for different types of highway vehicles. 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:

- 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)
- maintenance condition of the vehicle (well maintained, in need of maintenance, presence and condition of pollution control equipment)
- how the vehicle is driven (e.g., long cruising at highway speeds, stop-and-go urban congestion, typical urban mixed driving)

EPA United States Environmental Protection Agency

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The most current version of the computer model that EPA uses 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 or "emission factors" presented in this fact sheet are based on national average data representing the in-use fleet as of July 2008.

The emission rates for hydrocarbons (both volatile organic compounds [VOCs] and total hydrocarbons [THC]), carbon monoxide (CO), nitrogen oxides (NOx), and particulate matter (PM_{10} and $PM_{2.5}$) are presented in the following tables. The hydrocarbon (HC) numbers include both tailpipe and evaporative emissions, whereas the rates for the other pollutants are for tailpipe emissions only.

The emission rates assume an average, properly maintained vehicle, operating on typical gasoline on a warm summer day. Emission rates can be higher in very hot weather (especially HC) or very cold weather (especially CO).

National average values 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 up to 25 years old) 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 incorporated in these emission factors are:

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 or gases, such as CO2, that accumulate in the atmosphere and contributes to potential climate change
HC:	Hydrocarbons; molecules formed of hydrogen and carbon that constitute gasoline, diesel, and other petroleum-based fuels; a regulated pollutant
lb:	pound
NOx:	Nitrogen oxides; a regulated pollutant
PM_{10}:	Particulate matter under 10 microns diameter; 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 meth od for expressing the volatility, or tenden cy to evaporate, of gasoline
SUV:	Sport-utility vehicle; a subset of all light-duty trucks; examples include most Daim ler-Chrysler Jeep models, Ford Escape, Ford Explorer, GMC Yukon, etc.
THC:	Total hydrocarbons
VMT:	Vehicle miles traveled
VOC:	Volatile organic compounds; equivalent to THC plus aldehydes minus both methane and ethane

- Ambient temperature: 72 to 92 °F day time range
- Nominal gasoline volatility: 9.0 psi RVP
- Weathered fuel volatility: 8.6 psi RVP
- Gasoline sulfur content: 30 ppm
- Average speed: 27.6 miles per hour
- I/M program: No
- Reformulated gasoline: No

These calculations 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 the estimated average in-use fuel economy: 24.1 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 NOx 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 miles per hour (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 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.

Average Emissions and Fuel Consumption for Passenger Cars*

Pollutant/Fuel	Emission & Fuel Consumption Rates (per mile driven)	Calculation	Annual Emission & Fuel Consumption
VOC	1.034 grams (g)	(1.034 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	27.33 lb
THC	1.077 g	(1.077 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	28.47 lb
CO	9.400 g	(9.400 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	248.46 lb
NOx	0.693 g	(0.693 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	18.32 lb
PM_{10}	0.0044 g	(0.0044 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.12 lb
$PM_{2.5}$	0.0041 g	(0.0041 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	0.11 lb
CO_2	368.4 g	(368.4 g/mi) x (12,000 mi/yr) x (1 lb/454 g)	9,737.44 lb
Gasoline Consumption	0.04149 gallons (gal)	(12,000 mi/yr) / (24.1 mi/gal)	497.93 gal

*See Endnotes

Average Emissions and Fuel Consumption for Light-Duty Trucks*
(most pick-uptrucks, SUVs, etc.)

Pollutant/Fuel	Emission & Fuel Consumption Rates (per mile driven)	Calculation	Annual Emission & Fuel Consumption
VOC	1.224 grams (g)	(1.224 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	32.35 lb
THC	1.289 g	(1.289 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	34.07 lb
CO	11.84 g	(11.84 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	312.95 lb
NOx	0.95 g	(0.95 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	25.11 lb
PM_{10}	0.0049 g	(0.0049 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	0.13 lb
$PM_{2.5}$	0.0045 g	(0.0045 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	0.12 lb
CO_2	513.5 g	(513.5 g/mi) x (15,000 mi/yr) x (1 lb/454 g)	13,572.69 lb
Gasoline Consumption	0.05780 gallons (gal)	(15,000 mi/yr) / (17.3 mi/gal)	693.64 gal

*See Endnotes

For More Information

The other fact sheets in this series and additional information are available on the Office of Transportation and Air Quality's Web site at:

Emission factor fact sheets: www.epa.gov/otaq/consumer.htm

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

Fuel economy: www.epa.gov/fueleconomy
www.fueleconomy.gov

Improving fuel economy and reducing emissions: www.epa.gov/epahome/trans.htm
www.fueleconomy.gov/feg/drive.shtml

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

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 2008. 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 (CO_2), 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 in fuel consumption results in a corresponding 1% increase in carbon dioxide emissions. About 19.4 lb CO_2 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 CO_2 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-08-025), "Average In-Use Emission Factors for Urban Buses and School Buses" (EPA420-F-08-026), and "Average In-Use Emissions from Heavy-Duty Trucks" (EPA420-F-08-027).