

freedomCAR & vehicle technologies program

U.S. Department of Energy • Office of Energy Efficiency and Renewable Energy

Just the Basics

Vehicle Emissions

What Are Exhaust Emissions?

In most heavily settled areas of the U.S., the personal automobile is the single greatest producer of harmful vehicle exhaust emissions. Exhaust emissions are generated by the fuel-air mixture burning in internal combustion engines, both gasoline-powered and diesel-powered. Emissions are also produced by fuel evaporation within the vehicle when it is stopped, and again during fueling.

The constituents of car (gasoline and diesel) and truck (diesel) emissions vary depending on fuel type and individual vehicle operating characteristics. The bulk of vehicular emissions are composed of water vapor, carbon dioxide, nitrogen, and oxygen (in unconsumed air). There are other pollutants, such as carbon monoxide, nitrogen oxides, unburned fuel, and particulate matter, in smaller quantities as well. Some of these substances play a considerable role in vehicle-related air pollution including some that are “greenhouse gases,” believed by many scientists to contribute to climate change. The table at right identifies the important gases and solids found in exhaust emissions that are cause for concern.

Why Are Exhaust Emissions a Problem?

Exhaust, evaporative, and refueling emissions are major contributors to air pollution and the health problems it causes. In addition, many of the

compounds found in vehicle exhaust are known to be carcinogenic (cancer-causing) in significant, chronic exposures.

Other gases found in emissions—carbon monoxide and sulfur dioxide—contribute to the formation of ground-level, or tropospheric, ozone. Tropospheric ozone develops from the interaction between two or more precursor pollutants such as volatile organic compounds (VOCs) and nitrogen oxide (NO_x) in the presence of ultraviolet light (sunlight). This type of ozone is responsible for much of the poor air quality that develops throughout the U.S., especially during the summer months.



Less dependence on foreign oil, and eventual transition to an emissions-free, petroleum-free vehicle

Pollutants Found in Vehicle Emissions

Greenhouse and Tropospheric Gases	Air Toxics	Solids/Liquids
<p>Carbon Dioxide (CO_2), a greenhouse gas, produced by complete combustion.</p> <hr/> <p>Carbon Monoxide (CO), a toxic by-product of incomplete combustion.</p> <hr/> <p>Nitrogen Oxides (NO_x), also a greenhouse gas, which is formed by the interaction between oxygen and nitrogen in high temperatures and pressures found in engine combustion chambers.</p> <hr/> <p>Sulfur Dioxide (SO_2), which contributes to the formation of acid rain, dependent upon sulfur content of fuel (typically low for cars and trucks).</p>	<p>Hydrocarbons (HC), derived from unburned fuel during incomplete combustion, additionally Volatile Organic Compounds (VOCs), arising from fuel evaporative emissions, these may include benzene, toluene, xylene, 1,3-butadiene, acetaldehyde, and formaldehyde. Subsequent reaction in sunlight creates smog and other forms of air pollution.</p>	<p>Particulate Matter (PM), soot and smoke (microscopically suspended particles primarily arising from carbon, condensed water vapor, and soluble HCs) produced by internal combustion (notably diesel) engines.</p>

What Is Being Done About Exhaust Emissions?

When it first became apparent during the 1960s that exhaust emissions were contributing to worsening air pollution problems in much of the U.S., the federal government enacted the Clean Air Act. Several revisions later, the Clean Air Act and ensuing legislation have led to significant modifications in fuels and vehicles that have produced impressive improvements in air quality, such as:

- Major changes in U.S. fuel formulations, including removal of lead, addition of oxygenates, and reduction in sulfur content
- Placement of catalytic converters on all U.S. passenger cars and light trucks, minivans, and SUVs manufactured after 1974, to reduce CO, NO_x, HC, and VOC emissions
- Mandatory vehicle emissions testing in more than half of U.S. states, with requirements for vehicle repair or removal from use
- Installation of vapor recovery systems on gasoline fueling pumps in major metropolitan areas, to capture VOC emissions

While much has been achieved, more remains to be done. In the years since the Clean Air Act was first passed, the average number of vehicles per household has increased, many more vehicles use U.S. roads, vehicle miles per gallon of fuel are decreasing due to the popularity of sport utility vehicles (SUVs) and light trucks, and many drivers commute longer distances to and from work and school. Consequently, air quality is still unhealthy in much of the U.S., and the incidence of cardiopulmonary conditions such as heart disease, emphysema, and asthma is on the rise.

To help address these problems, the U.S. Department of Energy is funding research and development efforts that can improve fuel economy and engine efficiency, broaden the diversity of available vehicle fuels, and diminish the U.S.'s dependence on foreign petroleum while helping to reduce the amount of harmful vehicle emissions released into the air. These include:

- Oxygenating fuel additives and devices
- Alternative, non-petroleum-based fuels
- Improved combustion processes
- Technologies to replace internal combustion for transportation
- Diesel fuel with reduced sulfur levels
- Diesel oxidation catalysts
- Hydrocarbon traps
- Particulate traps

Where Can I Find More Information?

U.S. Department of Energy, Energy Efficiency and Renewable Energy—Air Emissions and Standards

http://www.eere.energy.gov/EE/trans_air_emissions.html

U.S. Department of Energy—FreedomCAR and Vehicle Technologies Program

<http://www.eere.energy.gov/vehiclesandfuels>

U.S. Environmental Protection Agency: Toxic Air Pollutants

<http://www.epa.gov/air/toxicair/index.html>

U.S. Environmental Protection Agency: Mobile Source Air Toxics

<http://www.epa.gov/otaq/toxics.htm>

Automobile Emissions: An Overview

<http://www.epa.gov/OMSWWW/05-autos.htm>

U.S. Department of Transportation, Federal Highway Administration – Transportation Air Quality, Selected Facts and Figures

<http://www.fhwa.dot.gov/environment/aqfactbk/factbk13.htm>

Vehicle emissions contribute to the haze and poor air quality that develops in many U.S. cities, especially during the warm summer months.



A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.



U.S. Department of Energy Energy Efficiency and Renewable Energy

August 2003

 Printed on recycled paper