Government of Canada / Gouvernement du Canada

Fuels and Air Pollution

When fuels are burned or combusted, a large number of chemicals are produced and emitted into the air. In fact, fuel consumption contributes greatly to air pollution as well as greenhouse gas emissions: in 2007, transportation sector emissions represented about 27% of Canada's total emissions inventory. Pollutants caused by fuel combustion include particulate matter, nitrogen oxides, volatile organic compounds, benzene, metals and sulphur dioxide, among others; many of these contribute to the creation of smog.

A large part of Canada's direct energy needs are met through the combustion of fuels such as gasoline, oil and natural gas. We use fuels to power our transportation, fire our power plants and heat our homes. Most petroleum-derived fuels, like gasoline or diesel, are a complex mixture of substances known as hydrocarbons and can contain additional chemicals known as fuel additives. Other fuels--promoted as alternatives to traditional fossil fuels--include propane, methanol and biofuels, which are derived from a form of biological matter such as corn or canola oil.

The Government of Canada plays an active role in assessing the health risks associated with outdoor air pollutants and establishing fuel quality standards and regulations to protect the health of Canadians. As part of this work, federal researchers also assess the potential health effects, risks and benefits associated with the use of individual fuels, changes in fuel quality, and specific fuel additives. This risk assessment process informs the policy decisions made about fuel use.

Fuels being addressed include:

Conventional Fuels

- gasoline,
- diesel,

Renewable Fuels

- ethanol, and
- biodiesel.

Conventional Fuels

Gasoline

As a fuel, gasoline can negatively affect our health both before and after combustion. We are usually exposed to gasoline vapour and gasoline-engine exhaust when we breathe, although it is also possible to absorb it through our skin or ingest it.

Before combustion, gasoline is a highly volatile mixture of natural hydrocarbons and other organic chemicals derived from crude petroleum. Manufacturers add more chemicals to gasoline to improve the octane rating, increase combustion efficiency, and protect engine and exhaust components. Gasoline typically contains more than 150 chemicals, with the exact content depending on factors such as the geographic region, the season, the gasoline grade/octane rating, the crude petroleum source and the producer.

Canadians are primarily exposed to minimal amounts of gasoline vapour when filling up the fuel tank at gas stations. If we breathe in higher concentrations of gasoline vapour, however, we could irritate our lungs or suffer from harmful neurological effects such as dizziness and headaches. More serious effects include coma and respiratory arrest.

After combustion, the exact content of engine exhaust depends upon the formulation of the gasoline being burned, the mechanical characteristics of the engine, the vehicle weight and speed, the driving characteristics of the vehicle operator and other factors.

We are exposed to gasoline-engine exhaust when we drive in traffic and walk or stand along busy streets. Due to its high level of particulate matter and other toxic chemicals, this exhaust is also linked to respiratory illness and cardiovascular symptoms.

Many of the harmful effects observed following gasoline exposure are caused by individual chemicals such as benzene. As a result, the Canadian government continues to study how the chemicals within gasoline impact our health and to take action based on its findings, such as reducing the benzene content of gasoline to protect the health of the general population. Federal scientists are also looking into the environmental and health risks and benefits associated with further reductions in the sulphur content of gasoline.

Diesel

The combustion of diesel fuel in vehicles contributes significantly to air pollution. Diesel engine emissions vary considerably depending of the type, age and condition of the engine, how it is operated, and the fuel formulation. There is also a significant difference between the emissions of on-road and non-road (locomotives, marine vessels, heavy-duty equipment, etc.) diesel engines that can generally be attributed to the older technology used in non-road vehicles.

Diesel engine exhaust is a complex mixture of hundreds of chemicals in either gaseous or particulate form. Diesel emissions include gases such as nitrogen oxides, carbon monoxide, formaldehyde, acetaldehyde, benzene, polycyclic aromatic hydrocarbons and nitro-polycyclic aromatic hydrocarbons. Diesel exhaust particles have a carbon core that absorbs organic compounds, nitrates, sulfates, metals and other trace elements.

Diesel engines are a major source of particle pollution: they create up to 100 times more particles than gasoline-powered engines, the size of which range primarily from 0.01 to 1.0 micrometre (μm), making them small enough to be deposited in lung tissue. Those less than 0.1 μm (one-thousandth of a millimetre) are known as ultrafine particles: these make up 1-20% of the mass of diesel exhaust particles and 50-90% of the total number of diesel exhaust particles. Ultrafine particles are able to penetrate the lung and walls of blood vessels to enter the bloodstream and affect other systems within the body, such as the cardiovascular system.

Current regulations require low-emission technology on all new diesel engines; yet older ("legacy") vehicles will continue to dominate the commercial truck fleet over the next two decades. Ongoing research is weighing the benefits against the costs of **retrofitting legacy diesel vehicles** and the feasibility of future government efforts to accelerate their adoption of clean diesel technologies.

Acute or short-term exposure to diesel exhaust can have immediate health effects: it can severely irritate the eyes, nose and throat, and produce bronchial and respiratory symptoms. It can also cause coughs, headaches, light-headedness and nausea.

Chronic and long-term exposure to diesel exhaust can increase or worsen allergic reactions and cause inflammation in the lungs, which may aggravate chronic respiratory symptoms and increase the frequency or intensity of asthma attacks.

Seniors and individuals with conditions such as emphysema, asthma and chronic heart or lung disease are especially sensitive to the fine-particle pollutants contained in diesel exhaust. Numerous studies have linked elevated particle levels in the air to increased hospital admissions, emergency room visits, asthma attacks and premature deaths among those suffering from respiratory problems. Children are also more susceptible than healthy adults to fine particles because their lungs and respiratory systems are still developing: childhood exposure to fine particles may increase the frequency of childhood illnesses and reduce their lung function.

Renewable Fuels

Ethanol

Ethanol, also known as grain alcohol, has been used as a fuel for many years. It is a biofuel produced by fermenting sugar or converting starch from a variety of agricultural or agri-forestry feedstocks, such as grains or wood waste.

In Canada, ethanol is produced primarily from corn and wheat, but there is ongoing research to develop commercially-viable practices for producing ethanol

from "waste biomass"--biodegradable wastes such as sewage, forestry or agricultural residues--that might normally be deposited in landfill but could instead be processed into a renewable source of fuel.

Read more about the Health Risks and Benefits Associated with the Use of 10% Ethanol-Blended Gasoline in Canada.

Biodiesel

Biodiesel is a liquid fuel that can be used as an alternative to petroleum diesel. It can be derived from several feedstocks, such as soy or canola oils, animal fats, or waste cooking oil. To produce biodiesel, the most common practice is to combine feedstock oil with alcohol in a process known as transesterification. The final product is a fatty acid alkyl ester, which has properties similar to conventional diesel fuel.

Diesel engines can run on diesel fuel blended with up to 20% biodiesel (by volume) with little effect on vehicle performance. Biodiesel fuel is generally blended with diesel fuel at levels of 2, 5 or 20%, and the combined fuel is termed B2, B5 or B20, respectively.

Because biodiesel is chemically different from conventional diesel, a blended fuel such as B20 will produce somewhat different emissions than conventional diesel when used to power a diesel vehicle. For example, studies have shown that tailpipe emissions of particulate matter, carbon monoxide, hydrocarbons and polycyclic aromatic hydrocarbons are generally lower for biodiesel than regular diesel. Studies of emissions tests, however, also report varying and inconsistent effects on other pollutants.

To understand the possible health risks or benefits associated with the use of biodiesel, it is important to thoroughly measure all chemical components of the exhaust emissions and assess their potential health implications. In 2012 Health Canada completed a full study of these health risks and benefits--compared to those associated with conventional diesel fuel. The results from the *Human Health Risk Assessment for Biodiesel Production, Distribution and Use in Canada* indicate that, based on currently available evidence, the potential incremental health risks or benefits of the production, distribution and use of biodiesel fuel blends in Canada are expected to be minimal compared to conventional diesel use. The findings contribute to the development of Canadian renewable fuels regulations.

Related Resources

Human Health Risk Assessment for Biodiesel Production, Distribution and Use in Canada - Executive Summary

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