

Sulphur Levels in Gasoline and Diesel

Sulphur is a naturally occurring compound in crude oil. When fuel is burned the sulphur combines with oxygen (SO_x) to create emissions that contribute to decreased air quality and have negative environmental and health effects.

The presence of sulphur in vehicle fuels also causes an increase in the release of other environmentally damaging compounds. High sulphur content decreases the catalytic conversion capacity of a system, thus increasing the emissions of nitrous oxides (NO_x), carbon monoxide (CO), hydrocarbons and volatile organic compounds (VOCs). However, the benefit of having sulphur in vehicle engines is that it also acts as a lubricant. Thus, while decreasing sulphur concentrations in order to decrease vehicle emissions, it will also be necessary to modify lubricants without compromising fuel economy or decreasing the oil change frequency. This could be accomplished by using lubricants with sulphur-free detergents, using a higher quality base stock and increasing the use of antioxidants. For further discussion on sulphur in lubricants please see:

http://www.eere.energy.gov/vehiclesandfuels/pdfs/deer_2005/panel1/2005_deer_bardasz.pdf

Fuels are subject to a variety of regulations, and recent changes in the regulations that are related to sulphur levels in gasoline and diesel are reviewed below.

The Impacts of Sulphur Emissions

The main environmental concerns related to sulphur emissions are acid rain and the formation of particulate matter. When sulphur dioxide (SO_2) is emitted and combines with water it forms sulphuric acid, or acid rain. Acid rain has many negative environmental impacts including the acidification of aquatic systems, increasing soil acidity and damage to vegetation. Acid rain can also cause the degradation of buildings and other human infrastructure. Sulphur is also emitted from vehicles in the form of sulphate particles (SO_4). Along with nitrogen oxides (NO_x), these particles contribute to particulate matter (PM) formation.

PM emissions result in reduced visibility and also have impacts on human health, resulting in an increased number of restricted activity days. Human health impacts are generally related to respiratory illnesses, including increased frequency in bronchitis and asthma. These illnesses have led to an increase in premature mortality.

Sulphur in Diesel: Regulation Changes in 2006

In 1997, regulations were changed to decrease sulphur concentration in diesel, now called Low Sulphur Diesel, to 500 ppm. Before 1997, regulations for sulphur in diesel were at 5000 ppm. The amount of diesel produced and imported in 2003, and the relative amount of sulphur, can be found in Table 1.

Table 1. Diesel fuel production and imports in 2003

	Produced/Imported		Sulphur mass (tonnes)	Average Sulphur content (% wt)
	m ³	% of total		
Low Sulphur Diesel	22,788,561	25.6	6,192	0.032
Diesel	3,325,323	3.7	7,017	0.247
Motor Gasoline	41,265,189	46.3	3,785	0.014

Source: Environment Canada. *Sulphur in Liquid Fuel*. 2003.

The new *Sulphur in Diesel Fuel Regulations* from the federal government will improve air quality and allow for improvements in the emissions control technologies used in diesel vehicles. These new technologies are already used internationally, and are expected in Canada in 2007. The new regulations for Ultra Low Sulphur Diesel set a maximum limit of 15 mg/kg (equivalent to 15 ppm) of sulphur in on-road diesel fuels. Production and imports of diesel are required to meet this limit by June 1, 2006. Diesel offered for sale must meet this limit by September 1, 2006.

Minor amendments are expected to allow for flexibility during the introduction of the new regulations. This also allows for similar timing with new U.S. regulations on sulphur in diesel fuel, permitting Canadian companies to remain competitive, and also to provide more consistency between production of diesel for Canadian use and production of diesel for exports.

There is currently no limit to the amount of sulphur in off-road and marine/rail diesel produced or sold in Canada. However, the new regulations include a limit of 500mg/kg for 2007, which will be further reduced to 15 mg/kg for off-road diesel in 2010 and for marine/rail diesel in 2012.

For the new regulations and background information, please see:

- For on-road diesel: <http://gazetteducanada.gc.ca/partII/2002/20020731/html/sor254-e.html>
- For off-road diesel: <http://canadagazette.gc.ca/partII/2005/20051019/html/sor305-e.html>

Sulphur in Gasoline: Regulation Changes in 2005

In 1999, the federal government imposed a limit and an accompanying time frame for sulphur concentrations in gasoline. At the time the average sulphur content in gasoline across Canada was approximately 320 parts per million (ppm). The regulations required a decrease to 150 ppm from 2002 through 2004, ensuring that by January 1, 2005, the average concentration would be 30 ppm. Table 1 shows the amount of gasoline produced and imported in 2003 (excluding aviation gasoline) and the amount of sulphur it contained.

As described previously, this decrease in sulphur content will result in decreased sulphur emissions and also allow for better after treatment systems, thus also resulting in a decrease in other harmful emissions.

For the new regulations and background information, please see:
<http://gazetteducanada.gc.ca/partII/1999/19990623/html/sor236-e.html>

The new regulations for diesel and gasoline both require that these fuels meet the American Society for Testing Materials standard (ASTM D5453-00), which uses ultraviolet fluorescence to measure sulphur concentrations in liquid hydrocarbons. Other specified methods may also be acceptable (e.g. X-Ray spectrometry), however producers must contact Environment Canada before using a different method. For further information on standards for testing sulphur concentrations in diesel, please see:

<http://www.astm.org/cgi-bin/SoftCart.exe/DATABASE.CART/HISTORICAL/D5453-00.htm?L+mystore+nqdb2030>