



How Much is One Part per Million?

By reducing amount of sulfur in diesel fuel from 500 ppm to 15 ppm, we can improve air quality. According to EPA estimates, with the implementation of these new fuel standards (Oct 2006) for diesel, nitrogen oxide emissions will be reduced by 2.6 million tons each year and soot or particulate matter will be reduced by 110,000 tons a year. What does this really mean? What does a ppm (part per million) look like?

Materials

- styrofoam egg carton
- water
- food coloring
- 2 pipettes (one for water, one for food coloring)

Activity

1. Use the pipette to put 9 drops of water in an egg carton compartment. Use the second pipette to place one drop of food coloring into this same compartment to make 10 drops of liquid. The amount of food coloring is 1 part per 10 parts.

How does the color of this solution compare with the food coloring?

How does the color of this solution compare with the color of the water?

2. Put 9 drops of water into the next egg carton compartment. Add one drop of water from the first compartment. This new solution is 1 part per 100 food coloring.

Compare the color of this liquid to the others. What do you see?

3. Put 9 drops of water into the third compartment of the egg carton. Add a 10th drop of liquid from the second compartment. The solution in the third compartment is 1 part per 1000.

4. Repeat the procedure three more times, each time taking the 10th drop from the previous compartment. The sixth and last compartment is 1 part per 1,000,000. The ratio is abbreviated as 1 ppm.

It is remarkable that this small amount can make such a big difference in air quality!

United States - Sulfur content of diesel fuel

As of September 2006, on-highway diesel fuel sold at retail locations in the United States is ULSD^[4]. **Ultra-low sulfur diesel was proposed by EPA as a new standard for the sulfur content in on-road diesel fuel sold in the United States since October 15, 2006.** The allowable sulfur content for ULSD (15 ppm) is much lower than the previous U.S. on-highway standard for low sulfur diesel (LSD, 500 ppm), which not only reduces emissions of sulfur compounds (blamed for acid rain), but also allows advanced emission control systems to be fitted that would otherwise be poisoned by these compounds. These systems can greatly reduce emissions of oxides of nitrogen and particulate matter.

Because this grade of fuel is comparable to European grades and engines will no longer have to be redesigned to cope with higher sulfur content and may use advanced emissions control systems which can be damaged by sulfur, the standard may increase the availability of diesel-fueled passenger cars in the U.S. European diesels are much more popular with buyers than those available in the U.S.

Additionally, the EPA is assisting manufacturers with the transition to tougher emissions regulations by loosening them for model year 2007 to 2010 light-duty diesel engines.^[5] As a result, Honda, Nissan, Subaru, Toyota, and others are expecting to begin producing diesel vehicles for the U.S. market to join those from Mercedes-Benz and Volkswagen.^[6]

According to EPA estimates, with the implementation of the new fuel standards for diesel, nitrogen oxide emissions will be reduced by 2.6 million tons each year and soot or particulate matter will be reduced by 110,000 tons a year.

On June 1st, 2006, U.S. refiners were required to produce 80% of their annual output as ULSD (15 ppm), and petroleum marketers and retailers were required to label^[7] diesel fuel, diesel fuel additives and kerosene pumps with EPA-authorized language disclosing fuel type and sulfur content. Other requirements effective June 1, 2006, including EPA-authorized language on Product Transfer Documents and sulfur-content testing standards, are designed to prevent misfueling, contamination by higher-sulfur fuels and liability issues. The EPA deadline for industry compliance to a 15 ppm sulfur content was originally set for July 15, 2006 for distribution terminals, and by September 1, 2006 for retail. But on November 8, 2005, the deadline was extended by 45 days to September 1, 2006 for terminals and October 15, 2006 for retail. In California, the extension was not granted and followed the original schedule. As of December, 2006, the ULSD standard has been in effect according to the amended schedule, and compliance at retail locations was reported to be in place.

Sulfur is not a lubricant, however the process used to reduce the Sulfur also reduces the fuel's lubricating properties. Lubricity is a measure of the fuel's ability to lubricate and protect the various parts of the engine's fuel injection system from wear. The processing required to reduce sulfur to 15 ppm also removes naturally-occurring lubricity agents in diesel fuel. To manage this change ASTM International (formerly the American Society for Testing and Materials) adopted the lubricity specification defined in ASTM D975 for all diesel fuels and this standard went into effect January 1, 2005.^[8]

The refining process that removes the sulfur also reduces the aromatic content and density of the fuel, resulting in a minor decrease in the energy content, by about 1%. This decrease in energy content may result in reduced peak power and fuel economy.

The transition to ULSD is not without substantial costs. The US Government has estimated that pump prices for diesel fuel will increase between \$.05 and \$.25 per gallon as a result of the transition.

ULSD will run in any engine designed for the ASTM D-975 diesel fuels.

It is, however, known to cause seals to shrink (Source: [Chevron paper](#)) and can cause fuel pump failures in [Volkswagen TDI](#) engines; biodiesel blends are reported to prevent that failure (Source: [HRCCC.org Biodiesel Best Management Practices](#)).

http://en.wikipedia.org/wiki/Ultra-low_sulfur_diesel