The Need for Alternative Fuel Sources: Biodiesel and Other Options

Jill Burrows

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Diesel Engines

- 94% of all goods in the United States are transported by vehicles with diesel powered engines.
- Used for their power, reliability, and durability.
- Can be recognized by their emissions of sooty, foul smelling exhaust.
Diesel Exhaust Contains:

- Unburned Carbon Compounds
- Carbon Monoxide and Dioxide
- Nitrogen Oxides
- Sulfur
- Polycyclic Aromatic Hydrocarbons
Unburned Carbon

- Becomes eye and lung irritants when emitted to the atmosphere
- Soot is able to bypass the body’s main immune-defense mechanisms, and become imbedded deep in the lungs
- Prolonged exposure can cause lung disease and asthma
- Responsible for corrosion, harm to vegetation, a reduction in visibility, and affects the climate
Carbon monoxide

- Transportation: 69.00%
- Industrial processes: 11.00%
- Solid waste disposal: 8.00%
- Fuel combustion, stationary: 2.00%
- Misc.: 10.00%
Carbon Monoxide

- Reduces air quality

- Human exposure to CO reduces the ability of the blood to carry oxygen to the body’s vital organs

- Low-exposure can cause dizziness, headaches, fatigue, and chronic flu-like symptoms

- High-exposure can cause death
Carbon Dioxide

- Disrupts the Earth’s natural carbon cycle
- An increase in Carbon Dioxide results in a decrease of infrared radiation able to escape the atmosphere
- Acts as a greenhouse gas and promotes global warming
- Absorbs heat in the atmosphere
Atmospheric Carbon Dioxide Concentration and Temperature Change

CO₂ CONCENTRATION
(Antarctic Ice Core)

Current Level

Level 1800 AD

Temperature change (°C)

Carbon dioxide (ppmv)

Thousands of years ago
Sea level rise

Precipitation

Temperature

Impacts on...

Health
- Weather-related mortality
- Infectious diseases
- Air-quality respiratory illnesses

Agriculture
- Crop yields
- Irrigation demands

Forest
- Forest composition
- Geographic range of forest
- Forest health and productivity

Water resources
- Water supply
- Water quality
- Competition for water

Coastal areas
- Erosion of beaches
- Inundation of coastal lands
- Additional costs to protect coastal communities

Species and natural areas
- Loss of habitat and species
- Cryosphere: diminishing glaciers

Source: United States Environmental Protection Agency (EPA)
Nitrogen Oxides

- Harmful to vegetation: reduces crop growth and production yield
- Reacts with water and oxygen in the atmosphere to produce acid rain
- Contributes to global warming by absorbing infrared radiation, and by contributing to the destruction of the ozone layer
- Creates tropospheric ozone
Ozone Layer Destruction

Ozone is formed by continuous reactions between oxygen and oxygen radicals

\[ \text{O}_2 \longrightarrow \text{O} + \text{O} \]

\[ \text{O} + \text{O}_2 \longrightarrow \text{O}_3 \]

Nitrogen oxides in the atmosphere readily react with the oxygen and free oxygen radicals to create nitrogen di- and trioxide, depleting the oxygen and free radicals available to form ozone

\[ \text{NO} + \text{O}_3 \rightarrow \text{NO}_2 + \text{O}_2 \]
\[ \text{NO}_2 + \text{O} \rightarrow \text{NO} + \text{O}_2 \]
\[ \text{O}_3 + \text{uv-light} \rightarrow \text{O}_2 + \text{O} \]

\[ \text{Net result: } 2\text{O}_3 \rightarrow 3\text{O}_2 \]
Sulfur Emissions

- Effects the respiratory tract and can aggravate cardiovascular disease
- Harms plants, trees, and decreases crop yield
- Along with nitrogen oxides, is the primary producer of acid rain
Acid Rain

- Sulfur and nitrogen dioxides react with water vapor and oxygen in the atmosphere to form sulfuric and nitric acid.

- Returns to the Earth in precipitation, altering the pH of bodies of water, soil nutrient balance, endanger entire ecosystems, and corrode surfaces.
Polycyclic Aromatic Hydrocarbons

- Identified as possible carcinogens
- Contaminate ground and surface water
- Highly toxic to aquatic life and birds
- Remains in ecosystems for extended periods of time due to ability to bioaccumulate
Alternative Fuel Sources

- Hydrogen Fuel Cells
- Ethanol
- Electricity
- Biodiesel
Biodiesel is a clean burning alternative fuel source derived from soybeans whose use has been approved by the Environmental Protection Agency.

Biodiesel benefits the environment, the performance of vehicles, and the economy.
Environmental Benefits

- Cleaner burning alternative to plain diesel
- Completely renewable: composed of mono-alkyl esters and fatty acids derived from vegetable oil
- Helps conserve natural resources: for every unit of energy needed to produce biodiesel, an additional 3.24 units are created
- “Biodiesel is less toxic than table salt, and degrades faster than sugar.”
### Average Biodiesel Emissions Compared to Conventional Diesel, According to EPA

<table>
<thead>
<tr>
<th>Emission Type</th>
<th>B100</th>
<th>B20</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Regulated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Unburned Hydrocarbons</td>
<td>-67%</td>
<td>-20%</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>-48%</td>
<td>-12%</td>
</tr>
<tr>
<td>Particulate Matter</td>
<td>-47%</td>
<td>-12%</td>
</tr>
<tr>
<td>Nox</td>
<td>+10%</td>
<td>+2%</td>
</tr>
<tr>
<td><strong>Non-Regulated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfates</td>
<td>-100%</td>
<td>-20%*</td>
</tr>
<tr>
<td>PAH (Polycyclic Aromatic Hydrocarbons)**</td>
<td>-80%</td>
<td>-13%</td>
</tr>
<tr>
<td>nPAH (nitrated PAH’s)**</td>
<td>-90%</td>
<td>-50%**</td>
</tr>
<tr>
<td>Ozone potential of speciated HC</td>
<td>-50%</td>
<td>-10%</td>
</tr>
</tbody>
</table>
Performance

- Biodiesel has the same vehicular performance as diesel in mild temperature, and actually performs better than diesel in cold temperatures.

- Current engines do not require any modifications to use biodiesel as opposed to diesel.
Economic Benefits

- Tax incentives are offered for the production and use of biodiesel
- Would eliminate dependence on foreign oil
- Production and consumption of biodiesel is increasing

Sales of Biodiesel
- 2004 -- 25 million gallons
- 2003 -- 20 million gallons
- 2002 -- 15 million gallons
- 2001 -- 5 million gallons
- 2000 -- 2 million gallons
- 1999 -- 500,000 gallons
Why not use Biodiesel instead of diesel
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