 Yellowstone Winter Air Quality Study: Winter Vehicle Emissions

Introduction

Yellowstone National Park with its thermal features and abundant wildlife draws about 3 million visitors a year, less than 5 percent visit during the winter. Rapid increases in the number of snowmobiles using the park in the mid-1990’s led to complaints about noise, poor air quality, traffic, and air pollution. Measurements of air quality at the West Entrance found CO concentrations comparable to highly trafficked urban areas. Emission studies found that the 2-stroke snowmobile engines were many times dirtier than wheeled vehicles. Multiple lawsuits preceded the development of a Winter Use Plan that limited the number of snowmobiles, required the snowmobiles meet emission standards, and prescribe guided groups.

In recent years, the majority of snowmobiles visiting the park have switched to 4-stroke engines. More people are using the snow coaches, and the number of snowmobile visits has declined. Has the air quality improved? Are the emissions lower? What is the present mode of transportation from an air quality perspective?

Changes in Air Quality

Starting in 1999-2000, efforts were made to limit the number of snowmobiles queuing up at the entrance stations. In 2002-2003 snowmobiles became available as rentals and between one-third to one-half of snowmobile entrance traffic was 4-stroke sleds. In 2003-2004, 4-stroke snowmobiles and guided tours were initiated with the result that approximate 80% of snowmobiles were 4-stroke. During the winter of 2004-2005, greater than 90% of snowmobiles were 4-stroke. These changes appear to have been effective in reducing the high CO concentrations near the entrance station.

Measuring Emissions in the Field

Ambient air monitoring was initiated at 2-3 locations. A remote sensing device was used to determine the emissions of CO, hydrocarbons, and NO for snowmobiles at the West Entrance Station. Portable instruments were used to directly measure exhaust gasses from a cross-section of snow coaches.

In the field, the compact emission analyzer was carried inside the vans and a hose run out to the exhaust pipe. Researchers traveled with the equipment.

Results of Emissions Studies

Emissions are presented in the table below as gm/mi/person. The change from 2-stroke to 4-stroke engines reduced CO by 47-69% and hydrocarbons by greater than 95%. The average snow coach emissions are slightly higher in CO but NO is lower. However, snow coaches with modern pollution controls were much cleaner than the cleanest snowmobile measured. On a tons per season emitted basis, the 4-stroke snowmobiles and the current fleet of snow coaches are roughly even.

Summary and Conclusions

- The historical decreasing trend in the number of snowmobiles is mimicked by decreasing CO concentrations and is the primary reason for the lower ambient CO concentrations.
- Both snow coaches and 4-stroke snowmobiles have lower emissions per person than the 2-stroke snowmobiles. Emissions reductions averaged 61% for CO and greater than -96% for hydrocarbons.
- The reduction in snowmobile hydrocarbons was significant (-96%) and readily observed. Visible exhaust plumes and odor were greatly reduced. The greater engine efficiency is reflected in an improved gas mileage by the 4-stroke snowmobiles.
- Snowmobile emissions were NOT observed to increase with speed on a gm/mile basis. Emissions are greatest during initial startup and idling, especially when the engine is cold.
- The snow coaches emissions on a round trip from Mammoth Hot Springs to Old Faithful are color-coded on this map. Higher CO emissions are seen with greater load, speed, and “off-cycle” excursions. The inset has shaded-relief of elevation to see the load effect.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Snowmobile 2-stroke average</th>
<th>Snowmobile 4-stroke average</th>
<th>Snowmobile cleanest 4-stroke average</th>
<th>Snowcoach average</th>
<th>Snowcoach cleanest</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>65</td>
<td>28.0</td>
<td>25.0</td>
<td>42.0</td>
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<tr>
<td>HC</td>
<td>81</td>
<td>3.4</td>
<td>3.1</td>
<td>1.7</td>
<td>0.1</td>
</tr>
<tr>
<td>NO</td>
<td>--</td>
<td>2.4</td>
<td>2.8</td>
<td>3.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The CO concentrations are much higher during the winter months despite that fact that traffic is much higher during the summer. The decrease in CO in winter is due mostly to the reduced traffic, but also to an emission reduction of 61%. Winter mean CO concentrations have also been coming down in recent years. This due to newer vehicles with modern pollution controls that are slowly replacing the fleet of old vehicles.

Snowmobiles emissions were measured on entry and exit. One sled was instrumented for direct exhaust emissions measurements.

The snow coaches emissions on a round trip from Mammoth to Old Faithful are color-coded on this map. Higher CO emissions are seen with greater load, speed, and “off-cycle” excursions. The inset has shaded-relief of elevation to see the load effect.

The oldest snow coaches are Bombardiers. Most have older carbureted engines that have high emissions.

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