The Snowmobile Dilemma
or
Who Spilled What in the Refrigerator vs. Who's Going to Clean It Up?

By Howard Haines
Lab Results

I first became aware of concerns about snowmobile emissions and noise around Yellowstone National Park a number of years ago while working on a project to reduce diesel soot and odor. There were documented problems related to health and worries about the environment at West Yellowstone and in the park. Snowmobiles were "guilty till proven innocent" because they were the vehicle of choice for most folks traveling the winter routes in the Yellowstone Park area.

Snowmobiles are powered by lightweight, high-power, two-stroke engines tuned to run rich for cold starts and better throttle response. Current design of these two-stroke engines lets 20-33% of the fuel and lubrication oil be emitted unburned. The rich fuel mixture and fuel bypass used for lubrication results in high amounts of emitted carbon monoxide, unburned hydrocarbons and smoke. These emissions in congested areas and on stagnant air days have been the main source of complaints.

The number of snowmobilers has dramatically increased in recent years because it is a fun way to see Yellowstone Park and the surrounding area. More than 75 percent of all snowmobilers visiting Montana tour the West Yellowstone area at some point during their stay. Reports show that on a given day in West Yellowstone, half of these snowmobilers go into the park while the others visit the surrounding national forests. Some winter days, as many as 2,000 snowmobiles leave West Yellowstone for one of those two destinations.

Concerns about emissions have increased to the point where they are quite noticeable for most folks in the area. The debate over cause and solution was quite heated when I went to my first winter use meeting in 1995. A pilot study measuring carbon monoxide discovered improper ventilation in a kiosk. This problem was repaired, but others remained. No one had information on the specific sources, causes, quantity and type of chemical compounds or possible near-term answers to the emissions question.

The situation reminds me of my four children who spend a great deal of energy and emotion determining who, when and what was spilled in the refrigerator. I get all the stories--fact, feeling and fiction--even how the kid visiting my sister 600 miles away caused the problem. It would be so much easier for them to just clean it up, reduce the risk of "it" becoming a new and deadly life form, and help them prevent "it" from happening again. The main and most important thing is to have them start doing something about the situation rather than trying to place blame.

The snowmobile situation is obviously more complex than my refrigerator, three teenagers, and a teen wanna-be, and will therefore require multi-faceted solutions. Emission-reduction methods used in different engines, fuels, and lubricants might work for snowmobiles in the short term. For example, general experience with automobiles shows that oxygenated fuels, including ethanol blends, could reduce carbon monoxide by about 20% on average in newer, fuel-injected automotive engines, with a greater reduction in older, carbureted cars.

Missoula, Montana, has climate conditions similar to those in West Yellowstone. Through the use of oxygenated fuels, Missoula has reduced carbon monoxide by 24.3% on average compared to 1990. Better news still for health concerns is the 1992/1993 study that showed the use of oxygenated fuels reduced carbon monoxide by 29-60% during daylight hours on days with stagnant air (when the wind velocity was less than one mile per hour). Missoula uses a fuel with 2.7% oxygen--about 8% ethanol. The ethanol is splash-blended with regular or premium gasoline, increasing octane over standard and premium grades of gasoline.

So we know the ethanol blend works in cars. Studies done in England, Germany, and Thailand showed that synthetic lubrication oil reduced particulates and smoke in two-stroke chainsaws and motor scooters--again, engines similar to snowmobiles but not the same. There were no reports describing how oxygenated fuel worked in snowmobile engines. Earlier investigations and the Missoula experience enabled us at the Department of Environmental Quality (DEQ) to speculate that the use of oxygenated fuels would reduce carbon monoxide generated by ALL transportation vehicles throughout the greater Yellowstone region, but there was no proof of this.

What we needed to know was how these products would work in snowmobile engines, what were the probable chemical culprits, and how we could reduce or eliminate these in the field without endangering life, the environment or local livelihood. No environmental solution is worth risking a life on a machine that gets stranded some late winter evening due to a product-caused failure.

To that end, the Montana DEQ partnered with the International Snowmobile Manufacturers Association (ISMA), the U.S. Department of Energy, the Wyoming Energy Office, the National Park Service and others in 1995 to develop a two-part program to evaluate how the use of commercially available biomass-based fuels and lubricants in snowmobile engines would effect emissions.

One part of the program is laboratory testing of snowmobile engines to determine how fuels and lubes effect emissions; for example, verifying that ethanol-blended fuels do reduce carbon monoxide. The tests identify a baseline emission rate for gasoline and conventional lube oil. This baseline is compared to results of other fuel and lubricants to determine effects on emissions, power, and fuel consumption. These impacts will be similar in other two-stroke engines such as lawn mowers, chainsaws, and marine engines.

The ISMA supplied two test engines--an air-cooled, 488cc carbureted Polaris and a water-cooled, 440cc Arctco--engines commonly used in the greater Yellowstone region. Fuels tested include a reference gasoline (Indolene), gasohol (10% ethanol) supplied by the Ethanol Producers and Consumers of Montana, and an aliphatic gasoline. The aliphatic gasoline contains virtually no aromatics, olefins, oxygenates, or sulfur. Its use in chainsaws and similar engines in other countries is known to reduce toxic emissions.

Lubricants evaluated were two biodegradable (biomass-based) synthetic lubricants, one with and one without a solvent, a high polyisobutylene (PIB) synthetic lubricant shown to reduce particulates in other two-stroke applications, and a conventional, petroleum-based lubricant.

Laboratory emissions tests were conducted on snowmobile engines this past May and June, 1997, at Southwest Research Institute in San Antonio, TX. The tests used an industry-approved test cycle developed from field use data. The tests determined how emissions could be effected by the use of ag-based products such as gasohol and lube oils. Lubrication oils, as expected, impacted particulate matter rates, and all synthetic lube oils reduced brake-specific fuel consumption. Some combinations of fuel and lubes were able to reduce hydrocarbons by 38%, carbon monoxide by 19%, and particulates by

55%, but no single combination reduced all three by this amount in both engines. The manufacturers now are investigating which combination of fuel and synthetic lube works best in current and previous equipment. Data from these tests are still being analyzed for other conclusions as to biodegradability and toxicity.

The test data showed that ethanol-blended gasoline with conventional lube oil produced 16% fewer hydrocarbons, 9% less carbon monoxide, and 24% less particulate matter than gasoline. Oxides of nitrogen (NOX) are naturally low from two-stroke engines. This confirms that the ethanol blend tested can reduce emissions. This fuel and other oxygenated fuels are covered in all manufacturers warranties--the first of many steps to resolve the problems.

Like everything else, users need to follow the manufacturers' recommended setup for fuel, temperature, and elevation for overall performance and safety of snowmobiling. Observations in West Yellowstone showed that a number of snowmobile users operated machines not properly set up for Yellowstone-area elevation. The typical increase in elevation of 1,000 feet along a Yellowstone-area trail will make the fuel mix richer due to less oxygen in a set volume of air and might cause the machine to operate poorly and produce more emissions.

To verify this observation, the Southwest Research Institute also ran a laboratory test on an engine not adjusted for elevation to simulate the effects of increased elevation on emissions and performance. The test showed that hydrocarbons increased by 31%, carbon monoxide increased by 14%, particulate matter increased by 27%, and fuel consumption increased by 16% while power decreased by 19%. This is obviously not good for the engine or anything else.

The results show emissions can be significantly effected by fuels and lubes as well as by improper setup. Future changes such as direct injection in two-stroke engine technology can help ensure proper setup at all elevations and will undoubtedly increase performance and reduce emissions. These changes are similar to those now being made in the marine and small engine industry, although four-stroke engines applicable to snowmobile requirements do not appear to reduce emissions as much as once thought. Other technologies are being explored by industry, including those that reduce noise.

All lab test results I've mentioned here are preliminary at this time. The data from tests on the second engine are still being compiled, and the chemical analyses are not yet complete. The second part of the project will use these promising products and combinations in pilot field demonstrations this winter. The pilot demonstrations will help determine how well these combinations work in the Yellowstone area and if they produce a reduction in emissions in the field. Dealers should contact manufacturers about the use of specific lubrication oils and other products in their snowmobiles.

Even with this much done, we will still need to answer questions about what these emissions are doing or have done to people and the environment in this cold climate--a personal exposure and possibly a water/snow quality study--so that we can prevent damage to the resources in the area. No one has studied these issues yet.

With some good science and hard work and without undue regulation, the coordinated actions of industry, government, and the local community initiated by this project will reduce the problems attributed to snowmobiles. In a meeting earlier this year, industry and National Park Service representatives agreed that the goal is a cleaner, quieter machine upon which to view the winter grandeur of Old Faithful. I hope this can be done while preserving both the scenery and local businesses for my great grandchildren's children. (And by then--who knows?--there might even be self-cleaning refrigerators!).

LAB RESULTS SHOW

ETHANOL BLENDS REDUCE SNOWMOBILE EMISSIONS

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There are concerns being raised about the effects of snowmobile engine emissions on public health and the environment in sensitive areas such as Yellowstone National Park (YNP).

The majority of winter visitors to Yellowstone use snowmobiles powered by two-stroke engines. Current design of these two-stroke engines emits 25-30% percent of the fuel and lubrication oil unburned. These engines are tuned to run rich for better throttle response and cold starts. The rich fuel mixture also produces more carbon monoxide, unburned hydrocarbons and smoke.

To address these concerns, the Montana Department of Environmental Quality (DEQ), in cooperation with the International Snowmobile Manufacturers Association (ISMA), the U.S. Department of Energy, the Wyoming Energy Office, the National Park Service and others developed a two-part program in 1995 to evaluate potential emission benefits of using biomass-based fuels and lubricants in snowmobile engines.

Previous studies showed that oxygenated fuels, including ethanol blends, reduce carbon monoxide by about 20% on average in newer, fuel-injected automotive engines, with a greater reduction in older, carbureted cars. Missoula, Montana, has climate conditions similar to those in West Yellowstone. Missoula has reduced carbon monoxide by 24.3% on average since 1993 through the use of oxygenated fuels and by 29-60% during daylight hours on days with stagnant air (when the wind velocity was less than one mile per hour). Missoula uses a fuel with 2.7% oxygen (almost 8% ethanol). The ethanol is splash-blended with regular or premium gasoline, increasing octane over standard and premium grades.

However, there were no data for oxygenated fuel used in snowmobile engines. With the data from the earlier investigations and experience from similar locations, DEQ theorized that the use of oxygenated fuels would reduce carbon monoxide generated by transportation vehicles in West Yellowstone, Yellowstone National Park, and throughout the greater Yellowstone region.

To check this assumption, laboratory testing of snowmobile engines was conducted in May and June, 1997, to verify that ethanol-blended fuels would reduce carbon monoxide. Test engines supplied by the ISMA included an air-cooled, 488cc, carbureted Polaris engine and a water-cooled, 440cc Arctco engine. Fuels tested include a reference gasoline (Indolene), gasohol (10% ethanol), and an aliphatic gasoline. The aliphatic gasoline contains virtually no aromatics, olefins, oxygenates, or sulfur, and is used in other countries to reduce toxic emissions. Lubricants evaluated include two biodegradable (biomass-based lubricants), a high polyisobutylene (PIB) lubricant shown to reduce particulates in other engines, and a conventional, petroleum-based lubricant.

Laboratory emissions tests were conducted on snowmobile engines using an industry-approved test cycle developed from field use data--the first of its kind for these engines. The purpose of the tests was to determine how emissions could be effected by the use of ag-based products such as gasohol and biodegradable lube oils. The test data showed that ethanol-blended gasoline produced 16% fewer hydrocarbons, 9% less carbon monoxide, and 24% less particulate matter than gasoline. Oxides of nitrogen (NOX) are naturally low from two-stroke engines. The results are preliminary because the data from tests on the second engine are still being compiled, and the chemical analyses are not yet complete.

Please call (406-444-6773) or email Howard Haines, Montana Department of Environmental Quality, if you have any questions or would like a summary of the report when it is available later this year.