E-10 Ethanol and Small Engines

Steve Stockton gave a very informative presentation on E-10 Ethanol and its use and benefits in small engines. The main benefits of E-10 Ethanol are that it is homegrown, renewable, and that it is considered a green fuel. It is made from the distillation of sugar and starch stalks. When broken down E-10 stands for unleaded gasoline mixed with 10 percent ethanol. This allows E-10 to burn much cleaner than gasoline. E-10 is made for use in what are called flex fuel vehicles. Surprisingly this is no new concept—ethanol was used in Henry Ford’s first vehicle the Quadricycle and in 1908 in Ford Motor Company’s first mass-produced vehicle the Model T. Some drawbacks to E-10 are that it only produces 70 to 80 percent of the energy that normal gasoline produces. It also tends to cause problems in open loop engines. One of the most important things to know when using E-10 is to keep water out of the mixture. When water is present phase separation occurs. Phase separation causes the heavier stuff in the mixture like lubricant to sit in the bottom while ethanol keeps engine combustion going causing the engine to lock up. To prevent this from happening never use old mixtures, all mixtures should be labeled with the date and stored in a temperature-controlled environment. For large storage tanks they should be tested for water presence with a water paste test and use what is called a Pig Water Hog to remove the water from the fuel. When properly used E-10 Ethanol offer an excellent alternative to the limited, high polluting gasoline.
E10 Ethanol and Small Engines
Growing Pains of Change

The Presentation
- Up to 40 minutes of class time
- 10 minutes of question time
- Goal today - communication
- Sender, Message, Receiver
- Fun, informative, informal
- Encourage YOU to help ME- participate
- My job is to do my best to help you.

My Promises To You
- I will make everything I have been able to discover about E10 and its benefits and challenges as straightforward, common sense, and as practical as I possibly can.
- Honesty – I encourage questions, but if I am asked something I don’t know – that will be the response you get.

How Did We Get Here?
- As a species we always seek the best, cheapest, most flexible, efficient and attractive technology to solve any problem.
- The bow and arrow was once the pinnacle of weapon technology.
- Evolution of technology and change is in constant motion. Sometimes fast, sometimes slow – music analogy.

Industrial Revolution to Now
Late 1780’s to 1900’s
- Switch from agrarian/handmade to industrial or factory, mass production.
- Greatly reduced “subsistence” lifestyle
- Industry/mechanization prevalent on a global scale.
- Use of steam, hydro, wind, other power besides human or animal muscle.
This Caused Demand for New Commodities

• Great need for technology to support it.
• Fuel for lighting, heating, etc for factories.
• Lubricants to keep these factories running at maximum output.
• These needs were originally met by biologically derived fats and oils.
• What was the most notable of these?

Whale Oil

• Whaling was one of the first great global industry, 1700s to mid 1800s.
• At its peak the U.S. owned 735 of 900 whaling vessels, mostly New England.
• What Industry does this closely mirror?
• In early days, gave rise to great fortunes.
• Depended on brute labor of thousands.
• Dirty, sweaty, dangerous, work.

• Started with supplies closest to home.
• Eventually spread to find sources in all corners of the globe.
• At its peak was considered a bulletproof industry which nothing could challenge.
• Products were so superior for their particular application, that it had no rival.
• Saw great increase in price, as demand tightened, which led to development of the next most preferable technology.
Our Modern Petroleum Industry

- Started in the U.S. in 1859.
- First commercial oil well at Titusville, Pennsylvania in 1859.
- Created a boom like the gold rush.
- Pennsylvania produced half of the WORLD oil until the Texas oil boom of 1901.
- Originally only concerned with extracting kerosene/lubricants to replace whale oil.

By the early 1900’s, kerosene was the industry standard for lighting and non-wood, non-coal heating.
- Over 50% of the kerosene manufactured was used by one U.S. Government entity.
- **What was this government entity?**
- Originally, as a part of the refinement process, a hazardous, explosive, and useless byproduct was simply burned, dumped, or otherwise disposed of. What was it called?

That’s right, the petroleum product that is most sought after today was originally thrown out because no technology existed to utilize it. (234,000,000 vehicles) (20 to 25 gallons gas from every 42 gallons crude) Over half.
- Soon changed with the invention of the automobile in 1892, their mass production.
- By 1920, there were 9 million autos on the road in the United States.

There have been shortages, supply problems, political instability, excessive price increases, health and safety concerns, technological challenges and other problems that have made continued use of this product painful.
- Despite that, petroleum based products have remained our primary motor and transportation fuel since 1950.
Ethanol, E10, E85 and Beyond

An early ethanol production facility.

What is Ethanol?
- Ethyl Alcohol, been around since man first discovered how to brew beer, distill spirits.
- Readily burns.
- Renewable fuel source, homegrown, considered a “green” fuel.
- Made from distillation of sugar/starch feedstocks.
- Most common in U.S. corn & sugar cane.

- Has about 70% to 80% of the energy potential of gasoline.
- Indy cars now run on 100% ethanol.
- Used as a gas line antifreeze for years.
- 113 octane in pure form.
- Also used to supplement/boost octane since 1970's.

Ethanol – Why the Fuss?
- Generally burns cleaner than gasoline.
- Renewable – unlike oil, CAN be produced and replenished.
- Can reduce our dependence on foreign oil.
- Has been successfully used as a motor fuel for longer than you may think.
- When first used – what application?

Henry Fords Quadricycle
- Forerunner of the first automobiles.
- Designed to run on pure alcohol.
- 1890’s – this is not a new idea.
• By the 1930’s there were over 2000 service stations in the midwest selling it.
• Has been used on/off since then as supply, demand, and necessity dictate.
• Is a component of reformulated gasoline.
• Is helping phase out MTBE. Methyl tertiary butyl ether – groundwater contaminate.
• Is here to stay – MANDATE by federal government.

• Calls to significantly increase U.S. use of renewable fuels for transportation.
• Expands the renewable fuel standard to REQUIRE the use of 36 BILLION gallons of renewable fuels by 2022.
• Since ethanol is now the most widely used renewable fuel in the U.S. it will most likely make up a major portion of this amount.

Ethanol Formulations
• E indicates an ethanol blended gasoline.
• Number following it indicates percentage.
• E10 is gasoline with 10% ethanol added.
• E10 is supposed to be compatible with all motor vehicles made since 1970 or so.
• E85 is gasoline with 85% ethanol added and is only for use in flex fuel vehicles.
• What was the make and model of the first flex fuel vehicle?

Henry Ford’s 1908 Model T
• That’s right the very first mass produced automobile was a “flex fuel” vehicle.
• It had a carburetor adjustment that allowed it to operate on gasoline OR alcohol.
• Flex fuel is a technology that is more than 100 years old.
• There are currently 5 million flex fuel vehicles on the road – not counting Model T’s.

2008 Department of Energy Study
• Most recent/complete study available.
• Completed for the Dept of Energy by Oak Ridge Nat’l Lab, Nat’l Renewable Energy Lab, and Battelle Memorial Institute.
• 136 page document, first real look at various blends from E0, E10, E15, E20.
• Ran a WIDE variety of tests on new, used, foreign, domestic legacy vehicles and SNRE’s (small non road engines).
2008 Study

- I will focus on general trends that were observed across the board and:
- SNRE’s (small non road engines).
- Used a variety of 2 cycle and 4 cycle engines, of various age, manufacturer, duty ratings, etc.
- Did my best to glean the most critical info from the technical report.

General Trends and Information

- Most all emissions declined – CO, HC, regulated (combo of NOX and HC).
- Performance of all vehicles exhibited a loss in fuel economy – (only 70% to 80% energy potential of gasoline)
- E10 – 3% to 5%
- E20 – 7% to 8%
- In flex fuel vehicles – can be 6% to 28%
- Saw a trend of exhaust temp increase – some cases 50C to 70C (100-150 F).

SNRE’s Specific Problems

- Millions sold each year in many configurations, vary widely, what may work in one, may not in another.
- Tend to be “open loop” engines, unlike modern cars, trucks SUVs – Explain.
- Commonly air-cooled, enleanment a major problem. Increased combustion temps. May not be as efficiently cooled (water)

- No specific materials compatibility issues were noted. (was not specifically studied)
- In 2 cylinder engines, exhaust temps varied greatly from cylinder to cylinder.
- Results varied from manufacturer to manufacturer.
- Many saw an “enleanment” problem, ethanol caused leaner running condition, higher exhaust temps, odd idle, etc.

- Enleanment also normally caused increase in idle speed, accidental clutch engagement as a result – safety issue.
- Not specifically characterized, no obvious materials compatibility issues noted – Other sources DO list material compatibility as a problem.
- For Example flex fuel cars (E85) DO have different fuel system components to combat this. (Remove AL, some rubber, pump mods)
- Ethanol is a solvent, and long term use COULD cause problems not seen in tests.
Phase Separation in E10

- E10 is subject to a potential problem called phase separation.
- Phase separation occurs when water either in the liquid or vapor form, reaches a significant concentration, or saturation point.
- Above the saturation point, a combustible ethanol water mix settles out of solution.
- This will typically settle out of solution to the lowest point because of weight.

- In 4 cycle engines, damage can occur due to the previously mentioned enleanment problems – particularly in older equipment.
- In 2 cycle engines, like chainsaws, blowers, etc, where the lubricating oil is mixed directly with the fuel, damage will almost CERTAINLY OCCUR.
- The heavier phase containing alcohol and water will have separated from the fuel/oil mix.

- This alcohol phase will still have sufficient octane to fire the engine in most cases, but will have ALMOST NO lubricating properties.
- A 2 cycle engine so fueled can overheat and seize in a very short time.
- Repairs will be extremely costly.

Testing, Facts, Data

- There is a myriad of info available on line, some contradictory.
- There are 2 great environmental variables which cannot be controlled, specifically humidity and temperature.
- Humidity will make phase separation more likely, discuss condensation process.
- Extreme change in temps also make phase separation more likely.
• I have found multiple studies that indicate phase separation will occur at levels where dissolved water exceeds 3.8 teaspoons per gallon.
• I have found other studies that stored cans of E10 would require over 200 days to absorb enough water to phase separate if atmospheric moisture is the only water source.

How do we get through this?
• There are many issues that CAN be addressed to help us through – remember this is a mandate – it is here until 2022 at a bare minimum. KEEP WATER OUT.
• Storage and supply protocols.
• Inspections of equipment, awareness.
• 2 Cycle specific items.
• Additives.

Storage and Supply Protocols

• Assess your tanks for water presence and risk. Perform a water paste test.
• Is there water there now?
• How did it get there?
• Look at seals, vents, delivery, and all other ports. Do you have a weakness?
• Are there any of these areas that need repair? Repair with ethanol tolerant parts.
• Remove any water present. Pig water hog.

Talk with your fuel supplier – is the fuel he is delivering E10? Does he know when it will start being E10?
• Work now may prevent problems later.
• Assess your facility, storage, equipment and develop a plan. Get prepared.
• When you go to E10 – stay with it.
• One way to minimize condensation is to keep your tanks full, or as nearly full as possible. Limits the air gap present.

This is particularly important during the months that you have the greatest temperature changes, spring and fall.
• Make sure any overhead tanks are tipped the right way – demo.
• Paint tanks white or silver. Limits heating.
Equipment and Awareness

- Knowing what you know now about the challenges of E10 – what equipment is at risk?
- Older equipment will generally fair worse, particularly if ignored.
- Fortunately older equipment is also frequently more adjustable than new.
- Change filters, clean screens, (solvent action may free up gunk/deposits).

- Once you start receiving your E10, adjust the carbs on all your equipment that is adjustable (reduces enleanment)
- Consider an additive for older equipment that contains a stabilizer, upper cylinder lube, etc. Simulead, Marvel Mystery, etc.
- Monitor equipment for proper operation, particularly older equipment.

- Look for odd/increased idle speed.
- Miss, stumble at WOT.
- Change in exhaust gas color, density.
- Operating temperature increase. If equipment has performed at X temp for years, now higher- may not be fixed yet AT RISK!

2 Cycle Specific Problems

- As discussed earlier 2 cycle presents special challenges due to fact lube oil is mixed in directly as a component of fuel.
- Phase separation will destroy a piece of 2 cycle equipment with astonishing speed.
- However, because of their small size, you have more options than with a tractor, truck, etc.

2 Cycle Recommendations

- Buy the best quality mix oil you can. Many manufacturers offer 2 cycle mix with stabilizers or other beneficial additives.
- Stihl offers a synthetic ultra oil that contains stabilizers, highly effective, universal (any ratio) and bio-degradable 80% in just 21 days.
- Do not mix any more fuel than you can use in 30 days or so. DATE IT!
• By limiting storage time, you limit potential exposure, and condensation problems.
• If at all possible, store the mix inside, or in a temperature controlled environment. Think of keeping a gallon of universal mix stored in one of your flammables cabinets inside. If room, do same with equipment.
• Shake the mix and the equipment well. Shake the mix can when making the fuel and EACH time before you fuel up the equipment.

• Shake the equipment thoroughly before starting and using it.
• Top off the tank at the end of the day before storing it. This will help to eliminate the condensation problem, same as your gas storage tank. Long term options?
• Keep your 2 cycle equipment well adjusted, again, pay close attention to the carb adjustment.
• Address any operational problems sooner rather than later to save money.

Additives

• Knowing what you know now, who would be most at risk of having a problem with E10 fuel?
  • Humid environment?
  • Large temperature fluctuations?
  • Long equipment storage times?

Boaters and Snowmobilers

• Recently there has been marketing of a variety of additives claiming to help address the problem of E10 and marine, or recreational environments. Startron.
  • Bear repellant analogy.
  • Do they work? – time will tell.
  • They could be snake oil, or just the technology we need for our growing pains.

Credits

• David Simpson and Waveland Outdoor Power.
• Wayne Bright and Co-Alliance Inc.
• Stihl power equipment.
• Ganos Power Equipment.
• Effects of intermediate ethanol blends on legacy vehicles and small non-road engines, Report 1.

The End
Credits – Cont’d.

- Textbook Clean Air and Energy Independence: An overview of alternative fuels and advanced technology vehicles.
- Wikipedia – multiple items.
- N.Y. Times – They used to say whale oil was indispensible too.

Credits – Cont’d.

- Dept of Energy – multiple references.
- Star Brite Start Tron fuel treatment.
- Lighthouse Tales Book
- Newpig water hog.