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Research to Answer Big Questions About Small Engines Running on E20

Students at the Minnesota Center for Automotive Research at Minnesota State University/Mankato are getting ready to start their engines. The small ones, that is. As the race toward acquiring U.S. Environmental Protection Agency (EPA) approval for E20 as a fuel continues, research is underway to determine if a 20 percent ethanol blend is substantially similar to gasoline for use in light-duty vehicles as well as small engines.

When legislation was passed in May 2005 to authorize the investigation of E20 as a legitimate fuel in Minnesota, small engine manufacturers expressed concern that small engines would not be included in the evaluation of the effects of E20 on engines.

“That wasn’t true,” explained Bruce Jones, director of the Minnesota Center for Automotive Research. “It’s just that testing on small engines was not scheduled to happen in the first phase of E20 research.”

The strategy of the Renewable Fuels Association (RFA) is to focus first on the effect of E20 on light-duty vehicles and look for “show-stoppers.” If E20 causes problems with automobiles, there would be certainly be problems with small engines, but not vice versa.

However, the concern is that there are thousands of small engines to test, with seemingly infinite variables. “Every engine is different,” explained Ron Obermoller, Expanded Uses Team Leader. “You have to test compatibility with all of the different metals and plastics and rubber seals. The technology goes all the way from being 30 to 40 years old to electronic ignitions and state-of-the-art engines, so it’s a pretty big job to tackle.”

The deadline for acquiring EPA approval is 2010.

To jumpstart the small-engine research, the Minnesota Research & Promotion Council (MCR&PC) has sponsored a $100,000 pilot study of the use of 20 percent ethanol blends in small engines.

Obermoller views the pilot study as more than just an opportunity to move forward on the research on small engines. “We’re also going to be working with the next generation of automotive technicians, who may be in the industry for another forty or fifty years. It’s a win-win situation when we work with Professor Jones and his team.”

The difference between automobiles and small engines
According to Jones, the fuel systems in small engines, including those in motorcycles and snowmobiles, are not as technologically advanced as those in light-duty vehicles. All automobiles and light trucks have an oxygen sensor that measures the air and fuel ratio. This oxygen sensor allows the engine to tune itself for different fuels.

“So when you go from gasoline to a 10% ethanol blend to a 20% ethanol blend, the oxygen sensor tells the computer that it’s a different fuel with different characteristics and the computer makes an adjustment to the air and fuel ratio,” Jones explained.

Small engines don’t have that capacity.

“The potential problem comes in the fact that as you add more ethanol to the blend, you have to adjust the fuel mixture,” added Jones. “Between gasoline and E10, there isn’t really a problem because it’s a slight change. But as the amount of ethanol in the blend increases, the air and fuel ratio needs to be weighted more heavily toward fuel.”

Cars do that automatically. But the small engines don’t. So the big question is, when the blend of ethanol increases to 20 percent, will the carburetor on small engines have to be modified? Or will the 20 percent blend have only a minimal effect on the air and fuel ratio?

“We have converted a lot of small engines to run on E85,” said Jones. “It can be done. However, you don’t want to put a fuel out there that requires an engine modification. Because some won’t make the modification and there could potentially be some damage done to the engine, if it’s not properly set up. So this pilot study is really a jumping off point for finding some answers.”

Funding allows more reliability and consistency
With the funding from the MCR&PC, Dr. Jones and his team has already begun testing the effects of E20 on a motorcycle and a Briggs & Stratton small engine typically found in a lawn mower or utility generator. The funding will also allow the center to make improvements to their small engine testing capabilities to ensure more reliable data. In addition, Dr. Jones and his team will be developing small engine testing procedures for a complex set of variables.

“With automobiles and light trucks, what happens is, the manufacturers produce a relatively small number of different models, but a high volume of each one,” Jones explained. “With small engines, the problem is that there is a large number of applications, but within each application, there’s a small number of units. Because you’ve got lawnmowers, weed eaters, leaf blowers, motorcycles, ATVs, snowmobiles, power washers, portable welders – it goes on and on. The problem is there’s a small number for each category. Part of our research will be to

identify which small engines will be similar applications and to develop a matrix of what to look for or what to look at."

The funding from MCR&PC will also allow the center to hire an engineering technician to help guide the research. "That's an exciting part of it for us, to be able to hire an individual to really devote their full-time effort into carrying out the day-to-day things."

Dr. Jones is one of two faculty members in the automotive program who split their time between teaching classes, supervising labs, and leading research projects such as this one. Having a full-time technician will take some of the load off of the two faculty members. More importantly, it will aid in consistency.

Jones added, "While all of these research projects in the past have been great for students and while there will still be students involved in these projects, the problem for us as faculty is, every year we get a new group. So you're retraining them on that part of it. With a full-time technician, we'll achieve our goal of more consistency."

Challenges ahead

When the EPA approved E10 as a fuel substantially similar to gasoline, small engines were not tested for emissions. Now, however, small engines are tested for emissions, so E20 must be approved to use with light-duty vehicles as well as small engines. According to Jones, that will make EPA approval of E20 a little more challenging.

Small engines have typically run dirty. Part of that comes from the fact that their air/fuel mixture has traditionally been pretty rich. In other words, the balance of air and fuel has been too much fuel, not enough air. One way to improve the emissions is to lean out the air/fuel mixture, which reduces carbon monoxide emissions.

Added Jones, "However, when you adjust the engine too lean, the temperatures in the engine go up and you do risk damaging the engine. Ethanol has a further leaning effect on the air/fuel ratio. If the manufacturers are adjusting engines extremely lean now to meet the emission standards, and if an added fuel causes too much of a leaning effect, then there is a potential for damage to be done to the engine."

Damage may include burning or melting of the pistons. "I'm not saying that it's definitely going to happen," Jones said. "But in extreme, extreme cases, if you go way too lean and the engine's under heavy load, then yes, damage can occur. Will a jump from 10 to 20 percent ethanol do that? I don't know. That's what we'll test."

Pilot study leads the way
The results from the pilot study will dovetail into the RFA's small engine research, which will begin once the research on the effect of E20 on light-duty vehicles is complete.

"The process we develop now will be used for the small engine study next year," said Jones. "We'll be in great position to start looking at this matrix of engines for testing and coordinating those tests."

Obermoller views the pilot study as a way to begin addressing the concerns of small engine manufacturers. "We know some of the manufacturers, like those who make snowmobiles, will be very concerned about the effect of E20 on their engines. That's part of what we learned last time, when the EPA approved E10. You get the big picture in testing the automobiles, but you can't forget about the rest of the segment using the fuel. They all have to be brought along at the same time."

[SIDEBAR ARTICLE]
MnCAR Teaches Tomorrow's Engineers About Ethanol

To students at the Minnesota Center for Automotive Research (MnCAR) at Minnesota State University/Mankato, ethanol is as familiar as gasoline and diesel. The research they will are conducting on the effect of E20 on small engines will add to the depth of knowledge they've gained about ethanol in the program.

"Ethanol is well-ingrained within our curriculum," said Bruce Jones, MnCAR director. "They have a good handle it from past projects we've done."

This year, MnCAR students are participating in two vehicle design competitions for which they will design and build vehicles running on ethanol. Their car for the Formula SAE competition, where students conceive, design, fabricate and compete with small formula-style racing cars, will run on E85. Their entry in this year's Clean Snowmobile Challenge will run on a 10% ethanol blend.

MnCAR was established as an applied research center in 1998. Students use the center to evaluate engine performance, vehicle performance, and emissions.

Containing over $300,000 in major equipment, MnCAR provides the same evaluation procedures as the U.S. Environmental Protection Agency and the California Resources Board. A central component of the lab is a chassis dynamometer that simulates the engine strain of realistic driving conditions and allows data to be collected on emissions and fuel economy. In addition, a separate engine test cell is capable of accommodating three more engine dynamometers.

An integral component of the AET Program, the MnCAR involves undergraduate students in comprehensive projects. In addition, the MnCAR equips the automotive industry and government agencies with direct assistance in automotive research and product development.

