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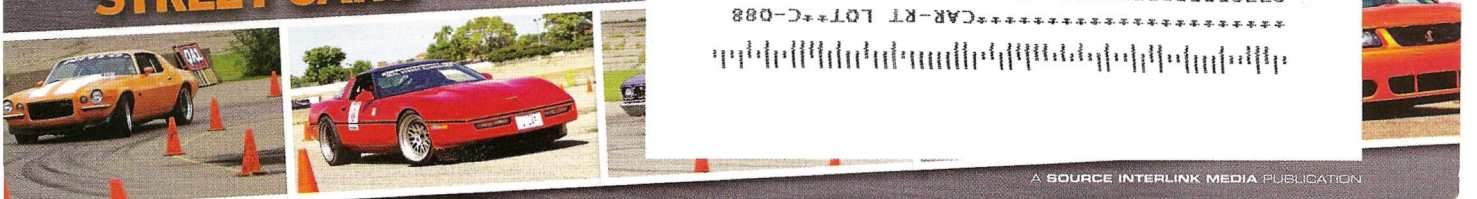
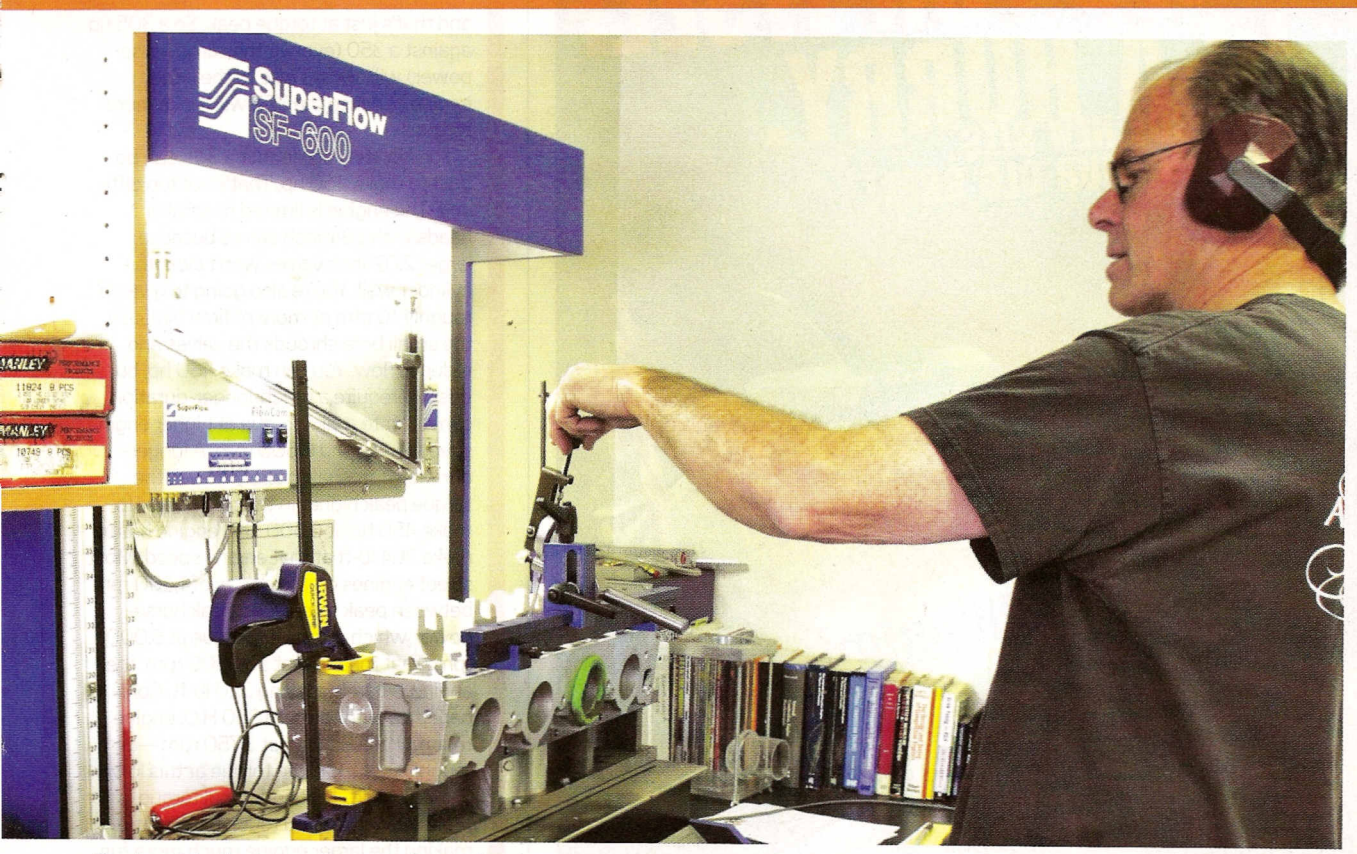


A SOURCE INTERLINK MEDIA PUBLICATION

WHAT'S YOUR PROBLEM?



Flow bench testing is an easy way to discover how bore size affects airflow and performance. If you want to increase the airflow of even a simple small-block Chevy cylinder head, just change the test bore size adapter from the 305's 3.735-inch diameter to something like the 400's stock 4.125-inch bore. This could be worth 10 cfm at max flow. If you watch closely when cylinder head companies state their flow numbers, the smart ones will use a larger bore to improve the flow numbers.

THE 305 CONTROVERSY, REVISITED—AGAIN

Ed Shagman; Corona, CA: This appears true of your magazine as well as your competition: A reader asks about building his 305 small-block, and the answer is to dump the 305 and start with a 350. This is an ongoing path you all seem to take. Why not change course and build a stout 305 new or a junkyard dog to prove it's possible? Also, why is it that Ford fans routinely build 281-inch two-valve engines with tiny 3.5-inch bores and get 400 hp or more, and the same magazines joke about the Chevy's 3.75-inch bore? I think a 305 can be built to 450 hp and more, so maybe you should come up with an engine builder's competition. It would be bitchin'!

Jeff Smith: It seems we have to deal with this question about once a year. Some people just want to build a 305—and that's fine. But let's go over why that's not the best idea if you're building an engine to make good power. You brought up bore size, Ed, so let's start there. The reason the Ford guys build the 281-inch mod motors with their tiny 3.5-inch bores is because that's all they have to work with within the engines available for the late-model Mustangs. Even the 5.4L truck engine only has a 3.5-inch bore, and the new 5.0L is only slightly larger at 3.029 inches. The mod engine was designed with a 3.93-inch bore spacing, so a 4.00-inch bore is physically impossible. But if the bore spacing were wider, you can bet your last lug nut that any serious engine builder would be using a 4.00-inch bore. When you're forced to work with an engine with a tiny bore, you make the best of what you have.

One reason tiny engines like the Ford mod make good power (besides three and four valves per cylinder) is because the builders are willing to spin those overhead cam engines to the moon. The classic equation you should have tattooed on your forearm is Horsepower = Torque x RPM/5,252. Using this equation, if you make 300 lb-ft at 4,000 rpm, the engine only makes 228 hp. Take that same 300 lb-ft and apply it at 7,500 rpm and the number jumps to 428 hp. That's great if you like to spin the engine that high. This also means you should shift at closer to 8,000 rpm to maximize acceleration. All that rpm is abusive on parts—much more so than shifting at 6,000 rpm. But even beyond that, a tiny, 281ci, normally aspirated engine that makes 420 hp at 7,500 rpm would be a miserable street engine because it would deliver minimal torque below 5,000 rpm. Then you have to put a deep gear in the car to make it accelerate.

Let's stick with this displacement idea for a moment longer. Let's use a typical 350ci small-block that makes 1.1 lb-ft per cubic inch. Multiply 350ci x 1.1 = 385 lb-ft, which is fairly typical of any mild small-block. GM's 350 H.O. crate engine is rated at 380 lb-ft at 3,800 rpm and 330 hp at 5,000 rpm. While enthusiasts are drawn to the horsepower numbers, I prefer to look at torque and horsepower because torque is what accelerates the car. A larger-displacement engine will always make more torque as a result of its size. That's how engine designers made power back in the '20s—with giant engines that ran slowly. They made monster torque—just no horsepower. Now let's take that 305ci engine and multiply 305 x 1.1 = 335.5 lb-ft of max torque. We're down roughly 50 lb-ft,

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Looking for a quick pick-me-up? At the Holley LS Fest, they were selling NOS energy by the case.

→WHAT'S YOUR PROBLEM?

and that's just at torque peak. So a 305 up against a 350 (even at the same horsepower) will always lose to the larger engine because the 350 will make more torque.

I completely agree that a 305 can be built to make 450 hp. That's not too difficult. The engine is limited to smaller heads with 1.94-inch valves because larger 2.02-inch valves won't clear the cylinder wall. You're also going to give up roughly 10 cfm or more of flow because the small bore shrouds the valves and reduces flow. You can make 450 hp, but this will require a much-longer-duration camshaft to make torque at higher engine speeds—around 6,500 rpm. A longer-duration camshaft merely moves the torque peak higher in the rpm curve. To make 450 hp at 6,500, this engine has to make 364 lb-ft at that engine speed. Most street engines create a span of 1,500 rpm between peak torque and peak horsepower, which puts peak torque at 5,000 rpm. That means that at 4,000 rpm, the engine is barely making 320 lb-ft. Compare that with the mild 350 H.O. engine that makes 380 lb-ft at 3,750 rpm—or roughly 60 lb-ft more torque at this lower engine speed. That additional torque is there every time you touch the throttle, making the larger engine much more fun to drive. Europeans have long suffered with tiny little engines to get decent mileage because gas prices in Europe are so high. But in the good old USA, we've always driven big cars with big engines that make tons of torque. That's why there are still people who think the 500ci Cadillac engine is worth massaging. Those engines make stupid torque.

We could also talk about how the 350ci engine parts are substantially cheaper because of the insane volume those engines enjoy. Compare replacement piston prices between a 350 and 305. The 305 piston is smaller, so it requires less aluminum, yet the 350 pistons are less expensive. That's because the 350 pistons are sold at ridiculously high volumes, which means the price comes down.

So what have we learned? Can you build a 305 to make 450 street horsepower? The answer is yes. Will it run as quickly in the quarter-mile in the same car as a 450hp, 350ci engine? No, because the 350 will make more torque that will help acceleration. So the bottom line is the 305 will cost more to build and won't make as much torque as a 350. Now I'll agree that if you live on a desert island and all you have is a 305 to build, go for it. But given a choice, I'll always go for more displacement to make more overall power. I understand that engine-building

decisions are often based on what you have lying around. All I'm saying is that you can find 350 Chevy small-blocks on almost any street corner in America, so unless you enjoy spending more money to make less power, the answer seems obvious. OK, now the emails can start flooding in!

SMOG-LEGAL MONTE

Al Harris; Pasadena, CA: I need your advice on an engine rebuild I'm having done soon. In 1993, I purchased a Chevy crate engine PN 10067353 to put in my '85 Monte Carlo SS. What would be your suggestion for a camshaft? I want to keep it smog-legal. What would be your horsepower and torque estimate for the current parts I have accumulated? I have an Edelbrock intake (PN 3701), exhaust (PN 68793), and World Products S/R Torquer heads (PN 042670-1). All I'm looking for is a slightly warmed-up daily driver that will pass the smog test.

Jeff Smith: Al and the rest of the long-suffering car crafters who live in high-population-density areas in California are burdened with proving emissions legality when attempting to build a '76-or-later street machine like his '85 Monte Carlo. Happily, there are several recommendations we can make to help complete the buildup. The crate engine Al referenced is the 350ci Goodwrench replacement engine that's rated at 195 hp but can make as much as 250 hp with a good intake and headers. This engine uses cast pistons squeezing 8.5:1 compression and is based on the older, two-piece rear main seal–style cylinder block. This engine makes a great starting point for a mild small-block Monte.

The stock cam that comes in the Goodwrench engine is very mild with 194/202 degrees at 0.050 with equally mild 0.383/0.401-inch lift numbers. Since you already have the Edelbrock intake and exhaust, you might consider running the Performer-Plus flat-tappet camshaft. The specs are quite a bit stronger at 204/214 degrees at 0.050 with 0.420/0.442-inch valve lift numbers with a lobe-separation angle of 110 degrees. That cam actually has a California Executive Order (E.O.), which makes it legal to use in emissions-controlled small-blocks up to 1985. That means Edelbrock has already done the testing to confirm that this camshaft will allow you to pass the typical California tailpipe emissions test.

Because Al's Goodwrench engine is a two-piece rear main seal engine, it's not equipped with the changes made to the

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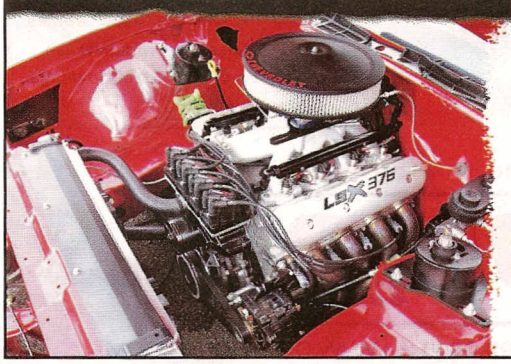

We just returned from Holley's LS Fest, and we thought this has to qualify as one of the cleanest third-generation Camaro engine compartments on the planet. This Camaro was running on the dragstrip, so ignore the green towel around the breather. It's also running Holley's new EFI system.

→WHAT'S YOUR PROBLEM?

later, one-piece rear main seal engines that would allow you to run factory-style hydraulic roller camshafts. You could still convert to a hydraulic roller camshaft, but it would be more expensive because you would have to purchase the retrofit aftermarket hydraulic roller lifters. These are much more expensive than standard production hydraulic roller lifters. Given that option, we spoke to Jim Hall at Tuned Port Induction Specialties (TPiS), a company that has loads of experience building '80s- and '90s-style performance engines. Hall recommended the company's ZZ8 camshaft that specs out with 212/212 degrees of duration with 0.483/0.483 inch of valve lift and a lobe-separation angle of 114 degrees. He says this will idle at 19 inches of manifold vacuum. TPiS built an LT4 engine with that ZZ8 cam, CNC-ported LT4 heads, and headers that made 430 hp. Your S/R Torquer heads are not quite as strong, so you could expect around 400 hp, which would make your Monte SS a great little cruiser.

You might even want to consider a mild upgrade to the heads while you're at it. The World Products S/R Torquer heads are perhaps the best-flowing, iron, direct-replacement castings on the market, but even these heads can use some help. The hot ticket is to improve the exhaust flow of the heads with a little pocket porting. All production-based small-block Chevy heads tend to be weakest on the exhaust side of the flow curve. A mild amount of bowl work directly underneath the intake and exhaust seats always results in the most amount of flow improvement for the least amount of labor invested. If you're thinking of doing the work yourself, check out past stories on home porting heads to get the technique. Or you can call our pals at Slover Porting in nearby Sun Valley, California, and they can do the work for you at a very reasonable price.

If your Monte needs a catalytic converter, California has also made life a little more difficult for those car crafters driving '80s and '90s OBD-I emissions-controlled vehicles. In 2009, California outlawed the use of less expensive, non-approved aftermarket catalytic converters. Apparently, these cheaper catalytic converters minimize the amount of precious metals such as palladium, platinum, and rhodium. I did some digging and discovered that MagnaFlow's parent company, Car Sound, makes an exempted replacement catalytic converter that is available in either direct replacement or universal applications. For the Monte, a California-legal, direct-fit four-bolt catalytic converter for the high-output Monte

This is the Monte we just completed that now sits on 17x8 Center Lines with 4½ inches of backspacing along with a set of 245/45R17 General Tire UHP Exclaim tires. The suspension is all Edelbrock.

Carlo is MagnaFlow's PN 36440, and we found it on Summit Racing's website for the excellent price of $247.61. These cats are a little more expensive because they must contain a higher precious metal content since part of the California law requirement is that the manufacturer offer a five-year, 50,000-mile warranty.

In case you missed it, we also did a complete suspension upgrade on a Monte just like yours called "Upgrade a GM Coil Spring Car" (Feb. '10) in which we bolted on a bunch of Edelbrock suspension goodies to this G-body to turn it into a corner scorcher. The G-body is also an outstanding candidate for an LS engine swap. A 6.0L iron truck engine or perhaps even the popular E-Rod LS3 6.2L engine that makes 430 hp would be an outstanding swap. You could even retain the performance-oriented 200-4R overdrive automatic.

MORE INFO

Edelbrock; Torrance, CA; 310/781-2222; Edelbrock.com
MagnaFlow Performance Exhaust; Rancho Santa Margarita, CA; 800/ 990-0905; Magnaflow.com
Slover's Porting Service; Sun Valley, CA; 818/768-0155

INJECTOR SCHOOL

Steve Telkes; Saddle Brook, NJ: What is the difference between a pintle- and disc-style fuel injector and which is better for performance use in a programmable aftermarket EFI system?

Jeff Smith: We decided to go to school for an hour or so with our friend Joe Alameddine, who is one of the design engineers with ACCEL. There are actually three different designs that include the pintle, the disc, and the newest ball and seat style. Within the world of older injectors, we'll limit this discussion to the two you asked about. The quick answer to your question is that injector response time is a critical function that is directly related to good driveability, especially for a performance engine. Based on that, Alameddine says the disc-style injector offers many advantages. These older EV1

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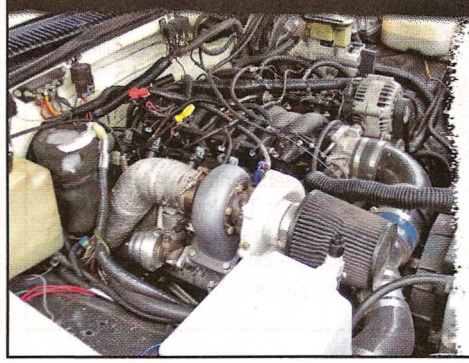

We ran across Bervil Hillis and his '94 Chevy 1500 pickup at the LS Fest. What makes his truck special is that '94 LS1 Corvette engine spooled up with a 67mm turbocharger that he bought used from an STS turbo system. Then Bervil made his own steel passenger-side exhaust manifold to mount the turbo. It makes for a great tow package.

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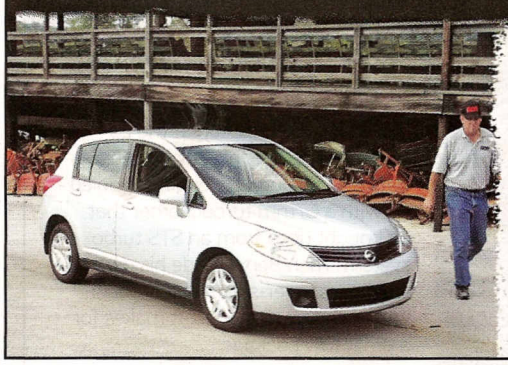

Here's the car we rented while in Bowling Green for the LS Fest. Thanks to the company's rental policy, we were forced to take a front-drive Nissan to an event celebrating the American muscle car. The look on Tech Editor Smith's face says it all. He took a long Chevelle bath upon returning home.

→WHAT'S YOUR PROBLEM?

The disc-style injector (*right*) offers far better response time than the older pintle-version injectors (*left*).

design injectors are larger, heavier, and more expensive to make than later, smaller, EV6-style injectors used on late-model LS engines, for example. But within the earlier-style injectors, the disc is far lighter than the pintle, which means the disc's response time will be much quicker. Moreover, pintles are also far more sensitive to foreign material in the injector because of their clearances. He even told us that these extremely tight tolerances are affected by any type of torsional movement that could put tension on the injector. Alameddine says he's seen actual examples in which a slight mismatch of the injector rail to the manifold was enough to place a slight bind on the injector housing that caused the injector to fail to open.

Beyond response time, the shape of the cone of fuel exiting the injector is also important. Alameddine says the pintle style offers a fixed cone shape usually between 20 and 40 degrees. ACCEL uses a cap over the disc that creates a tricone design that dramatically increases the surface area, which also helps driveability and throttle response. Alameddine also said that the late-model, factory ball and cone–style injectors are becoming much more fine-tuned to specific applications by directing the spray cone toward a particular spot in the intake port. That means attempting to use these later injectors in a nonstock application may be rewarded with poor part-throttle response.

Alameddine says the key to a well-executed aftermarket EFI-controlled engine can be reduced to three important considerations. First is the choice of a high-quality, fast response time injector that we've now seen would be a disc-style injector. Second is what Alameddine calls injector targeting, or the orientation of the fuel injector in the intake manifold and its position in relation to the intake valve. The third criterion is the electronic control package that allows the tuner sufficient freedom to fine-tune the way the injector is opened at different engine speeds and loads to extract that last bit of performance and throttle response. If you can balance those three variables, Alameddine says you'll have a happy engine.

MORE INFO

Mr. Gasket (ACCEL); Cleveland, OH; 216/688-8300; ACCEL-dfi.com

THE DREADED FLOATING DECIMAL POINT

If you're going to wade into the shark-filled waters of technical writing, you have to be willing to get bitten every once in a while. Even though this column includes numbers just about every month, numbers (unlike mere words) tend to be unforgiving when it comes to minor mistakes. Such is the case with our "Simple Battery Test" piece I penned for the Nov. '10 issue. The magazine must have been in our readers' mailboxes about 15 seconds when the emails began to appear letting me know that our milliamp definition was flawed. The correct definition of a milliamp is 0.001 amp. Where I crashed and burned was when I wrote "a typical stereo unswitched connection may pull 100 milliamps" followed by the number 0.001. Both statements were correct, but not when you put them together in the same sentence. Obviously, 100 milliamps would then be 0.100 amp. There is a rumored sighting of a lynch-angry posse of electrical engineers forming as this is written. I plan on lying low for a while. Thanks to all our sharp-eyed and electrically savvy readers who took the time to correct my current miscue.

THE OCTANE GAME

Ronald Corte; Draper, UT: Is there any specific reason why the eastern half of the United States gets 93-octane premium unleaded and the western half only gets 91-octane gasoline? I made a trip last year to Virginia and was able to fill up using 93-octane fuel, and my Jeep SRT8 ran great. When I crossed the Missouri River and started using 91-octane fuel, I noticed a difference. The prices seem to be the same for either grade, so in a sense, I feel I am paying more for less with the 91-octane fuel. Why not 93-octane for the whole country?

Jeff Smith: We presented your question to our friend Tim Wusz of Rockett Brand Racing Fuels, Ronald. According to Wusz, the pipeline that transports fuel all along the western coastline is a privately owned entity, and all the fuel companies that use the pipeline, such as BP, Chevron, Conoco Phillips, and Shell, have to agree on the octane of the fuel that will be transported. Several years ago, when reformulated gasoline was first introduced in California, 92 was the standard.

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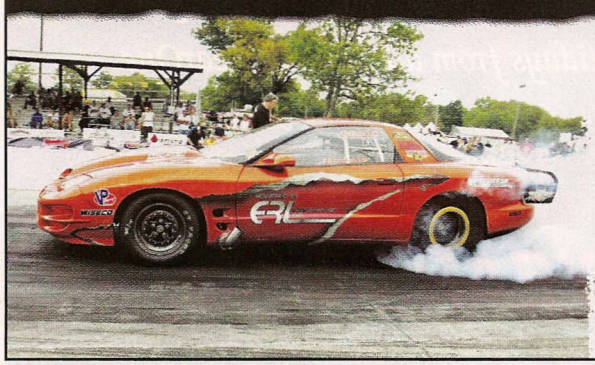

We didn't include it in the Horsepower! layout, but here's a starting line shot of Mark Koehler's Firebird. It's hard to believe this turbocharged, 2,000hp monster was once a 200hp grocery-getter.

→WHAT'S YOUR PROBLEM?

But sometime later, they all agreed to lower it to 91. Also according to Wusz, 93-octane is not necessarily universally available outside the West. There are several regions that also use 91. You may have also noticed that when you drive into any mountainous or high-altitude area, octane ratings drop because the density of the air is lower. This means cylinder pressure is lower, which results in a lower octane requirement. In these areas, 89-octane may be the premium fuel. It's also worth noting that California has its own requirements for fuel, as dictated by the California Air Resources Board (CARB) with a reformulated fuel that in 1999 eliminated MTBE (methyl tertiary butyl ether) as an aromatic and replaced it with ethanol, which is classified as an oxygenate because it incorporates an oxygen molecule. This reformulation is also only used in California, which is another reason California gas prices are among the highest in the continental United States.

All fuels are rated on domestic gasoline pumps as R+M/2 = AKI, which means the research (R) octane number plus the motor (M) octane number divided by 2 calculates the antiknock index (AKI). The research number test is the milder of the two and generally produces a higher octane number. What most car crafters should be more concerned with is the motor octane number. This is a higher temperature test that produces a much lower octane number. Averaging the R and M numbers produces a more accurate AKI. According to Wusz, high-performance engines under wide-open-throttle load generally respond better to a high motor octane number while part-throttle issues are generally more related to research octane numbers.

Another high-octane fuel that is finding increasing popularity with horsepower-addicted car crafters is E85. At 85 percent ethanol and 15 percent gasoline, as you can see from the following AKI chart, ethanol features relatively high research and motor octane numbers. Part of the difficulty in using E85 is it is not a consistent fuel at the pump. Blending ratios change according to the season, which means that even though it's supposed to be 15 percent gasoline and 85 percent ethanol, in the winter that could change to more like 30 percent gasoline. This obviously will also dramatically change the fuel's octane rating (despite the number posted on the pump). Rockett has just released an E85 race gas that looks promising with an AKI of 112. It's worth noting Rockett's much higher motor octane number of 108 versus straight ethanol's 103. Wusz told

ANTIKNOCK INDEX CHART

FUEL	RESEARCH OCTANE NUMBER	MOTOR OCTANE NUMBER	AKI
91 pump gas	96	86	91
Rockett 100-octane	106	96	100-101
Rockett E85 Race	116	108	112
Ethanol	120	103	111.5

me that straight ethanol easily raises the research octane number, but the spread between research and motor octane is greater, as indicated in the chart. So this could mean that Rockett is using a high-quality race gasoline as its blending fuel, which would raise the motor octane numbers. Combine this with ethanol's excellent ability to pull heat out of the air, and supercharged engines really respond to an E85 fuel. While for everyday street driving, Rockett's racing E85 is overkill, this would be the fuel to use when pushing one of those E85-fed, supercharged bad-boy big-blocks.

Wusz also mentioned that using octane numbers and octane tests initially designed for use with gasoline are not necessarily as simple when testing methanol or ethanol. One post I found on the Internet quoted a highly respected engineering book as listing research and motor numbers (R/M) for ethanol as 107/89. These are drastically different from the numbers Wusz supplied and different yet from other numbers on the Internet. My money is with Rockett.

An interesting thing happened just as we were about to go to press. The EPA has been studying the effects of allowing pump gasoline that is currently limited to 10 percent ethanol to go to 15 percent. I've received these alarming press releases from a coalition of very strange bedfellows that oppose this move, calling it a "50 percent increase in ethanol." While that number is true, it's also intended to alarm potential customers. The reality is that the proposed move is to increase the percentage from 10 percent to 15 percent total ethanol blending. This probably won't change the octane rating because the fuel companies will just change the total makeup of the fuel. A study we saw from the noted engineering firm Ricardo Inc. in which the company tested cars and light trucks from six different manufacturers from 1994 to current concluded that there would be a minimal impact on driveability and performance.

They only tested cars as old as 1994, and all these were obviously electronically fuel injected. This change of 5 percent will certainly affect nonfeedback carbureted engines, but the overall impact will tend to lean out the air/fuel ratio slightly. The only carbureted cars this might dramatically affect would be those that are right on the ragged air/fuel ratio edge that might need a main jet or idle feed restrictor increase. But for the most part, despite the scare tactics you may hear, the long-term effects of this decision (which at this time is not official) on engines and fuel system durability will probably be minimal. There could be some minor fuel system durability issues with water in the fuel system with this increase, but again, we are not aware of any testing that has been done to address the increase from 10 to 15 percent ethanol.

MORE INFO

Rockett Brand Racing Fuel; Mount Prospect, IL; 847/795-8400; RockettBrand.com

The AKI number you see carried on the pump represents the average of the research and motor octane tests, but the motor octane number is the one to pay attention to if you're interested in max performance. This is 100-octane unleaded race gas that's available from a gas station right down the street from my shop. It's also $8 a gallon!

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