Do octane boosters really work? Can you make your own octane booster?
Certified testing proves yes

power in a bottle

BY JAY CHEN AND DAVE COLEMAN
PHOTOGRAPHY BY LES BIDRAWN AND JAY CHEN

If it hasn't affected you yet, rest assured, it will. Like a cancerous plague, 91-octane gas is spreading itself across the country, and your quest for horsepower is its inevitable victim. The difference between 91-octane California gas and 93-octane Texas gas is an easy 10 hp on a stock EVO or STi, and at least half that on a 350Z. On a well-tuned street EVO, the power difference is more like 30 hp. And as modern engines make higher and higher specific output, it's becoming relatively common for bolt-ons to be completely ineffective if the car is suffering with 91-octane gas.

So what are you to do? Stepping up to race gas is impractical if you drive anywhere but from racetrack to racetrack, and blindly dumping octane boosters into your tank yields unknown results.

Well, not any more. Believing the claims on "magic car juice" bottles is something we've learned not to do, so it's time for a real octane booster test.

WHAT OCTANE REALLY MEANS

OK, smarty-pants, you may think you know enough about octane to skip this section, but don't. Oh sure, octane is a measure of a fuel's detonation resistance and the higher the number, the less prone the fuel is to detonation. You know detonation breaks things, and that high compression and high boost both demand higher octane to keep your engine from blowing up. But do you know the difference between RON and MON and what 98-octane Japanese gas is in the American octane scale? Didn't think so. Shut up and read.

power in a bottle

In Europe, 98-octane gas is common, in Japan, even 100 octane is common. Problem is, 95-octane in Japan or Europe is entirely different from 95-octane here. Like every other measurement, they use a different octane scale than we do. Unlike every other measurement, however, they don't bother to use a different name for it. Imagine if both centimeters and inches were called inches and you can see why octane is so confusing.

Japan and Europe use RON, or Research Octane Number. The RON rating is determined using a specific test method laid down by the American Society for Testing and Materials (ASTM) in the 1920s and spelled out in gruesome detail in ASTM standard D-2699. The test uses a standardized engine, called a CFR (Combustion Fuel Research) engine, which is a carbureted single-cylinder unit with variable compression. The head can be raised and lowered to change the compression ratio and thus increase knock intensity. By reading the knock intensity at a given compression ratio, the operator can determine the octane rating of a sample fuel.

The RON test is performed at 600 rpm with intake and air/fuel charge temperatures regulated at 125 degrees Fahrenheit. Ignition timing is held at 13 degrees BTDC.

The other, more strenuous test, called MON, or Motor Octane Number (ASTM D-2700, if you must know), uses essentially the same engine, but is performed at 900 rpm with intake air temperature held at 100 degrees F and air/fuel charge temperatures at 300 degrees F. Spark timing varies between 19 and 22 degrees BTDC depending on the compression ratio.

The more strenuous MON test results in lower octane numbers, but those aren't the ones we use either. The octane rating on U.S. gas pumps, also known as the AKI or Anti-Knock Index, is the average of these two tests.

Unfortunately, since the numbers are the results of complex tests performed on even more complex chemical concoctions, there is no direct conversion from RON to AKI (sometimes denoted as R+M/2), but as a general rule, if you take the RON rating and multiply by 0.95, you'll come pretty close to the U.S. AKI octane rating.

THE BOOSTERS

Octane boosters can be broken into three types based on their active ingredients. The first, most common types are methyl cyclopentadienyl manganese tricarbonyl (MMT) boosters. Second are ferosene boosters. And a third type uses alcohols or aromatics as the active ingredient. Don't worry, alcohol was the only one of those that made any sense to us, too.

Many backyard chemists use toluene as a home-brewed octane booster. Toluene, an aromatic circular hydrocarbon chain, is a regular component of pump gas and is available in various grades at chemical supply stores and better hardware stores. Premium street gasoline carries roughly three- to five-percent toluene. Unocal's 100-octane pump gas has almost 25-percent toluene.

We chose Nitrous Oxide Systems' (NOS) Racing Formula octane booster, which uses MMT as its active ingredient, and Pennzoil/Quaker State's Outlaw Super Concentrated octane booster, which uses ferosene. Outlaw originally had off-road and street formulations, but recently combined the two into just one street-legal formulation.

We've seen two theories tossed around about toluene. One suggests you can use it in similar proportions to off-the-shelf boosters, while the other says a 10- to 30-percent mix is needed. We tried both theories.

THE TEST

It would have been relatively easy for us to have simply put one of our octane-sensitive project cars on a dyno and monitor how it responded when we subjected it to a variety of fuels, but every engine will respond differently, and the results still wouldn't tell you the true octane obtained from octane boosters. If you live in 91-octane territory and you're going to tune an engine to work on 93 or 94 octane, you're betting your engine on your ability to brew up the right octane every time you dump some mystery juice into your tank. Guesswork will not do here.

In our never-ending quest to make your life better, we rolled a wheelbarrow of cash over to Saybolt LP, a certified, independent octane testing lab, and ran tests on three different types of octane boosters we prepared. Each sample, along with the base fuel, was tested using both the RON and MON methods, and the resulting numbers were averaged using a Tandy EC4015 pocket calculator.

These tests have a repeatability (same operator/same lab) of 0.2 octane for both RON and MON, and a reproducibility (different operators in different labs) of 0.7 for RON and 0.9 for MON. The Tandy calculator, as far as we can tell, is completely infallible with the ability to do simple arithmetic as accurately as the most powerful supercomputer.

power in a bottle

There is actually a simpler way to test octane. In addition to the ancient CFR engine, there is a newer infrared method. The infrared test offers a faster method of non-official octane measurement by spectral analysis of all the different chemical contents in a fuel. It guesses the octane of a sample based on the percentage of various hydrocarbons present and references these contents against a known library of data.

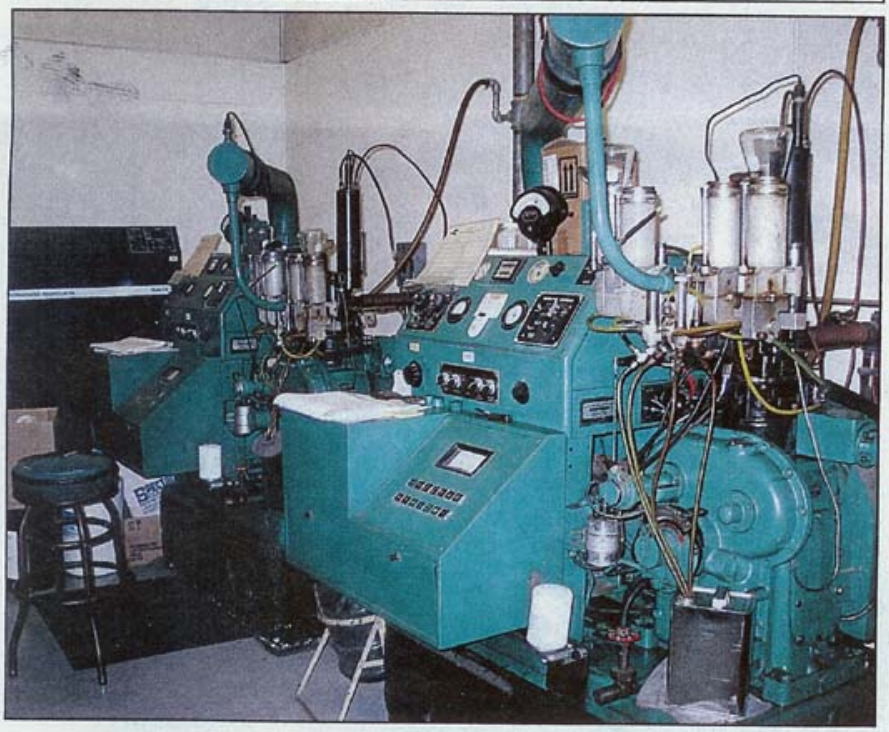
Unfortunately, this library of hydrocarbon data doesn't include the active ingredients found in commercial octane boosters. This is why our test was performed on a CFR engine. Plus, using the CFR method allowed us to impress you with the fact that our test was certified.

Store-Bought Octane

Brand	RON	MON	AKI (R+M)/2	Octane gained	Price per tank	Price per octane point per gallon	Active ingredient	Bottle content	Street legal?
Shell 91 octane	95.8	86.7	**91.2**	----	----	----	Gasoline	----	Yes
NOS Racing Formula	98.7	88.7	**93.7**	2.5	$9.99	**$0.27**	MMT	12 fl. oz.	No
The Outlaw	97.2	87.6	**92.4**	1.2	$3.99	**$0.22**	Ferosene	16 fl. oz.	Yes
Home-brew	96.0	86.8	**91.4**	0.2	$0.23	**$0.08**	Toluene	12.5 fl. oz.	No

Home-Brew

Base fuel	% content toluene added	RON	MON	AKI (R+M)/2	Increase in AKI over base fuel	Price per 15-gal. tank	Price per octane point per gallon
Shell 91 octane	0	96.3	87.9	**92.1**	0.0	----	----
Shell 91 octane	10 (1.5 gal)	97.3	88.4	**92.9**	0.8	$3.75	**$0.31**
Shell 91 octane	20 (3.0 gal)	99	89.2	**94.1**	2	$7.50	**$0.25**
Shell 91 octane	30 (4.5 gal)	100.7	90.3	**95.5**	3.4	$11.25	**$0.22**



The drawback to any of these additive ingredients is the diminishing effect they have on higher-octane fuels. Adding a bottle of booster to a tank of 87-octane pump gas will yield a disproportionately higher-octane gain than adding it to a tank of 91-octane premium gas.

Excessive concentrations of these additives also damage emissions-control hardware, such as spark plugs, injectors, O_2 sensors and catalytic converters. This is why some boosters are emissions legal and some are technically off-road only.

There is no point, of course, testing octane boosters on 87-octane gas, since the cheapest way to get an extra 4-octane points is just to spend the extra 20-cents per gallon on 91-octane. We tested on the "good" stuff. Our 91-octane gas came from a genuine California gas pump at a local Shell station, and the off-the-shelf Octane boosters came from real shelves at actual auto parts stores.

Our home-brew concoction used 99-percent pure gasoline-grade toluene sourced from the laboratory of Rockett Brand Racing Fuel [(714) 694-1286].

Each of our samples were mixed in a ratio equivalent to having added the entire contents of an octane booster bottle to a 15-gallon tank of 91-octane fuel. Then, one-gallon samples were stored in sealed metal containers at room temperature to prevent evaporation or degradation of the fuel or the octane booster. The toluene mix was composed of 12.5 ounces of toluene and 3.125 ounces of mineral spirits, treating the same 15-gallon fuel tank.

Because there was too little to make a difference in our one-gallon test samples, 0.375 ounces of transmission fluid from the Internet recipe (claimed to act as a lubricant) was left out. According to Tim Wusz of Rockett Brand Racing Fuels the mineral spirits and motor oil would only lower the octane rating if added in sufficient amounts.

The results were almost all positive.

First, 91-octane pump gas is actually 91 octane, not 82 as we've always suspected. Next, both of the off-the-shelf boosters actually worked, with the NOS booster giving us a Texas-like 93.7 octane and the ironically legal "Outlaw" giving 92.4, just like they get at the pump in Oregon. The home-brew did little, only giving us 91.4, but being so much cheaper, you could afford to use a lot more of the home-brew. That brings us to the next test.

The results of the home-brew were within the repeatability of the RON and MON tests, so it was still possible it did nothing at all. To clear that mystery up, we decided to see how much toluene you needed to get a meaningful boost in octane. Fresh out of wheelbarrows to carry our money around, we switched to the cheaper, infrared test. While this test doesn't work on MMT or ferosene, it is accurate with toluene. So, certified or not, it's perfectly valid for the home-brew booster.

Tim Wusz performed the infrared tests in Rockett Brand's lab. As a validation of the infrared method, we re-measured the RON and MON of the base gas and the home-brew mix. The 91-octane base fuel measured 0.9 octane higher with the infrared method, but the difference in octane is what matters here.

To see how much toluene had to be added to one gallon of base fuel to make a significant difference in the AKI, Rockett Brand concocted three different mixtures ranging from 10- to 30-percent toluene.

The results were more promising this time. The 30-percent toluene mixture pushed the measured result all the way to 95.5 octane. There is a limit to how far you can take toluene, though. According to Wusz, there is an optimal window of effectiveness, and beyond 30 percent things get ugly. Eventually the benefits of higher octane are outweighed by the poor vaporization and slow combustion of toluene.

Toluene-laden fuels burn slower and make less power on high-revving engines. So much, in fact, that much of the fuel/air mixture is still burning as the charge exits the exhaust port. For these reasons, true race fuels don't just use toluene or other active ingredients to boost the octane. Instead they use better-refined hydrocarbon chains to raise octane while retaining optimal combustion characteristics.

Step back and look at the cost-per-octane point-per-gallon, and the off-the-shelf boosters look pretty good. Ignoring the 8 cents-per-point-per-gallon rating of our home-brew (since the results are within the margin of error, the number is meaningless), all the boosters are similar. Bottom line? Octane gains and costs are comparable between the off-the-shelf boosters and our home-brew boosters. But the convenience of a little bottle of booster, compared to 4.5 gallons of toluene is obvious. Which would you rather carry in your trunk? ■

More@» sportcompactcarweb.com

SOURCES

Rockett Brand Racing Fuel
(714) 694-1286