# Guide to Fuel and Octane Ratings

Still uncertain about which octane fuel is right for your car? Think you're benefiting by tipping in premium?

**AUSTRALIAN RESEARCH with INTERNATIONAL INFORMATION**

# 10 Myths Busted

**1. Use the right fuel:** Never use a fuel with an octane rating lower than the car maker recommends. That's a great way to damage your engine. Going higher than the minimum octane the manufacturer recommends is quite OK. But it will cost you more money.

**2. Octane rating and energy content:** Octane rating has nothing to do with a particular fuel having more or less energy, intrinsically. Ethanol blended fuels pump up the octane rating, but they actually have less energy than low-octane gasoline. The two properties are (mostly) unrelated.

**3. Other common misconceptions:** Octane has nothing to do with the speed of combustion, or the heat of combustion. Simply not true.

**4. Knock:** Octane rating is all about knock resistance. It's about burning in a controlled way under pressure, while hot. High octane fuels simply resist auto ignition better than low octane fuels. Auto ignition - which is the fuel burning thanks to the heat and compression in the chamber - before the spark plug fires - causes knock. Which destroys engines at high rpm and big throttle inputs. That's bad. (Too much ignition advance also causes knock.)

**5. Octane and compression:** If an engine is optimised for high octane fuel the designers can increase compression and add ignition advance, because the fuel is more resistant to auto ignition. And it's these two things that lead to a peak power increase for engines optimised for high octane fuel.

**6. Using premium unnecessarily** if you use high octane fuel in an engine designed for low octane fuel, the engine will adapt up, slightly. The knock sensor will allow a small increase in ignition advance and there will be a slight increase in power. Slight. Certainly this adaptation will not produce as much additional economy/power as there would be if they increased the compression ratio and optimised for premium.

**7. Number seven: Economic rationalism:** Here in Australia, it's almost never economically rational to use premium fuel in a car designed for regular. The extra cost of the premium fuel is, in practice, never offset by the slight increase in economy. You're just blowing money out the exhaust pipe unnecessarily.

**8. Marketing premium to the masses**: Point number seven is of course fuel manufacturers talking up the alleged ancillary benefits of premium - such as the spurious claim that premium will also keep your engine 'clean'. And if you believe that, I'll sell you the Sydney Harbour Bridge. (Hit me up on the website for that...) It's such bullshit. They're not promoting premium because it's a benefit to you - they're promoting it because it's a benefit to them.

**9. Overseas octane ratings are different**: If you're reading owner's manuals from overseas, bear in mind that octane ratings are not constant around the world. Here in Australia, we use 'research octane number' or RON. Same standard as most of Europe. Note: *most* of Europe. But in the United States and Canada (ie North America) they use the Anti-Knock Index, which is the numeric average of the RON and another octane measurement standard called the Motor Octane Number (MON).

Essentially, for any given fuel, RON is about four points higher than the Anti-Knock Index. So 91 here - our entry-level cat's piss petrol - is about the same as 87 gasoline in the USA and Canada. And if you're wondering why so many Euro cars demand 95 here in Australia, it's because 95 is the default, entry-level cat's piss in Europe. They don't do 91.

**10. The full tech explanation**: Time to go 100 per cent propeller-head: Octane rating is an index of the knock resistance of a particular fuel compared to a laboratory standard kind of fuel called iso-octane. Which is actually 2-2-4 tri-methyl pentane. Iso-octane has an octane rating of 100, and another chemical - n-heptane has a rating of zero.

There's your measurement scale. So, essentially, 91 RON unleaded has 91 per cent of the knock resistance of iso-octane when you run the test in a special experimentally controlled engine with a variable compression ratio. (What I'm saying is if you make up a litre of fuel from 910 millilitres of iso-octane and 90 millilitres of n-heptane, it'll perform the same as 91 RON petrol from the pump, etc.) The engine runs at 600rpm for the RON test and 900rpm for the MON test and the difference between the two values is an index of what petrochemical propeller-heads call the fuel's sensitivity.

It's certainly possible to have octane ratings greater than 100, too. E85 is about 102, straight ethanol or methanol - both about 109, propane and butane (think: LPG) both about 112. Methane - that's natural gas - is about 120. Toluene - a fairly evil octane boosting additive - is about 121. And hydrogen gas is more than 130.

# Should you run premium fuel in your car?

**No, not necessarily.**

Premium petrol claims are almost entirely over-blown marketing hyperbole. If you need high-octane fuel, you need it and the carmaker will tell you explicitly, either on the fuel cap, the fuel flap and/or inside the owner's manual.

Otherwise, it's just a waste of money Unless, of course, the manufacturer specifically requires you to use a minimum octane rating, such as 95 or 98, as in the case of many performance cars, or for brands like Toyota or Volkswagen which can't be bothered spending the money to de-tune some of their engines to accept our 91 RON cat urine. Take the current Golf and C-HR which are required to run 95 RON as a minimum.

Whenever buying a new car, it's crucial not to get trapped by this often-unchecked technicality because it'll simply cost you more for no vestigial benefit. Do you actually get any benefits from running premium fuel even if your regular family SUV or passenger car says you only need to use 91? Can you still use premium and derive some tangible benefit? How much better for your equipment, down there, is the routine use of 98 or 95 RON fuel? What actual good does it do?

# Engineering for the novice

A really high compression ratio is totally a good thing, most of the time. Expansion over a greater range during the power stroke means more performance and greater efficiency. But there's a problem. Fuel/air mixtures are not infinitely tolerant of (increased) compression. At some point the mixture starts to burn spontaneously, too early. This is called engine knock or pinging.

This knock or pinging is the disruption of the delightfully synchronous ballet of sucking, squeezing, banging and blowing - it's upset by virtue of early blowing, which, at high revs and big throttle inputs can destroy your engine. So the designers try to avoid that, sometimes by using a high octane fuel.

At its core, octane rating is simply a scale that defines a fuel's tolerance for compression. The higher the rating, the more tolerant of high compression. High octane fuels don't burn hotter. It's knock resistance - end of story.

That ballet choreography is so important because an engine at 6000rpm is doing the 'suck-squeeze-bang-blow' sequence 50 times a second, per cylinder. And the precise timing of the spark is critical. The spark has to occur at exactly the right time in relation to the movement of the piston.

Basically the spark needs to occur early enough to give the flame front sufficient breathing space so that pressure can build up and generate a deliciously satisfying and effective blow. A critical thrust just as the piston kicks over top dead centre.

This ballet happens right down in the millisecond domain. It's impossible to conceive of the timing without being a mechanical Jedi and using the Force. And the dark side is always calling your engine, inviting it to knock.

This is of course why modern engines have knock sensors, little acoustic microphones that listen for engine knock. It's all they do. A modern engine manages its ignition timing in a feedback loop where the engine keeps advancing the ignition timing until the knock sensor detects incipient knock, and then it backs off a bit. Amazing.

So your engine might be doing a particular job on 91 RON fuel - punting you down the freeway at 100 KS an hour, or something. If you magically swapped it to 98, and keep everything the same, the same throttle position, same road, same everything - you'd look down and see the speedo on 105 or thereabouts. This is because the engine listens for knock and advances the timing. High octane allows slightly more advance, and that delivers slightly more performance. Hence, 105. (Footnote for the tech-savvy: high octane fuel is also a little denser, and this also contributes slightly to the result because you have more energy within that denser fuel.)

Alternatively, you could close the throttle slightly and cruise at 100 again. In other words, there's a slight increase in fuel economy when you switch to a higher octane fuel. Very slight. If you're running a million-dollar motorsport outfit, high octane fuel makes perfect sense. You'll get vestigial more peak power. But for average driving, this 'more power' presumption is nuts. A ridiculous way to look at fuel. This is because in average driving, you don't need an engine capable of delivering more power. If you want more power than you're making now, just open the throttle a little bit more.

It's difficult to exploit peak power in ordinary driving. You will certainly get better fuel economy on premium, but driving will be more expensive per kilometre because of the additional cost of the fuel. So, for most car owner's premium gasoline a nice idea that simply doesn't add up.

**RON & Anti-Knock Index.**

With the proliferation of online information about vehicles built and marketed overseas, where fuel knock ratings differ to Australia, it's important not to confuse RON with the Anti-Knock Index.

Anti-Knock Index, one of the rating systems for fuel in the United States, is the numeric average between RON and what's called Motor Octane Number (MON), which is the number seen rating fuel octane in the US.

MON is done similar to the RON test aforementioned, but using -preheated fuel samples and the test engine runs at 600 RPM. MON is usually 8-12 points lower and RON.

So if you pump in 98 RON, it will convert to about 90 MON, which averages out to about 94 on the Anti-Knock Index. This is potentially a major problem.

If you're searching for your fuel spec online and you don't realise the difference here, you can conflate an AKI number for the US and presume it's a RON rating and accidentally pump in an octane rating lower than recommended.

You could see 91 (Anti-Knock Index) on a US website, and think it's 91 RON for Australia, but that Anti-Knock number is actually stipulating about 95 RON, which would be our base premium grade fuel here.

**AUSTRALIAN USERS**

Do not rely on overseas information. Always use local Australian-based fuel octane data from the locally based manufacturer, wherever possible.

## Is E10 compatible with my engine?

The majority of modern cars running on unleaded petrol today are compatible with E10. Use our compatibility checker to see if your car can use E10.

Motorists should always follow their vehicle manufacturer's advice on the recommended fuel to use in their vehicle. In some cars, this information can be found written on the inside of the fuel flap. If not there, refer to the owner's manual or the manufacturer's website.

High performance vehicles and older cars, particularly those built before 1986 but also any that use older technologies, such as carburettors (a device that mixes air with a fine spray of liquid fuel), shouldn't use E10 as those engines are not designed to run on ethanol blends. Cars built with newer technologies will use a fuel injection system.

**Myth 1: E10 is bad for my engine**

A: E10 is compatible with most modern petrol cars on the road today.

**Myth 2: E10 is a dirty fuel**

**A:** Ethanol contains around 35% oxygen. Adding oxygen to petrol results in a cleaner burn.

**E10 is 94 RON:** E10 is a blend of regular unleaded (RON 91) petrol and between 9% and 10% ethanol. Blending the ethanol at this ratio increases the RON to 94.

At the pump, E10 is generally the cheapest petrol per litre. Because the energy provided by the ethanol is less than the energy provided by pure petroleum, E10 has around 3% less energy than the equivalent amount of RON 91 petrol.

On average, this can translate to an increase in fuel consumption of around 3%, which has about the same effect on fuel consumption as driving on tyres with inadequate air pressure.

**Is E10 better for the environment?**

Yes, E10 is better for the environment than regular unleaded, for a couple of reasons. Firstly, ethanol's manufacturing process is a lot less environmentally damaging than petrol. Petroleum products are refined from crude oil, which is pulled from the ground through high impact mining. Oil is also not a renewable resource, so there's only so much we can use.

Ethanol is an agricultural product. Admittedly, there are environmental issues associated with agriculture, including land clearing and the use of some pesticides. Even so, the environmental impact of producing ethanol is much lower than petrol.

E10 also produces lower emissions in the car. Ethanol is about 35% oxygen and burns cleaner than petrol. E10 fuel has been found to reduce the emissions of fuel by up to 30%. Most of Australia's ethanol is also locally sourced, primarily fermenting left-over starch from making flour. Queensland is a big source of ethanol, where it's made from sorghum.

Source information: All information is of public domain & supplied as general information for the reader to make their own decisions regarding which fuel to use.