

Outboard Fuels and Oils

One of the questions that outboard manufacturers technical support teams get all the time is “what type of fuel or oil should I use today?” Considering it is just on 20 years since the last major change to the fuels required and around 10 years for oils, that may sound like a strange question. However, outboard motors live a long time in recreational use so it’s not unusual to come across 20 or 30 year old engines still doing a good job.

Many of those older models are in the hands of recent new owners who were not into boating when the engine was brand new, so are unfamiliar with what’s required. And those lucky enough to have a 20 year old owner’s manual may be unfamiliar with the terminology, for example “use leaded premium or Super fuel” and “Use a BIA certified 2-cycle Oil” don’t mean much today. So here’s what they mean today for the owners of older models –

Fuels

In the 1960’s outboard boating grew rapidly and engine power jumped quickly. The largest outboard engines had grown to about 50 HP by the mid-1950’s then jumped to over 100HP by the end of the 1960’s. A large part of this power increase was the increase in compression ratios made possible by the ready availability of high octane leaded fuel for the cars of the late 50’s and 60’s. These engines needed a high octane fuel (95-96 RON) and it was readily available in local service stations as “Super” grade fuel with a high lead content included. Being 2-stroke engines without exhaust valves in the combustion chamber they did not really need the lead content, but it came in the high octane fuel so we got used to expecting it in our outboard fuel.

In the mid-1980’s all that changed. The North American market (which represented some 60% of the total world demand for outboards) decided to eliminate leaded high octane fuels and make the most commonly available fuel everywhere an unleaded of considerably lower octane. High octane fuels would still be available, but not everywhere and they’d be more expensive so engine manufacturers scrambled to bring out kits that would adapt earlier designs to new fuels. All new engine designs now concentrated on engines that can perform on 86 AKI octane (AKI = Anti Knock Index – an average of the Motor and Research octane ratings and required to be shown on US fuel pumps. Equivalent to 90 RON here).

Luckily here in Australia and New Zealand we did not have those problems as our leaded (and later Lead Replacement Petrol) fuels carried on for at least another 10 years. However, the outboard engines and their technical information is nearly all based on North American requirements so it can be confusing reading a lot of those older owner or shop manuals and bulletins. Here’s what it means today using the Evinrude and Johnson outboard brands as an example –

- If you own an Evinrude and Johnson that is 120 HP or larger, and built before 1986, then you need high octane fuel (96 RON).
- If you own an engine under 120 HP, or any engine built since 1986, then it will happily perform on a diet of ULP (91 RON).

If you own a different brand of one of those older models, built mid-1980’s or earlier, and it’s a large horsepower size, it would worth checking with your local dealer or manufacturers office just to be sure. However from the late 1980’s on, all sizes of recreational outboard engines are designed for ULP.

OUTBOARD FUEL RECOMMENDATIONS

**EVINRUDE
Johnson**



Engine Size

Engine Year Model

	All years up to 1985	1986 and later
ALL MODELS 120 HP AND LARGER	<p><i>These models must use high octane fuel - LRP or Premium ULP (95+ RON)</i></p>	<p><i>These models use normal ULP or Premium ULP (91 RON)</i></p>
ALL MODELS UP TO 115 HP	<p><i>These models use normal ULP or Premium ULP (91 RON)</i></p>	

Oils

If you go back nearly 50 years to the 1960's (and there's still lots of people boating today with 1960's model outboards) there were not many choices for oils. In fact there were not even special 2-stroke oils until the late 1960's, and they came about primarily because of the high detergent additives that were starting to appear to keep 4-stroke engines clean. These additives did not burn at all well (they tended to leave glowing ash deposits), so special 2-stroke oils were developed with unique additives like "diluent" that helped the oil and fuel mix easier. The advertising of the day called them "self-mixing" oils.

Two main types of 2-stroke oils started to appear – those intended for air-cooled engines like motorcycles, mowers and chain saws where the piston temps were high, but the engines tended to run at low loads mostly, and those intended for water-cooled engines like outboards where the piston temps were lower, but the engines ran at high loads most of the time. Using the wrong one could spell disaster for your engine, so industry bodies began to develop standards to help consumers easily identify the correct oil for their engines



For outboard motors the early standard was called “B.I.A. certified TC-W”. An oil bottle with this rating on the label was suitable for outboard motors. BIA stood for the Boating Industry Association (of America) and TC-W meant Two Cycle - Water cooled. Because of the increasing complex chemistry in oils, a chemical formula method of testing did not work well, so the TC-W standard was a performance based test. That is, the oil had to pass several laboratory tests, when being directly compared against a known test or reference oil. Static tests included rust prevention on exposed steel parts, resistance to thickening in cold temperatures, mixing compatibility with other TC-W oils, and the ability to pass through a test filter.

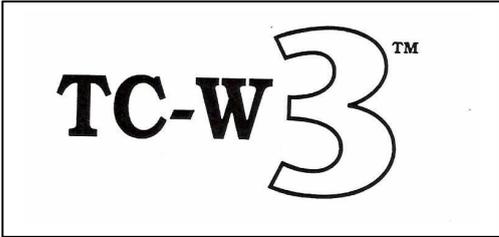
Dynamic tests in an engine included lubricity, spark plug fouling, pre-ignition resistance, piston ring sticking and skirt varnish, and exhaust port blocking. These tests are always conducted in tandem where the candidate oil under test was run in one engine while alongside, simultaneously another identical engine ran using the reference oil. At each test point the two engines would be compared. To pass the test the candidate oil had to equal or exceed the reference oil in every test. The tests occupied more than 120 hours of running time, 9,000 litres of fuel and 200 litres of the test oil! Its little wonder that the cost was in tens of thousands of dollars (US) and the certification tests took weeks.

NMMA TC-WII™

By the late 1980's outboard engines had grown to 300HP with up to 8 cylinders, and unleaded fuels were now becoming common. Life was getting tougher for the engine oil. So the NMMA (National Marine Manufacturers Association, successor to the BIA) overhauled the outboard oil test and changed the name to TC-WII.

The engine used in the original TC-W tests (a Johnson 1.5L cross-flow scavenged V4) was no longer in production and many modern engines had moved to the Loop charging system with its more compact, low-octane fuel friendly, combustion chambers. The TC-WII tests required two different engines, a 40 HP loop charged 2 cylinder engine and a 50 cc air-cooled single. Each of the engine tests required 100 hours of running, plus the usual laboratory bench tests, so it's little wonder there are only a small handful of laboratories in the world that could certify TC-WII oils.

TC-WII oils were required for new outboards beginning the 1989 and 1990 year models, but all was not well. Since the widespread adoption of unleaded fuel in the mid-1980's, there had been a very noticeable increase in the outboard engine problems caused by combustion deposits. Increased ring sticking and varnish deposits that could lead to piston seizure. As it was a fairly recent problem, and happened with both TC-W and TC-WII oils, most people thought that the new unleaded fuels must be the culprit. The problem seemed to be unique to engines with high loads and therefore high combustion temperatures, typical in most marine engines, and rarely seen in land vehicles. But the chemistry of fuels is very complicated and largely dictated by the car & truck industry (they do after all use about 98% of it), so the marine industry took steps to relieve the problem with the oils, something that was unique to marine engines. The fix was TC-W3.

The logo for TC-W3 is displayed within a rectangular border. It features the text "TC-W" in a bold, sans-serif font, followed by a large, stylized number "3" that has a thick outline and a small "TM" trademark symbol at its top right.

Developed for 1993 models, TC-W3 brought in additional and tougher tests. Two additional engines joined the testing regime, a 3 cylinder 70 HP and a 15 HP twin. Now there were four different 100

hour engine tests plus the lab bench tests and the performance requirements had also been toughened up. Each 100 hour test required 55 minutes of full throttle, full load running followed by 5 minutes of idle at no load, repeated 100 times. A tougher test is hard to imagine.

It was an immediate benefit in reducing piston ring and skirt deposits; however fuel qualities can vary a lot from one area to another, so some problems still remained in isolated areas. A couple of seasons of feedback with the original TC-W3 oils showed a big improvement, but still there were some areas needing more help in reducing combustion deposits. The NMMA test committee concluded their test fuels had not been “dirty” enough, so looked at making the TC-W3 tests even tougher to ensure any oil that passed would definitely keep an engine clean.

By now the NMMA oils committee knew which way to go to improve TC-W3 so the test specification was modified to become “Recertified TC-W3”. By requiring the candidate oils to pass two consecutive 15 HP tests, with slightly harder rules, (in addition to all the original TC-W3 tests) resulted in an oil with a higher additive content to ensure combustion deposits were prevented from accumulating to danger levels.

Recertified TC-W3 became available in 1995 and cases of deposit induced engine failures then almost disappeared. Now the marine industry had an oil formula that could counter the undesirable affects of unleaded fuels, and to be fair to the fuel companies, unleaded fuels had improved too after several years of constant development.

What do the results of some of these oil tests look like? Here, courtesy of Castrol are two pictures from the TC-WII days showing some of the results of oil testing. The test engine was an Evinrude Euro 4 HP, not one of the usual TC-W test engines, but a small engine with relatively high lubrication requirements that was used a simple screening test.



The results of an oil that failed the lubricity test! One melted aluminium con-rod.



ABOVE: With ordinary two-stroke oil, the pistons are heavily coated and the rings are partly stuck.

BELOW: A good BIA TC-W oil keeps pistons clean and rings free.



Comparative testing – 50 hours at wide open throttle and 4500 rpm.

Today, 10 years later after the original, the recertified TC-W3 is still the oil standard for all current recreational outboards. The industry has maintained this oil as the minimum required for all new engines so that outboard consumers will find getting the correct oil easy – just look for the TC-W3 logo on the bottle. One of the certification rules is that the logo must appear on all certified oil retail containers.

But time marches on and so do our boating expectations. The last 10 years have seen an increase in new outboard engine technologies and an increase in the use of synthetic oils. Today direct fuel injection engines with electronically controlled oil injection are commonly available, so now we can

have very precise control over the oil (and fuel) consumption and even be able to vary the amount of oil used. The Evinrude E-TEC engines have this feature allowing the economical use of the more expensive full synthetic oils by programming the engine's ECU to use less oil.

There are also more 4-stroke large outboards around now and of course they use very different oils from the more common 2-stroke outboard variety. The new 4-strokes do, like all outboards, need to run at high power settings most of the time, so car engine oils are not always suitable. The NMMA has recently released a standard for 4-stroke engine oils so that consumers can again find it easy to locate an engine oil that matches their outboard's requirements. It's called NMMA FC-W™ (Four Cycle Water-cooled) and for full details check out their website at - <http://www.nmma.org/certification/programs/oils/fc-w.asp>

So back to the original question, can you use modern fuels and oils safely in that old outboard? Absolutely. If it's an older, larger model you may need to use a high octane fuel to be safe, but the latest TC-W3 oils are definitely better than anything that was around when that engine was new.

And that 20 litre sealed, unused drum of old TC-W you found in the back of Granddad's garage? – don't even think about it!