

Four Stroke Outboards

Whether you're really into pleasure boating or just an interested spectator, you will probably have noticed a upsurge in information about Four Stroke outboards recently. If you're not really interested in things nautical you might wonder why, after all there is nothing new about four stroke engines, nearly all of the cars we drive every day have used this type of power plant for 100 years. But marine engines are different.

Weight is critical to performance with small boats, and especially so with portable engines, the type you want to be able to carry easily from the car boot to the water. This was also the case back in the 1920's when small motor boats started to become very popular, in fact it was because of the availability of small lightweight outboard motors that the popularity of small power boats took off. Outboard motors with aluminium cylinder blocks and heads were common by the 1930's.

Manufacturers in both Europe and the USA (the main market in those days) soon discovered the small two stroke was easier to produce because it had fewer parts and it generally had a better power to weight ratio than similar sized four strokes. The two stroke used more fuel, but fuel was cheap so few people saw the need to try other types of engines. However, there were four stroke outboards, even back in the very early days.

One of the very first attempts at an internal combustion outboard motor was in 1896, by the American Motors Co (not the car company of the same name) and it was a four stroke.. It used a vertical crankshaft and driveshaft, and bevel gears to drive a propeller shaft, just like today's outboards. However, unlike modern engines the con-rod and crank were exposed to the breeze (like the crank and rods of steam engines) and the gears were open and exposed to the water. The single 540 cc cylinder produced between 1 and 2 horsepower at 400 to 600 rpm. The engine was air cooled by using coils of copper wire tightly wrapped around the iron cylinder! It was not a commercial success.

Other four stroke outboards have appeared throughout the decades, usually with considerably more success than the American Motors Company's early attempt. One that some older members may remember here in Australia was the 4 cylinder 55 HP Homelite outboard that had some popularity in the late 1960's and early 1970's. Later it was developed up to 85 HP under the name Bearcat. It weighed a lot more than comparable two-strokes and for this reason was not popular on fishing and skiing craft, but it's ability to idle quietly all day made it popular for house boats.

Now in the late 1990's four strokes are again in the spot light with every major outboard brand listing a four stroke range in their current catalogue. The reason for this sudden change can be described in one word - emissions. Beginning with the 1998 model year, outboard manufacturers selling in the USA market must reduce the exhaust emissions of their outboards by at least 8% per year, until by 2006 exhaust emissions are 75% below the 1996 level.

The north American market represents more than 50% of the total world outboard motor market, so all brands are aware of how important it is to do well in this area. If they can produce engines which meet these low emissions requirements while still retaining all of the attributes today's boaters expect in an engine, than all markets will benefit. Two routes are open to manufacturers of current piston engines, direct fuel injection two stroke engines and four stroke engines. We covered some of the unique facets of direct injection engines in recent editions, so let's now look at pro's and con's of modern four stroke outboards and they stack up against the existing two strokes.

Firstly performance, traditionally the strong suit of the two strokes because of their more frequent power strokes and lighter weight. And this is still the case, although the gap is narrowing.

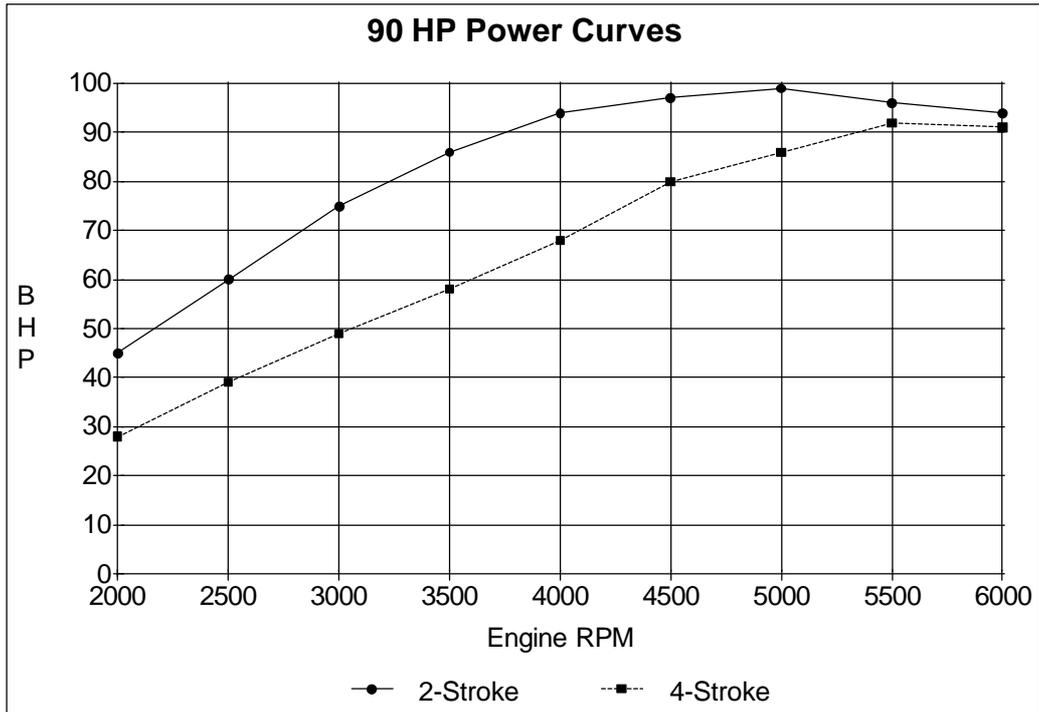


Figure 1, 90 HP Power Comparison.

Figure 1 shows the full throttle power curves of two and four stroke 90 HP outboards. Both are 1.6 to 1.7 litre 4 cylinder engines and both rated at 90 HP. The two stroke has a power advantage at most speeds which would translate into better acceleration and load carrying.

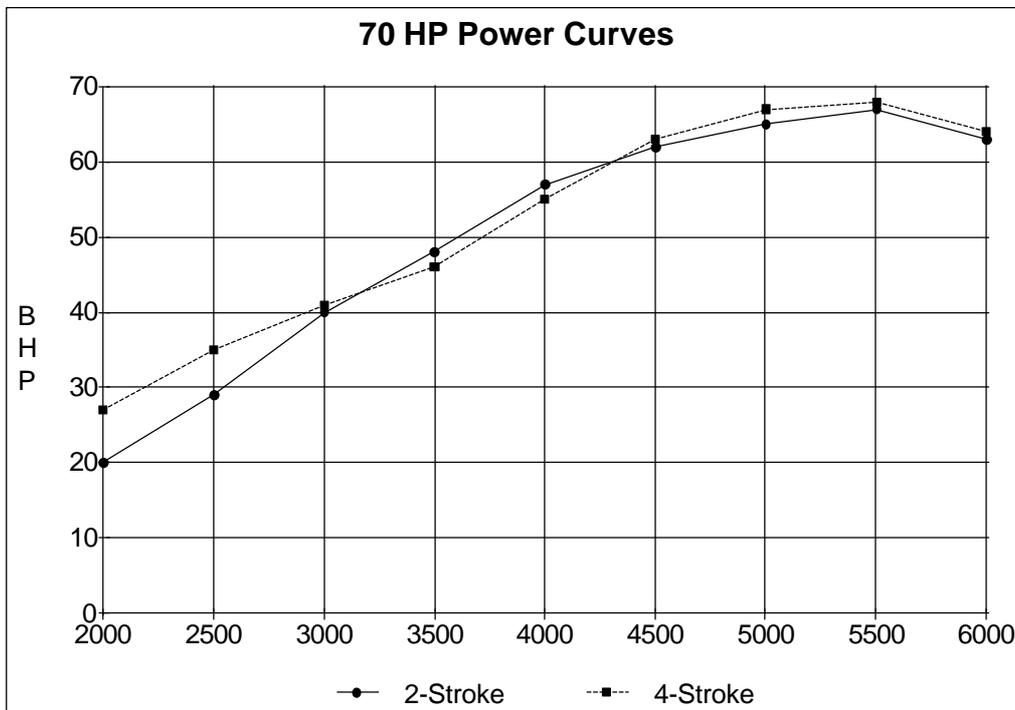


Figure 2, 70 HP Power Comparison

Figure 2 shows two 70 HP outboards, a two stroke and a four stroke, this time with very similar power curves, but not engine capacity. The two stroke is a 920 cc 3 cylinder, the four stroke a 1200 cc four cylinder.

These two charts illustrate the point that "horses are not always horses" when it comes to comparing different types of

engines. The maximum power ratings shown on the motor covers are definitely not the full story when it comes to boat engines as these charts show. On a similar hull the two 90 HP motors would have close top speeds, but the acceleration and load carrying capacity would vary markedly. The two 70 HP motors, however be very close in both top speed and acceleration.

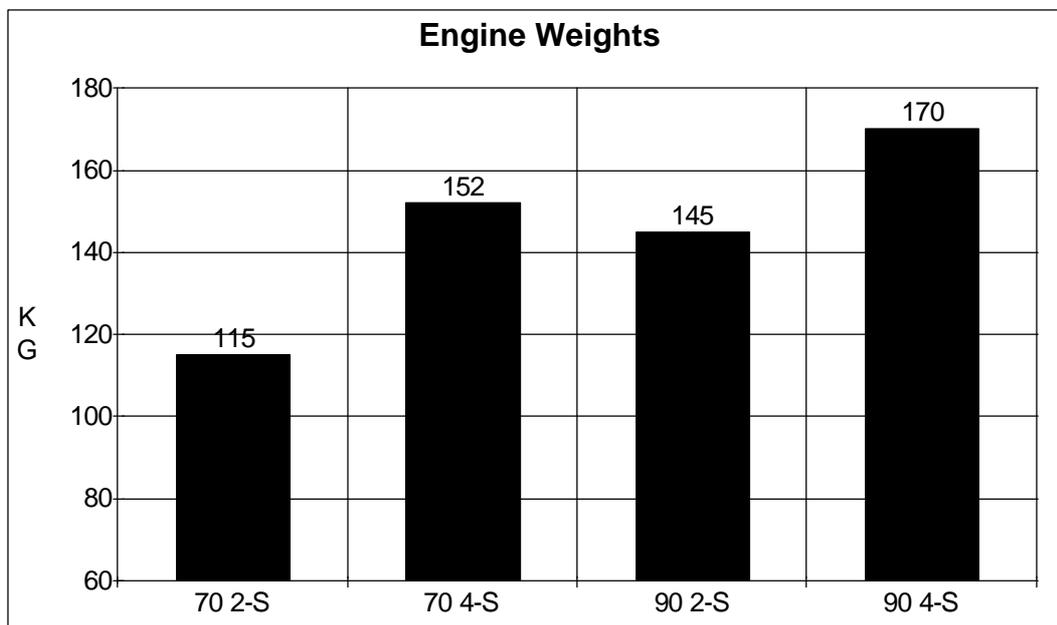


Figure 3, Weight Comparison.

Figure 3 shows the weights of these engines. Engine weight can have a major affect on performance, economy and load carrying. It all depends on just how much of the total rig weight is taken up by the outboard motor. If it's a relatively small or light boat, then the heavier motor will noticeably penalise performance, whereas if it's a larger and heavier rig, and the motor/s are a relatively minor part of the whole weight, then the affect may not be noticeable at all.

Figure 4 shows a scale drawing of the major difference in these two types of the engines, the cylinder head. The two stroke head on the left is for a 255 cc, twin cylinder two stroke, rated at 15 HP at 6000 rpm. The four stroke is a 305 cc, twin cylinder, single overhead cam, two valves per cylinder, rated at 15 HP at 5500 rpm. When you add to the four stroke sketch the intake and exhaust manifolds, sump, oil pump and cam drive mechanism, it's not hard to see where the extra weight is.

But it's not all bad news. Depending of how your boat is powered (which size engine you install) and how you use it, the modern four stroke is quite capable of satisfactory performance. If you're more interested in getting to your favourite fishing spots in comfort than pulling skiers or zooming around at high speed, well then the four stroke could be more than adequate for your needs.

Then there's the fuel savings to think about. Compared with traditional carburettor two strokes, four stroke outboards (and the new direct injection two strokes) can be around 30% more fuel efficient, more if you spend lots of time at low speeds. Here is the main reason these new four strokes are starting to appear, even from traditional two stroke engine manufacturers. The four stroke system keeps the inlet and exhaust events separated, with just a very small time when both valves are open simultaneously so the loss of any fresh charge out of the exhaust during scavenging is greatly reduced. Therefore emissions are reduced and fuel economy improves; the engine does become more complicated but it's a relatively proven and commonly available technology.

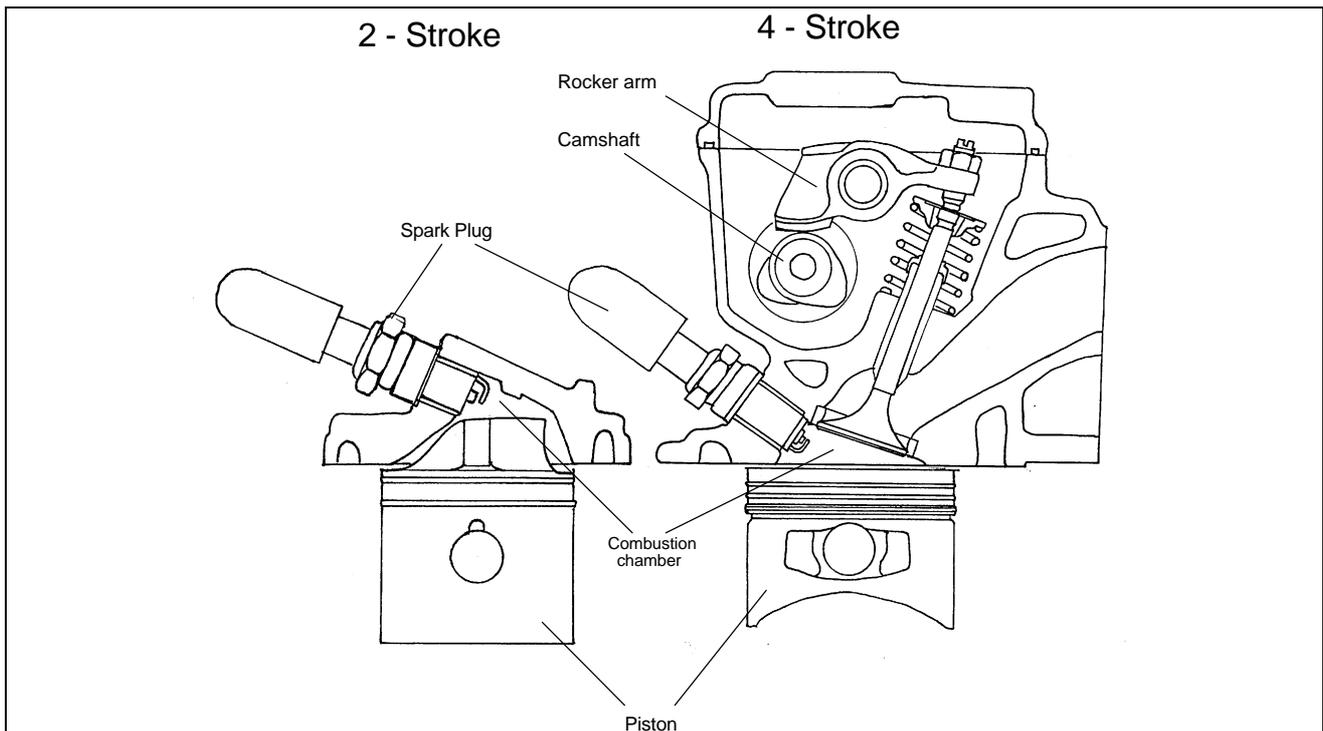


Figure 4, Cylinder Head Comparison.

What about maintenance, doesn't the four stroke have more parts that require some sort of maintenance? Let's review both types of motor, starting from the bottom and working up.

Lower unit and gearcase. There is little, if any, difference here between two and four stroke models here and those manufactures making both types of engine use the same lower unit parts. Gear oil changes are usually once per season or 100 hours. External grease points like steering and tilt pivots, shift and tilt linkages and so on, are like wise usually the same between both types of motor. Use a proper marine grease intended for the job and always apply it just after use, that is before putting your rig away in storage to wait for the next outing. This is important because things seizing and getting stuck can be fairly common on pleasure boats which spend most of their life in the shed or the yard. You need to remove any water from grease and oil points **before** it sits around for a few weeks or months. The best way to do this is by greasing or oiling those lubrication points after use.

Crankcase oil. Obviously an exclusive area to the 4 stroke models, but very often different to the oil recommended for your four stroke car. This is because the marine and car engines are intended for very different duty. Most current four stroke outboard makers are recommending a 10W-30 or 10W-40 SG or SH type oil, with oil changes every 100 hours or once per season, whichever comes first. Because boat engines work pretty hard some manufacturers are now also recommending a partial synthetic oil (after break-in is completed) for better protection and longer oil change intervals.

Having a sump full of oil requires some extra precautions for portable four stroke outboards. When the motor is laid down for transport it is very important to know which side it must lay on to ensure the oil does not escape through the crankcase breather system. This varies between manufacturers so is a "must read" in the owners manual. Most four stroke manufacturers also recommend allowing the motor to stand for 5 or 10 minutes, after attachment to the boat, before you attempt to start it. This wait is to ensure all oil has drained back into the sump.

Cooling system. Both types of outboards are raw water cooled, so salt and silt deposits should be removed by flushing as soon as possible after each outing. The four stroke engine has more cooling system passages with its more complex cylinder head and manifolds, so it's important to ensure it is flushed properly. Some manufacturers now provide "flushing ports" where a garden hose can be connected to flush the whole cooling system, without running the motor. This is great for staying on good terms with the neighbours, and removes the potential problem that most clip on "ear muff" style flushing attachments have of allowing the water inlets to draw in air with consequent water pump damage.

In all cases it is also essential that the outboard motor be allowed to remain in a vertical position after flushing, until all

water has drained from the cooling system. This is important to reduce any long term corrosion problems that can occur even with fresh water if it is left in place for long periods of storage.

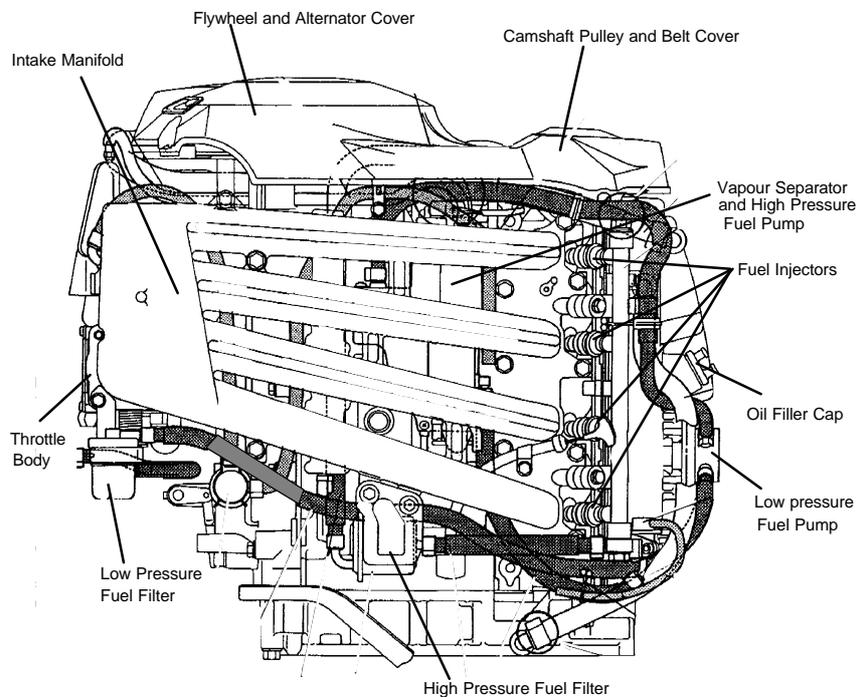
Powerhead. Extra four stroke servicing items on the powerhead include oil and oil filter, usually changed at the 100 hour or annual service, and valve tappet clearances. Camshaft drive belts also require regular inspection for condition and in some cases regular replacement. Interestingly, spark plugs usually live longer in four strokes, even those with a "waste spark" ignition system that fire two plugs at a time. This type of ignition system is common because it removes the need for distributor and long HT leads. Even though the plugs are fired at every TDC (like a two stroke) they are only exposed to combustion temperatures on every other revolution, so electrode wear is reduced.

Fuel System. Very similar carburettor and EFI systems exist on both two and four stroke outboards. They also operate similarly, with one exception. Four stroke carburettor models often have acceleration pumps where two strokes do not. This can make starting a bit tricky if you are in the habit twisting the throttle before starting, as small four stroke engines can be easily flooded.

Operating characteristics. Two and four stroke outboards can feel quite different to the boat operator, even though they are doing the same job. The lower number of firing strokes in the four stroke engine makes it sound quieter at all speeds. Actually, the decibel meter shows that similar sized engines of both types are very close in noise output, especially at high speeds, but the human ear favours the lower frequency sound of the four stroke. Four strokes are generally more content to idle smoothly for long periods, a benefit of the separated intake and exhaust events mentioned previously.

Which is best? This argument will probably rage for years. History indicates the two stroke has been favoured because it is easier to get high power outputs, has less parts and is lighter. Low emission models retaining their performance and with much better economy are now becoming available, but with the added complication of direct injection and electronic engine management.

Four strokes engines on the other hand are heavier, have some extra servicing requirements and depending on your intended use, may not have the performance you expect. However they are commonly available technology, very happy to quietly idle for long periods and their fuel economy is very good. Pleasure boating has always about choices, with the enormous variety of boats available, things to do and places to go. And just to prove it, there are now more engine choices than ever before!



Port side view of a modern four stroke outboard powerhead, an Evinrude 70 HP. It's a 1200 cc, 4 cylinder, SOHC, 2 valve per cylinder engine using sequential EFI. Note the long intake manifold runners for boosting mid range torque.