

Engine health check

Fixing diesels is not so different to treating patients, says Gilbert Park

When ordering an oil analysis for *Merlot*, my lockdown project boat, an idea struck me. Routine health checks are part of medicine so why not for my engine?

Merlot used to be the Poole Harbour workboat and is probably 30-40 years old. The previous owner told me she was re-engined in 2008 with an inboard Yanmar 3GM30 diesel engine. The service history

was a little scant so I decided to do an oil analysis. This showed a lot of iron (perhaps crankshaft wear) and silicon (dirt).

Being inquisitive and remembering my earlier days as a doctor I thought I'd listen to the crankshaft and bought a mechanic's stethoscope for a fiver off ebay. I listened and it was fine. The Oil Lab, which did the test, recommended an oil change and retesting in six months; just like we used to do with blood tests

when I was a doctor.

The important part of any health check is to record values and findings so that if something goes wrong you know what the normal value was when all was well. It's usually trends that are important in

Gilbert listens to the engine using a mechanic's stethoscope. Notice the bulb just below his right hand which acts as an amplifying box for the probe



BELOW The service history that came with *Merlot* is brief. Some essential items had not been changed for six or more years

Make	Part	Size	Qty	On the boat	When changed	Comments
9/10	1/1	1/1	1/1			
9/10						
0/10	1/1/1/1					
10/10	1/1/1/1					
7/10						
2/10						

Bought 2/10/2011



ABOVE The old air filter (left) next to the new filter (right). This may explain the silicon in the oil analysis, as the filter appears not to have been changed for many years

detecting problems, not absolute values.

Remember, also, that as engines wear things change and some of the changes are expected, so a range may be given for values. The health check can be done at the same time as an engine service (it's not intended to replace it) or on a more regular basis.

The other thing you do as a medic is to think of systems. So as I serviced my engine I remembered what I'd been taught and done over the years. The three common things that will stop a diesel engine from running are lack of cooling, poor fuel and no air.

1 Present history

The first part of any health check is to ask if there are any current problems – the 'present history'. In *Merlot's* case it was the oil analysis and was the crankshaft in danger? I spoke to the very helpful Yanmar agent in Emsworth, and he told me not to worry, just change the oil. Listening to the engine revealed no lower end knocks so all seemed well. As for the silicon, I changed the air cleaner filter noting that the difference between the old and new was striking.

2 Past history

Next was to investigate the past history – which was sparse! The oil was a

supermarket own brand and the oil filter an aftermarket variant. The gearbox oil and engine fuel filter were six years old. I tried to get the history of the reconditioned engine (fitted in 2008) but sadly the reconditioning company didn't have records going that far back.

It's worth looking back through your logbook to see how much oil and water you've had to put in over the last year. Is it increasing or static? If it's increasing is there a reason, such as has the engine having been run for more hours than previous years? If not then looking for a cause becomes important during the rest of the checks.

3 Family history

The final part of taking a medical is family history. Are there any known faults you should look out for in the family of your engines? For this you can search the internet, or, in my case ask the agent. He told me that the exhaust elbow on my engine is regarded by Yanmar as a service item. They recommend it should be changed every two years at a cost of over £200! He showed me one, but the one on my boat was different and appeared to address some of the common corrosion problems caused by the injection of salt water near a weld on the original elbows.

Date	Course	Long	Speed	Dir	Wind	Sea	Lat & Long	Remarks
35	076	295	4				Slipped Emsworth	Check
15	3316	295	5				Bar Beacon	Check
	Chimney	FS	0.56				U/NW	
30th	345	296					FS Choppy Sea	Coast
15	345	295					Slipped Cores 36L Fuel Fil	Glign
25							Passage plan solvent coast	Geo
13/197	3629	299	2				50.37 01N 001.38 30W	2.9 3 91
	Left Aircraft Crank Off						Woodley Battery	
	Responded	1223						
200	197	3815	3				50.19 229001.23010	2.8 40 2.5
100	20	3969	3				50.06 02N 001.53131	2.9 3 81 82
50	199	40915	3				49.54 00N 001.55701	2.9 3 81 82
100	217	4207	3				49.53 230 002.05 201	2.9 2 80 2

LEFT Gilbert records engine oil and temperature in his logbook

Diesel smoke

An engine running properly should produce no smoke.

White smoke

This may indicate there's unburnt diesel in the exhaust. Often this is from a fault with the injectors, but there are other causes as well.

Black smoke

The result of incomplete burning of fuel, perhaps from a clogged air cleaner or other causes.

Blue smoke

This is the rarest colour of smoke and is caused by oil being burnt. Overfilling with oil is one reason but, as with the other smoke colours, there are many possible causes.

4 Examination

Onto the examination. Look, listen and feel was always the order of the examination.

Look

First start by looking at the engine without starting it. Use a very bright inspection torch. Not only does this help you see leaks, etc in the depths, it will help you to concentrate where you are looking so you are less likely to miss things.

Are there any stains caused by leaking water, oil or exhaust?

Are there dangling wires that need reattachment, cracked hoses, missing hose clamps and the like?

Is there water in the fuel filter housing?

Then, after the routine prestart tests, start the engine. If you'd seen stains before is there any active leaking going on

Take a close look at the exhaust. Is there water coming out, what colour (if any) is the exhaust smoke (see panel, above)?

BELOW Gilbert took several pictures of the engine, such as this one, and noted the temperature measurement points. Another option is to print off the photo and mark the measurement points with a pen. Each time he measures these, it's a simple matter to record a new column of temperatures, along with date, engine hours and other comments



KEY
 Note you may need several photographs to show, for example, the alternator bearings, etc. Each recording takes a matter of seconds – point and shoot with the thermometer.

A. Exhaust hose – after water injection
B. Exhaust elbow
C. Raw water out of heat exchanger
D. Fuel pump
E. Fuel filter
F. Oil sump
G. Injector pump
H. Fresh water return to engine
I. Raw water into heat exchanger
J. Fresh water into heat exchanger
K. Heat exchanger

Listen
 Before starting the engine make sure you are safe (see panel, below). When the engine is running listen to it – are there any unusual noises? If so, increase the rpm and see if the noise changes. Some may disappear, some may get worse. This is where the mechanic's stethoscope comes in useful. You can put the point on

where you think the noise is coming from to pinpoint the bearing or whatever.
 It's good practice to listen to the rest of the engine so you know what normal is.
 However, before using the stethoscope on a moving engine please read the safety panel and be careful if you become engrossed in what you are hearing.

Feel
 Feeling comes down to mostly checking the hoses – try gently squeezing them to see if they are still flexible and supple. If they are hard and inflexible then they may

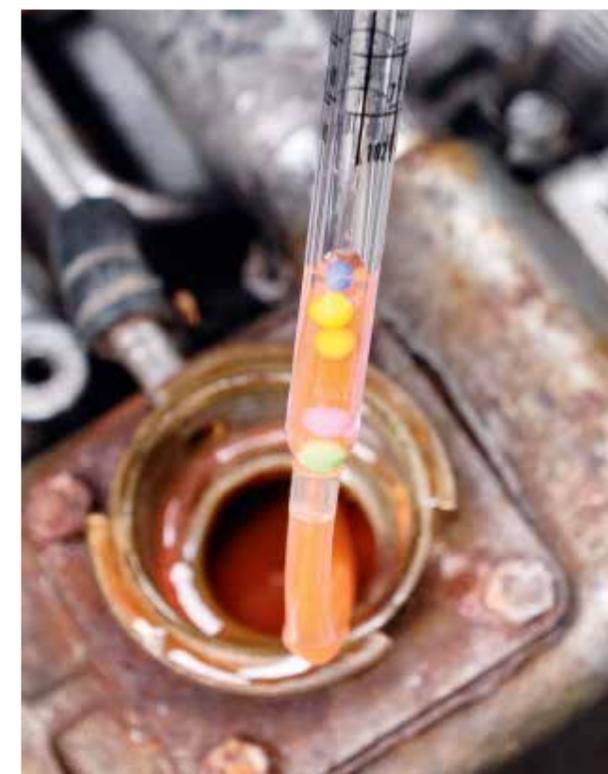
LEFT Newer engines and displays enable a screenshot to be taken of the various engine parameters and are an easy way to store a lot of data. The file name usually has a date on it as well



crack with the engine vibrations at some point in the future so you may want to consider changing them as a preventative measure. The same with belts. Are they cracked or loose?

5 Tests
 So that's the history and examination done. Now onto the tests. With all tests it's important to record the conditions under which they're done as well as the results themselves. Were the recordings made at tickover or at wide open throttle (WOT)? Was the engine hot or cold?

On any boat I take out under power, once the engine has warmed up and I'm clear of the harbour I always do a WOT test. If the engine is going to break then near the harbour is the place for it to



LEFT This simple, inexpensive device will tell you the temperature that the coolant will freeze and boil at by counting how many of the five coloured balls are floating. In this case it is three which translates to -23°C and 105°C. Should be enough!

ENGINE OIL TEST RESULTS	
SYMPTOMS: Note levels of: Iron and Silicon	
DIAGNOSIS: Iron indicates some ferrous wear, possible crankshaft, Silicon possibly dirt/grit	
ACTION: Please continue monitoring sample, change lubricant and filter	
Date Sampled	14/10/2020
Date Received	16/10/2020
Date Tested	19/10/2020
Oil Life (hrs)	
STATUS	CAUTION
PHYSICAL PROPERTIES	
Viscosity @ 40°C	cSt 97
Water Content	%wt 0.0
Total Insoluble Matter	%wt 0.9
Total Base	mgKOH/g 8.9
Fuel Present	<135c 0
Fuel Dilution	% 0
SPECTROCHEMICAL ANALYSIS	
Iron	ppm 95 **
Chromium	ppm 10
Aluminium	ppm 11
Molybdenum	ppm 41
Copper	ppm 6
Lead	ppm 4
Tin	ppm 1
Nickel	ppm 0
Silicon	ppm 96 **
Sodium	ppm 4
Barium	ppm 421
Vanadium	ppm 0
Calcium	ppm 3379
Phosphorus	ppm 989
Zinc	ppm 1080
Magnesium	ppm 12
Barium	ppm 0

This is the oil analysis for the Yanmar engine in Merlot that started off the whole train of thought about annual health checks for engines

Safety when examining engines

- If you have an old engine some of the moving parts such as belts and crankshafts may be exposed. Take great care that you don't have loose clothing, hair, jewellery and the like that can get caught and injure you.
- If you have a large engine or are working in a confined space protect your hearing with ear defenders.
- If there is a risk of 'bits' coming off the engine such as loose particles of paint or rust use eye protection.
- Remember to wear gloves. There are a variety of nasty compounds around your engine. It also means it's much

easier to clean your hands at the end of the day. Even doctors wear gloves when examining patients!
 ■ Make sure you're in a well-ventilated area, especially if there is any risk of inhaling exhaust fumes. There is also a risk of carbon monoxide poisoning. Diesel engine exhaust is a cause of lung and bladder cancer. Although the studies reporting this looked at traffic exhaust they recommended that everyone should reduce their exposure to this carcinogen (find out more at the American Cancer Society, www.cancer.org)



ABOVE Noise and fumes are a health risk if you are in an engine compartment while the engine is running. Always ensure good ventilation

happen, not far out to sea. The same is true for the annual health check.

If the boat has an engine that is interfaced to your multifunction display you can take a screenshot, print it out and compare later results with it. If you do find something different a screenshot will be invaluable, easy and straightforward to compare. Modern engines have many variables you can record. Normal values can usually be obtained from the handbook, or the manufacturer's website or the agent.

What, if like with Merlot, you don't have that level of sophistication?

Temperature
 Temperature is a good place to start. It may be that your engine has a temperature gauge, like mine, with its sensor on one of the hoses that you can record a value for. Alternatively, it may have an overheat/lack of water sensor built into its control panel. An infra-red remote thermometer with a built in laser spot where the measurement is being taken is invaluable. For an annual health check you might like to take several readings from known spots so you can compare results.

Fresh water coolant
 The other thing to check is the fresh water coolant. Not only do you need to make sure there is enough, but also if the amount of antifreeze is sufficient for the winter. An inexpensive solution can be found on various websites that have different coloured, floating balls and the ones that float tell you the temperature protection you have.

Oil pressure
 Next is oil pressure. Merlot doesn't have an oil pressure gauge. So instead I record the time it takes for the oil pressure alarm to go off when the engine is cold and warm. If it starts to take longer then it may be something is going wrong and further investigation is needed. Remember that oil pressure will be dependent on temperature and the grade of oil you have.

Battery voltage
 A low battery voltage with the engine running will tell you if you have a problem with the charging system. Again this may be obtained from a gauge or NMEA data, but if you don't have these but do have a

ABOUT MERLOT



Merlot (previously Rumpas) is a Romany 21 made in Poole in the 1970/80s. She used to belong to the Poole harbourmaster, and has a towing post fitted just behind the engine box. In about 2008 she was re-engined with a Yanmar 3GM engine and gearbox. Gilbert Park bought her as a lockdown project and has enjoyed all the challenges she has posed.

simple chartplotter or depth finder you may find concealed in a sub-menu 'voltage', useful for the health check. If you have none of these then it's a case of connecting a multimeter to the batteries when the engine is running to check the voltage, or wait until the system fails and the red light on the panel comes on!

Oil analysis
 The final test is the expensive one – oil analysis. Like a blood test, an oil analysis will tell you what you can't see. Not only does it look at wear of various parts of the engine, it will also tell you the state of the oil and if water or fuel is leaking into the engine. You can also see if the oil needs changing or not, saving money and the environment if it doesn't. Like all complex tests, however, just because something is abnormal doesn't mean there's a problem. Usually the test comes back with an interpretation, but without detailed knowledge it can be misleading. Speak to the oil lab or an agent if you don't understand something.

6 Keep a record
 Once you have all the results of the history, examination and tests, remember to keep a copy on board. This could be a paper record or on a tablet or smartphone. If something does go wrong at least you'll have the normal results with you. You can also use this record for the next health check to see what, if anything, has changed.
 Merlot's Yanmar has had her health check and service. Now it's time to relax when I am out in Chichester Harbour knowing I've done my best to maintain her.