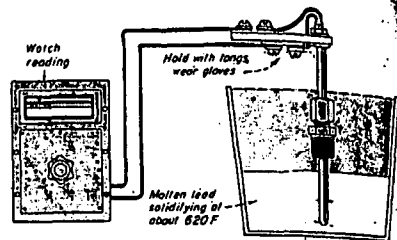


EXHAUST temperatures are quickly checked by this engineer from pyrometer installed on the control and alarm panel here



TEST pyrometer by placing thermocouple in pot of molten lead. Check reading when lead starts solidifying at 620 F

"Log Pyrometer Readings,"

says C Morgan Jones, Diesel Engineer,

"... and end diesel mysteries. A pyrometer takes most guesswork out of trouble-shooting. Log its readings and do away with headaches." Here's how to "read," how to maintain one

► MAC ADMITS he knows more about diesel engines than anyone else. When I asked why he didn't log his individual cylinder temperatures, he said, "What's the use? I can tell how she's running by just looking at the stack, or feeling the exhaust headers."

What he didn't know was that individual exhaust-temperature readings often tip you off about trouble, long before exhaust smoke and touch method do. They might tell, for example, when water jackets need cleaning, or if fuel injection is early or late.

Operator naturally knows everything isn't OK when exhaust is smoky. Trouble might be one cylinder overloaded from faulty injection. But one cylinder can be overloaded without engine smoking. How? Because combustion is completed in hot exhaust headers, where it does no good. Pyrometer will find that in a hurry.

Carbon builds up in combustion spaces of that cylinder, but may not be bad enough to smoke at once. In the meantime, if cylinder heads are lifted, Mac will be surprised and say, "Look at this. All other cylinders are clean and

haven't smoked." So another mystery of diesel gossip starts going round. Then it's entered in the maintenance log book for posterity—to be thrown at some unsuspecting salesman. Exhaust pyrometer would have found this trouble also.

Again, if a cylinder shows a very high exhaust temperature, you might check fuel pump, injector, even the fuel, and still not find cause of high reading. Thinking everything is all right, you start engine, blaming pyrometer. Then you forget it, but before long you lose your plant. How could this happen?

Well, you should have checked liner and piston, also. Careful check shows first signs of scoring, causing overheating registered by pyrometer. No breakdown if this had been checked and lube-oil service overhauled.

THINGS TO CHECK

Scale can form in engine jackets if you don't keep water hardness to a minimum. It forms slowly and robs engine of its efficiency. Scale gathers slowly, but the exhaust pyrometer tells all about it. Temperature of cooling water might decrease as thin layer of scale prevents

cylinder heat passing to cooling water. But gradual increase for all cylinders tips you off to need of a descaling job. Quick check of 2-cycle engine's cooling system without draining is to take off air-box hand doors. Then bar engine over slowly. Check rings with a strong flashlight as they slowly pass ports. First blackened ring that passes marks lowest point blowby has reached. All rings should be polished. Stop bar-ring, push ring with wooden wedge. Ten to one, it will be stuck.

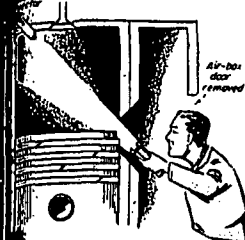
Lie on your back and shine torch upward through port. Then, as engine is jacked over, you can see carbon streamers on otherwise shiny liner. You can even see injector tip. Rings will be gummed from lack of oil. Lube oil burns off from high temperatures caused by poor cooling. Blowby might take place for whole length of piston, from crown to skirt edge, far as you can see.

Remove crankcase doors if 4-cycle engine. Don't jam clothing or yourself in webs while engine is barred over carefully. Piston skirt's bottom and liner's lower part can often be inspected for blowby indications, sketch.

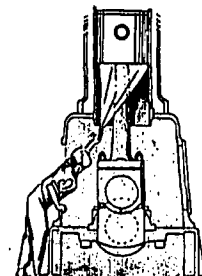
If blowby shows for liner's full length, smell the lube oil. It may reek of fuel oil. If so, take sample and place in tube, sketch. Take same amount of unused oil in another tube of same length and diameter. When both are same temperature, use two steel balls (ball bearings) of same weight, slightly smaller than tube.

Drop one ball into each tube, at same time. If ball in used sample sinks faster, oil is diluted. This test is very practical. The faster the ball travels in used oil, the greater the dilution.

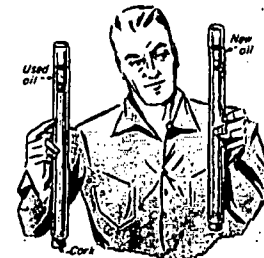
Here again, carefully logged exhaust temperatures could have saved trouble. So keep an accurate log. Don't skip degrees and say reading is "about so and so." There must be no "about"—it must be exact to tell true story.



LOOK INSIDE cylinder through air box signs of blowby, sticking rings, etc



FOUR-CYCLE liners are checked for blowby by looking up from inside crankcase



DILUTION TEST is made by comparing ball's travel through new and used oil

Take case of a 2-cycle engine where cylinder does most work because it gets too much fuel. Pyrometer shows higher reading for this cylinder, but it's usually ignored. But trouble in this cylinder can spread to others.

As overheating from overload congests carbon forms in ring grooves and combustion spaces. That distorts injection spray. Some nozzles also clog, carbon builds up fast. Then carbon seals exhaust ports. So cylinder works on less air supply. More carbon forms, clogging ports. Then temperature soars as less air enters cylinder.

To maintain speed, governor advances fuel rack, causing other cylinders to respond. But large cylinder gets more fuel also. Then higher temperatures seize piston to drag and score.

More fuel is injected as governor tries to make up power loss. Other pistons strain and pull in response to throttle. Then these cylinders start overheating. Same cycle starts all over again. Combustion spaces carbon-up, rings stick, ports plug, fuel spray is distorted, and lube oil burns.

LOOK FOR TROUBLE

When engine is stopped, you find cylinder damaged and about to seize. Connecting rods may be damaged slightly, and other damaged parts may pass unnoticed. Don't kid yourself. Damage will show up—and how!

Late injection to any cylinder is easily found with a pyrometer. It means higher temperatures, incomplete combustion, carbonization. Early injection may cause detonation as piston passes through top dead center. Then pyrometer reading is low.

Briefly, a pyrometer showing high temperature also tells: (1) need for changing injection timing (2) need for reducing fuel supplied to any overloaded cylinder (3) if one cylinder is getting too much fuel. But if temperature is

low, it shows: (1) need to advance injection (2) if rings or valves are leaking, or (3) if cylinder isn't getting enough fuel.

When temperatures are high in all cylinders: (1) engine is overloaded, or (2) exhaust backpressure is too high from muffler or silencer being plugged, or (3) exhaust turbine is dirty, or (4) exhaust piping is too long or small.

Pyrometer has only four parts: Indicator, thermocouples, switch and extension wires. Indicator is actually small millivoltmeter.

Thermocouple for diesels is two wires of different metals: Iron and constantan. Wires are welded together at one end, connected to indicator at other to serve all cylinders.

Welded end is "hot" junction, other "cold." When "hot" end is heated, a small voltage is generated. Voltage travels along wires through switch to indicator, where it's measured. But indicator scale is calibrated in degrees of temperature. Hotter the temperature, higher the reading.

To test, place thermometer at "cold" end (this end is at switch when alloy wire connects thermocouple to indicator, at thermocouple when wire is copper). Leave thermometer there for 40 to 60 minutes. Then take reading and compare with that given on indicator dial. If not same, adjust indicator with small knob or screw provided for this purpose. Indicators, fitted with cold-end compensators, need no adjusting.

If you know engine temperature is going up while pyrometer says it's going down, wires are reversed at switch connection or terminal. Reverse, and readings will be OK.

Set indicator dial at room temperature, not zero. And don't test indicator with dry battery or other power source. Smallest current slammed across terminals will damage coil, springs, and perhaps bend pointer. So be careful.

Thermocouple wires must not touch engine. Keep dry, and protect against vibration. If extension wires are of standard type, look for fraying at bends or at flexes.

Thermocouples are mounted in protecting tubes or "wells." For this purpose, seamless steel is preferred to wrought iron—steel responds to temperature changes quicker. Clean tubes at regular intervals. Don't scrape—wipe. Tips of thermocouples should project into center of exhaust header.

KEEP INDICATOR IN SHAPE

Indicators get sluggish from dirt. Clean with carbon tetrachloride. Don't adjust internally. Oil indicator bearings (often jeweled) with light machine oil on pipe cleaner.

Causes of pyrometer trouble are: damage to indicator, loose or broken contacts or connections, dirty contacts, grounded wiring. Fluctuating pointer indicates loose wiring. If connection between elements (iron and constantan) breaks, remake using electric welding.

Slightest rupture in wiring insulation means complete loss of current through grounding. If no reading, and insulation is all right, check for switch damage. Bypass switch with two short leads to indicator terminals.

Some indicators have simple locking device to short-circuit moving coil during transit. It's connected to terminal posts and must be removed before indicator can operate. Don't forget this when fitting a new one.

Check pyrometer's accuracy every year. Place thermocouple's welded-end in bath of molten lead. When lead is at point of solidifying, temperature is about 620 F. sketch on facing page. Compare reading with indicator's.

After years of trouble-shooting around diesels, both at sea and ashore, I have found that a pyrometer is one of the best investments an owner can make.