

# Part #59

## Diagnostic Leak Testing

*By Mike Stratman*

You've decided to take on your engine work. You followed the manual or the repair video to the letter. But how do you verify that everything has been done right and is ready to go ..... no mistakes .....no leaks.....no surprises.....or do you just fire it up and hope for the best?

This month we'll show you some quick and easy ways to function test your repair work. The same tests can be used to quickly spot trouble or diagnose a failed engine. Remember, if we are going to find the cause of the failure and prevent it from happening again we can't just start removing parts until we find the failed part. Diagnostic engine repair requires a few simple tests that can go a long ways to both pinpoint and verify the cause of engine problems. By the way, these tests have been used for years by experienced two stroke mechanics, but won't find them in the factory manuals.



*Photo #1 – With the use of a few plug caps, hand pump and gauge. We can test both the combustion chamber and the cooling system for leaks and possible trouble.*

**Combustion Chamber Leak Test:** Air intake leaks can bring high EGT temps and heat seizures. The air leak acts to lean the fuel mixture because now the carb is no longer completely in charge of regulating the mixture. The bigger the leak the leaner the burn. A watchful operator will see this on an EGT indicator before a piston heat seizure. An improperly equipped engine or careless pilot will not. If we have had a failure this is a great test to run before starting disassembly. This test will find the smallest leaks in head gaskets, intake manifolds, cylinders, crankcases, crankcase half seals, front and rear seals. Here at CPS we have got in the habit of including this in the process of a normal rebuild. It's a nice knowing that the engine is going back to the customer without the slightest hint of a leak.



*Photo #2 – Sealing the exhaust ports with 1/8" thick aluminum plates and rubber gaskets will allow us to pinpoint possible leaks in the combustion system.*

To accomplish this test we need to seal both exhaust ports, install and torque all spark plugs, and cover both intake ports. To cover the intake ports you will need some sort of plastic or rubber plug to seal the openings. CPS now carries these tapered plastic plugs that can be wedged into each port for a good seal. They are also great for sealing and engine up for prolonged storage. They are less than a buck apiece. See photo.



*Photo #3 – Plugging the intake manifolds is easy with these tapered plastic plugs. CPS Part # 9734.*

The exhaust ports are a little more difficult. We fabricated cover plates out of 1/8" aluminum plate and made a rubber gasket out of a tire inner tube. With four 8mm Allen head bolts we can snug up the fasteners to create a good tight seal.



**Photo #4 – Connecting our vacuum source to the fuel pump pulse port we can test the entire combustion system for leaks.**

To apply a vacuum to the system we use a hand pump and gauge combo (CPS Part #A3800) attached to the fuel pump pulse port. See photo #1. Using the hand pump we pump the system down to minus 5 psi and close the valve at the gauge to remove the pump from the system. The engine should hold -5 psi for at least 30 minutes. Why do we use vacuum rather than pressure, you ask? Either will work except that the problem of plugs and hoses wanting to pop off is greatly reduced. If a leak is present you obviously won't be able to hold the vacuum.

To find the leak move the hose to the pressure port on the pump and bring the system to + 5 psi. Using a spray bottle filled with 50% water and 50% liquid dishwashing soap, spray the solution at all possible sources of leaks. Head gaskets, base gaskets, intake manifolds, etc. The leak should produce bubbles at the source pinpointing your problem. See photo.



**Photo #5 – Pressurizing the system to +5 psi and spraying the block with a solution of 50% water and 50% liquid dishwashing soap will pinpoint any leak. Here we have loosen a water pump housing bolt during the cooling system test to show the bubbles created by a leak.**

On 503 engines the leak test should be done the intake cowling in place and the manifold torqued up to finish spec. The exhaust is best done without the cowling in place and the cover plates installed on the bare exhaust ports. Often times it's hard to get the exhaust ports to seal right off because of carbon deposits, flex in the plates/gaskets, etc. Remember that a leak here is not a potential problem to the operation of the engine but it will foul your test results so do what it takes to get a good seal here. On some engines a gearbox mounting bolt may want vent pressure. Your soap solution should locate this. Plug it with an 8mm bolt. Obviously this test won't give you a reading on ring wear or piston seizures. For this we will have to go to a compression test.

**Cooling System Leak Test:** On all liquid cooled 532, 582, 618 engines we have a sealed cooling system that flows throughout most of the block. Being able to bench test this system is another way to confirm your work is ready for service. It will also show if the RV shaft seals have been compromised. This test will take just a few minutes and requires a minimum of special stuff.



**Photo #6 – Capping the water outlets is easy with these 1" rubber caps Part # 9723.**

For this test you will need to cap all water outlets, steam vent, and install a 1/8" npt male pipe fitting (CPS Part #8520) in the sender port found dead center in the middle of the head. For capping the water outlets you need some sort of cap. CPS Part #9723 rubber caps that slips snugly over all radiator hose outlets. Use a Part #860-610 Bing carb primer port cap to plug the steam vent on the head or water pump housing (inverted engines). All these pieces should cost you less than \$5 and take you a minute or two to install.





*Photo #7 – Using the sender port in the middle of the head gives us a place to pull the vacuum from. Note steam vent on left plugged with #860-610 Bing primer port cap.*

Connect your hand pump and gauge (CPS Part #A3800) used for your first test to the water sender port. Pump the system down to -5 psi and close the valve at the gauge. Again, the cooling system should be able to hold -5 psi for a minimum of 30 minutes. If the system leaks, reverse the pump as you did before and go to +5 psi and spray the block with your solution as before. Bubbles locate the leak same as before. See photo.

A while back I had the embarrassing experience of sending a rebuild out only to have a water leak thru the witness passage. Seems the brand new Rotary Seal on a Model 99 Blue head 582 was cracked. I do this test on every engine now.

*Compression Test:* I can't believe the number of customers looking for tech help who haven't done a compression test. If you have a failure or some sort of event, break out your compression tester and note the results. Compression should be 110 to 125 psi but more importantly equal. Readings more than 10% different per cylinder is a dead give away you have a seized piston or stuck ring.



*Photo #8 – A good Compression Tester is one of the quickest ways to spot trouble. This hose type tester comes with a variety of adapters to fit most any engine. Compression should be 110 psi to 125 psi and EQUAL. A 10% or more variation is a sure sign of ring trouble.*

A good compression tester can be had for around \$40. You need the screw-in hose type (CPS Part # 9605) that holds the highest reading. This kit also includes a whole spread of adapters that should cover just about any spark plug hole metric or standard. These hose types are vastly preferable to the "just hold it down hard" type that requires a second person to pull the cord. Just thread it into the spark plug hole and give the recoil 3 hard pulls or 5 seconds on the electric starter.

*Compression Blow-by:* On a four cycle engine worn or leaking rings cause a slight loss of power, oil consumption, exhaust smoke, etc. all conditions that will not cause the engine to stall. On a two stroke engine compression blow-by destroys the pumping cycle of the engine and causes immediate shutdown. Often times the operator will think the event is electrical because it's just like you switched off the ignition. What has really happened is that the rings failed to seal in one cylinder. This can be caused by aluminum from a piston seizure invading the ring groove or in a neglected engine from carbon build-up.

Either way the engine does not have the ability to overcome the lower end being pressurized by the passes combustion gases and shutdown will occur:

*The Self Healing Engine Syndrome:* Often times after the engine has been allowed to cool down the operator will be able to restart and be fooled into thinking the problem is gone. It's Not!! The event will likely happen again and very soon. Your compression tester is the quickest way to verify ring health.

So there you have it. Three quick tests you can perform to either spot trouble or check your work after an overhaul. In the case of the combustion leak test you have to fabricate the plates and gaskets to cover the exhaust opening which takes a little time the first time around. All other parts are off the self out of the catalog. The following is a list of the items you will need for each test. Good Hunting!

*Combustion Leak Test:*

- 2 @ - Cover Plates for Exhaust
- 2 @ - Rubber Gasket for Exhaust port
- 8 @ - 8mm x 20mm Allen Bolt
- 2 @ - #9732 Intake cover Plug – 447-503
- or
- 2 @ - #9734 Intake Cover Plug – 582
- 1 @ - #A3800 Hand Pump and Gauge Kit
- 1 @ - 13/16 Spark Plug Wrench

*Cooling System Leak Test:*

- 4 @ - #9723 Water Outlet Cover
- 1 @ - #860-610 Steam Vent Cap
- 1 @ - #8520 1/8" npt Male Pipe Hose Barb
- 1 @ - #A3800 Hand Pump and Gauge Kit

*Compression Test:*

- 1 @ - #9605 Compression Test Kit
- 1 @ - 13/16" Spark Plug Wrench