

## Automotive Engine Tests “The Basics”

Hani Ali Almubarak

Industrial Training Institute (Sabah Al Salem)

The public Authority for Applied Education and Training, Kuwait

Ahmad Hussain Albloushi

Industrial Training Institute (Shuwaikh)

The public Authority for Applied Education and Training, Kuwait

### ABSTRACT

The aim of using engine tests is to know the information about engine health, performance, and problems if exist. Engine malfunctions can be detected by using the test devices mentioned in the research to find out the problem such as leakages in the engine block or engine head and check, replace or repair the parts if required to get a perfect high engine performance in addition to required horsepower with low emission and low fuel consumption.

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### I. INTRODUCTION

**Compression Test:** It requires a perfect compression to run the engine properly. To find out the conditions in the cylinder block, and cylinder head, technicians can use the compression test to diagnose the internal combustion chamber in the engine. Compression test provides technicians the information of the engine health to determine engine performance and horsepower.

**Cylinder Leakage Test:** The percentage of compression that is lost in the engine can be defined as a leak down. Technician usually needs the required tools and equipment such as gauges and pressurized the cylinder with adequate air to measure how much air is escaping. To determine the percentage of air leakage, technician needs a leak down tester which has two gauges and source of compressed air. On gauge tester measures the cylinder pressure. The other gauge measures the percentage of the pressure lost through leakage, so by having the percentage of the leakage, technician can diagnose the condition of the cylinder.

**Ignition System Test:** The goal of using ignition system is to get a spark that can ignite the mixture of fuel-air inside the cylinder of the engine. If the timing period of that spark is off by a small fraction of a second, the engine will not run efficiently or will not run at all. If not enough

spark, power goes down, and emissions gets worse. It is therefore important to ensure that it is good condition, since even if the car does start and run, neglecting the ignition system may result in poor performance, reduced fuel efficiency and an increase in unpleasant emissions due to unburned fuel.

**Fuel Pump Pressure Test:** By testing the fuel pump, technician will be able to find out the fuel pump runs properly or runs poorly. Measuring the fuel pump pressure and volume are required in fuel pump testing. Sometimes, if the engine runs poorly or not runs at all, it is the result of the fuel pump not delivering the required pressure or volume of the fuel while the engine is running. It is vital to check and examine the fuel pump in all engine running conditions.

### Compression Test

A compression test is performed when symptoms suggests that it might be a poor compression. To check cylinder compression, a compression gauge is used.

Dial face of the typical compression gauge shows the pressure in both units (kPa) and (psi). The vent valve which holds the highest pressure reading on its meter exists most compression gauges.



*Figure 1: Compression gauge*

The data about the engine's top end (valves, pistons, rings, and gaskets) given by the tester.

**NOTE:** To develop correct readings, we need to have:

- 1- Normal operating temperature for the engine.
- 2- Fully charged battery.

**WARNING:** It is important to:

- 1- Wear special gloves when the engine is hot.
- 2- Wear required eye protection when the engine is hot.
- 3- Keep your hands away from moving parts such as fans and belts.
- 4- Protect yourself from electric shock or burns.

**Operation:**

1. To Prevent strange objects from falling into the cylinders, we should use compressed air and clean the area around the spark plugs before removing the spark plugs.
2. Remove all spark plugs from engines with single plug per cylinder. Note the position of the plug wires to be replaced correctly at the end. When working with engines together with (2) spark plugs per cylinder, remove only (1) plug to each cylinder.

3. The throttle linkage in the wide-open position should be blocked.

4. The coil wires from the distributor ignitions must be removed. The connector from the coil pack of the electronic ignitions must be removed.

5. It is required to disable the fuel pump circuit for fuel injected and electric fuel pump vehicles when we take out the fuse of the fuel pump.

6. In the number one spark plug hole, install the compression gauge. You may apply any of the supplied adapters. You can attach & remove the gauge make use of a quick-release chuck. Make sure the installation is safe and close.

7. Watch the gauge after cranking the engine over several compression strokes. In a healthy and strong engine, the compression will be ready quickly. If the piston rings are worn, a low compression on the first stroke followed by a slow and not good build-up of pressure will be observed. Leaky valves, a blown head gasket or cracked head are result if the low compression does not build up. Carbon deposits on the valves can also cause low pressure and mark the highest compression readings.

8. Repeat this process for all cylinders and write on the results.

9. In low compression engine, add approx. 7 grams of motor oil for each cylinder through spark plug hole and then repeat the process. If the

compression increases after adding the oil, worn rings are indicated. If the compression does not increase substantially, the leakage is in the valves or head gasket (or cracked head).



Figure 2: A compression tester

10. If compression is low in two adjacent cylinders, it is most likely that the cylinder head, between them, is leaking. If coolant liquid is found in the combustion chambers / crankcase, this possibility is confirmed.

11. When we noticed that compression of (1) cylinder is 20% slower than the other cylinders, with tough engine idle, it seems that the camshaft has a worn lobe, or the valve is stuck.

12. When the compression is elevated exceeding the engine specifications, it is most probably that the cylinders are carbonized. A qualified mechanic should eliminate the carbon after removing the engine's head.

13. If the compression differs from (over 15%) from the highest compression cylinder to the lowest, or lower than the specification, a professional should check for a leak-down test to identify and fix the problem.

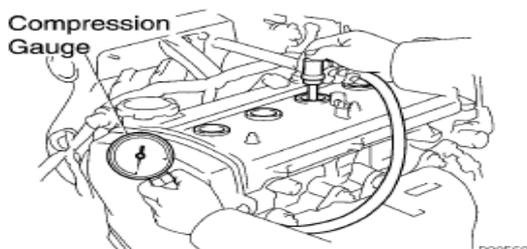


Figure 3: Compression Gauge

3. To locate the source, listen at these locations:
  - A) Oil dipstick tube..... for bad rings, cylinder leakage.
  - B) Radiator filler..... for cylinder wall cracks.
  - C) Adjacent port..... for head gasket leakage.
  - D) Tail pipe..... for exhaust valve leakage.
  - E) Carburetor air horn..... for intake valve leakage.

Add a little engine oil into the cylinder through the spark plug hole, If the cylinder compression in one or more cylinders is low:

- 1- The compression gauge must be inserted into the spark plug hole.
- 2- The compression pressure can be measured when the engine is cranked. Cylinders with low compression by adding oil helps, the chances are that the piston rings and/or cylinder bore are damaged. If pressure remains low, a valve might be sticking, seating is not proper, or there may be leakage past the gasket.
- 3- Re-install spark plugs.

### Cylinder Leakage Test

The test is performed to measure the percentage of compression lost and help locate the source of leakage by applying compressed air to a cylinder through the spark plug hole.

The location of the leak can be found by listening and feeling around different parts of the engine.

### Benefits:

- Indicates problems resulted from “compression check or cylinder balance check”.
- Uses air to ascertain leakage source and the total of leakage measured in a % of loss.
- If equipped with a pressure gauge, the measure monitors inlet pressure to make sure accurate testing.
- Leak down measure measures the ratio of compression leakage.

### How does it Works?

1. The leakage rate can be measured by the gauge when supplying compressed air to every cylinder.
2. Oil dipstick and radiator cap are to be removed and separate one end of the PVC hose. If your engine comes with a carburetor, take out the air filter and open throttle all the way. If fuel injected, take out air filter or throttle body hose to listen.

F) Fuel injection throttle body ..... for intake valve leakage

**Table 1: Cylinder combustion pressure leakage diagnosis chart**

CONDITION	POSSIBLE CAUSE	CORRECTION
Air escapes through throttle body	Intake valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace as necessary
Air escapes through tailpipe	Exhaust valve bent, burnt, or not seated properly	Inspect valve and valve seat. Reface or replace, as necessary. Inspect valve springs. Replace, as necessary.
Air escapes through radiator.	Head gasket leaking or cracked cylinder head or block	Remove cylinder head and inspect. Replace defective part
More than 50% leakage from adjacent cylinders	Head gasket leaking or crack in cylinder head or block between adjacent cylinders	remove cylinder head and inspect. Replace gasket, head, or block as necessary
More than 25% leakage and air escapes through oil filler cap opening only	Stuck or broken piston rings; cracked piston; worn rings and/or cylinder wall.	Inspect for broken rings or piston. Measure ring gap and cylinder diameter, taper, and out-of-round. Replace defective part, as necessary.

**How to Use Tester?**

**WARNING-** Be certain vehicle is not working & hands are clear of the engine section as engine rotation may occur while utilizing this tool:

1. Run engine until it gets normal temperature.
2. Take out the oil measure from engine and radiator cap then disconnect one end of the PVC hose. If you have carburetor engine, remove the air cleaner then open choke away. If fuel go out, try to remove air cleaner, or throttle body hose to check at the throttle body.
3. Remove all spark sockets and position the tested cylinder to approximate top dead center on the compression stroke so both valves are closed. Rotate machine in proper engine rotational direction. Tips to help position the cylinder correctly:
  - a) The ignition rotor points up on compression to cylinder coming.
  - b) Piston is at approximately top dead center when reflector teeth align with stationary core.
  - c) The whistles can be quickly coupled to the cylinder hose of your tester on the compression stroke and stops at approximately TDC.
4. Turn the regulator knob fully counterclockwise then connect the air compressor (45-150 PSI max) to the regulator without the cylinder hose connected. Turn regulator clockwise until percentage gauge reads zero at the yellow band.
5. Screw the cylinder hose into the spark plug hole and connect the coupler plug onto the quick coupler socket of the tester. The gauge will show the

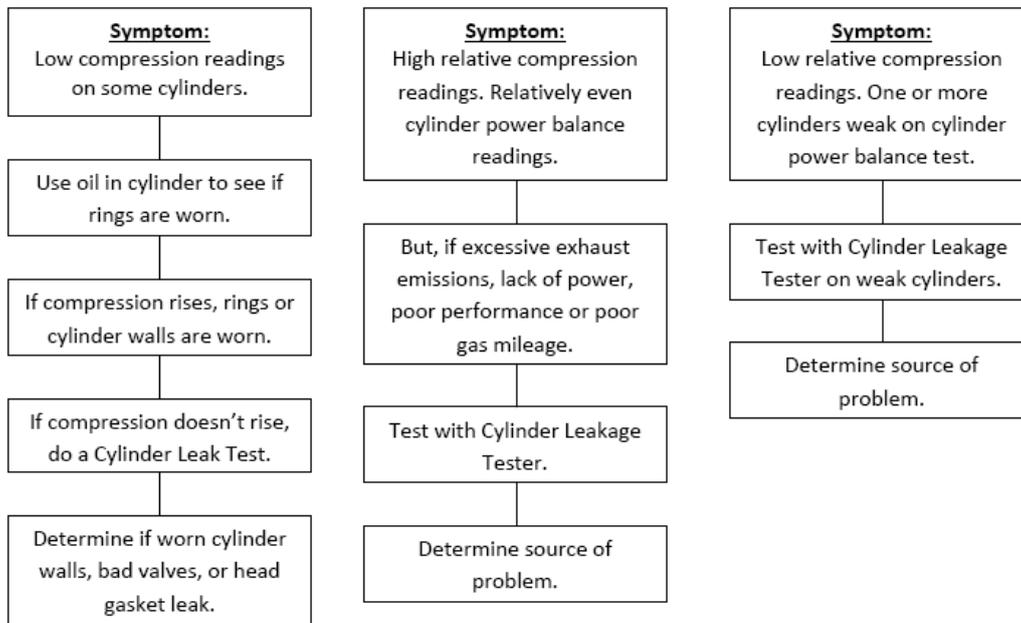
amount of leakage as a percentage loss. Locate the leakage location if it is excessive.

6. Test the other cylinders and compare leakage to determine which cylinders are bad and why.

**Helpful Hints:**

- 1- If the percentage gauge shows a 100% or excessive leakage, the cylinder may not be at TDC on the compression stroke. Make sure the cylinder is correctly positioned to have the valves closed.
- 2- If cylinder rings are broken, walls are scored, and excessive leakage will appear.
- 3- It is important that all cylinders have uniform readings. 15– 30% differences, indicates excessive leaking. Large engines tend to leak more than small ones.
- 4- There will always be leakage past the rings even in a new engine.
- 5- If there is excessive leakage in a vehicle with relatively low mileage, piston rings may be stuck. Tune up the engine’s oil and re-test before disassembling the engine.
- 6- The lower the pitch of the leakage sound, the greater the leakage.
- 7- Readings may vary 10% or more when repeating tests on the same cylinder(s). The piston position and the temperature of the engine can cause the variations.
- 8- If a car has many problems, bad rings and burned valves, the tester may only show the most serious problems.
- 9- Try to position just before TDC, for uniform results.

**Symptom Flowcharts:**



**Ignition System Test**

The ignition system ignites the fuel inside the engine's combustion chamber at the right time in the piston stroke to produce the power while emitting the least of amount for emissions as possible.

All configurations of ignition systems operate on the same principle. Creates a low energy field and collapse it onto a high energy coil so it transfers the electrical energy into the secondary ignition system, i.e., coil wire, distributor cap and rotor (if equipped), plug wires and to the spark plug.

System is triggered by the primary ignition system. It varies depending on manufacturer, but all operate

on the same principle. Uses low voltage trigger system (crankshaft position sensor (CKP) and camshaft position sensor (CAS)).

The low voltage system (1.5 to 3.0 volts) is amplified to 12 volts by an ignition module (amplifier), and then transferred to the primary side of the ignition coil.

The ECM (engine control module) controls the engine ignition timing by advancing and retarding the primary trigger signal. In old cars, a condenser and a vacuum unit perform this job.

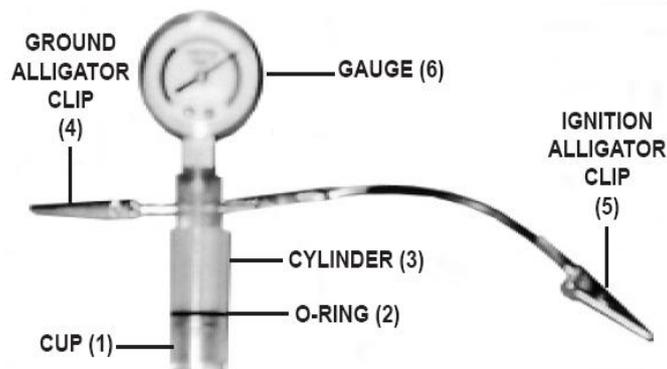


Figure 4: Ignition tester

Part	Description	Part	Description	Qty
1	Cup	4	Ground Alligator Clip	1
2	O-Ring	5	Ignition Alligator Clip	1
3	Cylinder	6	Gauge	1

### Operating instructions:

1. Remove all the engine's spark plugs.
2. Remove the Lower Cup (1) from the Ignition Tester. With a drop of water, wet the O-Ring (2) on the cylinder (3) to make the cup move easier in the cylinder (3) of the tester. Do not use oil, grease, solvents, cleaners, or any other agent as a lubricant so it damages the Ignition Tester.
3. Inserting the Cup (1) into the Cylinder (3), using a twisting/sliding motion to pressurize the Ignition tester. Make sure not to damage the O-Ring (2). Move the Cup up toward Alligator Clips (4, 5) until the Gauge (6) pointer reaches the end of the green band. Do not force the pressure to rise passing the end of the green band.
4. Connect the Ground Alligator Clip (4) to a clean metal engine ground point so the tester does not move when the engine is cranked.
5. Connect the Ignition Alligator Clip (5) to the spark plug wire. Make sure the Clip has firm contact with the metal terminal within the rubber boot of the spark plug wire. Ground the coil wires not being tested to prevent coil damage, for engines with one coil for each cylinder. Make sure the metal ground surface is clean and not of corroded.
6. Crank the engine with its rope or starter, while watching the arc in the cylinder's plastic body (3) of the Ignition tester. If the arc color is BLUE and firing on a timed consistent basis, the engine's ignition system is in proper working order. The arc will occur between the two studs of which the Alligator Clips (4, 5) are attached.

### Troubleshooting

1. If there is no arc, or an interrupted arc, reduce the test pressure with the engine stopped to the middle portion of the green band on the Gauge (6) by applying an outward twisting force to the Cup (1). Then crank the engine again while noting the condition of the arc or lack of arc.
2. Repeat Step 1 in, reducing the test pressure to the lower portion of the green band and into the yellow and red bands, or until the arc generates a constant "timed" spark.

### Diagnosis and correction procedures

1. Refer to the following problems and their solutions, using the color or presence of a spark and the matching color band on the gauge:
  - A. If there is a blue spark and the pressure gauge reads Green: The system is operating normally.
  - B. If there is a yellow spark and the pressure gauge reads Green: The system is operating marginally. Reduce pressure, retest, and clean all connections.

- C. If there is a blue or yellow spark and the pressure gauge reads Yellow: The system is operating marginally. Clean all connections and retest.
  - D. If there is a blue or yellow spark and the pressure gauge reads Red: it is a weak ignition coil.
  - E. If there is an orange or red spark and the pressure gauge reads Green: The connections are dirty and/or corroded. Clean or replace the points and the connections. Check the condenser so it may also be faulty.
  - F. If there is an orange or red spark and the pressure gauge reads Yellow: it is a weak ignition coil.
  - G. If there is an orange or red spark and the pressure gauge reads Red: it is a faulty ignition coil and/or condenser.
  - H. If there is no spark, but the arc color is Green: Reduce test pressure to "yellow" range and repeat test.
  - I. If there is no spark, but the arc color is Yellow: Replace the points and condenser. Then retest for proper coil operation.
  - J. If there is no spark, but the arc color is Red: it is a faulty ignition coil. Replace or service the coil.
2. If the engine has one coil for each engine cylinder, repeat Steps 3 through 6 in the "Operating Instructions" section for each cylinder, making sure the coils that are not being tested, have their spark plug wires grounded.
  3. If the engine is equipped with a "sealed" solid state ignition system and all external connections are clean and secure and the solid-state module should be replaced.

### Fuel Pump Pressure Test

The vacuum gauge is also a valuable tool in troubleshooting of a Fuel Pump Pressure. The fuel pump pressure will determine the ability of the pump to deliver fuel to the carburetor. This test can also be used to check the fuel system's ability to draw fuel from the tank to fuel pump supply lines. Most fuel pumps are rated at engine idle speed. It is better to connect all fuel and ignition lines If the engine will run. Start the engine and allow the car to run to fill the carburetor float bowl. Shut off the engine and proceed to the following steps:

**WARNING:** Fuel vapors are extremely flammable. Keep any heat sources, sparks, and open flames away from the engine when performing a fuel pump pressure test. No smoking while working on your car, as gasoline vapor is extremely flammable.

1. Disconnect the fuel supply line from the carburetor.

2. Connect the hose from the gauge to the fuel supply line, using appropriate adapter(s).
3. Start the engine at idle for a minimum of 10 seconds, observe the pressure reading on the gauge. If the fuel pumps pressure is within the manufacturer's specifications, it indicates a good fuel pump. If the pressure is lower than the manufacturer's specifications, the fuel line may be Restricted, or the pump may be weak or defective. Check Fuel Pump for internal leaks.
4. After performing the Fuel Pump Test, quickly shut off the engine.
5. Continue observing the reading for 20 seconds. If the reading is maintained within the manufacturer's specifications for the 20 seconds, the pump and the integrity of the fuel lines are good. If the pressure drops below specifications, the fuel pump's check valve may be leaking or there may be a leak in the fuel lines.

## II. CONCLUSION

**Compression Test:** It requires a perfect compression to run the engine properly. To find out the conditions in the engine block, and engine head, technicians can use the compression test to diagnose the internal combustion chamber in the engine. Compression test provides technicians the information of the engine health to determine engine performance and horsepower.

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