Compression Testing and Cylinder Leakage

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Aim of the Project

The aim of the project is to demonstrate the importance of compression in an engine and the ways in which to test for compression and possible points of compression leakage.

Background

Internal combustion engines need 3 things to run correctly; Spark, Fuel and Compression. Without any one of these 3 things, the engine will not run properly or at all.

For this project, we will focus solely on compression and testing for it. Compression is the result of the upwards force of the piston in the cylinder with the intake and exhaust valves closed. The piston rings ensure tight seals are formed around the outside of the piston and allow for maximum compression. The compression along with the spark and atomized fuel mixture results in the fuel burning and allows the engine to move onto its power stroke.

It is imperative for the engine internals to be in good condition, as carbon build-up, wall scoring or excess wear from contaminated oil can cause damage to the seals of the valves, bearings and cylinder walls and cause the compression to drop.

Compression testing: is a simple, generally quick task and provides a relatively clear view of the health of the engine. Compression ratings will change from engine to engine due to different compression ratios, but as a rule, a reading over 120 psi is acceptable and near or over 150 psi is generally a healthy engine. The variation in compression between each cylinder should not be greater than 10%.

A Cylinder leakage test is used to identify possible compression leaks using high pressure air and listening for whistles or gusts in the engine. With a piston at Top Dead Center (TDC), high pressure air is forced into the cylinder. A technician will then listen for any signs of air escaping from the cylinder head, intake or exhaust ports or from the crankcase.

Procedure for Testing Compression

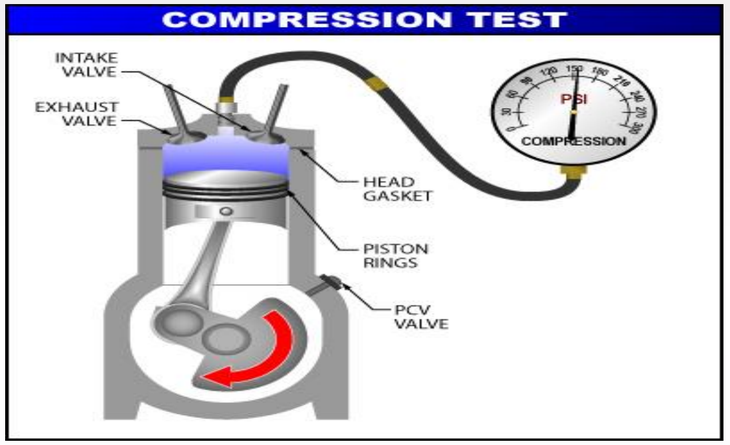

Figure 1: Compression Testing (eEurcarparts.com)

If an engine is performing poorly, it may be suspected there is a loss in compression.

Testing compression is outlined below:

1. Remove the fuse for the fuel pump, then start and run the engine until it runs out of fuel.
2. Once it is out of fuel, unplug the coils and remove the spark plugs from each cylinder.
3. In place of the spark plugs, thread in a compression tester gauge into the cylinder head and crank the engine for 5s.
4. Repeat this for all cylinders, until all readings are obtained.

If the engine appears healthy, and the compression figures lie within the manufacturers suggested range on autodata, the spark plugs can be threaded back in, and the engine can be reassembled as the problem more than likely lies elsewhere. If the compression is low, a technician may move onto a leak-down test to identify the possible fault.

Cylinder	Reading (Bar)
1	11.2
2	12.2
3	12.1
4	13

Figure 2: Compression readings from a test we carried out in the TUS Workshop.

Figure 2 shows readings obtained from a compression test on a Toyota 4g-fe engine carried out in the TUS workshop. Cylinder 4 had very high compression, which may be due to excess carbon or more serious internal issues. Auto data states readings should be between 9.8 and 12.8 bar for this engine

Procedure for Testing Cylinder Leakage

If compression tests are poor, a cylinder leak-down test may be performed. This test involves pushing high pressure air into the engine instead of the engine pushing air into the gauge. Air takes the path of least resistance and will find a gap in a seemingly sealed area. For this reason, it is very effective at diagnosing faults within the cylinder in areas that have not sealed completely

To test for leaks in a leak-down test, an engine must be:

1. Rotated to top dead centre on a compression stroke and then fixed in place.
2. Once locked, high pressure air is fed through the “test” port of the leak-down tester. This allows for a controlled release of air and allows a technician to listen for leaks.

As the air is forced into the cylinder, it will try to force its way past the piston rings, and past the intake/exhaust valves. Once it finds its path, it will gush out and produce an audible sound that will let a technician know where the faults may lie. Worn piston rings will produce a sound from the crankcase, audible with the oil cap removed. Faults in the valves will produce a gushing sound in either the intake or the exhaust ports or both.

Figure 4 show the results of a cylinder leak down test carried out on a VW 1.9 PD. This engine performed very poorly. It was losing air from the piston rings and both valves.

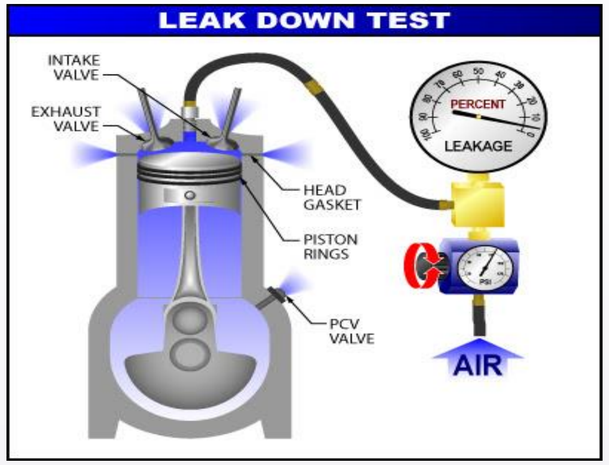

Figure 3: Leak Down Test.

Figure 4: Cylinder leak-down test carried out in the TUS Workshop

Conclusion

In conclusion, compression tests and leak-down tests when used alongside a borescope, a small handheld camera that can be fed through the spark plug threads, can be very useful for identifying possible issues within a vehicle's engine. If a vehicle comes in with a dead misfire on a specific cylinder while all other cylinders are performing well, a compression test may be carried out and then a leak-down test afterwards. The leak-down test will help confirm a diagnosis. For example, a dropped valve would have excess air coming through a particular port be it intake or exhaust and a melted or otherwise destroyed piston would result in air coming through the crankcase. An inspection with a borescope should then result in a quick, correct diagnosis of an internal fault.

References

Pictures not taken by us (Figures 1 and 4), were obtained from the following sources :WCEngineering.com eEurocarparts.com. Compression Ratings for the Toyota 4G-FE engine were obtained from Autodata.