

# TUNING HONDA ENGINES

## AIRFLOW & CYLINDER HEAD MODIFICATION WITH CPL RACING

**T**o date, in our technical articles, we have looked at evaluating performance, engine management systems and the difference between tuning and optimization. Now we are going to look further at optimization through cylinder head modification.

In issue 3, we looked briefly on the fact that improved airflow into the combustion chamber will aid volumetric efficiency, and that this ultimately results in more power and torque. Although standard Honda cylinder heads are very good straight from the factory, for those in search of a good overall performing package, these can certainly be improved upon. There are no quick fix tips for improving the flow and velocity, so it is essential that these improvements be carried out with the aid of a flow-bench to verify the results.

### THE FLOW BENCH

For those that have not come across a flow-bench before, here is a brief explanation of how they work, and a picture of one of these machines can be seen in figure 1.

A flow-bench is a machine which has a very powerful fan, strong enough to simulate the pistons' sucking and pushing action during intake and exhaust strokes. On top of the flow-bench sits a circular adaptor which should be the same diameter as the bore that the cylinder head will be used on.

With the valves installed, the head is fitted to the bore adaptor. If testing the inlet ports, the inlet valves are opened at increments until the maximum valve lift of the intended camshaft is reached. At each increment of valve

lift, airflow and velocity readings are taken. The same operation is also undertaken to the exhaust ports - the only difference being that the flow-bench is set to blow instead of suck, in order to simulate the pushing action of the piston as opposed to the sucking on the inlet side. With airflow readings taken, the ports can be modified and then re-tested to ensure the desired results are achieved.

### CYLINDER HEAD MODIFICATION

One of the reasons that gains in airflow and velocity are possible is that a mass-produced cylinder-head has limitations in the shapes that can be achieved. Additionally casting flash and such like are present in mass produced castings. Figure 2 shows porting underway.

It is important to point out that a polished finish on the ports does very little or nothing to improve airflow - it is the SHAPE and SIZE of the ports that is important. A correctly shaped, smooth finish port, with 60-80 grit abrasives, will give the desired result and there is absolutely no point in spending time polishing the ports any further once this has been achieved.



### VALVE GUIDES

The valve guides' primary job is to support the valve as it reciprocates on and off of the valve seat. It goes without saying that a good quality guide should always be used in a performance head. Airflow can be improved by tapering the inlet guide and radiusing the exhaust guide in the correct way. Also in a race head, valve guides can be flushed with the roof of the



ports, however this does reduce the support provided by the guide due to its shorter length. Factory cylinder heads use a cast iron material for the manufacture of their valve guides, this is because they are intended for use over a large service life (usually over 100,000 miles) however using different materials with better self-lubricating qualities and different expansion rates can allow the use of closer valve to guide tolerances which will bring the valve back squarer onto the valve seat when the valve closes, and thus allow engine to be revved to a higher level. Figure 3 shows an example of three valve guides made from different materials (Iron, Phosphor Bronze & Colsibro).

### VALVE SEATS

Re-profiling the valve seats can also improve airflow. Generally, the Honda heads leave the factory with three angles cut into the valve seats, additional angles can be cut to improve airflow or even a full radius can be machined into the seats. Most of the time a cutter is made with the desired profile or angles. This is then used to produce the profile onto the valve seat. Alternatively the 'Rolls Royce' method of re-profiling valve seats is the single point CNC type valve seat cutters which are able to profile multi angle/multi radius shapes into the seat without restrictions.

Time spent on the flow-bench is the only way to arrive at the best flowing valve seat profile.

### VALVES

In reality, the factory Honda valves can be used in many setup combinations, excluding all out race engines.

There are, however, a number of reasons to replace your factory valves with aftermarket valves.

These are:

- Larger diameter to increase airflow mostly in very high revving engines
- Improved valve profile to increase airflow
- Different materials for more durability where more heat is being produced - typically stainless steel, Inconel or titanium.

### CAMSHAFT PROFILE

The purpose of the camshaft can be broken into two main areas:

1. To lift the valve off the seat to the desired height
2. To open and close the valve at the optimum times so that as much of the improved airflow through the cylinder head casting can be trapped in the cylinder during the combustion stroke, thus creating as much cylinder pressure as possible.

Choosing a suitable camshaft profile in conjunction with having your cylinder head modified is extremely important. In short, there is no point in having the cylinder head ported to flow with 12mm of valve lift when the camshaft only provides 11mm of lift. (This is purely an example - there are many other considerations and variables when selecting a cam profile, but you get the idea).

Camshafts are often considered in the same vein as other "bolt-on" parts, as the next best thing to upgrade once the usual cat-back, exhaust manifold, air intake etc. have been upgraded, but most performance enthusiasts would not have access to the correct data or measuring equipment to select suitable camshafts for their setup, so this is best left to an expert to calculate for you. It is important to note that fitting the wrong camshafts can actually result in the car losing power, and can be a costly mistake.

*In the next edition of Total Honda we will be looking at geometry and chassis setup.*

CPL Racing has been working with Total Honda Magazine since its launch to bring readers a valuable insight to tuning Honda engines.

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