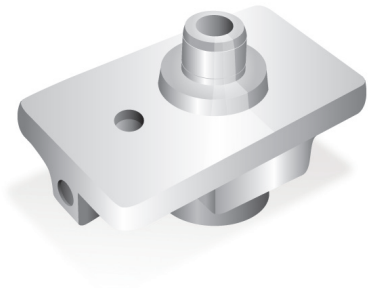
Application note A127: Cylinder head – fuel injection pump

TalyMaster

Cylinder Head – Fuel Injection Pump

Greg Roper, Applications Engineer



Customer requirements

This manufacturer in recent years has been supplying an increasing number of fuel injector pumps, as more car manufacturers use purchased pumps instead of designing and building their own. Inspections of the cylinder heads are currently completed by different instruments to quantify roundness, concentricity, seat angle and seat form.

With production numbers running far in excess of 300,000 and different fixtures having to be used to measure the same part, a new technique is required to measure all these features with one instrument and fewer fixtures, to specifically reduce time and manual effort and to increase throughput.

Background – how does a fuel injection pump work?

In order for an injection action to occur, a build-up of pressure is required. In the Common Rail Accumulator Injection system, the actual build-up of injection pressure is separate from the injection action itself. Pressure is generated in the Rail (also known as an accumulator) from a high pressure pump. This high-pressure pump is driven by the crankshaft of the engine and supplies fuel to the rail at 1,600 bar, even at low engine speeds. The high pressure produces a very fine atomisation of the fuel leading to better and cleaner combustion. As the rail is pressured all the time, the fuel supply can be optimised independently to each injector. The time and duration of fuel injection is controlled by the ECU and can be controlled precisely to optimise combustion and emissions.

Benefits of the common rail principle compared with conventional diesel engines are lower engine noise levels, stronger performance and greater efficiency leading to lower emissions and enhanced fuel economy.

Because of the high pressures involved in this mechanism the sealing faces of the pump are critical in terms of form, angle and surface finish and require tight control.

The solution – TalyMaster

Talymaster is a brand new inspection concept combining roughness, roundness and contour on a fully automated inspection system. The instrument incorporates complete part manipulation ensuring high throughput and significantly reduced inspection costs compared to the traditional inspection methods.

The cylinder heads were mounted on a magnetic plate (dedicated fixtures would be required in a production environment) and under program control roundness, concentricity, straightness, parallelism and seat angle were measured and quantified. Only four cylinder heads were supplied, though more components can be fixtured if required.

A critical feature on the cylinder heads is to be able to migrate from one hole to another without removing the part. Using the TalyMaster XY stage it is now possible to mount several components at one time, measure all features on each part as well as compute the distance between features.

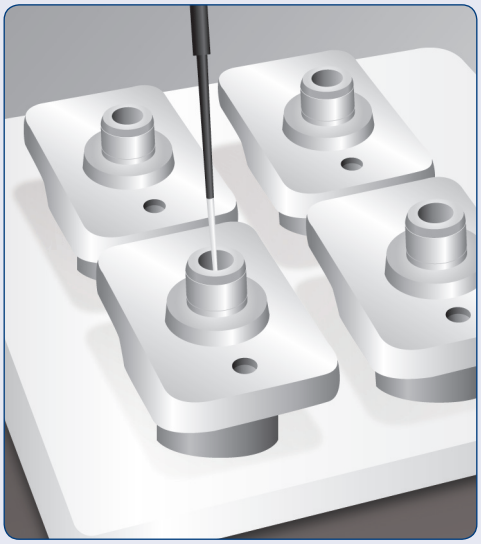


Figure 1: Several components can be mounted at one time

In a production environment a simplified user interface would be used, utilising simple drop-down menus allowing the operator to select the required measurement operation, number of parts and their individual locations on the pallet. Additionally, the interface also supports the ability to identify machine ID for SPC export. Specific to this application is the use of arcuate correction on the Talyrond gauge – Please see Technical Note T125 for further details of arcuate correction.

Measurement capability normally associated with the Form Talysurf such as seat angle, seat surface finish and seat straightness can now be evaluated. These measurements can be performed with respect to the datum axis of the part and therefore are more functional.

The calibration artifact, separate to the main fixture is located outside the XY measurement area preventing interference with fixture design and can be called upon at any time under program control. Although best practice is to calibrate at the beginning of every shift, this arcuate calibration has been shown to be extremely stable.

Once the measurements have been completed, Ultra can automatically export the results into Talymap Contour and automatically apply a template to complete the analysis. Using Talymap Contour it is possible to calculate seat angle and form – surface finish can also be added to the template if required. If a number of different analyses are required Talymap will simply open more Tabs so the end user can evaluate individual results after all analyses are complete.

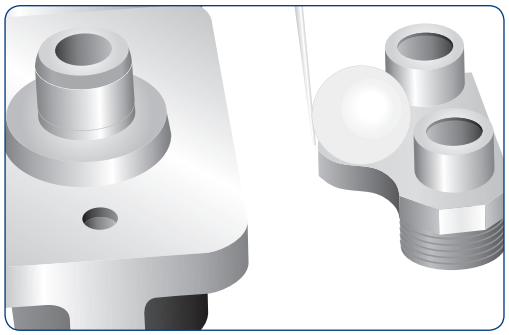


Figure 2 Arcuate correction on the Talyrond

Figure 3 Ultra imports directly into TalyMap Contour

Efficiency & throughput

Inspection normally consists of utilising two instruments for both roundness, surface finish/form and seat angle, typical inspection times would be approximately fifteen minutes for roundness/form for both holes (two fixtures positions required and two centre and levelling procedures need to be completed, four minutes for surface finish and seat angle/form, giving a total of nineteen minutes for the complete cylinder head.

A reduction in the number of instruments and the simplified measurement technique means that a less skilled operator can now run the instrument. Using the spreadsheet to the right, the total savings can be calculated and used as an effective method of communicating the value of the TalyMaster product. This application is showing an increased inspection throughput of 53%.

Table 1: Measurement requirements: roundness, straightness, parallelism, seat angle and form

	TalyMaster	Roundness and surface finish
Part measurement time (mins)	9	19
Parts / shift	100	100
Attendance time per shift (hours)	0.15	31.7
No of shifts	2	2
Attendance time in year (hours)	110	23116.7
Cost per hour	40	40
Days per year	365	365
New productivity days	2876	
Total saving per annum	$920,287	
Over 10 years	$9,202,867	
Increased inspection throughput	53%	

Taylor Hobson UK
(Global Headquarters)
PO Box 36, 2 New Star Road
Leicester, LE4 9JD, England
Tel: +44 116 276 3771
taylor-hobson.sales@ametek.com

Taylor Hobson France
Tel: +33 130 68 89 30
taylor-hobson.france@ametek.com

Taylor Hobson Germany
Tel: +49 611 973040
taylor-hobson.germany@ametek.com

Taylor Hobson India
Tel: +91 80 67823200
taylor-hobson.india@ametek.com

Taylor Hobson Italy
Tel: +39 02 946 93401
taylor-hobson.italy@ametek.com

Taylor Hobson Japan
Tel: +81 36809 2406
taylor-hobson.japan@ametek.com

Taylor Hobson Korea
Tel: +82 31 888 5255
taylor-hobson.korea@ametek.com

Taylor Hobson China Beijing Office
Tel: +86 10 8526 2111
taylor-hobson.beijing@ametek.com

Taylor Hobson China Shanghai Office
Tel: +86 21 58685111-110
taylor-hobson.shanghai@ametek.com

Taylor Hobson Singapore
Tel: +65 6484 2388 Ext 120
taylor-hobson.singapore@ametek.com

Taylor Hobson USA
Tel: +1 630 621 3099
taylor-hobson.usa@ametek.com