Super-abrasive bore finishing

Cycle times halved and tight-tolerance repeatability achieved when machining turbocharger housings

Cummins Turbo Technologies Ltd, which has an outstanding track record in the automotive sector, recently installed a single-pass four-spindle super-abrasive bore-finishing machine to help it halve cycle times and achieve repeatability on the critical tolerances of two types of turbocharger bearing housings.

The company's Huddersfield facility is its world-wide technical centre and its European base for the production of turbochargers. Around 1,000 people at this site help to design and manufacture the full range of Cummins' renowned Holset turbochargers and related components. These are supplied to various' sister plants around the world, to be fitted to the ever-increasing number of medium- and heavy-duty diesel engines.

Essentially, the turbochargers manufactured at Huddersfield are split into four product groups: mid-range; heavy-duty; high-horsepower; and variable-geometry types. To further enhance bore-finishing operations (while maintaining very strict tolerances) on its turbocharger bearing housings, the company considered acquiring a replacement for its conventional reciprocal honing machine which, though still reliable, was nearing the end of its useful life.

Taking up the story, operations engineer Howard Earnshaw says: "We actually looked at replacing this machine a while ago, and we made an enquiry for an Engis machine, because we knew it was based on single-pass technology. Single-pass bore finishing appeared both simpler and faster than conventional reciprocal honing and was therefore of great interest to us. We sent some bearing housings to Engis for bore finishing, and the results were 'spot on'. However, the project had to be postponed due to funding restraints."

Project revival

With the recent upturn in the automotive industry, the project was revived, and Mr Earnshaw insisted once more that single-pass bore-finishing technology should be considered. "We looked at three machines, but the Engis machine was more robust than its rivals, and we found the Engis team to be extremely responsive to our needs, which proved to be a major influence in our decision to buy the company's SPM model."

The SPM bore-finishing machine supplied to Cummins Turbo Technologies by Engis (UK) Ltd, Henley-on-Thames (Tel: 01491 411117 – www.engis.com), features four spindles and a six-station rotary index table that accommodates quick-change fixtures for different types of turbocharger bearing housings. It uses three single-pass diamond tools to finish the bores; the fourth spindle is fitted with an abrasive brush to remove any shards or metal residue.

Manufactured from grey cast iron, bearing housings are a vital turbocharger component. They provide locations for a fully floating bearing system for the shaft, turbine and compressor, which can rotate at up to 170,000rev/min. CNC machinery mills, turns, drills and taps housing faces and connections, after which the bores are finish-honed to meet stringent roundness, straightness and surface finish specifications.

Installed at Huddersfield in late 2009, the Engis SPM was subject to a strict testing programme that involved mounting the bearing housings it had processed on actual 'engine beds', to ensure that the new machine had not affected their performance. With these tests successfully completed, the machine entered production at the start of 2010.

"The bore that we hone is not a straightforward through-bore; it features two pods, and the parallelism tolerance between the bores honed in each pod is extremely tight. However, the Engis SPM is very adept at meeting these requirements in a repeatable and reliable manner."

Bore roundness also features a critical tolerance, while bore surface finish is a further strict requirement. All of these production challenges are now described as "no problem whatsoever", using the Engis machine.

The four spindles of the machine are tooled to produce a sequence of: rough; semi-rough; brush; and finish. Programming the machine's Mitsubishi CNC is extremely simple, and all spindles come down simultaneously, with the table indexing one station at the completion of each cycle.

"As a result, a completed component emerges every 60 seconds," says Mr Earnshaw. "Using our previous reciprocal machine the cycle time was in excess of 2min. While quality was our prime concern, halving the cycle time helped justify the capital expenditure, as it means we can achieve a quick return on our investment."

Engis SPM-series machines are designed specifically with small to medium-size parts in mind — primarily, parts with internal diameters of 50mm and smaller. Machines are available with 4, 6, 8, and 10 spindles; a stroke of 457mm is standard, although extended-stroke options are available.

Quick adjustment

Running over two shifts, the machine at Cummins has been set up to finish the bores on two types of turbocharger bearing housings. Because quality is so important, each component is subject to 100% inspection for final sizing. In the event of any process drift, tooling can be adjusted quickly and easily, although this is rare.

"The operators are extremely happy with the new machine. Compared with our previous model, it is far easier for them to use and requires very little adjustment — plus it uses coolant instead of honing oil.

Furthermore, while Engis originally suggested that we should get around 10,000 parts out of the tooling, we have currently machined over 23,000 with the same set of tooling — and it is still in use."

Crankshaft specialist goes from strength to strength

Nash Sharma, managing director of Allens Crankshafts, bought the company in 1981 and moved it to Wolverhampton 10 years ago. His subsequently won a contract to produce crankshafts for Rolls-Royce Motor Cars and the MoD — "for the six-year duration of the contract, we never had a crank set returned" — and the company has gone from strength to strength since then.

It continues to work for the MoD, and it now produces compressor cranks for companies like Gardner Denver and RAM Pumps. It is also the sole supplier of crankshafts to Engine Developments (for Judd engines), and it provides high-performance cranks for motor-sport applications, including the Honda K20 engine.

The company's involvement with Mori Seiki UK (www.moriseiki.co.uk) began with the purchase of an MT-series machine for heavy-duty milling and turning. As demand grew and extra capacity was needed, it bought a mill-turn centre from a different supplier, but that machine proved to be unsuitable for crankshaft manufacture.

Mr Sharma says: "It was not solid enough for the production of cranks, so we sold it after two years and invested in a Mori Seiki NT4250 1500S. The difference is considerable: the NT4250 weighs 24 tonnes — compared with 11 tonnes for the machine it replaced — and it produces parts 33% faster." The NT4250's BMT (Built-in Motor Turret) and ORC (Octagonal Ram Construction) enable it to achieve metal removal rates of around 1.024 litres per min — impressive

for a mill-turn centre. "We have a 100-station tool changer on our NT, and we use the best-quality tools with through-coolant at 70 bar. Tool life is now 100% better than we achieved on the old machine."

Machining times can vary between 2 and 5hr, depending on the design of the crankshaft; six-cylinder cranks typically take 4.5hr. Using the NT4250, Allens Crankshafts can produce a complete part in one operation, starting from a solid billet of EN40B. Journal diameters are left at +0.5mm; the part subsequently undergoes dynamic balancing, nitriding, finish grinding and final balancing.

"The Mori Seiki produces very consistent cranks, which are completely concentric and hardly need any balancing. If I produced a part now and then another a year later, they would both be exactly the same weight, giving us excellent repeatability."