Threading efficiency for Forth Tool & Valve

Application of the Horn thread milling system has resulted in significant manufacturing economies for Glenrothes-based Forth Tool & Valve Ltd. The tooling cuts threads by circular interpolation of a milling cutter, which is ground to the required thread form. It has eliminated a recurrent problem with thread quality on larger diameter tapped threads (from 0.750 inches/M20 upwards). This had occasionally necessitated that threads be finished by hand, rather than on the machine tool. Using Horn, cycle time is more predictable while quality and thread form accuracy is virtually guaranteed.

Multi Faceted

Forth Tool & Valve is a multi-faceted company whose facilities include one of the UK's leading medium to large capacity subcontract machine shops. This has an established pedigree within the oil and gas industry supply sector, though the company also takes on defence, aerospace and general machining work. Component size may be up to 20 tons, while batch quantities rarely exceed five.

David Reekie, the company's operations director, comments. "Our reputation is based on being able to handle high value added machining of complex components. We do a lot of 'Christmas tree' valve work for oil industry clients, as well as engine casings, pump bodies and so on. Tolerances are tight in terms of both dimensions and finish and are applicable to every aspect of the job."

He continued. "We have a need to produce threads from 2 mm to 200 mm diameter in materials from mild steel to exotic alloys. Historically we had relied on either tapping or – for larger diameters – use of a facing head to cut the threads. Both methods can give rise to quality problems. Depending on the quality of the tap it is possible to damage the thread on withdrawal, and we have also encountered tap breakage. Likewise, when using a facing head, restrictions on cutting speed can lead to chatter and poor finish while set-up time is lengthy."

Because tapping is usually carried out at an advanced stage of a lengthy machining process – up to 700 hours in some cases – any problem can cause major disruption to delivery schedules. At its most serious, if repair or rework is not possible it could lead to a high value component being scrapped. The exposure to risk is compounded by the number of threads needing to be machined; a single block valve body may require up to 140 tapped holes.

"It was apparent that a capable, reliable threading process would save us considerable time and cost," said Mr Reekie. "Thread milling appeared to provide the answer but previous trials with both solid carbide and indexable insert tooling had proved inconclusive. Solid carbide tools were easily chipped or broken and expensive to replace, while inserted tools had not performed well."

A series of trials was initiated, overseen by Derek Bence, Forth Tool & Valve's CAM manager. In this instance the Horn thread milling system was under test, using tooling provided by Horn's Scottish distributor, Peter Campbell (Sales), with initial technical assistance from Horn UK.

"We set up a series of 'worst case' trials to see how the Horn tooling would perform." Mr Bence reports. "We used one of our older horizontal borers which has a maximum spindle speed of 3000 revs/min and operated at a ram extension of around 0.9 metres. The tool was used to produce UNC threads of 0.75 inch, 1.125 inch and 2 inch diameter in carbon steel in a single pass. If we achieved an acceptable result then we anticipated no problem applying the tooling elsewhere."

He continued. "We achieved a perfect thread on all of the tests, as a result of which we began to introduce the Horn system to the shop on a selective basis. As replacement of tapping with thread milling demands modification to the CNC program we have prioritised based on the programming workload and availability of existing tooling"

At Forth Tool & Valve the most used carbide grade is Horn TN35, a TiN coated grade particularly suitable for thread cutting at lower speeds in unfavourable conditions; other specialist grades are available if needed.

Horn offers a variety of thread milling insert types combined with a variety of carbide grades. Triple tooth Horn type 306, 308, 311, 313 and 328 inserts are used, ground for 55 degree and 60 degree pitch angle. These are used with high rigidity Horn toolholders (with facilities for through-coolant) to provide stable cutting conditions.

"There is much more scope for optimizing cutting conditions with thread milling than with tapping." Mr Bence remarked. "This is extremely useful when we are processing clad materials as the speed can be adjusted as the tool passes through the clad layer. Overall the process has much to recommend it. Another area where it scores is on tapping to depth in blind holes. Final tapping to depth was sometimes left to the fitting shop but we have sufficient confidence in the Horn tooling to complete all threading operations on the CNC machines."

Compared with the cost and maintenance requirements of dedicated taps the Horn tooling is significantly more economic. Moreover the toolholder shanks used for thread milling can also be applied to general groove milling tasks.

Forth Tool & Valve's experience is that insert life is highly satisfactory with the added advantage that a worn insert is much easier to detect than a worn tap. On a super duplex valve body, for instance, where 16 holes of 1.25 inch diameter require tapping, a single insert suffices for each body. In practice Forth Tool & Valve adopts a two stage thread milling process in which the first pass semi - finishes to a 0.005 inch allowance, followed by a finishing pass. The finishing insert is used for semi-finishing the next component.

In terms of cycle time, thread milling is slightly slower than tapping on some materials, though on tougher materials such as Inconels the times are similar. Thread milling has also supplanted use of facing heads on some of the larger diameter threads where the improved rigidity and faster set-up of the Horn system confers a decisive advantage.

Mr Reekie concluded "We've definitely achieved the quality improvement that we hoped for. It has helped us tremendously and all but eliminated the need for rework on tapped holes."