

Potentially outsourced work stays in house – at a greater profit

Twelve-tooth groove milling tool bites 19 hours off cycle time in Inconel®

BAY CITY, Mich., June 2014 – You know you have a problem workpiece on your hands when your outsourcing vendors turn down the work. Inconel® parts do that. As a result, Cambron Engineering's already full backlog now overflowed, creating strong company interest in cycle time reduction for a particularly vexing feature on the parts. A chance encounter with Horn Application Engineer Brett Kischnick satisfied that interest with a new tooling approach that cut cycle time from 59 sec. to 10 sec. for the feature, taking 19 hours out of the part's 80 hours total machining time.

The two parts are Inconel® 600 (nickel, chromium, iron) plate, about eight feet in diameter and 1.875" (47.63 mm) thick, to be used as tube sheets in a shell-and-tube heat exchanger, an ideal application for this strong, heat/corrosion resistant material. Each disc must be drilled through with 1400 1.5" (38.1 mm) diameter holes, each with two 0.126" (3.2 mm) wide



Bryon Christilaw (R), Tool Engineer for Cambron Engineering, monitors the work of new Horn USA 12-flute groove milling cutters with company representative Brett Kischnick.



Milling the two tiny grooves inside each bore consumed 25 percent of the part's total cycle time when using a 3-flute cutter, Cambron's original approach.

x 0.015" (0.38 mm) deep grooves milled into the circumference of each bore. It's a touchy and tough piece of work with the material alone worth about \$60,000 (USD), according to Cambron Tool Engineer Bryon Christilaw, but it's well within Cambron's capability. The Bay City, Michigan, company is a go-to supplier for nine GM plants, offering a climate-controlled 33,000 sq ft (3065 m²) shop and 47-person staff capable of design and manufacture of gages, dies, tooling, fixtures, and special machinery, as well as CNC machining of large fabrications.

"These parts come through several times a year, and on one occasion with our backlog already high, we needed to outsource the work," said Christilaw. "The material and features proved a major problem, however, and no one wanted to touch it."

Cambron machines these parts on a 25 hp (18.6 kW) Kuraki boring mill, and the interpolated grooving cuts were particularly difficult. "We were using a 3-flute, 0.125" (3.18 mm) wide groove milling insert that was 0.697" (17.7 mm) in diameter," explained Christilaw. Running at 750 rpm and 9 IPM (228 mm/min) feedrate with 0.004" (0.10 mm) per tooth engagement, each groove took about 30 seconds – consuming 19 hours of the part's 80-hour machining time. "This didn't include the operator's time for in-process measurements, cutter compensation and insert changes," he added.

Do sweat the small stuff

A part this size and configuration naturally attracts attention when fixtured up, so Horn Application Engineer Brett Kischnick – visiting the shop to handle questions about lathe grooving – asked the operator about it and learned about the tool life and cycle time issues. He later proposed a solution with a Horn 713 12-flute groove milling insert, 0.854" (21.7 mm) in diameter and 0.118" (3 mm) wide. The small differences prove what a game-of-inches machining can be, because the new insert reduced cycle time for each groove from 30 seconds to five seconds.

Here's how: The larger tool diameter – just 0.157" (4 mm) larger – reduces the length per cut from 1.830" (46 mm) to 1.337" (34 mm), about 27 percent. Increasing the number of cutter teeth from 3 to 12 allows a 400 percent increase in feedrate from 9 IPM to 36 IPM (228 mm/min to 914 mm/min), while maintaining the same 0.004" (0.10 mm) per tooth engagement.

In addition, the smaller width of the 12-tooth 0.118" (3 mm) tool versus the 0.125" (3.18 mm) tool leaves 0.008" (0.20 mm) material for the second pass on each groove. This produces a larger chip to minimize heat buildup in the tool, which is amplified when trying to "rub off" 0.001" (0.025 mm). "It is important to have enough stock to produce a good chip to carry the heat away," explained Kischnick. "Otherwise, the tool will absorb more cutting heat. The cooler the tool, the longer it stays sharp." In fact, the 12-tooth tool lasts nearly three times as long as the 3-tooth tool: 45 minutes vs. 18.

The 713 12-tooth milling cutters produce a very smooth cut. They are designed for grooves up to 0.185" (4.7 mm) deep and 0.039" to 0.118" (1 mm to 3 mm) wide in holes as small as 0.886" (22.5 mm) diameter. The interchangeable carbide inserts are secured to the front face of a standard carbide shank with a single screw, and utilize straight or staggered cutting edges, depending on the width.

"These tiny grooves had always taken a big chunk of the total cycle time, but this new tool cuts that down to a proportion that's more in line with their size," added Christilaw. "Anytime you can cut twenty-five percent off the cycle time for a part by simply going to a different style tool, it's a real game changer."



Horn USA's 12-flute 713 milling cutter reduced the cycle time for each groove from 30 seconds to five seconds.

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