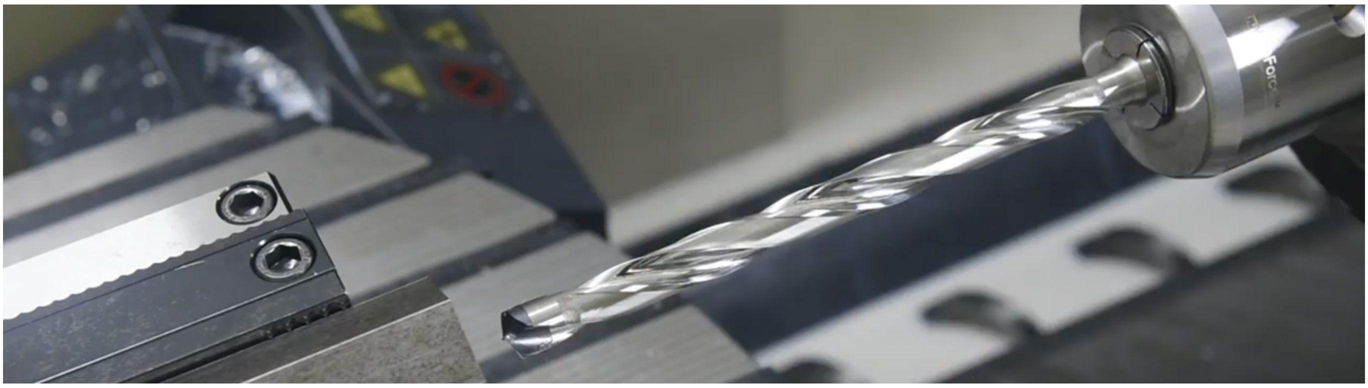

Metalworking

From Carbide to Coolant-Through: Deep-Hole Drilling, Simplified

Kip Hanson | Jun 13, 2023

Deep-hole drilling is among the most challenging of all metalworking operations, plagued by inadequate coolant flow, chip packing, drill walk and other problems that can challenge even the most skilled machinist.

Unfortunately, the mechanical world is replete with parts requiring such holes. Hydraulic cylinders and manifolds, aircraft landing gear, automotive fuel injectors, gun barrels and plastic injection molds are just a sampling of the everyday components that depend on a machinist's ability to solve the deep-hole drilling riddle.

Depth vs. Diameter

The definition varies, but most industry experts suggest that any hole more than 10 diameters deep (10xD) requires a specialty drill designed for such work and, quite possibly, a complete change in holemaking strategy.

Options include the time-honored technique of gun drilling, invented more than two centuries ago for improving the accuracy of gun and cannon barrels; BTA or single-tube drilling (BTA is an acronym for its inventor, the Boring and Trepanning Association); ejector, also known as double-tube system (DTS) drilling; trepanning for humongous holes; and abrasive jet drilling for smaller holes in very hard materials.

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Each of these are mature, well-known drilling technologies, some of which can punch holes the size of a Sunday ham several hundred diameters deep, and all of them able to produce straight, round and smooth holes in the most common workpiece materials.

There's just one problem: Unless your shop does a lot of deep-hole drilling and has invested in one of these dedicated systems, you're stuck with sending parts out to a shop specializing in such work.

And even for those who already own the necessary equipment, drilling said holes requires a secondary operation, driving up part costs and increasing lead time.

Gaining on Gun Drills

While the lion's share of deep-holes have long been produced using gun drills and the dedicated machinery just mentioned, that paradigm is beginning to shift in favor of solid carbide extended-length drills, says Frank Martin, the product manager for solid carbide drills at Kennametal.

"In the smaller diameters, gun drilling has historically been a favored process" despite its drawbacks, he says. "It requires a special machine with a series of bushings to guide the drill. And since the tool itself has only a single cutting edge, gun drilling also takes a long time."

The landscape started to change around two decades ago, when Kennametal and other cutting tool manufacturers began producing coolant-fed, solid carbide drills in extremely long lengths.

Add to that the growing number of CNC machining centers equipped with high-pressure, through-the-spindle coolant and many machine shops have found themselves able to skip the trip to their gun-drilling subcontractor.

Pros and Cons

Drilling with these ultra-long tools presents its own challenges, however. As anyone who's shopped for solid carbide drills knows, they're significantly more expensive than their high-speed steel (HSS) and cobalt counterparts and the longer the drill, the higher the price tag.

Because of this, steps should be taken to avoid breakage and ensure that the drill produces the highest hole quality possible, which begins with drilling a pilot hole.

Kennametal's approach is using a pilot drill of the same diameter as the deep-hole drill, but with a slightly larger H-value.

> **"Solid carbide drills—whatever their length—are far more effective than the alternatives."**
> Paul Larson
> Guhring

That provides a very small amount of clearance (up to 0.0004 inch), guiding the deep-hole drill and protecting its margins, Martin explains. In addition, the pilot drill should have a point angle greater than that of the deep-hole drill.

That forces the latter to make initial contact at the drill's point rather than the margins, preventing tool-killing chatter.

"You might not need a pilot hole at 12xD hole depths, but for anything more than this, it's a must," Martin says. "And if you're drilling a series of holes, as in a heat exchanger, you should pilot the first hole and then drill it to its final depth before moving on to the next one. Yes, this takes more time for tool changes, but the alternative—pilot-drilling everything first—will leave chips in the holes, almost certainly leading to breakage of the extended-length drill."

Easy Does It

Paul Larson, Guhring product manager for drills and thread mills, agrees, noting that a pilot hole is needed for any hole-drilling operation greater than 12 times the diameter (12xD). He also recommends that once the pilot hole is complete (1 diameter deep is adequate), additional care should be taken when engaging the deep-hole drill.

“Approach the workpiece with the spindle rpm way down and the coolant turned off,” Larson says. “Feed into the pilot at a fairly good clip until you’re 0.05 inch or so from the bottom, then engage the coolant, bring the spindle speed up, and punch the hole. Don’t peck, and be sure to reduce spindle rpm when you disengage the drill—otherwise it will whip and almost certainly break.”

To this last point, anyone reading this might be wondering whether a modern machining center with its super-fast tool changer presents a risk to extended-length drills. Larson says he’s seen no issues.

“We have a newer 5-axis machining center at our grind shop and have not had any problems there,” he says.

Best Practices

Using pilot holes, engaging a drill’s chisel edge first, and leveraging high-pressure, through-the-tool coolant is good advice no matter the hole depth, but it’s crucial for success in this application. So is minimizing runout, which is why high-quality shrink-fit or mechanical toolholders are a must.

“We know through testing that hydraulic toolholders boost the life of a solid carbide deep-hole drill, probably due to the built-in dampening effect,” Martin says.

“And be sure your coolant pressure is sufficient,” Larson notes. “I visit a lot of shops that think 300 psi is plenty, but it should be at least 1000 psi for the best results.”

For extremely deep-holes—say 30xD and above—it might also be a good idea to use progressively longer drills. That serves to extend tool life for the longest, most expensive drills while the shorter drills do most of the work, thus maximizing investment.

“Solid carbide drills—whatever their length—are far more effective than the alternatives,” Larson adds. “Everyone’s looking for cycle time reductions and process stability, and these tools with their double margins, coolant-through capabilities, and advanced cutting geometries produce consistent, very high-quality holes in the shortest time possible.”

What are your best tips for deep-hole drilling? Tell us in the comments below.

