"Deep Hole Drilling" "Simple Tips to Achieve More Productivity And Tool Life"

Machinists often find deep hole drilling–at depths from 12 to 30 times drill diameter–daunting. Many are unsure about the process along with all that is required to maintain good hole straightness, tolerance/size and surface finish. Fortunately, there are some simple tips that will allow machinists to achieve near-perfect deep drilled holes while also increasing productivity as well as tool life.

1. Match pilot drill diameter

When deep hole drilling, a machinist must first produce a pilot hole, typically at a depth of two to three times the pilot drill diameter. Pilot holes should be the same size diameter as the deep hole drill to be used. This matching hole size creates a starting point and helps guide –almost like a bushing–the long drill, keeping it straight and preventing it from walking. **Without a pilot hole at all, the long drill would vibrate back and forth at the start of the hole and eventually break.**

2. Switch off the spindle when entering the hole

A common mistake machinists make is to feed an already rotating deep hole drill into a pilot hole. This causes the long drill to slap the sides of the hole, decreasing the tool's life. Instead, leave the spindle off, fast feed the drill into the hole, then turn on the spindle when the drill tip is about 0.020 in. (0.5 mm) above where the pilot hole ends and begin to **drill without pecking**

Rapid feeding drills out of deep holes is a mistake as well. At the end of the drilling depth, the machinist should reduce the spindle speed to a few hundred rpms and retract the deep hole drill at a slow rapid to where drilling started. At that point, the machine spindle is switched off, and the drill exits the remainder of the hole.

Stopping a drill's rotation before it enters a hole, retracting it slowly and at reduced rpms can increase drilling cycle times, but by barely a fraction of a second. **The resulting gains in tool life far outweigh that little amount of added time.**

3.Pay attention to drill geometry

Drill geometry is a key factor in successful deep hole drilling. Pilot drills, for instance, can have 140^{o} point angles, while long drills may have 136^{o} point angles. This ensures that the centre of the long drill will contact the material first while in the pilot hole and seat itself. Then, the corners make contact.

Some deep hole drills also have two land margins per flute. The drill tip does the cutting, while the land margins at the sides help hold the drill in place during operation. On long drills, land margins are located only at the very ends of the flutes for clearance that prevents drag. The more flute drag, the more heat generated and the higher the risk of drill breakage.

Solid-carbide drills are a must for producing hole depths greater than 12 times the drill diameter. Carbide tools are stiffer and less likely to wander as compared with HSS and cobalt tools in deep hole drilling. However, deep holes with large diameters. (76.2 mm or more–will require the use of insertable deep hole drills.

4.Ensure proper chip evacuation

The number one reason drills fail is due to **inadequate chip evacuation.** While most long drill geometries provide effective chip breaking, they must then evacuate the chips out of the hole. Those drills with both polished flutes and back tapers will work best.

Coatings minimize frictional heating and thus contribute to increased tool life. Coolant, however, is the most important factor for chip evacuation. Even one chip left in the hole can break the drill, so high pressure through-tool coolant is the only option. High pressure coolant forces them up the drill flutes and out of the hole. Through-coolant drills also eliminate the need for pecking cycles.

5.Use the right toolholder

Hydraulic and shrinkfit toolholder systems generate the least amount of runout, making them ideal for deep hole drilling applications. Both systems can cost a bit more, and precision collet chucks are one alternative, but they must be high quality and provide low runout.

A final and very important tip is to consult a tooling expert. A partnership between a shop and its tool supplier makes all the difference in choosing the right drill for deep holes, or any holes for that matter.

EDM Technology Most Economical For Hole-Drilling Applications

Changes in market demand are frequently the catalyst for advancements in machining technologies; such is the case for modern EDM hole-drilling machines. While traditional hole features have typically afforded manufacturers the flexibility to use a variety of manufacturing approaches, modern product designs and production requirements have spurred new manufacturing challenges and innovations. **Compared to alternative hole-production technologies such as lasers and mechanical drilling, EDM technologies have advanced rapidly to become the fastest and most economical means of hole manufacturing.** In fact, for some modern applications, the EDM process may be the only viable method for meeting complex hole requirements.

This evolution in hole features can be attributed to the changing demands of several key market segments, particularly **medical and aerospace.** Within these industries, manufacturers are encountering increasingly complex hole designs and specifications that demand unique and specialized EDM hole-drilling technologies. Selecting the appropriate EDM technology for modern hole-drilling applications is critical to achieving the highest production throughput, best part quality and accuracy, and lowest manufacturing cost. This article addresses the varying EDM hole-drilling technologies available as well as their **advantages and disadvantages and ideal production requirements.**

While improved speed and precision are desirable performance attributes for any manufacturing process, the growing demand for exotic materials and improved production capacity has significantly raised customer expectations for hole-drilling capabilities within the general production market. In response to this demand, EDM hole-drilling technologies have diversified and matured to meet specific requirements of accuracy, quality and production volume for various applications. These advancements in EDM technologies offer several advantages over traditional manufacturing methods. In many cases, the EDM drilling process can reduce lead-times by eliminating the need for secondary post-machine operations by producing burrfree hole features with greater precision. When compared to conventional processing methods, such as mechanical drilling, the small hole diameters and often contoured part designs will typically bend or break conventional drilling tools. In addition, **EDM processes are unaffected by the hardness of workpiece materials, making it an effective solution for a wider variety of applications.**

In the medical market, design engineers are pursuing a higher degree of complexity surrounding hole sizes and quality. Applications such as surgical tooling and implantable devices are being designed with extremely small hole diameters, hereto referred to as "fine hole diameters," that require exacting tolerances (often ±0.005 mm) and hole diameters as small as 0.010 mm. Hole quality at the entrance and exit of these hole features are critical to workpiece acceptance, requiring identical sizes and characteristics with no tooling marks or burrs on the surface of the parts. These challenges have driven the development of several highly specialized EDM hole-drilling technologies, which emphasize precision over speed.

Similarly, the **aerospace market encounters its own unique blend of hole-production requirements.** The most common hole features seen in modern aerospace applications are known as film cooling holes. These hole features are machined directly into the leading and trailing edges of blade and vane segments used within jet engines, and serve a critical role in providing cool airflow through the hollowed center of these parts.

Aircraft blade and vane components commonly feature high volumes of film cooling holes as **well as shaped hole features known as diffuser shapes.**

Production requirements for these holes typically range in diameter from 0.5 mm to 1.5 mm, with average accuracy tolerances of ±0.050 mm. Since **EDM drilling is a thermal process, attention must be paid to the impact of the process on the metallurgical quality of the workpiece.** The heat affected zone (HAZ) and recast in the material around the drilled hole typically have a maximum allowable value under 0.050 mm. These characteristics have led to development of several new EDM hole-drilling technologies that emphasize speed over precision, such as multi-sided part positioning and back-strike prevention.

Source : Makino Inc.

EDM Technology Most Economical Hole-Drilling Applications

Machining centre manufacturers spend effort, design, and cost to make sure the spindle in the machine will operate on centreline. Spindle rotational accuracy as well as spindle alignment play an important role in cutting tool performance and productivity.

Cutting tool manufacturers use the latest materials and grinding equipment to assure the cutting edges are uniform in location, size, and tolerance to the centreline. This assures the tool will rotate on the centreline.

With these issues getting so much attention and focus, why do we pay so little attention to the accuracy of our toolholder and tool clamping products and the maintenance of the spindle rotational accuracy? The tool "connection" between the machine tool spindle and the cutting tool is as important as the maintenance of the jet engine. If airlines did not maintain the engines regularly, flying would be a lot more dangerous and expensive.

Studies have shown that for every .0001 in. the cutting edge runs out on TIR, the cutting tool edge life is reduced by an average of 10 per cent. This means a $100 cutting tool operates as a $90 one with just .0001 TIR and as a $50 tool with a .0005 TIR.

So how do you maintain the centreline of your manufacturing processes?

1) Spindle Taper maintenance and care. On a daily basis, use a spindle wiper to ensure your spindle taper is free from fine metals caused in the machining process and passed through the coolant onto the toolholder and machine spindle during tool changes. The fines can embed in the spindle taper as well as the coolant and tram oil can be "squeezed" into a thin sticky layer holding the fine metal particles. This causes excessive toolholder shank wear and potentially excessive spindle taper wear leading to excessive TIR in the connection.

2) Spindle alignment. Since all spindles rotate and most are on a rotational axis, alignment in reference to the centreline of rotation is critical to cutting tool location "away" from the spindle face. Axial runout and the spindle rotational axis in reference to your table/fixture, determines the runout of your cutting tool edge and this determines your cutting edge tool life even before you start machining. Spindle alignment test arbors used in your PM (preventative maintenance) program will make sure your spindle alignment, as well as your spindle rotational accuracy is maintained. Test arbors will even help indicate when your spindle bearings are showing

excessive wear and run-out.

3) The spindle drawbar. Maintaining this within factory specifications is critical to the life of spindle bearings, spindle taper surface, and toolholder taper accuracy. If a drawbar fails to maintain the proper load on the connection, metal removal rates are reduced due to chatter, cutting tool movement, and cutting tool edge location based on programming location. In addition, vibration between the "loose connection" and the taper interface will cause excessive spindle taper wear, fretting (a burning of the material surface due to high frequency vibration between surfaces) – which damages spindle and tool taper material integrity. Pull force gauges should be part of your regular PM program to ensure that the machine manufacturer's drawbar tension force is maintained.

Toolholder selection is important. Poor quality (low TIR accuracy tool holders) can push your spindle rotation TIR to .0005 -.0009 or higher, costing you valuable tool edge life and production rates. With the evolution of the tool holders from end mill holders through collet chucks to today's shrink fit technology; the TIR has improved with every evolution/innovation of the tool holders in the market.

Maintenance of the tool holder system is critical to the accuracy of the assembly as well. What impacts the maintenance of a tool holder?

1) Proper torquing of the collet nut to proper grip the cutting tool shank in the collet. Under torquing the collet nut will allow the collet to grip the cutting tool shank with less strength and machining dynamics will cause the cutting tool to move in the assembly. Over torquing the collet nut will cause the collet to "twist" thus causing axial run-out in the tool assembly and collet fatigue reducing the clamping strength of the collet over time.

2) Proper cleanliness when assembling the tool clamping system – removal of all chips and grime from tool taper and ID taper before assembly

3) Retention stud installation is important because improper torquing of the retention stud will cause distortion of the tool taper leading to taper contact reduction and axial run-out growth.

4) Handling of the tools from storage to machine carousel determine how well the tool taper is maintained. Improper handling of the tools allows the tapers to get knicked, dented, or scratched, which destroys the taper surface.

Two important facts to consider:

Average tool holder shank accuracy is three to five years before the taper is beyond standard manufacturing tolerances from wear and every day use. This means that the taper will have excessive TIR in it resulting in loss connection TIR.

Putting "used" toolholders on new machine spindles reduces the life of the new machine spindle taper surface by 50 per cent because you introduce "poor" quality connections to a new connection accelerating the wear on the new machine spindle surface.

You can get a lot more out of your machine and machining processes if you are centered with your machining centre processes. This is where quality and price determine the outcome of machining performance and machining costs.

Source : **Shopmetaltech.com**

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Source : **Meusburger**