TECHNICAL PAPER

EMUGE FRANKEN

KNOWING DRILLS

TYPES, MATERIALS AND APPLICATIONS

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Drilling is a critical metalworking process, especially to prepare the hole for tapping and threading. Reviewing some tips before selecting a drilling tool can save time and mitigate challenges once in production. One of the most important considerations is whether to use a multipurpose or application specific drill. The answer depends on several factors, including the material you are drilling, the depth of the hole you need to create, the level of accuracy and volume of parts for your application(s).

Material Matters

A multipurpose drill for shops is designed to work on a wide range of materials, especially well-suited for common materials ranging from carbon steels, stainless steels, aluminum and copper alloys, and to some extent certain nickel alloys. However due to their specialized design, application specific drills may be a better choice for drilling challenges. Challenging materials such as titanium and nickel alloys, Inconel and high-strength and hardened steels and hard castings, are among those that application specific drills may be a more optimal solution.

Multipurpose Drill Considerations

Multipurpose drills are engineered with versatility in mind, making them ideal for job shops with a higher mix and lower volume of parts. Look for drills that are constructed using specialized carbide grades that make the tools harder than conventional carbide grains for drilling, yet still retain the ability to withstand shock and chipping. The tool coating also plays a role, and it should have high hardness that reduces friction at elevated temperatures.

The latest multipurpose tools feature concave cutting edges, providing higher chip shearing ability and a tightly controlled edge preparation process that provides consistent performance and long tool life. Tools are designed to help stabilize the drill in the cut, allowing rounder, more accurate holes. For maximum chip evacuation, look for a drill web construction with a wide open flute form. Self-centering tools will eliminate pre-spot drilling applications, and coolant-thru capability is optimal.

Application Specific Drill Considerations

Application specific drilling tools have been designed to provide options for specific challenging materials, in order to maximize hole quality in longer production runs.

The new Multipurpose EMUGE MultiDRILL™ line of 3XD and 5XD high quality solid carbide multipurpose drills are ideal for a wide range of materials and applications typically found in high mix – low volume job shop environments.

EMUGE PunchDrill is a totally new drill design offering high feed drilling which doubles the feed rate compared to standard drills without increasing the axial force or spindle speed, ideal for machining cast aluminum alloys with at least 7% Si content and magnesium alloys.

FINDING THE RIGHT DRILL SIZE FOR TAPPING.

One of the most common mistakes a machinist makes when tapping a hole is using the wrong size drill. Not intentionally of course, it is just that most machinists are using outdated charts designed back in the 1950's when high speed drills were the norm. To reduce the risk of thread failure, the Design Engineer was often cautious and specified high percentages of thread height in tapped holes. The percentage of thread values that older tap drill charts provide is higher than needed in most cases. Another reason why some tap drill charts are outdated is that most drills for producing tapped holes were high speed steel or cobalt when the charts were created. Many tap drill holes are now being created with high performance carbide drills and these carbide drills generate more accurate holes than high speed steel drills. High speed drills typically cut larger actual hole sizes than carbide drills.

Making the correct tap drill size choice will affect the machining operation. Many tool manufacturers suggest using percentage of thread values between 60% and 70% for most pre-drilling applications. By increasing the pre-drilled hole diameter, the machinist can expect to increase the life of the tap by reducing the amount of force required to form the thread. It is important to realize that thread strength is not directly proportional to percent of thread. According to some sources, 100% thread specification is only 5% stronger than a 75% thread specification but requires 3 times the torque to produce. Tap life is greatly reduced in an effort to theoretically increase thread strength.

As an example, a 7/16-14 UNC cut thread is usually denoted as a letter "U" (0.3680 in) diameter drill on most older tap drill charts which equates to a 75% value for percentage of thread. In fact, a 9.4 mm (0.3701 in) drill might a better choice. The slightly larger drill diameter still provides a 73% of thread value which is more than acceptable. But that 2% reduction in thread percentage will reduce torque on the cutting tool and increase tap tool life. As a general rule, the tougher the material, the less the percentage of thread is required to meet design requirements. In some harder materials such as nickel alloys, stainless steel, and hardened steels, it is possible to tap with as little as a 50% of thread value.

Roll form threads require tap drill sizes that are larger than those specified for cut taps. A 7/16-14 UNC roll form thread will require a 10.25 mm (0.4035 in) minor diameter. Material is being displaced and formed instead of cut, requiring the pre-drilled hole to maintain the correct amount of material to be formed into the taps thread profile.

Choosing the correct tap drill size for an internal threading application is not just as simple as looking at a possibly outdated tap drill size chart. Understanding how the values can affect the manufacturing process is an important consideration.

These higher performance tools with specialized geometries are the go-to choice for specific material groups or applications where cycle time is critical. For example, based on the application and material, these tools can have a very long life, and are ideally suited for a high volume and lower mix of parts. Application specific drills usually have a higher price than multipurpose drills, however their value in gained productivity, especially in challenging applications and hard materials, can make them a better cost performance alternative.
Specialized drills feature a double margin design for improving hole quality and improving guiding and adding stability during breakout, and a reverse web taper and coolant hole channels that prevent chip packing and premature tool failure. Drills are designed to operate without peck cycles to reduce cycle times. For deep hole drilling, specially formulated premium multi-layer coatings such as TiALN are post-polished.

Application specific drills are designed for particular materials, especially challenging ferrous ones such as steel, alloyed steel, martensitic stainless steel and nickel alloys common in aerospace parts manufacturing.

High-penetration rate solid carbide drills that can drill and chamfer in one operation are another application specific example. These drills save time and provide a more accurate hole-to-chamfer location, resulting in the most optimal hole preparation for tapping or thread milling. Tools feature a double margin design on the minor diameter for the roundest threaded hole size, and the web construction is adjusted for each diameter for maximum chip evacuation efficiency.

Micro Drills are an application specific alternative that produce high-performance results in demanding materials at high feed rates. Solid Carbide Micro Drills achieve ideal results when machining challenging materials such as alloyed steel, stainless steel, cast iron and nickel. These drills are self-centering and operate at top end cutting speeds and the highest feed rates to ensure the best hole quality. A unique flute and point geometry combination ensures outstanding surface quality and excellent tool life.

Deep hole drilling, which would be considered holes over 5 times diameter deep, presents its own set of challenges. And when the drill diameter falls below 3.0mm (0.118”) the task is even tougher. Drill flute and point geometry options are limited in micro drilling applications due to the size of the tool. For example, deep hole drills are most effective when the drill web thickness is reduced, allowing for increased flute space for chip evacuation. Micro drills, and in particular, carbide micro drills, require heavier web thickness percentages than larger diameter drills due to the fragility of the small tool. The stronger web or core diameter is more robust, but the chip space is restricted.

High performance carbide micro drills are addressing the issue of chip evacuation with the introduction of internal coolant holes and parallel web construction. High pressure coolant is introduced at the cutting zone and this helps eject chips from the flutes. The other benefit of using coolant-through drills is the ability to reduce and even eliminate peck cycles. The efficient evacuation of chips reduces the need for chip clearing drill retractions. Point geometry and web thinning options are also limited due to the size of the tooling. Faceted point grinds are the most common because they provide added cutting edge stability. Advanced coatings are necessary with high penetration rate drills if they are to be used in high temp alloys, stainless steel and other materials that create high levels of heat during the drilling process. Coatings, such as special TiALN, aid in wear and heat resistance and are effective with carbide micro drills.

The EMUGE EF Step Drill is a high-penetration rate solid carbide drill that drills and chamfers in one operation, saving time and providing a more accurate hole-to-chamfer location.

EMUGE EF-Series of high penetration rate drills include a line of sub-micro grain carbide coolant-fed micro drills. The tools are ideal for ideal for aerospace, medical and precision automotive applications designed for producing very small deep holes.

There is also a new exceptionally specific drill solution, EMUGE PunchDrill, that is designed for the fast, high volume machining of cast aluminum alloys with at least 7% Si content and magnesium alloys – a material range that is steadily growing due to its lightweight properties. PunchDrill doubles the feed rate compared to standard drills without increasing the axial force or spindle speed. The drill reduces machining forces and optimizes chip-breaking, producing cycle time savings of 50% or more which results in shorter machining times, fewer tool changes, and high metal removal rates, in addition to higher productivity and reduced power consumption.

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