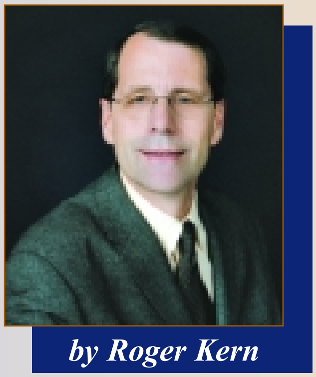
Techtips



by Roger Kern

Techtips is a collection of useful ideas, techniques, and procedures designed to further EDM knowledge.

EDM TAPPING 101

The two primary applications of EDM for producing threads are EDM tapping and EDMing mold cavities that will produce threaded parts. We'll examine EDM tapping in this exercise and cover EDMing threaded mold cavities in a subsequent article.

Figure 1

EDM Tapping Methods

There are four available methods used to accomplish EDM tapping.

Hand servo lead nut tapping

was the original EDM tapping method. With this method, a fixture containing a lead nut corresponding to the pitch diameter and lead of the thread to be EDMed is attached to the ram of the machine ***(See Fig 1)***. The lead nut often incorporates a spring-loaded ball plunger mounted in a cross-drilled hole through its threads, which maintains a constant electrical contact with the electrode, precluding inadvertent EDMing of the lead nut threads. An appropriately undersized threaded electrode is engaged with this nut and manually turned into the workpiece, while the operator carefully and tediously watches the voltmeter to coordinate his rate of turning with the progression of the burn.

Advantages (Few):

- The tapping fixture is relatively inexpensive and can be affixed to any type EDM.
- The electrode can be removed for redressing without losing the lead of the thread.

Disadvantages (Many):

- The tapping unit consumes a considerable amount of Z height, limiting workpiece thickness.
- The machine must allow the Z-axis to be locked.
- A separate lead nut is required for each thread size.
- The necessary clearance between the electrode and the lead nut often results in a sloppy thread.
- Human beings make very poor servos. The burn is not smooth and constantly shorting out. Being a human servo will be one of the operator's less memorable trade experiences.
- The process is extremely slow.
- All the burning takes place at the leading edge of the thread, concentrating the wear on the end of the electrode. Numerous redressings are often required.

Machine servo lead nut tapping

was the next advance in EDM tapping. The operator turning the tapping electrode was replaced by a servomotor controlled by the power supply. In some units the electrode was mounted externally to the lead nut unit assembly, allowing a much higher level of motion accuracy. It is now seldom used, except in certain custom applications.

Advantages (Few):

- Smoother cutting than hand tapping.
- Some degree of unattended operation.
- Better threaded hole geometry.

Disadvantages (Many):

See above for hand tapping plus:

- Tapping unit is very expensive.
- Tapping unit is heavy and bulky.
- Thread lead is difficult to maintain for re-dressings or electrode changes.

CNC Z-A axis helical interpolation tapping

With the advent of 4-Axis CNC machines, it becomes possible to generate all the necessary tapping motions programatically within the CNC. In theory, this sounds great. In reality, it is not the answer to the maiden's prayer.

Advantages:

- No special tapping fixture required.
- Can run unattended.

Disadvantages:

- All the burning takes place at the leading edge of the thread

concentrating the wear on the end of the electrode.
- Numerous redressings are often required.
- Electrode must be held so that it runs straight and true, otherwise thread will be sloppy.
- Electrode fixturing must accommodate electrode removal and replacement for redressing without losing the lead. (Redressing is usually accomplished by removing an exact number of leads and compensating in the CNC for this amount).
- The process is quite slow. A short circuit anywhere along the threads might require the electrode to back out all the way to clear.

Orbit Tapping

is accomplished by utilizing a vastly undersized electrode, whose O.D. is small enough to drop down vertically full depth into the tap drill sized hole, and applying a planetary motion to it (similar to thread milling on a machining center), feeding radially outward until the finished thread size is reached. The planetary motion is applied either by a CNC attachment fixed to the Ram, or by planetary motion induced through the X & Y axes of the CNC table of the machine. (Important Note: Do not attempt orbit tapping with a mechanical orbiter whose orbit is generated by Z-Axis motion of the ram.) Orbit tapping engages the electrode over the entire depth of the hole, allowing a much larger "frontal burn" area, while spreading the electrode wear over the entire surface of the electrode. Short circuits are instantly cleared by collapsing the orbit. Often, the electrode may not have to be redressed. Orbit tapping is the method of choice for the modern toolroom. Once you've used it, you wouldn't even think of going back to the other obsolete methods!

Advantages:

- Totally automated.
- Fast-Tapped holes take minutes, not hours.
- No taper.
- Low wear — Since the wear is distributed over the entire surface of the electrode.
- Size and fit can be adjusted with the orbit.
- Roughing and finishing can be accomplished within the orbiting routine.
- Orbiting induces flushing.

Disadvantages:

- Loss of Z height, if an attachment is used.
- High cost of orbiting attachment, if used.

Tapping Electrodes

Electrode Types:

- **Non-Orbiting Straight Threads**

These electrodes feature a pitch diameter that is undersized only by an amount necessary to accommodate overcut. Unfortunately, the electrode manufacturer has already decided on this undersize, and you have to live with that standard.

- **Orbiting Straight Threads**

These electrodes feature a pitch diameter that is small enough so that the electrode will easily fit into the tap drill sized pre-hole. Because they are severely undersized, they can be quite odd-looking and fragile, especially in the smaller thread sizes. ***(See Fig. 2 for comparison view of 1/4-20 conventional and orbit tapping electrodes)***

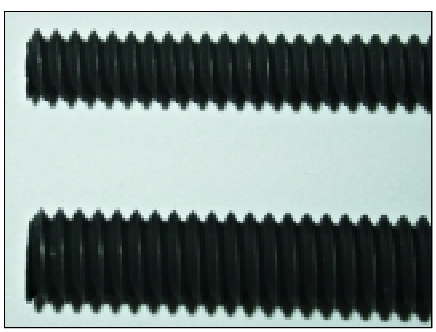


Figure 2

- **Orbiting Pipe Threads**

These tapered electrodes look like an undersized pipe fitting. The pitch diameter that is small enough so that the electrode will easily fit into the tap drill sized pre-hole. Setting up and selecting the correct finish orbit can be challenging. ***(See Fig. 3 for a comparison view of a 1/4" NPT tap and orbit tapping electrode)***

Figure 3

Electrode Materials:

- **Brass:**

This was the original EDM electrode material 60 years ago. About all that can be said for it is that it is easy to manufacture. It has a very high wear ratio. Almost no one uses brass any longer, except a few diehard users with servo driven lead nut tapping devices EDMing carbide.

- **Copper:**

Better than brass, but not much. Can be used on low wear settings, but speed is slow and corner wear (on the external thread vee's) is a problem.

- **Graphite:**

The ideal tapping electrode material, especially if a premium grade is used. Burns fast at low wear settings, while suffering minimal corner wear. Very fragile!

- **Copper Graphite:**

Stronger than plain graphite and can be used in carbide. May burn more smoothly than plain graphite. However, corner wear is double (and thus electrode life is only half) that of plain graphite.

- **Copper Tungsten:**

Exceptional corner wear. Ideal for carbide. 1/4 the cutting rate of graphite. Very expensive as the raw material is expensive, and threading copper tungsten is difficult.

Calculating Overcut Allowance

Because overcut is perpendicular to the thread form and not the pitch diameter, the overcut allowance per side must be 2X the actual overcut (or 4X on the pitch diameter). ***(See Fig. 4)***

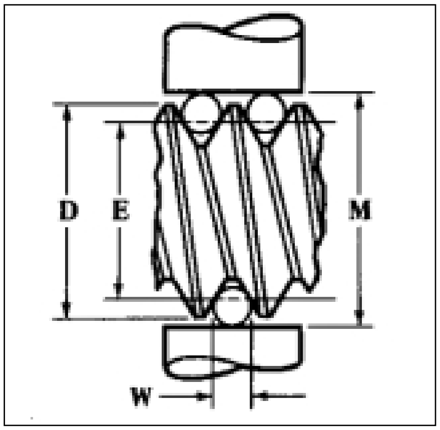


Figure 4

Measuring Tapping Electrodes

Straight Threads

Assuming the electrode is the correct pitch, the two dimensions that can be measured on a straight tapping electrode are the O.D. and the pitch diameter. Be advised that they are not always related since the O.D. may not be the tip of the sharp 60 degree vee. Comparing the measured O.D. of the electrode with the nominal O.D. of the threaded hole will give a good approximation of the pitch diameter undersize for most applications. However, if accurate internal threads are required, the pitch diameter of the electrode should be measured by the Three Wire Method. ***(See Fig. 5)***

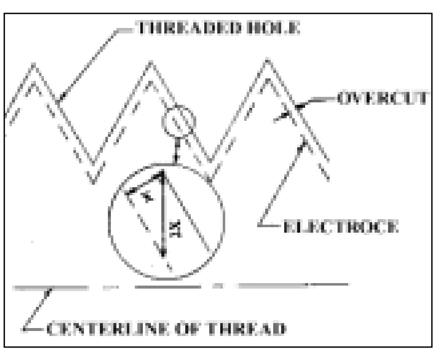


Figure 5

Pipe Threads

Because a pipe tapping electrode is tapered, there is no set dimension that can be measured. The electrode is designed to go into the tap drill hole, and is longer than the threaded portion of the hole needs to be, so that it can run off at either end. See the Pipe Tap Electrode Setup section.

Tapping Tips

- Always burn a tap drill sized pre-hole first — for any tapping method.
- Purchase tapping electrodes with flushing hole (if possible) and flush through the electrode. This is especially important for non-orbiting applications.
- Put a blocker plate on the bottom of a block with through holes, or feed the bottom of the hole with flushing.
- Use an electrode holding device that holds the electrode by the threads for easy redressing without losing the lead. ***(See Fig. 6)***
- Be certain that the electrode undersize matches the lead nut of the electrode holder. Unfortunately, this is not always the case depending on the manufacturer of both the electrode and the nut.
- Always burn on low wear settings to preserve the electrode.
- If an existing threaded hole is to be repaired, use a metal electrode to pick up the threads and then substitute a graphite electrode for the actual burning, being certain to maintain the lead orientation between the two electrodes.

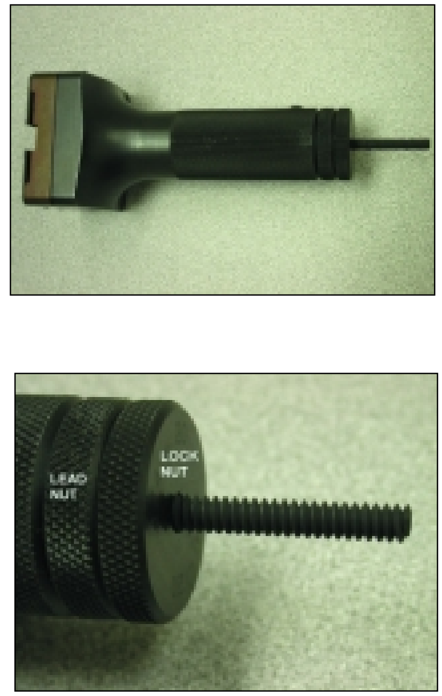


Figure 6

- Redressing without the use of a lead nut electrode holding device can be accomplished by removing the electrode toolholder from the EDM, removing an even number of leads in the Wire EDM, returning the electrode toolholder to the EDM, and finally lowering the Z-Axis by the same number of leads that were removed in the Wire EDM.

Pipe Tap Electrode Set-Up

- Decide how much engagement you need for either a sample fitting or the Pipe Thread Gage. Measure the O.D. of the reference sample at the point which will be flush with the top of the part.
- Measure the O.D. of the electrode 1/8” down from the big end.
- Set the Z-axis of the machine so that the big end of the electrode is 1/8” above the top of the part.

• Set the ultimate orbit per side to be a little less than 1/2 the difference between the measured O.D. of the electrode, and the measured O.D. of the gage.

• Sneak up to the final size slowly until the fitting or gage engagement is correct. ***Caution:*** *A small radial outfeed will drop the gage a lot. You can trig this out with cotangent of 1/2 the included taper angle of the pipe thread.*

Measuring EDM Tapped Holes

Straight threads

By definition, tapped holes are intended for fasteners. Therefore, for most applications, the intended fastener is used as a gage. However, care must be taken when deciding what to do when the hole is finished but the fastener won't go in. The fastener could be held up by either the major diameter (the O.D.) or the pitch diameter (the sides of the threads). Since the delicate tips of the threads on the electrode formed by the 60 degree vee will wear faster that the flanks of the threads, the major diameter is most often the cause of binding in the hole. If this is the case, then the electrode needs to be cut back. Just blindly orbiting out until the screw fits will result in a hole with an oversized pitch diameter, and a loose thread that is only guided by the major diameter.

Pipe Threads

Pipe tapped holes are often gaged with a sample pipe fitting, orbiting out until the fitting engages to the proper depth. This method can be dangerous because there is a large variation in the threading of pipe fittings, and if your customer uses a different fitting than the one you gaged with, the results can be problematic, since if the hole is tapped too deep, the joint will leak and the job is scrapped. The proper way to gage a pipe tapped hole, is with a pipe tap thread gage. ***(See Fig. 7)*** The pipe tap thread gage has a ground reference flat that should be flush with the top surface of the part, when the gage is bottomed in the hole. ***(See Fig. 8 and Fig. 9 for examples of pipe tapped holes, one of which is correct and the other is oversize.)*** *(Please note the same precautions concerning the thread tip wear as mentioned for straight threads)*

Figure 7

Figure 8

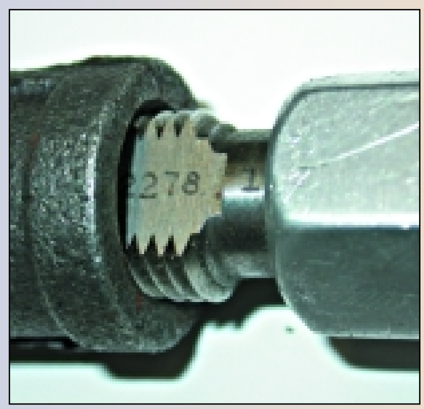


Figure 9

Conclusion

Hopefully, this in-depth analysis of EDM tapping (for those of you who are still awake) will provide a sound basis for attacking those often dreaded threading jobs without getting "screwed".

Any suggestions for future topics are welcome. Tell us what you would like to read about.

kernroger@sbcglobal.net

EDM