Speeds & Feeds for Knurling

For convenience, Knurling is often performed at the same speeds used for turning operations when using high speed steel tool bits. But to prevent seizing of the rolls on the pin, we recommend a maximum surface speed of about 150 SFPM (Feet/Min) or 50 m/min. You may find you get longer knurl life and improved appearance by slowing down the spindle to about 50 SFPM (15 m/min) for harder steels and stainless. CARBIDE knurl pins are strongly recommended for all high speed knurl applications. DOWEL pins with a plus tolerance SHOULD NOT be used because of the possibility of the knurls seizing up and breaking.

For BUMP knurling with a SINGLE TOOL HOLDER from the cross-slide, the infeed would normally be .001-.004"/rev (.025 - .1mm) to roll the part complete 5/20 revolutions. When knurling stainless steels, it is important not to roll any longer than necessary as this material work hardens as it is formed. The total amount the tool penetrates into the workpiece is approximately 50% of the tooth depth of the wheel. You may have to travel more than this amount to allow for the flexing of the part or holder due to rolling pressure. Some trial and error will be required.

If you are using a two die STRADDLE HOLDER, the infeed rate should be 5 or 10 times faster because the wheels are coming in tangentially instead of head on. Before knurling, the holder should be set so that the distance between the two wheels is smaller than the workpiece diameter by approximately the depth of the knurl tooth. Then to knurl, move the holder so that the two wheels are as close to the centerline as possible to minimize the knurling pressure on work spindle and cross slide. To initially find the centerline using a two die straddle holder, you may use this method:

1. Bring the the preset holder and knurls towards the workpiece up to just touch a flat plate of any thickness inserted between the knurls and workpiece.

2. Remove the plate and advance the holder the thickness of the plate + 50% of the diameter of the knurl wheels + 50% of the diameter of the workpiece. The two knurls should then be over and under the centerline of the workpiece.

If you will also be axial feeding to produce a knurling pattern that is wider than the knurling wheels, chamfers should be on the edges of the wheels. If the knurling doesn't go up close to a shoulder, the use of our CONVEX axial feed wheels is strongly recommended to further reduce the knurling forces, extend tool life and improve the cosmetic appearance of the workpiece. The normal axial feed rates would be from about .004-.020"/rev. (.1 - .5 mm/rev). The slower feed for stainless steels and tough or semi-hardened steels and faster for mild steels, brass or aluminum. When using CONVEX axial feed wheels, even faster feeds may be used.

END KNURLING from the turret (axial feeding only) is usually done at .005/.030"/rev (.1-.7 mm/rev), using the slower range for coarser Knurling on high-alloy steels, faster for finer pitches and on brass, aluminum or mild alloy steels. Normally the dies are fed off the work about twice as fast.

CUT TYPE KNURLING is done at similar speeds and feeds as pressure knurling, but the method of initial contact is critical if clean knurling is to be produced. Please click below for recommended speeds and feeds.

IMPORTANT: If you are having problems with double or mis-tracking, it usually can be solved by increasing the infeed on bump or cut knurling. For end-knurling from the turret, increase the axial feed rate. The deeper and wider the penetration of the knurling wheel into the workpiece on the first revolution, the more likely it will fall into step the next time around.

An estimated best workpiece or knurling wheel diameter can be calculated, but it may not always work the first try. Variations in the material hardness, sharpness of the crest of the knurling wheel teeth, width of knurling, initial in-feed rate, or spindle speed all affect the initial tracking.

Another common way to correct a mis-tracking problem is to grind or stone a small flat of up to .004" (.1mm) or slightly more on the crest of the knurl wheel teeth. This also may actually improve tool life because the wheel is less likely to chip out. Usually, the flat in the root of the rolled workpiece is not noticeable.

DIAMOND KNURLING

When someone requests DIAMOND" knurl or wants to roll a "DIAMOND PATTERN" on a part, there are several questions that need to be answered. It is very easy to confuse what is required on the part and on the knurling die itself. First we need to know whether a MALE (raised pyramid) or FEMALE (depressed pyramid) pattern is required on the part to be rolled. If the print just says "Diamond Knurl", we assume it to mean "MALE DIAMOND" Knurl on the part. Then we need to know what type holder will be used.

Rolling a "MALE" Pattern from the Cross-slide

- Use a set of RH and LH Diagonal knurls if a double roll holder is available. The rolls can be fed axially at .005/.030" per revolution if necessary. Most of the knurling pressure will be absorbed in the holder if it can completely straddle the part, thereby greatly reducing part deflection and wear on the main spindle and cross-slide.
- If only a single roll ("BUMP") holder is available, a "FEMALE DIAMOND" knurling tool must be used. This method is fine as long as the knurled section is relatively narrow, close to the collet and large enough in diameter so as not to deflect/bend too much.

Rolling a "MALE" Pattern from the Turret

- If a Brown & Sharpe (or other brand) two die holder with swivel knurl blocks is available, us a set of (2) straight knurls set a 30° angle to the axis of the part. Feed axially onto the work blank at approximately .010/.030" per revolution. Bevels are not required on the knurls.
- If the knurl blocks do not swivel, or you need to knurl close to a shoulder, use a set of RH and LH Diagonal knurls (convex axial feed knurls are recommended, chamfered wheels as a second choice).

Rolling a "FEMALE" Pattern

- A female pattern on the work can only be produced using a "MALE" diamond tool. This is normally accomplished by using a single "BUMP" knurl tool from the cross-slide. Although it is possible to use two knurls in a straddle type holder, it is not normally done because of tracking problems and the necessity of custom matching the tooth form of a set of knurls axially.

Under normal circumstances a single "MALE" or "FEMALE" knurling die cannot be fed along the axis of a part. If this is a necessity, the holder must be tipped slightly and the knurl fed axially so that it advances very close to one axial pitch of the tooth spacing for each revolution.

KNURLING TIPS

A very important part of any knurling application is the set-up. The dies must be correct and the holder be rigid enough to withstand the rolling forces encountered.

1. Since proper tracking is usually established after only **one complete revolution** of the part, the secret to success is to **RAM THE DIE INTO THE BLANK!!** By forming a deeper, wider impression on the first revolution, the die teeth are more likely to step back into the initial grooves the second time around. Many tracking problems we solve are merely a matter of increasing the feed rate. For bump knurling from the cross-slide, the feed rate should be be fast enough so that the part is completed in 5-20 revolutions. Other solutions to tracking problems include: altering the blank diameter slightly, stoning or grinding the die O.D. approximately .002 smaller, honing the bores .002/.003 over nominal size.
2. If you are knurling on a CNC, and are having double tracking problems, you may want to stop (or gently slow down) the spindle for the initial contact. Resume normal speed as soon as the tool has penetrated approximately 20-40% into the blank.
3. Use LOTS of lubricant. Knurling generates some extreme pressures, and improperly lubricated dies are likely to bind up on or gall the pins. Slower spindle speeds and CARBIDE PINS reduce the possibility of the dies seizing as well.
4. Do not over-roll with knurls. In general, try to roll the pattern only about 90% full. When rolling stainless steels (especially 303) roll up the pattern in the fewest revolutions possible to minimize work-hardening the piece. The same can be said when rolling brass and other soft materials, but here it's to prevent "FLAKING" caused by rolling the part too many times after it has been completely formed.
5. Control the blank diameter within a reasonable limit. A variation of .0005 in the blank diameter will usually result in an O.D. difference of .001. One large blank can destroy a set of knurls.
6. If you are knurling from the end with a straddle-type holder that has blocks that can be swiveled, we generally recommend rolling male diamond patterns by using straight knurls set at 30° to part axis. This eliminates the need for bevels, and provides a gradual build-up and lead-out for better part finishes. Diagonal dies can produce straight knurls with the same benefits. Unfortunately, this method cannot be used if the knurling has to be done close to a larger shoulder on the part.
7. If you are knurling a "WIDE" pattern, you should be concerned about the amount of force required to roll up a full form. There are many ways to reduce these forces and avoid unnecessary loads on your machine's spindle bearings and lead screw. For "DIAMOND" knurling, using a straddle-type holder instead of a single "BUMP" knurl is one option that will greatly lower the forces on your machine. "STRAIGHT" knurling with a straddle holder however, sometimes results in a certain percentage of "DOUBLE-TRACKED" parts due to the fact that there is no connection between the two knurls as they each start their own track on the first revolution. Other options for reducing knurling forces are:

8. If none of the above tips solves your problems, please give us a call at 1-413-562-4800

Surface Speed to RPM Conversions

Work Diameter	Surface Speed (feet per minute)									
	50	60	70	80	90	100	110	120	130	140
1/16	3056	3667	4278	4889	5500	6112	6723	7334	7945	8556
1/8	1528	1833	2139	2445	2750	3056	3361	3667	3972	4278
3/16	1019	1222	1426	1630	1833	2037	2241	2445	2648	2852
1/4	764	917	1070	1222	1375	1528	1681	1833	1986	2139
5/16	611	733	856	978	1100	1222	1345	1467	1589	1711
3/8	509	611	713	815	917	1019	1120	1222	1324	1426
7/16	437	524	611	698	786	873	960	1048	1135	1222
1/2	382	458	535	611	688	764	840	917	993	1070