

Multi-Form Thread Mills are a fast way to threadmill a part. Since they use the entire length of cut in a helical interpolation environment, specific machining parameters are needed to avoid deflection and breakage. These tools can be used successfully in materials ranging from Aluminum up to and including Hardened Steels.

### Speeds & Feeds calculations:

1. Determine the correct SFM and Chip Load (IPT) for the cutter and material
2. Calculate the Speed (RPM) and Linear Feed (IPM)
3. Adjust Linear Feed to account for helical interpolation of internal or external threads
4. Determine correct number of radial passes at full axial depth

Example: Tool #V547751 to machine a 1/2-20 internal thread in 17-4 stainless steel

1. From Speeds & Feeds chart (next page), SFM is 200 and Chip Load (IPT) is .00101
2. Calculate Speed (RPM) and Linear Feed (IPM)

$$\begin{aligned} \text{RPM} &= (\text{SFM} \times 3.82) / \text{Cutter Diameter} \\ &= (200 \times 3.82) / .370 \\ &= 2065 \end{aligned}$$

$$\begin{aligned} \text{Linear Feed (IPM)} &= \text{RPM} \times \text{IPT} \times \text{Number of Flutes} \\ &= 2065 \times .00101 \times 4 \\ &= 8.3 \end{aligned}$$

3. Adjust Linear Feed (use Table 1 to determine Major Thread Diameter)

$$\begin{aligned} \text{Adj Internal Feed} &= [(\text{Major Thread Dia} - \text{Cutter Dia}) / \text{Major Thread Dia}] \times \text{Linear Feed} \\ &= [(.562 - .370) / .562] \times 8.3 \\ &= 2.8 \end{aligned}$$

$$\begin{aligned} \text{Adj External Feed} &= [(\text{Major Thread Dia} + \text{Cutter Dia}) / \text{Major Thread Dia}] \times \text{Linear Feed} \\ &= [(.562 + .370) / .562] \times 8.3 \\ &= 13.8 \end{aligned}$$

4. Determine Number of Radial Passes using Table 1

- For Easy Machinability = 1 Radial Pass at full Axial Depth
- For Moderate Machinability = 2 Radial Passes at full Axial Depth
- For Difficult Machinability = 2 Radial Passes at full Axial Depth

#### Definitions:

Easy Machinability materials include Non-Ferrous alloys and Lead Steels  
 Moderate Machinability materials include 200/300/400 Stainless Steels and Steels up to 35 Rc  
 Difficult Machinability materials include Inconel, Titanium and Steels 36-45 Rc

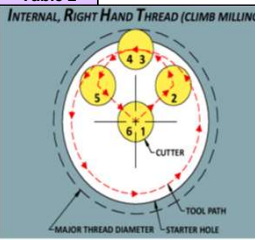
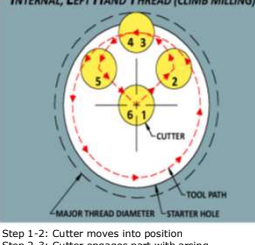
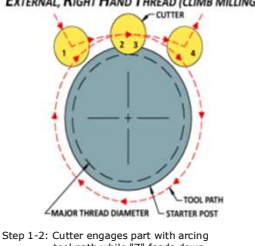
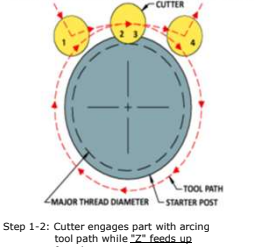
5. Conclusion

In this example, the tool would run at 2065 RPM, 2.8 IPM and make 2 Radial Passes

### Setup & Use:

1. Check software and input proper feed values (Linear or Adjusted)
2. Choke up on tool
3. Minimize runout (consider entire system of spindle, collet, holders etc)
4. Minimize all vibration (consider tool holding, work holding, rpm "sweet spot" etc)
5. To break in the tool, reduce feed rates by 75% on the on the first one to two holes
6. Cutter should engage part using an arcing toolpath to avoid shock loading (see Table 2)
7. Climb mill for best finish and tool life (see Table 2)
8. Flush chips with coolant to avoid recutting

| Table 1         | Thread Size | Major Thread Diameter | Number of Radial Passes |                        |                         |
|-----------------|-------------|-----------------------|-------------------------|------------------------|-------------------------|
|                 |             |                       | Easy Machinability      | Moderate Machinability | Difficult Machinability |
| 0-80            |             | 0.060                 | 2                       | 3                      | 4                       |
| 1-64            |             | 0.073                 | 2                       | 3                      | 4                       |
| 2-56            |             | 0.086                 | 2                       | 3                      | 3                       |
| 3-48            |             | 0.099                 | 2                       | 3                      | 3                       |
| 4-40            |             | 0.112                 | 2                       | 3                      | 3                       |
| 5-40            |             | 0.125                 | 2                       | 3                      | 3                       |
| 5-44            |             | 0.125                 | 2                       | 3                      | 3                       |
| 6-32            |             | 0.138                 | 2                       | 2                      | 3                       |
| 8-32            |             | 0.164                 | 2                       | 2                      | 3                       |
| 8-36            |             | 0.164                 | 1                       | 2                      | 2                       |
| 10-24           |             | 0.190                 | 2                       | 2                      | 3                       |
| 10-28           |             | 0.190                 | 1                       | 2                      | 2                       |
| 10-32           |             | 0.190                 | 1                       | 2                      | 2                       |
| 12-24           |             | 0.216                 | 2                       | 2                      | 3                       |
| 12-28           |             | 0.216                 | 1                       | 2                      | 2                       |
| 1/4-20          |             | 0.250                 | 2                       | 2                      | 3                       |
| 1/4-28          |             | 0.250                 | 1                       | 1                      | 2                       |
| 5/16-18         |             | 0.312                 | 2                       | 2                      | 3                       |
| 5/16-24         |             | 0.312                 | 1                       | 1                      | 2                       |
| 3/8-16          |             | 0.375                 | 2                       | 2                      | 3                       |
| 3/8-24          |             | 0.375                 | 1                       | 1                      | 2                       |
| 7/16-14         |             | 0.437                 | 2                       | 2                      | 3                       |
| 7/16-20         |             | 0.437                 | 1                       | 1                      | 2                       |
| 1/2-13          |             | 0.500                 | 2                       | 2                      | 3                       |
| 1/2-20          |             | 0.500                 | 1                       | 1                      | 2                       |
| 1/2-32          |             | 0.500                 | 1                       | 1                      | 2                       |
| 9/16-12         |             | 0.562                 | 2                       | 2                      | 3                       |
| 9/16-18         |             | 0.562                 | 1                       | 2                      | 2                       |
| 5/8-11          |             | 0.625                 | 2                       | 2                      | 3                       |
| 5/8-18          |             | 0.625                 | 1                       | 2                      | 2                       |
| 3/4-10          |             | 0.750                 | 2                       | 2                      | 3                       |
| 3/4-12          |             | 0.750                 | 1                       | 2                      | 2                       |
| 3/4-16          |             | 0.750                 | 1                       | 2                      | 2                       |
| 7/8-9           |             | 0.875                 | 2                       | 2                      | 3                       |
| 7/8-14          |             | 0.875                 | 1                       | 2                      | 2                       |
| 1-8             |             | 1.000                 | 2                       | 3                      | 4                       |
| 1-12            |             | 1.000                 | 2                       | 2                      | 2                       |
| 1-14            |             | 1.000                 | 2                       | 2                      | 2                       |
| <b>NPT/NPTF</b> |             |                       |                         |                        |                         |
| 1/16-27         |             | 0.312                 | 1                       | 1                      | 2                       |
| 1/8-27          |             | 0.405                 | 1                       | 1                      | 2                       |
| 1/4-18          |             | 0.540                 | 1                       | 1                      | 2                       |
| 3/8-18          |             | 0.675                 | 1                       | 1                      | 2                       |
| 1/2-14          |             | 0.840                 | 1                       | 2                      | 3                       |
| 3/4-14          |             | 1.050                 | 1                       | 2                      | 3                       |
| 1-11.5          |             | 1.315                 | 1                       | 2                      | 3                       |
| 2-11.5          |             | 2.375                 | 1                       | 2                      | 3                       |
| <b>METRIC</b>   |             |                       |                         |                        |                         |
| M2 x 0.40       |             | .079 (2mm)            | 2                       | 3                      | 4                       |
| M2.5 x 0.45     |             | .099 (2.5mm)          | 2                       | 3                      | 3                       |
| M3 x 0.50       |             | .118 (3mm)            | 2                       | 3                      | 3                       |
| M4 x 0.70       |             | .157 (4mm)            | 2                       | 2                      | 3                       |
| M4.5 x .75      |             | .177 (4.5mm)          | 1                       | 2                      | 2                       |
| M5 X .8         |             | .197 (5mm)            | 1                       | 2                      | 2                       |
| M6 X .75        |             | .236 (6mm)            | 1                       | 2                      | 2                       |
| M6 X 1          |             | .236 (6mm)            | 1                       | 2                      | 2                       |
| M8 X .75        |             | .315 (8mm)            | 1                       | 2                      | 2                       |
| M8 X 1.25       |             | .315 (8mm)            | 2                       | 2                      | 3                       |
| M10 X 1         |             | .394 (10mm)           | 1                       | 1                      | 2                       |
| M10 X 1.5       |             | .394 (10mm)           | 2                       | 2                      | 3                       |
| M12 X 1         |             | .472 (12mm)           | 1                       | 1                      | 2                       |
| M12 X 1.75      |             | .472 (12mm)           | 2                       | 2                      | 3                       |
| M14 X 1.5       |             | .551 (14mm)           | 1                       | 2                      | 2                       |
| M14 X 2.0       |             | .551 (14mm)           | 2                       | 2                      | 3                       |
| M16 X 1         |             | .630 (16mm)           | 1                       | 2                      | 2                       |
| M16 X 2.0       |             | .630 (16mm)           | 2                       | 2                      | 3                       |
| M18 X 1.5       |             | .709 (18mm)           | 1                       | 2                      | 2                       |
| M18 X 2         |             | .709 (18mm)           | 2                       | 2                      | 3                       |
| M20 X 2.5       |             | .787 (20mm)           | 2                       | 2                      | 3                       |

| Table 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
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| <p><b>INTERNAL RIGHT HAND THREAD (CLIMB MILLING)</b></p>  <p>Step 1-2: Cutter moves into position<br/>         Step 2-3: Cutter engages part with arcing tool path while "Z" feeds up from bottom<br/>         Step 3-4: Cutter moves helically one rotation<br/>         Step 4-5: Cutter exits part along arcing tool path while maintaining "Z" feed<br/>         Step 5-6: Cutter returns to center</p> <hr/> <p><b>INTERNAL LEFT HAND THREAD (CLIMB MILLING)</b></p>  <p>Step 1-2: Cutter moves into position<br/>         Step 2-3: Cutter engages part with arcing tool path while "Z" feeds down from top<br/>         Step 3-4: Cutter moves helically one rotation<br/>         Step 4-5: Cutter exits part along arcing tool path while maintaining "Z" feed<br/>         Step 5-6: Cutter returns to center</p> <hr/> <p><b>EXTERNAL RIGHT HAND THREAD (CLIMB MILLING)</b></p>  <p>Step 1-2: Cutter engages part with arcing tool path while "Z" feeds down from top<br/>         Step 2-3: Cutter moves helically one rotation<br/>         Step 3-4: Cutter exits part along arcing tool path while maintaining "Z" feed</p> <hr/> <p><b>EXTERNAL LEFT HAND THREAD (CLIMB MILLING)</b></p>  <p>Step 1-2: Cutter engages part with arcing tool path while "Z" feeds up from bottom<br/>         Step 2-3: Cutter moves helically one rotation<br/>         Step 3-4: Cutter exits part along arcing tool path while maintaining "Z" feed</p> |



**Product Table:** Thread Mills - Multi-Form  
**Characteristics:** UN, Metric, NPT, NPTF

**Hardened Steels:**

For 46-54 Rc:  
 130 SFM, 75% of IPT (from 29-37 Rc section)  
 3-4 Radial Passes at full Axial Depth

**For 55-60 Rc:**

80 SFM, 50% of IPT (from 29-37 Rc section)  
 4-5 Radial Passes at full Axial Depth

| Material Guide                         |                                                                                    | Hardness               | SFM      | Chip Load (IPT) By Cutter Diameter |        |        |        |        |        |        |        |        |        |        |        |
|----------------------------------------|------------------------------------------------------------------------------------|------------------------|----------|------------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
|                                        |                                                                                    |                        |          | 3/64                               | 1/16   | 5/64   | 3/32   | 1/8    | 3/16   | 1/4    | 5/16   | 3/8    | 1/2    | 5/8    | 3/4    |
| Carbon Steel                           | 10XX, 11XX, 12XX, 12LXX, ASTM A27, ASTM A36                                        | 29-37 Rc (279-344 HBn) | 550      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00067 | .00090 | .00125 | .00150 | .00200 | .00250 | .00300 |
| Low Alloy Steel                        | 13XX, 41XX, 43XX, 51XX, 86XX, 93XX                                                 | 29-37 Rc (279-344 HBn) | 450      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00067 | .00090 | .00140 | .00169 | .00225 | .00281 | .00338 |
| Tool Steel                             | A, L, O, P, W series                                                               | 29-37 Rc (279-344 HBn) | 325      | .00012                             | .00016 | .00021 | .00025 | .00033 | .00049 | .00066 | .00110 | .00132 | .00176 | .00220 | .00264 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 200      | .00011                             | .00014 | .00018 | .00021 | .00028 | .00042 | .00056 | .00093 | .00112 | .00150 | .00187 | .00224 |
|                                        | D, H, M, T, S series                                                               | 29-37 Rc (279-344 HBn) | 225      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00045 | .00060 | .00100 | .00120 | .00160 | .00200 | .00240 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 180      | .00010                             | .00013 | .00016 | .00019 | .00026 | .00038 | .00051 | .00085 | .00102 | .00136 | .00170 | .00204 |
| Austenitic Stainless Steel             | Nitronic 50, Nitronic 60, 301, 303, 304, 304L, Incoloy 27-7MO, 316, 316L, 321, 347 | 29-37 Rc (279-344 HBn) | 400      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00067 | .00090 | .00140 | .00169 | .00225 | .00281 | .00338 |
| Martensitic & Ferritic Stainless Steel | 403, 410, 416, 420, 440, 430, 446                                                  | 29-37 Rc (279-344 HBn) | 350      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00067 | .00090 | .00125 | .00150 | .00200 | .00250 | .00300 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 200      | .00011                             | .00014 | .00018 | .00021 | .00028 | .00042 | .00056 | .00093 | .00112 | .00150 | .00187 | .00224 |
| PH Stainless Steel                     | 15-5, 17-4, Carpenter 450, Carpenter 465                                           | 29-37 Rc (279-344 HBn) | 200      | .00011                             | .00015 | .00019 | .00022 | .00030 | .00045 | .00060 | .00100 | .00120 | .00160 | .00200 | .00240 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 160      | .00010                             | .00013 | .00016 | .00019 | .00026 | .00038 | .00051 | .00085 | .00102 | .00136 | .00170 | .00204 |
| Nickel Alloy                           | Hastelloy C-22, Inconel 625, Waspaloy, René 41, Inconel 718, Incoloy 20            | 29-37 Rc (279-344 HBn) | 90       | .00010                             | .00014 | .00017 | .00020 | .00028 | .00041 | .00055 | .00081 | .00098 | .00130 | .00163 | .00195 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 70       | .00009                             | .00012 | .00015 | .00017 | .00023 | .00035 | .00047 | .00069 | .00083 | .00111 | .00138 | .00166 |
| Titanium Alloy                         | Ti 3Al-2.5V, Ti 6Al-4V, Ti 10V-2Fe-3Al                                             | 29-37 Rc (279-344 HBn) | 275      | .00012                             | .00016 | .00021 | .00025 | .00033 | .00049 | .00066 | .00096 | .00116 | .00154 | .00193 | .00231 |
|                                        |                                                                                    | 38-45 Rc (353-421 HBn) | 150      | .00011                             | .00014 | .00018 | .00021 | .00028 | .00042 | .00056 | .00082 | .00098 | .00131 | .00164 | .00196 |
| Wrought Aluminum Alloy                 | 2014, 5062, 6061, 7050, 7075, 7475                                                 | ≤ 28 Rc (≤ 271 HBn)    | 1200     | .00015                             | .00020 | .00025 | .00030 | .00040 | .00084 | .00113 | .00172 | .00206 | .00275 | .00344 | .00413 |
|                                        | 5% - 8% Si (4XXX)                                                                  |                        | 1000     | .00014                             | .00018 | .00022 | .00027 | .00036 | .00076 | .00101 | .00154 | .00186 | .00248 | .00309 | .00371 |
|                                        | 8% - 12% Si (4XXX)                                                                 |                        | 800      |                                    |        |        |        |        |        |        |        |        |        |        |        |
| Cast Aluminum Alloy                    | 319.0, 328.0, 355.0, 360.0, 380.0, 383.0, 390.0, 520.0, 535.0                      | ≤ 28 Rc (≤ 271 HBn)    | 750      | .00015                             | .00020 | .00025 | .00030 | .00040 | .00084 | .00113 | .00172 | .00206 | .00275 | .00344 | .00413 |
|                                        | 3% - 5% Si (3XX, A3XX, C3XX, 4XX, A4XX, B4XX)                                      |                        | 750      |                                    |        |        |        |        |        |        |        |        |        |        |        |
|                                        | 5% - 8% Si (3XX, A3XX, C3XX, 4XX, A4XX, B4XX)                                      |                        | 700      | .00014                             | .00018 | .00022 | .00027 | .00036 | .00076 | .00101 | .00154 | .00186 | .00248 | .00309 | .00371 |
|                                        | 8% - 12% Si (3XX, A3XX, C3XX, 4XX, A4XX, B4XX)                                     |                        | 650      |                                    |        |        |        |        |        |        |        |        |        |        |        |
|                                        | 12% - 16% Si (3XX, A3XX, C3XX, 4XX, A4XX, B4XX)                                    |                        | 475      |                                    |        |        |        |        |        |        |        |        |        |        |        |
| Copper Alloy                           | Cu-ETP, CuBe2, CuZn30, CuZn36Pb3, CuZn10, CuSn5                                    | ≤ 28 Rc (≤ 271 HBn)    | 450-1000 | .00014                             | .00019 | .00024 | .00029 | .00038 | .00068 | .00091 | .00144 | .00173 | .00231 | .00288 | .00346 |
| Magnesium Alloys                       |                                                                                    | ≤ 28 Rc (≤ 271 HBn)    | 1500     | .00015                             | .00020 | .00025 | .00030 | .00040 | .00084 | .00113 | .00172 | .00206 | .00275 | .00344 | .00413 |
| Zinc Alloys                            |                                                                                    |                        | 800      |                                    |        |        |        |        |        |        |        |        |        |        |        |

**General Notes:**

All posted speed and feed parameters are suggested starting values that may be increased given optimal setup conditions. Chip loads reflect uncoated cutters and may be increased 5%-10% if coated. For ferrous materials with hardness ≤ 28 Rc, chip loads can be increased 3%-5%.

If you require additional information, Valor Holmaking has a team of technical experts available to assist you through even the most challenging applications. Please contact us at **866-840-1505** or **Valortech@harveyperformance.com**.

WARNING: Cutting tools may shatter under improper use. Government regulations require use of safety glasses and other appropriate safety equipment in the vicinity of use.