Principles of Fabrication for Ferro-Tic Alloys®

Planning the Work

It is unnecessary and uneconomical to allow excessive stock for grinding after hardening.

Ferro-Tic alloys move very little during heat treatment because of the stable carbides in their structure.

Since stock removal is more rapid on annealed material, where possible all machining and grinding should be done in this condition. Where very close tolerance must be maintained, sufficient stock should be allowed for removal after hardening.

Slender parts or thin walled rings can be heat treated with minimal distortion. In the annealed state they should be machined to .010" - .015" over the heat treat size, stress relieved, then machined to the heat treat size and hardened.

Basic Machining Principles

- Cutting speed must be slow.
- Tools must be sharp and dry. Remove all oil before use.
- Do not use cutting fluids.
- Maintain a heavy chip load – minimum .003" per cutting edge.
- Heavy depth of cuts can be taken.

If material starts to glaze, check tool for wear or chipped edges. If problem persists reduce cutting speed.

The following are specific recommendations for the more common chip removal operations:

LATHE TURNING

Tool Geometry: 0-5° negative back rake, 5° side rake, .030" nose radius
Tool Material: Tungsten Carbide (C-2 class)
Tool Setting: Slightly below center
Depth of Cut: .050" to .100"
Feed Rate: .003" to .012" per revolution
Cutting Speed: 35 SFM
Coolant: None

MILLING

Tool Material & Type:
Solid or brazed insert cutters:
Tool Material: High Speed Steel, Tungsten Carbide or Cobalt
Indexable insert cutters:
Tool Material: Tungsten Carbide (C-2 class)
Tool Geometry**:** Double negative rake, with a large lead angle
Depth of Cut: .010" to .050"
Feed Rate: .003" to .012" per cutting edge per revolution
Cutting Speed: 35 SFM
Coolant: None

REAMING

Tool Geometry: Straight or spiral flute
Tool Material: Carbide or carbide tipped
Stock Allowance: .004" per side minimum
Feed Rate: .002" to .004" per revolution
Cutting Speed: 45 SFM
Coolant: None

DRILLING

Holes 1/8" diameter and larger
Tool Material & Type: H.S.S. or Cobalt, 118° split point
Feed Rate: .002" to .010" per revolution
Cutting Speed: 20 SFM

Holes under 1/8" diameter: EDM preferred

SAWING

Tool Geometry: 3 to 10 pitch blade, raker set
Tool Material: Hard back carbon steel or high speed steel bi-metal
Feed: Medium to heavy pressure
Cutting Speed: 30 SFM
Coolant: None

TAPPING

Tool Material & Type: 5 Flute High Speed Steel
Procedure: Drill for a 50% thread (see chart).

- Assure straight tap entry by using a fixture.
- Apply an anti-seize compound* to the tap.
- For through holes, tap through in a steady motion. Do not back off.
- Blow chips away with an air blast.
- For blind holes, back off to remove chips before bottoming out.
- Keep length of thread to a minimum by relieving or counterboring. A thread length of 1 ½ times the diameter is sufficient.

*Bostik Never-Seez

Drill Selection and Speed for 50% Thread

Thread Size	Drill Size	Drill Speed RPM
8-32	#27	530
8-36	#26	520
10-32	#18	450
¼-20	7/32	350
¼-28	#1	330
5/16-18	J	275
5/16-24	9/32	270
3/8-16	Q	230

GRINDING

Flat or Form Grinding

Wheel Type: Relatively soft, open structure, vitrified bond, aluminum oxide.

Type of Grinding	Wheel Grade	Coolant	Table Speed (fpm)	Cross Feed (in.)	Down Feed (in.)
Annealed	A80G	Flood	50-60	.010-.015	.0005-.001
Hardened	A80G	Flood	50-60	.010-.015	.0005-.001
Form Grinding	A80G	Flood	50-60	-	.0002-.0005
Fine Form	A120G	Flood	50-60	-	.0002-.0005
Inner Corners	A150K	Flood	50-60	-	.0002-.0005

O.D. Grinding

Material Condition	Wheel Speed (fpm)	Work Speed (fpm)	Infeed In./pass	Traverse Rate (wheel width per rev.)	Wheel Type
Annealed or Solutionized	4000 To 6000	40 To 60	Rough: .001 Finish: .005 max.	1/6 1/12	Diamond or CBN
Aged or Hardened	5500 To 6500	40 To 50	Rough: .001 Finish .0002 max.	1/5 1/10	Diamond or CBN

I.D. Grinding

Material Condition	Wheel Speed (fpm)	Work Speed (fpm)	Infeed In./pass	Traverse Rate (wheel width per rev.)	Wheel Type
Annealed or Solutionized	4000 To 6000	50 To 150	Rough: .0005 Finish: .0002 max.	1/3 1/6	Diamond or CBN
Aged or Hardened	1200 To 1500	30 To 50	Rough: .001 Finish .0003 max.	1/3 1/6	Diamond or CBN

HONING

Diamond stones are used for honing annealed or hardened Ferro-Tic, to obtain the surface finishes below:

Grit Size	150	220	400	600
Microfinish	30	20	7	3-4

Surface Finishing

Lapping and Polishing

For drawing, wiping or forming tools, working surfaces must be lapped or polished to remove any broken carbides or smeared metal resulting from grinding. First rough lap with a coarse (D400) diamond grit to remove grinding marks. Work at a slow speed of 30 SFM or less and apply light pressure. Next, use a medium (D600) grit to remove scratches and lapping marks from the previous operation. Finish lap with a fine (D1200) grit to produce a scratch free, smooth surface. Whenever possible, lapping should be performed prior to hardening.

Final Buffing

To obtain a slight relief of the hard, rounded titanium carbide micrograins for maximum lubricity and resistance to galling, buffing with a 1.0 micron alumina slurry following the final lapping step is required.

Alumina powder is mixed with water to form a thick slurry. Apply the slurry to heavy felt or felt backed up by soft wood. Using heavy hand pressure, buff the workpiece until the polished surface takes on a milky or cloudy appearance. The carbides are now in relief and the tool is ready for production.

Electrical Discharge Machining (EDM)

Standard electrode materials can be used. Ferro-Tic can be machined up to 4 times faster than tungsten carbide with a 4:1 improvement in electrode wear.

If extremely close tolerances are required, make a finishing cut after hardening at the lowest possible power setting. After the finish EDM cut, quench-hardenable grades should be re-tempered at the last tempering temperature used in the original heat treatment.

Wire EDM provides an excellent surface finish at cutting rates similar to that of hardened D-2 tool steel and about twice as fast as tungsten carbide. Starter holes can be easily drilled in the annealed Ferro-Tic. The heat affected surface layer is very thin. Wire EDM of hardened material is generally satisfactory.

Joining

Due to its machinablility and strength, it is preferable to use mechanical methods of joining Ferro-Tic to backing members (i.e. bolt holes, threads, dovetails, etc.)