

## Processing Parameters

- NitroSteel® tube and bar products machining characteristics are the same as the base metal being used. 10V45, 4130, St52.3 are typical base materials and would machine in a similar fashion. The hardened surface wear layer and light shallow case of NitroSteel®'s diffusion zone requires standard carbide tooling.
- Ceramic tools are not needed.
- Once through the hard, thin surface, high-speed tooling can be used if preferred. NitroSteel® products are highly polished so hard steel chucks, collets, or vises should be avoided. Brass, bronze plastics or soft composites are commonly used.
- This is case-hardened material. Like any hardened steel, 90° corners and sharp leading edges should be rounded. Oblique angles (rounded corners) should be applied to the edges of cross-drilled holes. Remove the hardened surface layer prior to cross drilling.
- When sawing NitroSteel® products, carbide toothed blades work well and give significantly better saw blade life compared to high speed steel blades. Abrasive cut off wheels work very well.
- As with chrome plated products, saw cutting in fiber tubes (card board packaging sleeves) helps eliminate handling damage but water soluble cutting fluids can soak the cardboard and release paper acids that can cause corrosion. Wet fiber tubes must be removed from the steel.
- Be aware that one end of each length of steel has a small cross-drilled hole. This hole is used to hang steel in the furnace and should be avoided by saw blades and machining tools. The cross-hole is within 1" on one end of each bar.

## Welding

- NitroSteel® products are being welded in the same fashion as chrome plated steel. As with chrome plate, the laying of a weld bead directly on the wear surface should be avoided.
- The nitrogen-enriched surface should be removed at the weld site (machine, chamfer or grind) so as to create a groove for the weldment ("J" groove).
- The vast majority of NitroSteel® processing is done to medium carbon steels so welding techniques suitable for the specific grade of steel should be utilized. NitroSteel® treated products are ideally suited for friction/inertia welding.
- Like chrome, a heat affected zone 1/8" to 1/4" immediately adjacent to the weld site can reduce both hardness and corrosion resistance. This area is not considered a wear site and is usually painted along with the clevis or rod end.

## Wear Characteristics

- The high surface hardness of NitroSteel® products (64 Rc to 71 Rc), the surface smoothness (16 Ra max.), and the layer depth (0.001") gives the product exceptional wear resistance.
- The iron nitride wear layer is generated so as to create an outer surface with controlled columnar porosity (micro-porosity). This micro-porosity, which extends to approximately half the nitride layer depth, creates an excellent oil bearing or oil-retaining surface. The ability of the NitroSteel® surface to carry oil significantly improves "slip" characteristics and reduces overall friction.
- The nature of the NitroSteel® furnace treatment and the creation of the columnar micro porosity eliminates the "too smooth" concern. NitroSteel® products will have a surface Ra range of 8 Ra to 16 Ra max.
- Product wear is further enhanced by the dimensional uniformity of NitroSteel® bars. NitroSteel® products are free of high and low spots common in chrome plating. Layer depth is consistent side-to-side and end-to-end.

## Corrosion Resistance

- NitroSteel® products are inherently more corrosion resistant than chrome plated. No corrosion will be evident in NitroSteel® samples tested to 150 hours of ASTM B-117 Neutral Salt Spray. The outstanding corrosion resistance stems from a synergy of three unique characteristics of the NitroSteel® surface:
  1. The iron nitride wear layer is a true “non-metallic” and exhibits excellent corrosion resistance.
  2. A black iron oxide film then permeates the nitride layer’s porous zone, which effectively seals the surface. Iron oxide, having already been oxidized, is extremely corrosion resistant.
  3. The porous outer surface helps carry oil, which contributes to lubricity, reduces wear and further adds to corrosion resistance.
  4. When you machine the OD or ID surface and expose bare metal you lose your corrosion and dent resistance in these areas. Typical treatments of these exposed areas are divided into several categories.
    - A. Engineering/Design. The bare surface is covered by a mating part or placed inside the cylinder in a non-corrosive environment.
    - B. Coating. Areas left exposed to the elements are generally coated with a good quality epoxy paint.

## Salt Spray Testing

- NitroSteel®’s corrosion resistance can be readily documented by neutral salt spray testing. The following applies to NitroSteel® sample preparation for neutral salt spray testing.
- (From ASTM B-117) *Specimens shall be suitable cleaned. The cleaning method shall be optional depending on the nature of the surface and the contaminants (B-117. 6.3).*
- Because NitroSteel uses an oil emulsion quench as part of the patent process, vapor degreasing is not a suitable cleaning methodology. The oil emulsion is over 80% water and cleans easily and completely with de-ionized water.
- (From ASTM B-117) *Specimens coated with paints or nonmetallic coatings shall not be cleaned or handled excessively prior to test (B117. 6.3).*
- The patented Nitrotec process forms nonmetallic layer of Iron Nitride ( $Fe_3N$ ) as the wear layer. De-ionized water is the preferred cleaning methodology for removing surface oil. Independent testing laboratories routinely use this method for cleaning prior to testing. The uses of distilled solvents (i.e. acetone, etc.) are not considered acceptable cleaning agents for nonmetallic surfaces.
- Acetic acid salt spray (ASTM B-287) and copper accelerated acetic acid salt spray (ASTM B-368) are not appropriate corrosion test methodologies for NitroSteel products (or chrome plate).

## Additional Application Considerations

- NitroSteel® should not be used in environments above 500° Fahrenheit (260° Celsius).
- NitroSteel® processed products are not suitable for field repairs (i/e/ patch plating). However, to salvage a rod, the iron nitride layer can be ground down and the rod plated to size.
- Being a surface hardened product, NitroSteel® bars and tubes are not suitable for bending.
- As with chrome plate, NitroSteel® surfaces are not resistant to sulfuric or hydrochloric acids (commonly used to etch steel).