

NOTES: TITANIUM COIL SHAVING-POLISHING AND SMALL DIAMETER COIL TO BAR PROCESSING

Hetran has supplied more coil to coil shaving and polishing lines and bar peeling and polishing machines to titanium producers than any other finishing machine manufacturer. Hetran has a 40 year history of supplying these type processing lines to North American titanium bar and coil processors.

Also, personally, I am very familiar with titanium coil to coil, coil to bar, and bar to bar processing given my 15 years time as Managing Director of Shalmet Corporation, a major convertor of titanium bar and coil for ATI, Timet, and Dynamet. Additionally, I have visited on numerous occasions practically all the USA based titanium processors and this exposure has added to my know-how.

There are many titanium alloys. Ti 6-4 Titanium (Titanium with 6% Aluminum and 4% Vanadium added as alloying elements) and CP (**C**ommercially **P**ure, i.e., low interstitial) are two of the most common. Ti 6-4 is commonly used in aerospace and in many other applications including golf clubs and face shields for hockey goalies and American football facemasks for players. Many times CP is used for medical implants.

Titanium has unique physical properties that must be considered when cold finishing the product. It has extraordinary corrosion resistance, high tensile and yield strength, very poor thermal conductivity, yet elasticity and yield can significantly be improved by heating (most titanium alloys) to relatively low temperatures (600-800 degrees Fahrenheit) without inducing a structural transformation.

Generally speaking, the processing speeds, including the peeling and grinding (polishing) surface speeds in machining must be slower than those used for processing other metals. Cold drawing of titanium is not possible with standard soap and grease lubricants.

The cold finish processing methods and equipment design features for straightening, peeling, polishing, grinding and drawing of titanium typically are different from those used for stainless and super-alloys.

Hetran has supplied more bar and coil shaving machines to North American producers than all other machine builders combined. you will recognize these producers and processors: Dynamet, Perryman, ATI, Timet, and Tech Spec.

Dynamet and Perryman, with production facilities in Pennsylvania and Florida, are very competent producers of precision shaved and polished coils, coil to bar products and larger bars to (125mm). Combined they have at least 12 Hetran coil to coil shaving polishing lines (none from other machine producers) and six bar to bar processing lines (also 100% supply from Hetran). Dynamet and Perryman are leading suppliers of precision turned and polished coils and precision ground small diameter bar from coil for aerospace and medical implant applications.

Hetran is a major supplier of coil to coil, coil to bar and bar to bar peeling and polishing machines also to Russian and the UK titanium processors.

Titanium processors know that processing methods to finish titanium coil and bar are not widely understood and generally they are extremely protective of this technology. Seldom will they allow visitors to see their finishing facilities and methods.

REGARDING COIL TO COIL PROCESSING

It is not possible to die shave these alloys as the required surface speeds are much too high for titanium and for the carbide cutting tools. Die shaving ("broaching") cutting tool failure is almost instantaneous if titanium is processed. Only rotary style peeling is possible as the surface speeds can be varied. Hetran has been the leading supplier of these machines. Coolant flow and pressure, cutting tool geometry, chip clearance, spindle speed and tool holder design in the spindle assembly are special.

The coil to coil shaving (peeling) process requires abrasive polishing capability in-line between the peeling head and the take-up. Hetran planetary polishers are ideal for this application and are the standard for the titanium industry. No one who truly understands titanium coil to coil shaving or customer requirements would attempt peeling titanium coil to coil without polishing in-line.

Casting the coil dead and simultaneously avoiding surface marking during take-up requires special features due to the high strength. Coil to coil shaving is readily done in sizes up to 13 mm and is done with care as small as 2.5mm. Coil to coil shaving much above 15 mm is impractical and instead bar to bar processing is desirable.

Line speed is dictated by the tolerance to be attained. It is possible to make ultra precision diameter tolerances on the Hetran coil to coil shavers and polishers as close as +/- 0.0076 mm and where the finish is mirror smooth and reflective but the line speed will be slow as low as 2.0 m/minute, or even slower depending upon diameter. Laser gauging is a must. A roughing pass may be needed before peeling the coil to finish.

Peeling titanium coils to +/- 0.07mm or more liberal tolerances is done at much higher line speeds. Coil to coil shaving and polishing of decent quality 10mm titanium rod (not excessively out of round) with 0.05 mm removal from the diameter can be done on grade 2 or 5 coils at line speeds as high as 6 meters/minute or more.

Titanium has erratic “spreading” characteristics. During hot rolling the rod often times becomes significantly out-of-round. It is not uncommon to have hot rolled coils that are 0.5 to 1.0 mm out- of- round. In these cases, a peeling “roughing” pass to round up the coil on the coil shaver is recommended before peeling to finish.

If drawing is to be done, the drawing lube must be totally dry. Typically the coil payoff is enclosed in a “furnace” where it is heated to assure the lube is totally dry. Lubers with graphite and/or moly di-sulfide are typically required.

REGARDING COIL TO BAR & BAR TO BAR PROCESSING

Some coil to bar processors feel it is necessary to heat coils to enhance straightening. Generally, Hetran coil to bar machines are designed to eliminate this requirement. Our equipment design and our coil to bar processing know how enables Hetran machines to convert a hot rolled coil into a standard tolerance (H-10, H-11) bar by uncoiling, straightening, peeling, rough polishing, cutting to length, 2-roll burnishing, then finish polishing in one continuous coil to bar process. As a general rule, this process methodology is reliably performed on grade 2 and 5 titanium alloys in finish diameters between 7 and 13.0 mm. IT produces a bar that is directly comparable to a standard quality centerless ground bar but with much higher processing efficiencies.

If precision ground bars (like +/- 0.0076mm) are required coil to bar in this size range, it is necessary to use a centerless grinder to finish the bars from the coil to bar machine. Typically one, and certainly no more than two finish grinding passes are required to make the finish precision ground bar from the H-10 or H-11 bar from the coil to bar machine. It is highly recommended to have a small press straightener to “bump” straighten some of the bars made coil to bar that may have a slight out of straightness condition that could interfere with precision grinding. This optimizes the yield of precision ground small diameter bars that are processed coil to bar.

Hetran has working arrangements with a company that supplies fully remanufactured Cincinnati Twin Grip centerless grinders including automatic size compensation that are ideal for precision centerless grinding requirements and are very affordable in comparison to buying a new machine.

Hetran has an arrangement with a precision press straightener company that builds these relatively small inexpensive “bump” straighteners. Bars can easily be checked for straightness by rotating and traversing the bar across the straightener and measuring the TIR straightness, press straightened, and rechecked along the entire length of the bar. Bars can easily be straightened to 0.06mm TIR along the entire length of the bar with these special straighteners, thereby assuring that bars can be precision centerless ground. The occasional bump straightening of bars from the coil to bar line that may be required can be done by the centerless grinder operator as he is doing the grinding.

For larger diameters, one should consider bar to bar processing.

Generally, Hetran processing lines for processing cold finish titanium bar to bar are sized 12 to 32mm, 20 to 50mm, 35 to 75mm, and include black bar straightening (bars must be heated for black bar straightening), peeling, 2-roll burnishing and, abrasive belt polishing. These processes produce centerless ground equivalent bars with higher efficiencies and yields than is possible via the standard turning and centerless grinding methodology. Tolerances achieved in these Hetran bar processing cells are H-10, H-11. If tighter tolerances are required, centerless grinding bars from the bar-to-bar process from a very small oversize is recommended.

Hetran also builds turn and polish machines for peeling larger titanium bar up to 650 mm diameter. Hetran has extensive experience in processing large diameter bar for aerospace applications where the peeled and polished bar must have a very smooth and uniform bar surface for immersion UT evaluation. Hetran routinely supplies all the processing machines for these large bar peeling and polishing lines including the handling equipment required for the ultrasonic testing machinery itself. The UT equipment per-se is supplied by other vendors with whom we have working arrangements. Typically Hetran integrates their testing machines into the processing line.

SUMMARY

Hetran has extensive experience and know how regarding titanium coil to coil, coil to bar and bar to bar finishing. Clearly we are well positioned.

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