



## Comparison of Tantalum Shell and Tube Heat Exchangers to Graphite Heat Exchangers for Steel Pickling Applications

ITEM	CARBON BLOCK HEAT EXCHANGER	TANTALUM HEAT EXCHANGER
<b>Material Of Construction</b>	Resin impregnated carbon with carbon steel shell	Tantalum with carbon steel shell
<b>Basic Construction</b>	Graphite blocks gasketed together to form heat exchanger	Fully welded metal design forms a monolithic piece of equipment with no potential spare parts required.
<b>General Thermal Design Concept</b>	Utilize the customer specifications to maximize the acid velocity through the heat exchanger while not to cause erosion of the blocks.	Take customer design acid flow to calculate a tantalum tube count that maximizes acid velocity to maximize heat transfer and minimize heat transfer surface area required (reducing the cost of the heat exchangers and making the heat exchanger operate considerable longer than graphite heat exchangers between cleanings.
<b>Typical Equipment Life Expectancy</b>	2 – 4 Years (Including repairs)	8 – 10 Years (No repairs usually required)
<b>Acid Flow Hole Diameter</b>	Typically .3125" - .625"	.72"
<b>Thermal / Mechanical Shock</b>	Mechanical shock is a common problem with carbon block heat exchangers because the fragile nature of the graphite used and the gasketed mechanical design of a carbon block heat exchanger. The mechanical shock caused by water hammer cause blocks to break causing excessive downtime and increased unnecessary maintenance.	Tantalum is immune to thermal and mechanical shock. The fully welded metal design resists damage that causes carbon block heat exchanger to fail.
<b>Gasket Leaks</b>	A carbon block heat exchanger is designed using multiple graphite blocks stacked on top of one another with gaskets in between to seal the acid. Carbon block heat exchanger often leak acid into the shellside of a heat exchanger which causes severe corrosion in the heat exchanger shell, condensate piping and boiler tube.	A tantalum heat exchanger utilizes a fully welded metal design that has no gaskets to leak.

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## METAL FINISHING

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<b>Corrosion Resistance</b>	Graphite as a material is very corrosion resistant to acid but it is porous by nature. In order to seal the graphite pores so they don't leak pressure they impregnate the graphite with phenolic resin.	Tantalum is a reactive metal meaning it has a continuously regenerating oxide layer that is a ceramic. This oxide layer is completely corrosion resistant to hydrochloric and sulfuric acid that are used in carbon steel pickling. Tantalum does not corrode at all in hydrochloric / sulfuric acid pickling applications.
<b>Erosion Resistance</b>	Erosion can be a problem if acid velocities exceed more than 3 meters / second	Tantalum is a reactive metal meaning it has a continuously regenerating oxide layer that is a ceramic. Tantalum is immune to erosion at any acid velocity common in shell and tube heat exchanger design. This erosion resistance allows us to utilize acid flows almost twice of what is allowable in graphite.
<b>Fouling / Plugging</b>	The phenolic resin used to impregnate the carbon block has a thermal expansion rate much higher than the graphite it is impregnating. As the heat exchanger heats up and cools down this resin flakes from the surface similar to water freezing on roads causing potholes. This increased roughness causes the acid to stick to the side of the hole. This fouling causes decreased heating capability as well as will fully plug fairly quickly. As the heat exchanger gets older the time in between cleanings greatly shortens causing the heat exchanger cleaning to be more frequent.	The tantalum tubing used in tantalum shell and tube heat exchangers is very smooth and remains smooth because of its continuously regenerating oxide layer. Tantalum heat exchangers typically go several years without the need of cleaning because of the characteristics of the tantalum tubing.
<b>Heat Exchanger Cleaning</b>	The cleaning of a graphite heat exchanger usually consists of totally disassembling the graphite heat exchanger (see diagram attached). Drilling out the plugged holes and cleaning the ones that are fouled by using methods that do not cause erosion on the graphite blocks / domes. Replacing all the gaskets during reassembly. This can take between 2 – 5 days depending on how dirty the heat exchanger is and how easy the gaskets seal during reassembly. Special care needs to be taken not to over tighten bolts and break graphite blocks / domes but get gaskets to seal.	Remove the tantalum heat exchanger from the piping. You have full access to the tubes for cleaning. Use a high pressure heat exchanger cleaning water lance (20 – 40,000 psi). This will allow you to clean the heat exchanger to a "like new" tube inside diameter condition. Usually removal, cleaning and reinstallation takes less than 6 – 8 hours. If you have this cleaned by heat exchanger cleaning company it costs between \$900 – 1500 USD (Much less in countries like India / China).
<b>Testing Prior to Shipment</b>	Hydrostatic testing	Dye Penetrant, Helium Leak Testing, Hydrostatic Testing
<b>Handling and Installation</b>	Graphite heat exchangers are considerably bigger and heavier than and are more prone to damage and leaks during handling and installation	Tantalum heat exchangers are a fully welded metal heat exchanger that can be handled like any other metal heat exchanger. Tantalum heat exchangers are immune to damage during handling and installation
<b>Heat Exchanger Operation</b>	New graphite heat exchangers usually need cleaning within the first year and more frequently the older the heat exchangers get. Repair or graphite block / graphite dome replacement is common within 12 – 18 months	Under normal operating conditions a tantalum heat exchanger requires cleaning every 18 – 24 months. So tantalum heat exchangers have operated for as long as 36 months without needing cleaning.

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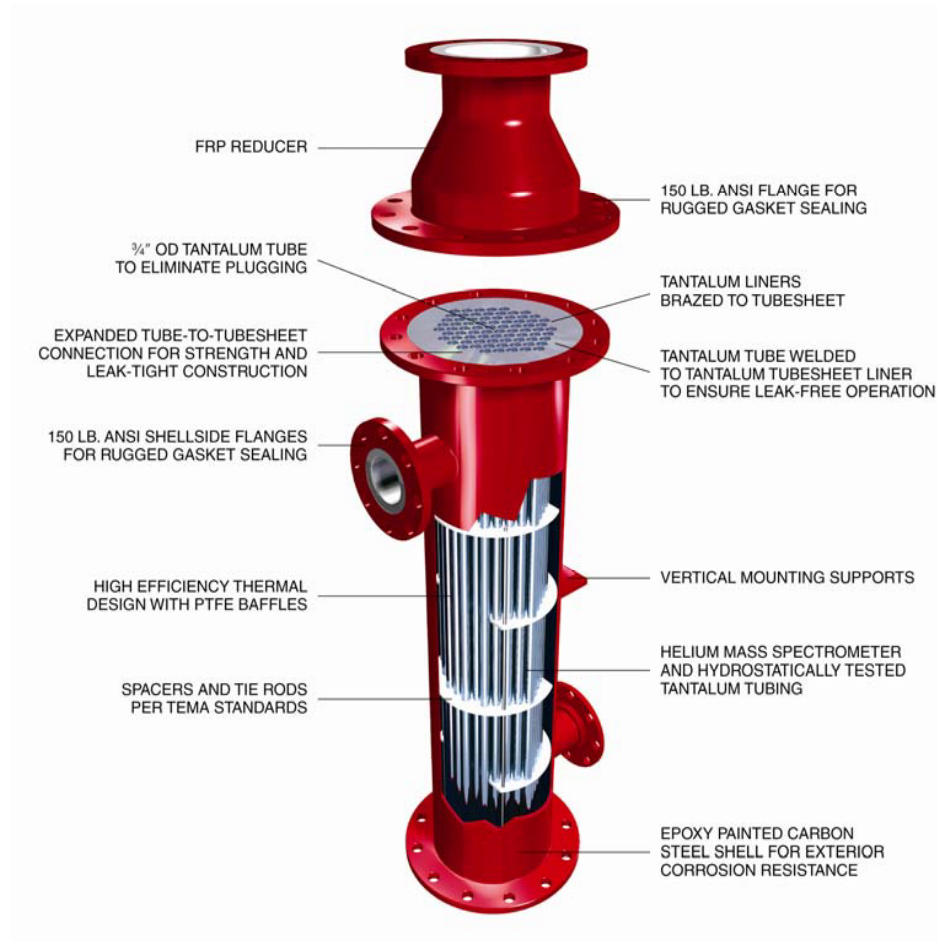
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General Comparison	Prior to the introduction of tantalum heat exchangers, carbon block heat exchangers offered a cost effective solution to heating steel pickling baths with consistent maintenance, repair and attention during operation	<p>The introduction of tantalum heat exchangers have proven to eliminate maintenance and downtime as well as increase productivity because tantalum heat exchangers stay clean longer. A tantalum heat exchanger is typically cost competitive with graphite heat exchangers manufactured in North America and Europe. Most of the world's leading steel manufacturers and steel engineering companies utilize tantalum heat exchangers. Some of the companies using tantalum are as follows representing hundreds of tantalum heat exchanger installations supplied by TITAN Metal Fabricators, Inc.:</p> <p><b><i>US Steel Corporation</i></b>  <b><i>Nucor Steel</i></b>  <b><i>ThyssenKrupp Steel</i></b>  <b><i>ArcelorMittal Steel</i></b>  <b><i>SMS Siemag</i></b>  <b><i>Siemens VAI</i></b>  <b><i>Nelson Steel</i></b>  <b><i>Worthington Steel</i></b>  <b><i>Beakart</i></b>  <b><i>SSAB Tunplat A.B.</i></b>  <b><i>Usiminas</i></b>  <b><i>Altos Hornos De Mexico</i></b>  <b><i>Severstal North America</i></b>  <b><i>Kenwal Steel</i></b>  <b><i>Tokyo Steel</i></b>  <b><i>Dufurco S.A.</i></b>  <b><i>APM</i></b></p>

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### Features and Benefits of a Tantalum Shell and Tube Heat Exchanger For Steel Pickling



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## **METAL FINISHING**

### **Design Attributes of Graphite Block Heat Exchangers**

