The Economic Advantages of Carbon Steel + Titanium Clad Lining Systems

At the onset of a project, engineering teams, and the clients they serve, in the hydrometallurgy and chemical process industries have an important decision to make: what lining system best suits their final design requirements? The answer to this materials-based question can provide long-term savings, especially if these teams are open to ***titanium clad lining systems*** (titanium clad) to fulfill their clients' objectives.

The global hydrometallurgy and chemical process industries have long relied on pressure oxidation autoclaves, made from special metal or lining systems, to protect vessels against corrosion, high temperatures and abrasion. ***Cladded vessels***, consisting of titanium or other corrosion-resistant metal bonded to a carbon steel shell, and refractory linings, with corrosion- and chemically resistant membranes, are the only lining systems used in these industries today. Both lining systems impact process vessel size, cost and maintenance—which remains true, from conception, design and engineering, through to construction, commissioning and operation of the plant, for the life of the resource.

Historical Stigmas To Address

The high-pressure acid leach (HPAL) industry has relied on ***titanium clad autoclaves*** for decades, while the pressure oxidation (POX) industry has traditionally used carbon steel with a membrane and brick lining. Common misconceptions in the pressure oxidation industry (around titanium clad) include:

- Potential for ignition in enriched oxygen environments (pyrophoricity)
    - It should be noted that POX brick-lined autoclaves have internal solid titanium components including agitators, shafts, blades, bolts, washers, etc.
    - Titanium can also be found in compartment walls, anti-swirl baffles, nozzle sleeves, sparges, etc.
- All of the above operate both in the Liquid Phase and/or Vapor Phase of the autoclave
- Potential reduced abrasion resistance, especially to slurries of sulphide ores
- Susceptible to pitting and/or crevice corrosion in reducing environments
- Titanium clad is expensive

These misconceptions can be overcome when the resource characteristics are clearly identified, the right engineering company is selected, the correct quality of materials are used, the fabrication is of the utmost quality and the operation of the plant is undertaken safely with skilled persons within the guidelines of the industry regulations.

Engineers Have Options: Consider Titanium Clad In These Process Conditions

Lesser-known and often misunderstood in the pressure oxidation industry, ***titanium clad*** is sometimes overlooked in the Feasibility Stage, yet it can be a more favorable, long-term option, offering more predictability, flexibility and productivity. In most cases, ***titanium clad is the optimum lining system*** when engineering teams need the following criteria:

- Excellent corrosion resistance in oxidizing environments
- Exceptional ductility of the titanium clad
- Titanium can be in direct contact with process media
- Smaller and lighter vessel or, larger internal volume for the same size vessel
- Reduced foundations necessary to support the vessel as brick linings are very heavy
- Higher temperature limitations – up to 315°C (600°F) permitted by ASME Code
- No specific curing of the titanium clad is required
- Start up or cool down can be quite rapid
- Titanium clad is not susceptible to pressure or temperature fluctuations
- Larger process and agitator nozzles, or a close grouping of process nozzles are possible
- No hazardous materials, such as lead membrane or lead oxide mortars are used

Titanium Clad Favorability Relies On Technical And Economic Factors

In addition to these conditions, capital costs, plant location and timeline, engineering teams should consider the operational and maintenance strategy for the life of the plant upfront. Titanium clad is more favorable material for a plant's long-term operational viability and economic life.

For many autoclave projects, a ***titanium clad vessel*** typically costs 40% less than a brick-lined autoclave, for the same diameter and operating conditions. Internal components such as anti-swirl baffles and compartment walls can be attached directly to the internal titanium clad, which means no on-site installations are required.

When engineering teams select ***titanium clad***, the fabricated vessels arrive on-site, ready for final assembly and commissioning. This is unlike brick-lined autoclaves, which require large, on-site construction crews for long periods of time, including the use of lead oxide mortars, which present a long-term maintenance issue, whilst site conditions can introduce many variables to the project timeline, resulting in higher costs overall.

Let's take a closer look at how titanium clad autoclaves can help global companies solve complex material design challenges, in a cost-effective way, with unbreakable metals.

Lining Systems Impact Process Vessel Size, Cost And Maintenance

In pressure vessels, the use of brick lining equates to an internal diameter loss of approximately 500mm. This can result in a significant loss of the operational working volume, depending on the size of the autoclave.

Every Hydromet project is different and there are cases when vessel size, internal volume, overall weight, and operating temperature and pressure bring the cost of brick-lined and titanium clad autoclaves into alignment. However, brick-lined autoclaves have maximum diameter limitations, due to lining integrity, which highlights another titanium clad advantage: there are fewer size limitations to contend with, aside from those that address what can be fabricated and transported. That means there are many ways to design, fabricate and transport titanium clad autoclaves to their final, on-site destination and, once installed, titanium clad offers operational efficiencies, without sacrificing reliability.

Unlike refractory linings which can take days to cool, ***titanium clad*** can be cooled down quickly when routine or unplanned maintenance is required. It's also easier to spot and address needed repairs, because the carbon steel pressure vessel is not hidden behind a brick lining and membrane. That means, after maintenance, operations with titanium clad autoclaves can start up and return to production faster than refractory linings.

Titanium Clad For World's Largest Pox Autoclave

When one of Russia's largest gold producers, Polymetal International (Polymetal), set out to expand their existing processing facility in Amursk, they turned to Hatch, an experienced engineering firm, to design and build a new pressure oxidation autoclave.

Polymetal's goals were clear: double production capacity and treat a high refractory ore type. Yet, the project posed significant obstacles, including high-temperature and high-pressure operating conditions. The vessel, once fully constructed, also would be the largest pressure oxidation autoclave in the world.

After assessing which lining system—a cladded vessel or a refractory lining—gave the hydrometallurgical designers a more economic and reliable solution, Polymetal decided to use ***explosion bonded titanium clad construction***.

Understanding the unique operating conditions at hand, Hatch then looked to NobelClad as a longtime partner and leader in global, dissimilar metal solutions, to provide the explosion welded titanium clad plate, and Coek Engineering to lead the autoclave construction.

A Favorable Solution: Carbon Steel + Titanium Clad

When engineering teams in the hydrometallurgy and chemical process industries have an important lining system decision to make, NobelClad comes prepared to offer one. They can count on us to find solutions that use optimum materials, quality design, best-in-class manufacturing technologies for explosion bonded clad plates, and provide fabrication techniques to the pressure vessel fabricator, resulting in long-term savings to the end user.

The future is bright for composite metals, like carbon steel and titanium clad autoclaves, and the pressure oxidation industry. As has been the case for more than five decades, the world can continue to rely on NobelClad's leadership in supplying trusted, unbreakable dissimilar metal solutions and service to help solve demanding problems for the world's fast-growing industrial infrastructure.

To learn more about our use of explosion welded titanium clad for the world's largest pressure oxidation autoclave

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