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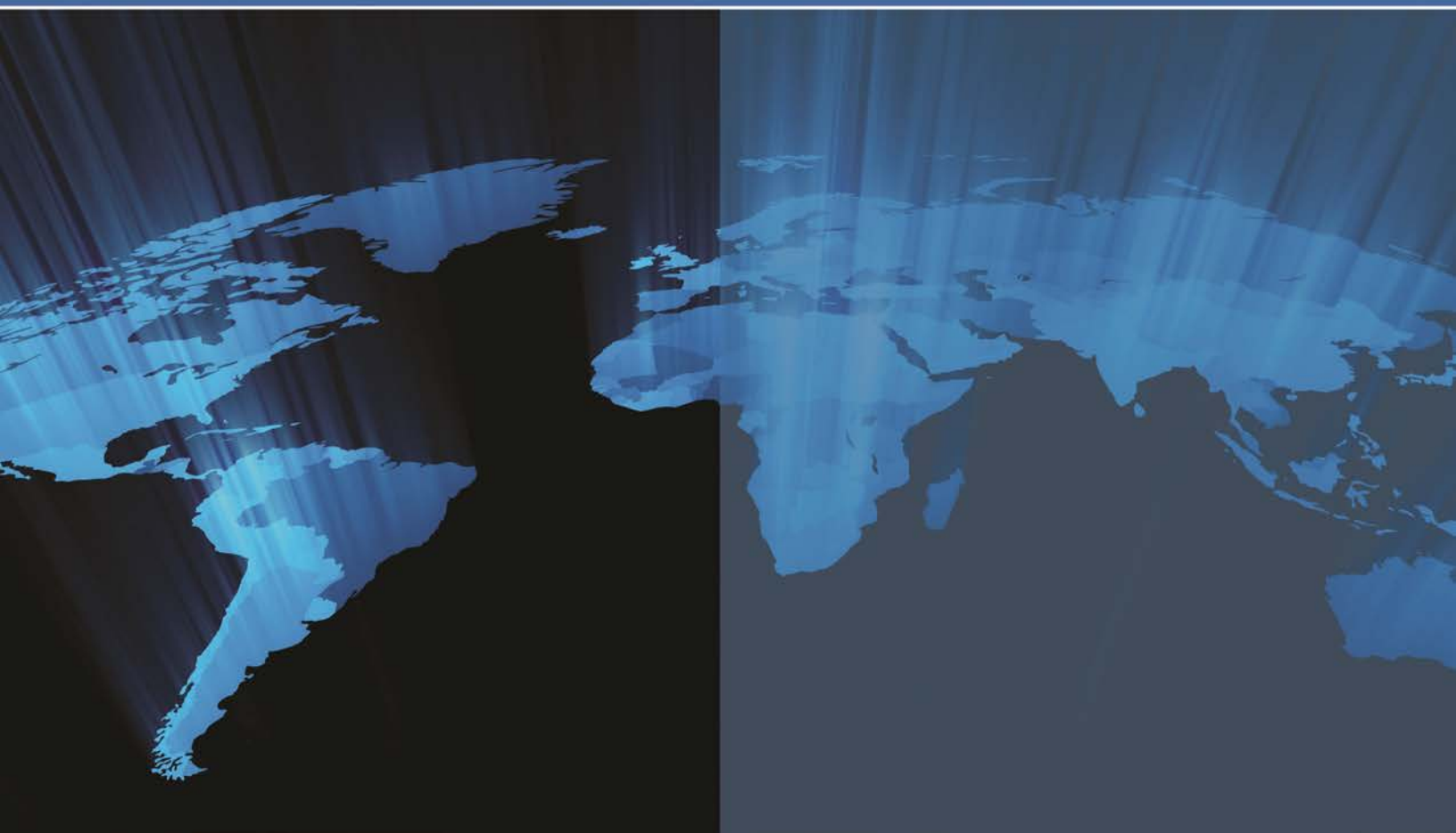
Design and Fabrication of Hypochlorite Storage Tanks Using Titanium

Authors:

Charles Young, Metallurgist & Business Development Manager
Pete Philippon, Director of Project Management
Tricor Metals, Wooster, Ohio

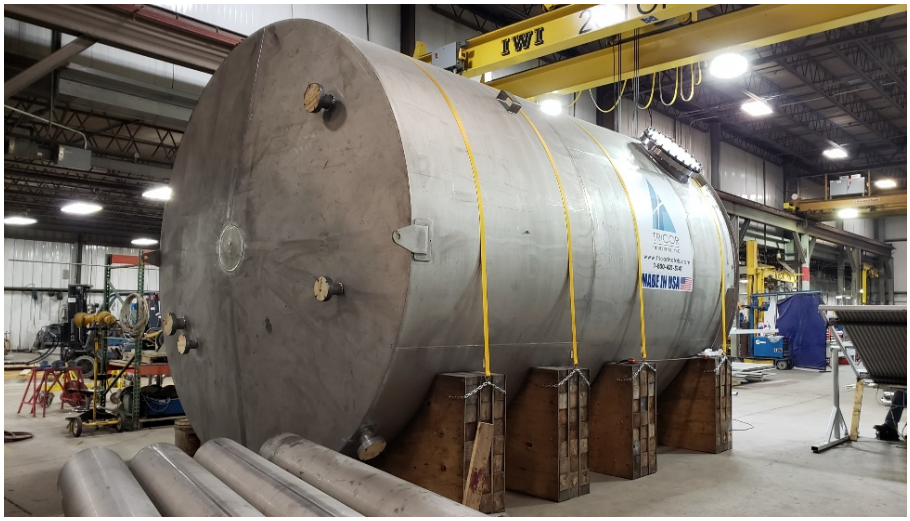


Design and Fabrication of Hypochlorite Storage Tanks Using Titanium

Abstract

This technical white paper explores the design, fabrication, and lifecycle considerations for hypochlorite storage tanks, focusing on the use of titanium as the material of choice. Due to the challenges associated with hypochlorite storage, such as corrosive environments, traditional materials like carbon steel and stainless steel often face reduced lifespans. Titanium provides a durable, corrosion-resistant alternative, extending the service life of these tanks significantly. This paper covers essential design elements, compares ASME and API code standards, details fabrication techniques for both shop and field applications, and presents lifecycle cost analyses comparing titanium tanks to alternative materials.

Introduction



Hypochlorite, commonly known as bleach, is a highly corrosive substance often used in water treatment plants and chlor-alkali processes. The design and fabrication of storage tanks for such corrosive chemicals require materials with superior corrosion resistance and durability. While stainless steel, carbon steel, and fiberglass-reinforced plastic (FRP) are commonly used for tank construction, they are prone to failure over time due to corrosion, requiring frequent replacement and causing unplanned downtime. Titanium, particularly Grade 2, offers a longer-lasting, low-maintenance solution, making it an ideal choice for hypochlorite storage.

This paper highlights the key considerations for the design and fabrication of titanium bleach storage tanks and compares lifecycle costs with alternative materials.

Design Considerations for Bleach Storage Tanks

API vs. ASME Code

The design of bleach storage tanks often requires a combination of standards from both the American Petroleum Institute (API) and the American Society of Mechanical Engineers (ASME). Each code has its strengths and limitations concerning material choice and tank design.

- **API Tanks**:
  API standards for storage tanks, such as API 650, do not recognize titanium as an approved material. Instead, the API focuses on materials like 316 stainless steel, carbon steel, and nickel alloys. API tanks are typically flat-bottom designs that require uniform support, such as concrete foundations, and must be anchored for wind loads. For tanks with a diameter of less than 30 feet, a minimum wall thickness of 5/16 inches is recommended.

- **ASME Tanks**:
  Titanium is recognized as a material suitable for pressure vessel design under ASME Section VIII. ASME standards focus on internal pressure and temperature when determining design thickness. Unlike API tanks, ASME tanks do not use flat-bottom designs and require a code stamp ("U" stamp for new construction, "R" stamp for repairs). Welding procedures and welder qualifications are also governed by ASME Section IX, which is critical for maintaining the integrity of titanium welds in both shop and field applications.

The combination of API 650 and ASME Section VIII standards is often used to optimize the design of titanium bleach storage tanks, ensuring safety, performance, and compliance with regulatory requirements.

Fabrication Techniques

Shop Fabrication

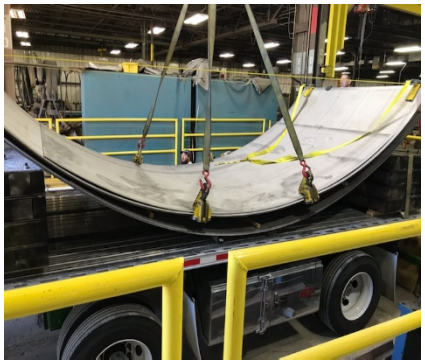
Shop fabrication offers the highest level of control over quality and consistency. The following key techniques are utilized:

1. **Welding**:
   Titanium requires specialized welding procedures to prevent contamination and ensure durability. Gas tungsten arc welding (GTAW), also known as tungsten inert gas (TIG) welding, is commonly used. During this process, the weld area must be shielded with argon or helium gas on both the front and backside of the weld until the metal cools to below 400°F. Contaminants like oxygen can make titanium welds brittle, so cleanliness and shielding are paramount.

2. **Material Traceability**:
   All materials used in the fabrication process must be traceable to ensure compliance with ASME Section IX standards. This includes certification of welders, inspection of weld joints via liquid dye penetrant or spot X-ray, and adherence to both Tricor and customer specifications. ASME code inspectors verify the integrity of the fabrication process.

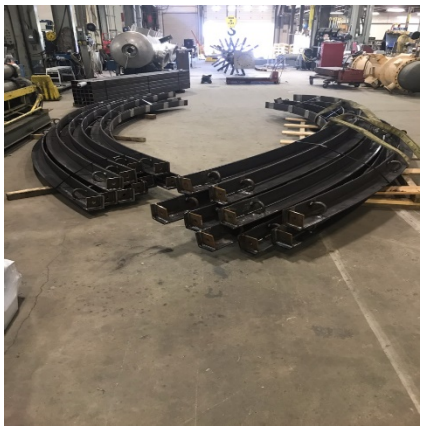
3. **Quality Control**:
   Titanium fabrication requires strict quality control measures. Each weld must be inspected, and final quality certifications must be provided to the customer. These include drawings, material certifications, and test results.

Field Fabrication



Field fabrication presents additional challenges compared to shop fabrication, including environmental factors like weather, dust, and plant safety requirements. Despite these challenges, the quality concerns in field fabrication are identical to those in shop fabrication:

- **Pre-Fabrication**:
  To minimize field welding, components are pre-fabricated in the shop and shipped to the site for assembly. This includes forming cylindrical sections that are welded together on-site.
- **Welding**:
  Just as in shop fabrication, titanium welds in the field must be carefully shielded from contaminants and performed under strict environmental controls. Field conditions like wind, rain, and temperature fluctuations can affect weld quality, so proper shielding and equipment protection are essential.
- **Safety Considerations**:
  Field fabrication increases safety risks, particularly when working at heights or near other operational equipment. Coordination among fabricators, contractors, and plant personnel is critical for a successful project.



Lifecycle Costing (LCC)

One of the most compelling arguments for using titanium in bleach storage tanks is its lower lifecycle cost compared to alternative materials. Although titanium has a higher initial cost, its longevity and minimal maintenance requirements make it the most cost-effective solution over time.

Example 1: 20' Tall x 12' Diameter Municipal Water Treatment Tank

In this case, a Grade 2 titanium tank with a shell thickness of 3/16” to 5/16” and a flat bottom head of 3/8” is compared to a high-density polyethylene (HDPE) tank and a fiberglass-reinforced plastic (FRP) tank.

- **Titanium Grade 2**:
    - Initial cost: 5X
    - Expected lifespan: 36+ years
    - Lifecycle cost: 1X
- **Fiberglass-Reinforced Plastic (FRP)**:
    - Initial cost: 2X
    - Expected lifespan: 12 years
    - Lifecycle cost: 1.43X
- **High-Density Polyethylene (HDPE)**:
    - Initial cost: 1X
    - Expected lifespan: 6 years
    - Lifecycle cost: 1.73X

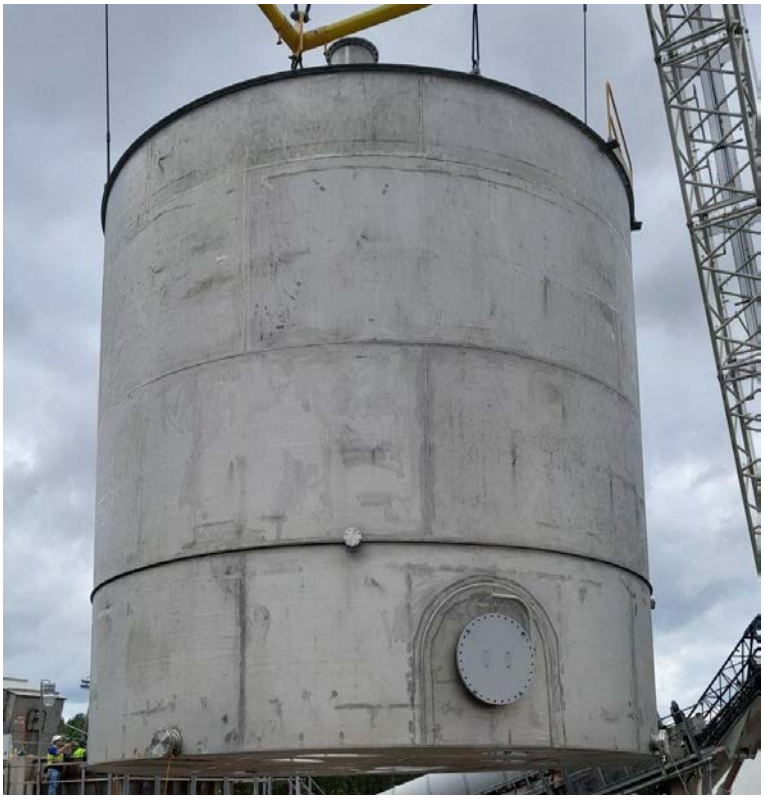
While the initial cost of a titanium tank is higher, its lifecycle cost is the lowest due to its longer service life and fewer replacements.

Example 2: 28' Tall x 30' Diameter Chlor-Alkali Plant Tank

This example compares a field-fabricated titanium tank with a rubber-lined steel tank.

- **Titanium Grade 2**:
    - Initial cost: 1.7X
    - Expected lifespan: 40+ years
    - Lifecycle cost: 1X
- **Rubber-Lined Steel**:
    - Initial cost: 1X
    - Expected lifespan: 10 years before relining
    - Lifecycle cost: 4.1X

Despite the higher initial cost, titanium proves to be significantly more cost-effective over the long term due to the need for fewer replacements and less maintenance.



Example 3: 43' Tall x 12' Diameter Chlor-Alkali Plant Tank

In this scenario, a titanium tank is compared to an FRP tank.

- **Titanium Grade 2**:
    - Initial cost: 2.5X
    - Expected lifespan: 40+ years
    - Lifecycle cost: 1X
- **FRP**:
    - Initial cost: 1X
    - Expected lifespan: 10 years
    - Lifecycle cost: 3.8X

Again, the lifecycle cost analysis demonstrates that titanium is the superior material for long-term cost savings.

Conclusion

Titanium is the material of choice for hypochlorite storage tanks due to its superior corrosion resistance, durability, and lower lifecycle cost. While the initial investment in titanium tanks may be higher, the reduced maintenance, fewer replacements, and minimized downtime make it a cost-effective solution over time.

The combination of API and ASME standards ensures that titanium tanks are designed and fabricated to the highest quality standards, providing long-lasting, reliable service in corrosive environments. Whether fabricated in a shop or in the field, titanium offers unparalleled performance in bleach storage applications.

References

For additional information on the design and fabrication of titanium bleach storage tanks, please contact Tricor Metals at 330-264-3299 or visit www.tricormetals.com.

This paper emphasizes the need for careful consideration of lifecycle costs when selecting materials for hypochlorite storage tanks.

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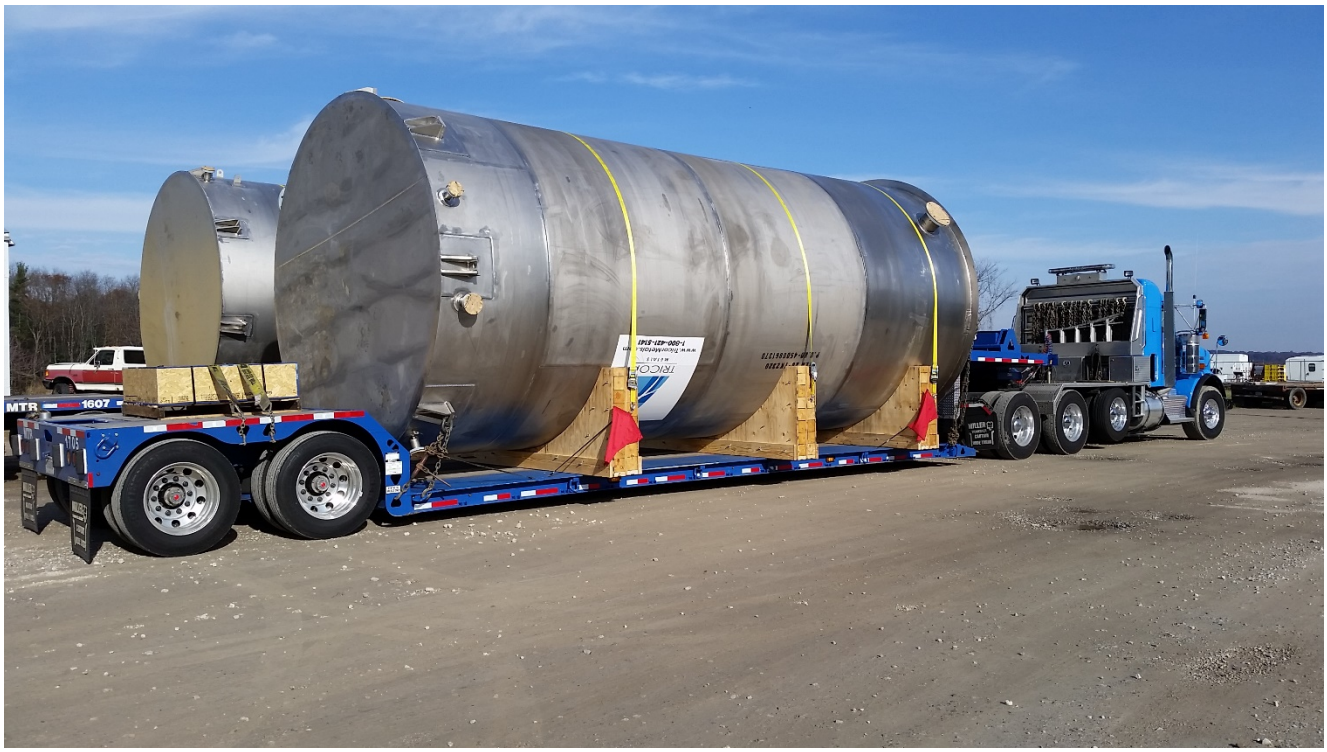

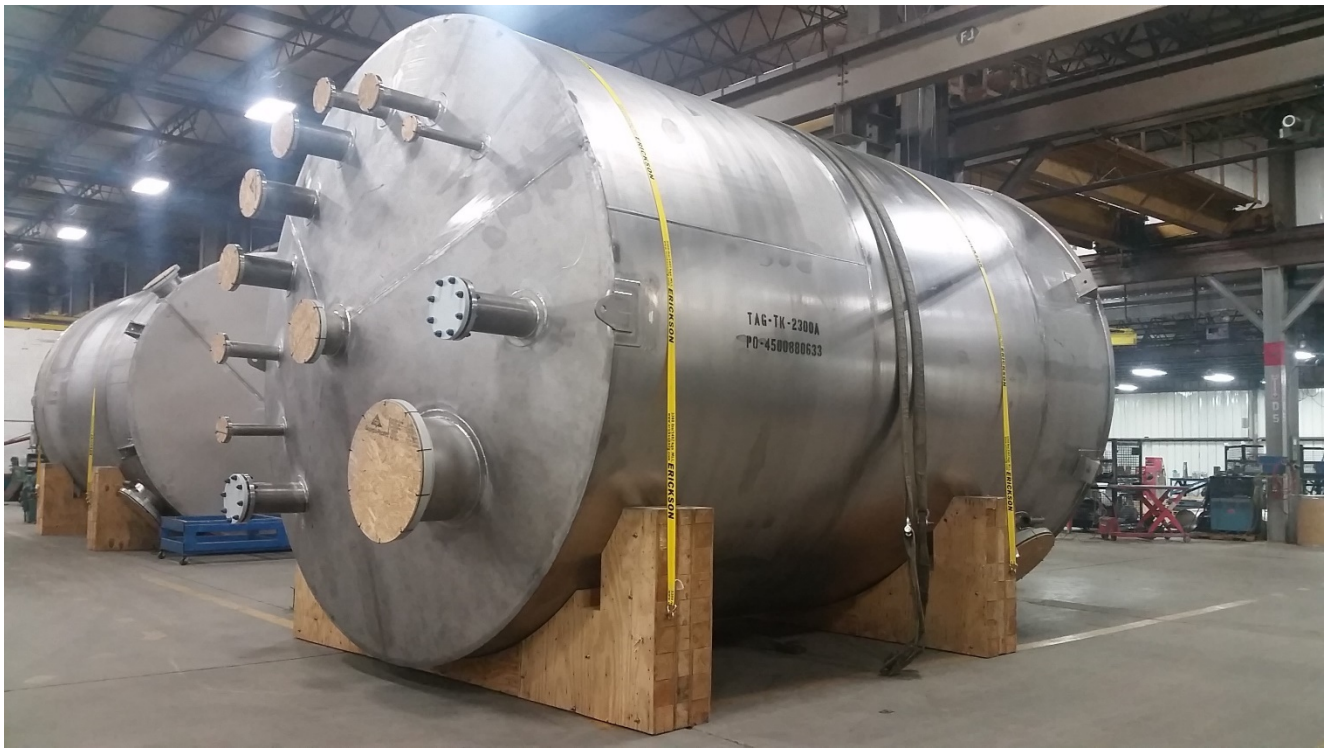

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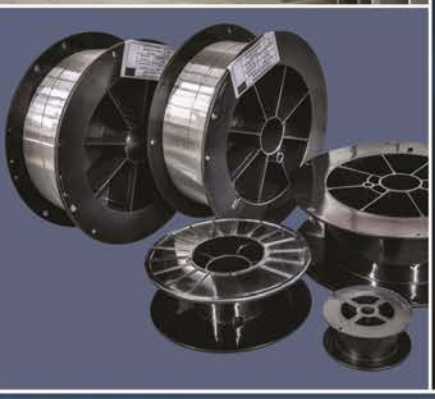

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