Engineered ZeCor® Equipment for Sulfuric Acid Service

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St. Louis, MO

Presented at AIChE Convention
Clearwater, Florida
June, 2007

Abstract

Selection of materials of construction for various applications in a sulfuric acid plant is a balance between the features and benefits of a material versus its capital cost. Over the years the sulfuric acid industry has adopted standard materials of construction for various applications. As an example, drying and absorbing towers historically have been made of brick-lined carbon steel. Advantages to this design include corrosion resistance over a wide range of acid strengths and temperatures. Disadvantages, however, include maintenance headaches and high repair costs when bricks heave and come loose. Similarly, acid piping, distributors, and coolers have had safety, maintenance, and reliability problems resulting from the choice of material of construction.

A decade ago MECS, Inc. introduced the ZeCor® family of alloys. This material technology was designed by MECS to improve the overall cost-performance proposition for sulfuric acid plants. ZeCor® offers superior corrosion resistance in strong sulfuric acid applications ranging from 93% to 99% concentrations at a wide range of temperatures. Priced competitively, ZeCor® offers an economical total installed project cost and lower life cycle maintenance cost. The life expectancy of ZeCor® is greater than twenty years in some applications. Plant shutdowns can be shortened since fully fabricated ZeCor® vessels can be set into place. Maintenance is minimal. With lower corrosion rates than cast iron, ZeCor® equipment reduces sulfate formation and promotes a cleaner, safer, more efficient operation.

Applications of ZeCor® include vessels such as drying towers, absorbing towers, acid coolers, and pump tanks as well as tower internals like acid distributors, packing support, and mesh pads. Piping and fittings are also included in the ZeCor® product line.

Background

In any sulfuric acid plant's strong acid system, the proper choice of material of construction is a critical decision impacting the plant's safety, cost, reliability and operability. These decisions are becoming more and more challenging as plant management is faced with higher priorities for social responsibility and increased demands for financial performance.

Technology improvement is one key to helping plant decision makers deal with these challenges. Until twenty years ago, choices for absorption towers, drying towers and pump tanks were limited to brick-lined carbon steel construction. These materials eventually resulted in leakage through the brick lining, sulfate formation, brick heaving, and ultimately leaks in the carbon steel shell. In strong acid piping systems, cast iron generally was regarded as the workhorse material. Cast iron is, however, susceptible to catastrophic failure due to its mechanical characteristics. Cast iron designs are also very heavy and require a large number of flanges which increase operating risks in the plant. Tower distributors were either cast iron troughs or pipe designs of cast iron or alloy construction. Using cast iron equipment was the cause of major operating and maintenance problems in sulfuric acid plants. Extensive sulfate build-up, excessive mist carryover, SO_3 slippage, frequent tower cleanouts, pipe orifice pluggage and other problems have come to be the trademarks of these designs.

Over the past twenty years, MECS has been providing high performance alloy products with great success. This newer technology addresses the material issues associated with brick-lined carbon steel and cast iron.

Sulfuric acid plant personnel are continuing to look for new solutions to maintenance and operability problems. Old approaches were tolerated in the past, but now are no longer acceptable with the present environmental regulations, safety requirements, and financial goals.

Strong Acid Technology and Design

MECS, Inc. has standardized on ZeCor® austenitic stainless steel for use in strong sulfuric acid applications ranging from 93% to 99% concentrations. ZeCor® is available exclusively from MECS, Inc. The corrosion rates for ZeCor® are less than 1 mpy (0.025 mm/yr) depending on the acid concentration and temperature. Extensive corrosion and workability tests were conducted with very impressive results. Installations of ZeCor® towers, distributors, piping systems and other equipment have been in operation for almost a decade with corrosion results matching or exceeding these lab results.

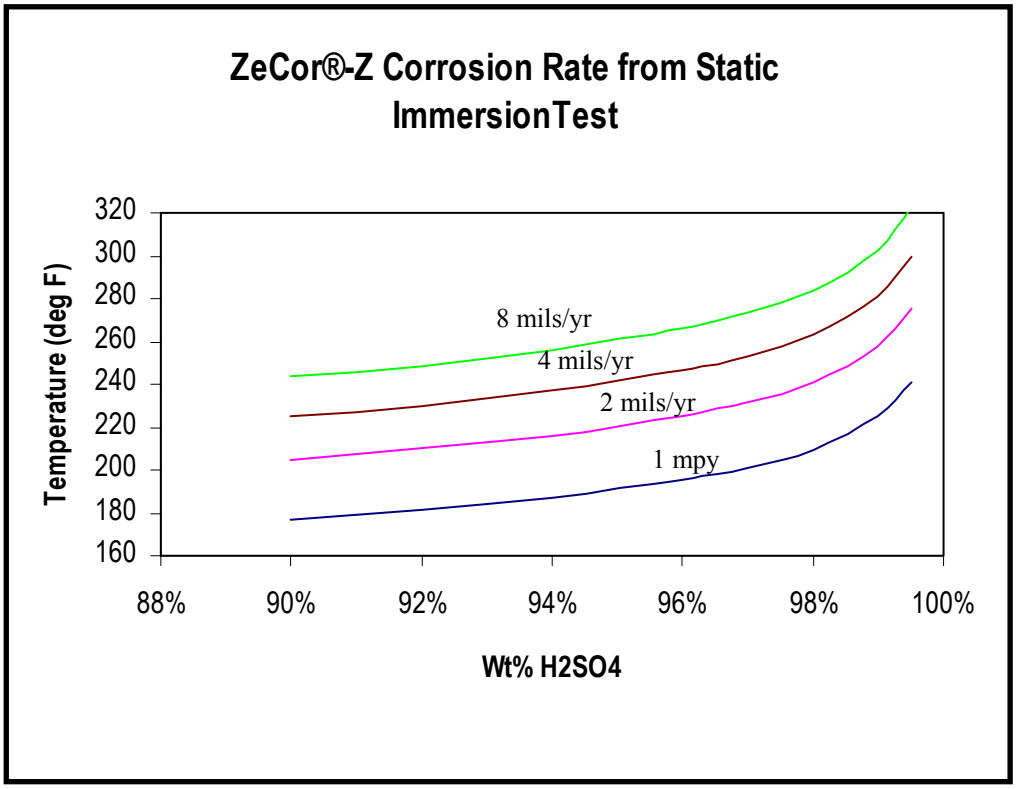

Figure 1: ZeCor® Isocorrosion Curves

ZeCor® offers many advantages over other alloys in sulfuric acid service:

- Lower cost.
- Plate thickness is not limited to a few options. ZeCor® alloys are available in a variety of thicknesses allowing for customized equipment designs to accommodate differing corrosion requirements.
- Proven proprietary welding process is basic gas tungsten arc weld (GTAW -TIG) with the use of ZeCor® filler wire. Resulting welds have been qualified to ASME code section IX procedure and maintain their corrosion resistant properties throughout.
- Weldability is similar to that of 304/316 stainless steel which allows onsite repairs to be easily performed by plant maintenance personnel.

Initially proven in laboratory tests and now in plant installations, this versatile family of alloys can solve many of the material engineering problems found throughout the strong acid system.

Applications

The ZeCor® family of alloys was developed by MECS for superior corrosion resistance in a wide range of sulfuric acid concentrations, temperatures, and specific applications. MECS offers a complete line of major components and maintenance upgrade accessories fabricated from ZeCor® alloys.

Towers and Pump Tanks

MECS process technology allows for towers and pump tanks to be made smaller and much lighter than conventional brick-lined vessels. As a result, foundation material and construction costs are lower. A scheduling bonus is achieved as well, since plant shutdown and field construction time is significantly shortened. The use of ZeCor® towers improves acid quality by lowering the iron content and minimizing the level of sulfates normally found in the strong acid circuit. Less sulfates means cleaner acid towers which operate at higher efficiencies and require less maintenance. Tower internals such as nozzle sleeves, vortex breakers, and outlet strainers can also be supplied in ZeCor® material.

Figure 2: ZeCor® Tower

Packing Support

The packing support in any tower is critical to the overall performance of the tower. ZeCor® packing support grids provide greater than 80% open area with no need for aludur beams or partition rings. This is a significant benefit for good gas distribution compared to the 60% open area in traditional arch and dome designs. The alloy grids are entirely prefabricated in the shop and shipped in pieces to the site. Installation into a tower can be completed quickly. ZeCor® packing support grids can be installed in new or retrofit applications in both brick-lined and alloy towers.

Figure 3: ZeCor® Packing Support and Grids

UniFlo® Trough Distributors

MECS UniFlo® acid distributors provide continuous and precise distribution of acid throughout the tower packing which ensures optimum absorption efficiency, minimum mist generation and maximum service life of downstream equipment. A set of uniquely designed and patented gate assemblies in each trough allows for quick, easy flow adjustments. The UniFlo® trough and downcomer system provides complete coverage of the tower. More coverage means less required packing, which, in turn, lowers the tower's pressure drop. The wider and deeper troughs reduce acid velocities, thus reducing the mechanical mist generation. The UniFlo® distributor is lightweight and can be easily installed by plant maintenance personnel. Low corrosion rates of ZeCor® trough distributors means that the service life is expected to be up to twenty years rather than the three to nine year life that is typical with cast iron trough and header systems.

Figure 4: ZeCor® UniFlo® Distributors

Figure 5: TowerGARD™ Mesh Pad

Mist Eliminators

ZeCor® TowerGARD™ Mesh Pad designs incorporate the best of materials technology and mist collection efficiency. TowerGARD™ mesh pads can remove up to 99.9% of particles down to 2 microns with only 2" w.c. pressure drop in some applications. ZeCor® mesh pads can be used in 93% and 98.5% acid service and increase service life three to five times versus Alloy 20.

Acid Coolers

ZeCor® Acid Coolers provide optimal thermal performance; they are not susceptible to erosion corrosion or limited by velocity like anodically protected acid coolers. The alloy cooler design eliminates the need for anodic protection systems, and subsequently eliminates the need for spare parts and costly annual inspections. With virtually no maintenance and a greater than twenty year life expectancy, ZeCor® acid coolers have a lower life cycle cost compared to anodically protected coolers.

ZeCor Piping

When compared to cast iron piping, ZeCor® piping systems have fewer flange connections, which result in less potential leak sites and a safer workplace. Additionally, the low corrosion rate reduces the iron content of product acid and creates less sulfate buildup resulting in less pluggage of tower internals. MECS also offers ZeCor® fittings, orifice plates, and inline strainers.

Figure 6: ZeCor® Piping

MECS Expertise

The ability of our engineers to fully understand the operation and performance of the entire acid plant allows MECS to design, fabricate and provide the client with the most cost effective solution to meet the sulfuric acid plants' needs. MECS plant and equipment designs embody more than 80 years of learning about what does and does not work in the real world of acid plant operations.

The understanding of subtle design detail differences and knowledge of localized conditions is vital to good process design. The superiority of MECS' designs resides in the fine details. Proprietary metals and specialized equipment features are applied in dry zones and zones of high SO_3 to minimize potential process problems. Proprietary lining systems are utilized in localized weak acid areas where additional corrosion protection is required.

For over twenty years, MECS has been providing the sulfuric acid industry with high performance alloy products. Currently there are over one hundred MECS alloy tower and more than 800 MECS acid distributor installations. An impressive reference list shows MECS' extensive field experience using the family of ZeCor® alloys.

Summary

MECS, Inc. is committed to providing the best service, quality, and technology in the industry. Engineered ZeCor® alloy products are proven to provide superior corrosion resistance in strong acid service. Competitive prices and minimal maintenance make ZeCor® attractive to both plant decision makers and operators.