

Process Technologies for Harsh and Corrosive Environments



Designing an efficient industrial process system requires careful consideration of several factors, especially when working with harsh and corrosive fluids. Design approaches, materials of construction, and component selection should be thoroughly evaluated to ensure that the system meets reliability and output requirements while tolerating continuous exposure to corrosive agents. Partnering with a process technology solutions provider with expertise in corrosive environments will help industrial operators achieve optimal performance, safety, efficiency and reliability in their applications.

System Design Solutions

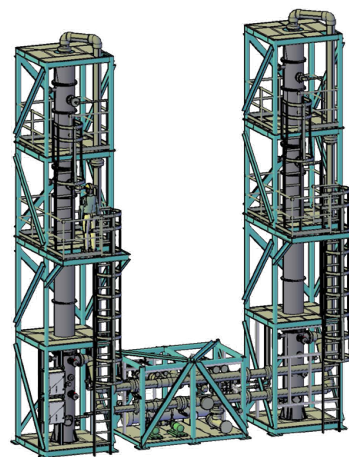
When designing a process system for a corrosive operation, it is important to consider all the constituents in the process stream, including potential minor contaminants, operating environment and application of the system.

Acid Considerations

The type and concentration of acid used in a process system will influence various aspects of system design. It's important to make sure all material surfaces, sealants, and finishes are compatible with the acids encountered during operation. In terms of environment, considering how the acid might interact with the presence of corrosion-accelerating factors such as temperature, pH, moisture, and pressure is critical for achieving a safe and industry-compliant system design.

Common acids found in process systems include:

- Hydrofluoric acid
- Hydrobromic acid
- Hydrochloric acid
- Sulfuric acid
- Nitric acid
- Bromine



System and Site Considerations

The system and site factors that need to be included during the design selection process are:

- Site limitations
- Target operational life
- Serviceability
- OPEX/CAPEX considerations
- System requirements
(new, expansion, or retrofit)
- Prior operational concerns

System Design Solutions

At CG Thermal, our process system design experience and deep understanding of corrosive process environments allow us to optimize the design according to the needs of each unique application. Our system design packages and services include:

- Engineering design package
- Major equipment package
- Turnkey packaged unit
- Consulting services
- Stand-alone equipment



We have extensive experience in designing solutions for the following corrosive processes:

- **Dilution:** The dilution process safely dilutes the acid to a target concentration while closely controlling and monitoring stream ratios and rates of dilution. A well-designed dilution system is constructed from corrosion-resistant materials and equipped with temperature sensors and other safety features to accommodate the exothermic nature of the dilution process.
- **Synthesis:** The synthesis process uses combustion, gas cooling, and absorption to produce acid or optimize properties from reaction products. A properly designed system will optimize production efficiency and safety while reducing negative environmental impacts.
- **Scrubbers:** Scrubbers are used to remove particulates and waste gas from exhaust streams to comply with applicable environmental regulations. Caustic, reductive, and oxidative scrubber solutions and systems can be designed depending on the types of substances requiring removal.
- **Absorption:** The absorption process facilitates acid recovery from process streams using either adiabatic or isothermal absorption technologies. Process-specific designs and high-quality, acid-compatible materials such as graphite, ceramics, nickel alloys, and lined steel ensure optimal safety and efficiency during the process.
- **Desorption:** Desorption uses heat to raise the volatility of a contaminant, allowing it to be removed from production and either reused or thermally destroyed. In any desorption process, it is important to be aware of the potential formation of new contaminants that can result from the incomplete breakdown of compounds.
- **Recovery:** Recovering acid waste generated from manufacturing processes is becoming a common practice in response to tighter environmental regulations and rising costs of acid waste disposal. Well-designed recovery process systems integrate durable components lined with fluoropolymer and other corrosion-resistant materials to enable the safe processing and containment of acid byproducts.
- **Azeotrope breaking:** Azeotrope breaking involves adding a component or solvent to create a new heterogeneous azeotrope with a lower boiling point. Vacuum- or positive-pressure azeotrope breaking systems can be constructed from various acid-resistant materials to meet specific process requirements.

Process Components

The components used in corrosive process environments should be mechanically robust and chemically inert to ensure a safe and efficient operation. Common process system components and relevant design considerations for corrosive environments are discussed below.

Heat Exchangers

In process systems, heat exchangers enable the transfer of heat from one fluid to another. Optimizing the configuration and composition of heat exchangers for corrosive environments requires close consideration of multiple factors, including pressure, temperature, fluid composition, dimensional limitations, pressure drop, and fouling resistance.

Heat exchanger designs for corrosive environments include:

- **Shell and Tube:** Shell and tube heat exchangers are available in both metallic and nonmetallic construction and with various flow arrangements to accommodate flow volumes and temperature ranges. Tube and shell materials are chosen with safety, optimal operating life and cost in mind.



- **AirBTU VPRR:** AirBTU high temperature gas-to-gas shell and tube recuperators are highly engineered for an exceptional operating life using corrosion-resistant stainless steel constructions under very harsh operating conditions.
- **Multi-Blox™ Cylindrical:** Equipped with Impervite® impervious graphite blocks, CG Thermal's Multi-Blox™ Cylindrical heat exchangers are specially designed for long-life, higher-pressure applications involving corrosive fluids. Severe duty designs are available.
- **Cubic Block:** Ideal for interchanger services, Impervite® cubic block heat exchangers are compact units with high thermal efficiency. Impervite® graphite blocks and fluoropolymer-lined heads make these heat exchangers ideal for processing a variety of corrosive fluids and for temperature cross applications.

Columns/Towers

Columns and towers aid in mass and heat transfer process systems. In corrosive process environments, these structures are often constructed of steel and lined with fluoropolymer corrosion-resistant materials.

Packed towers are used when a longer residence time is required. With a wide range of materials available, it's important to consider resistance to corrosion, function, weight and cost when making the material choice.



Drums/Receivers

Drums and receivers are hollow cylindrical vessels used for process fluid separation, collection, or storage. Like columns, drums and receivers can be lined with various corrosion-resistant materials based on process requirements.



Other

Other critical components used in process systems include:

- Pumps
- Valves
- Piping
- Instrumentation and controls

Materials of Construction

When working with acids and other corrosive fluid streams, specifying the appropriate materials during process system design is critical for ensuring safe operation and long-lasting components. Examples of corrosion-resistant materials include:

- **Umax ceramic:** Umax ceramic is an inert silicon carbide material which is universally corrosion resistant when exposed to strong acids as found in pickling lines, acid dilution, and other corrosive process systems. Constructed from chemically inert, sintered alpha SiC tubes, the Umax advanced ceramic heat exchanger resists erosion and is 100% thermal shock resistant.



- **Impervite® (impervious graphite):** Made from synthetic graphite specifically designed for heat transfer service impregnated with a phenolic resin, Impervite® graphite is most commonly used in process applications involving hydrochloric acid. Impervite® graphite is also compatible with sulfuric acid, phosphoric acid, chlorinated hydrocarbons, and various waste acids.

- **PPS-GR:** Combining the benefits of graphite and polyphenylene sulfide polymer materials, PPS-GR is a low-fouling, highly corrosion-resistant material. The material's relatively high thermal conductivity results from an advanced extrusion method.



- **Alloys and stainless steel:** Carbon steel, stainless steel, and nickel alloys exhibit various levels of corrosion resistance, making them effective materials for high-temperature gas-to-gas recuperators and suitable for specific process streams.
- **Fluoropolymer lining:** The chemical resistance and thermal stability of fluoropolymers makes them ideal for lining pipes, columns, and other components used in highly corrosive process environments.
- **Fiberglass reinforced polyester (FRP):** FRP is an affordable fiberglass-reinforced composite material used in low-pressure process environments with temperatures under 200°F and acid concentrations under 70%.

Custom Designs

Every process environment is unique and requires an equally unique design approach to achieve maximum efficiency and safety. When it comes to corrosive process environments, understanding the physical and chemical properties of the corrosive agents involved is essential for designing a solution with the required safety features and material compatibility.

An experienced process system solutions provider can design the process system and its components to maximize operating life while meeting the customer's output, quality, and budget requirements. The provider can also offer expert recommendations on how to achieve the appropriate CAPEX/OPEX balance based on the project's considerations.



Partnering With CG Thermal

CG Thermal is a process technology solutions provider with a range of unique qualifications and experience, including:

- Access to exceptional real world systems experience, such as designing, commissioning, and troubleshooting a wide range of chemical processes, with a focus on HCl, Cl₂, and H₂SO₄.
- Focusing on safety within every design and offering a haz-ops review option as part of all engineering services.
- Stringent designs to meet or exceed emissions and environmental requirements.
- Extensive knowledge of materials of construction for harsh process streams.
- Refined design and fabrication approach based on 150 cumulative years of experience.
- Expertise in pairing materials with specific process environments to achieve optimal efficiency and operating life.
- Advanced material and component options for the development of cutting-edge solutions.

Our personalized design approach, proprietary materials, and custom-designed components allow us to provide solutions for the most challenging process environments. We also offer a range of expertly designed heat exchangers that can be tailored to meet various chemical processing applications.

As a technology-driven and customer-oriented provider, we rely on complete transparency and open communication to provide our clients with quality products and individualized services. Our experience with corrosive process environments combined with in-house thermal and mechanical design capabilities allow us to design and construct a wide range of corrosion-resistant products and process solutions. Each unit is designed, manufactured, and thoroughly tested to meet the latest quality and fabrication standards.

We also provide engineering support, technical assistance, and expert recommendations aimed at maximizing efficiency, minimizing operating costs, and enhancing our customers' competitive edge. Whether you require a complete turnkey system or improvements to an existing system, our engineering team can work with you to customize a solution that accommodates your in-house capabilities and constraints.

To learn more about our process technology solutions for corrosive environments, please [contact us](#) today.

About Us

CG Thermal provides process technology solutions for harsh and corrosive process streams. Our services range from providing customer specific process equipment and technical support to consulting and turn-key engineered solutions. We aim to consistently deliver well-engineered, superior-value solutions to the world's leading

chlor-alkali, fine chemical, specialty chemical, steel pickling, battery, olefins, aromatics, petrochemical, agricultural chemical and fertilizer producers. We build on the industry's leading materials and thermal design technologies in all the heat exchanger and chemical processing equipment we offer.



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