

# ENGINEERED SYSTEMS



*Hydrogen chloride process*

*Sulfuric acid dilution*

*Hydrochloric acid process*



**MeRseN**

## MERSEN ANTICORROSION AND PROCESS EQUIPMENT

The Mersen group is a **world leader** in the design and manufacture of heat exchangers, pressure vessels, columns and piping, manufactured from high-grade materials. This equipment is perfectly suited to corrosive and hot environments. Mersen is recognised for its expertise in the design and manufacture of impervious graphite based corrosion resistant equipment for a wide variety of industries, notably phosphoric acid, steel pickling and chemical.

Mersen's century old experience is combined with its exceptional technical materials including GRAPHILOR® 3, our impregnated graphite which is fully designed and manufactured by the group. **GRAPHILOR® 3 is the combination between ultra-fine grain graphite and specific resins** and resulting in high resistance to corrosion, temperature and mechanical pressure.

	Equipment				Engineered Systems	
	Reactors Pressure Vessels	Heat exchangers Blocks/Shell & Tubes	Columns	Piping Bellows Fittings	HCl Systems	Acid Systems
Graphite					<ul style="list-style-type: none"> <li>- Direct Synthesis, with steam generation in option</li> <li>- Absorption</li> <li>- Evaporation</li> <li>- Concentration</li> <li>- Dilution</li> <li>- Organics treatment</li> </ul>	<ul style="list-style-type: none"> <li>- HBr Synthesis Unit</li> <li>- H<sub>2</sub>SO<sub>4</sub></li> <li>- HF dilution</li> <li>- Cl<sub>2</sub> stripper unit</li> </ul>
SiC						
Tantalum					 	
Zirconium						
Titanium						
Carbon Steel Stainless Steel Nickel Alloys						
PTFE						

Services & Maintenance

## MERSEN YOUR EXPERIENCED PARTNER FOR ENGINEERED SOLUTIONS IN CORROSIVE APPLICATIONS

Mersen has been manufacturing HCl based engineered systems for well over 50 years. With over 600 references worldwide, Mersen is a recognized world leader in the design and manufacture of HCl synthesis packages.

**Packaged systems can include any or all of the following:**

- Basic and/or detail engineering, design package
- Major equipment
- Instrumentation and control
- Piping and valves
- Structural steel support frame
- Pre-assembly of the above into a turnkey “skid” package

### Mersen, your one-stop-shop supplier :

- Project development from feasibility study to commercial operation
- Project management and project engineering
- Operation and maintenance organization including operation procedures, staff training and spare-parts management

### Our specialized own-made equipment portfolio :

- HCl synthesis units
- Columns and reactors
- Heat exchangers (shell & tube: polytube®, block style: Polybloc® and Cubic)
- Vessels

### Our worldwide technical presence

- 4 workshops on 3 continents with experience in equipment manufacturing and skid-mounted
- 10 local repair shops with technical sales & service expertise

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## PRODUCTION OF HYDROCHLORIC ACID OR HCL GAS SINTACLOR®, THE SYNTHESIS OF CHLORINE AND HYDROGEN

With over 600 references in operations throughout the world, Sintaclor® - Mersen HCl synthesis unit - is acknowledged as a proven solution.

### Sintaclor®: system is composed of

- One compact integrated synthesis unit that performs the combustion, the absorption and the cooling
- One packed tail tower that scrubs the residual gas and releases clean vent gas from the atmosphere (H<sub>2</sub> and inerts)

The synthesis unit and the tail tower are manufactured in Graphilor® 3 while piping is made of Armylor®.

### 3 flexible modules for a global offer

- Module 1: Graphite equipment and engineering documents
  - Synthesis unit
  - Tail tower
- Module 2: Accessories
  - Flame arrestor
  - Automatic ignition package
- Module 3: Sintaclor® package
  - Combination of modules 1 & 2 equipment in a turn-key skid
  - Piping and hand valves
  - Tanks and pumps (optional)
  - Field instruments and control cabinets
  - Steel structure
  - All of the above items are pre-assembled in the factory.

### OUR SINTACLOR® STRENGTHS

#### Safety

- Outstanding material: Graphilor® 3 withstands extreme conditions of temperature up to 430°C with carbon impregnation
- Top-mounted burner (downward flame) with internal liquid protection that allows a smaller size of furnace
  - Smaller size of furnace (better mechanical resistance and smaller volume of dangerous/explosive gas)
  - No need of condensate drain
  - Combustion chamber is far from the ground
- Bottom-mounted safety disc to have a better control of effluent in case of breakage
- Automated plant
  - Automatic ignitor (pilot burner)
  - Remote controlled start-up

#### Reliability

- Special burner design: to minimize the hydrogen excess
- Compact system
- Exceptional lifetime of the Graphilor® 3 (more than 15 years)
- Long-term experience (more than 600 references)

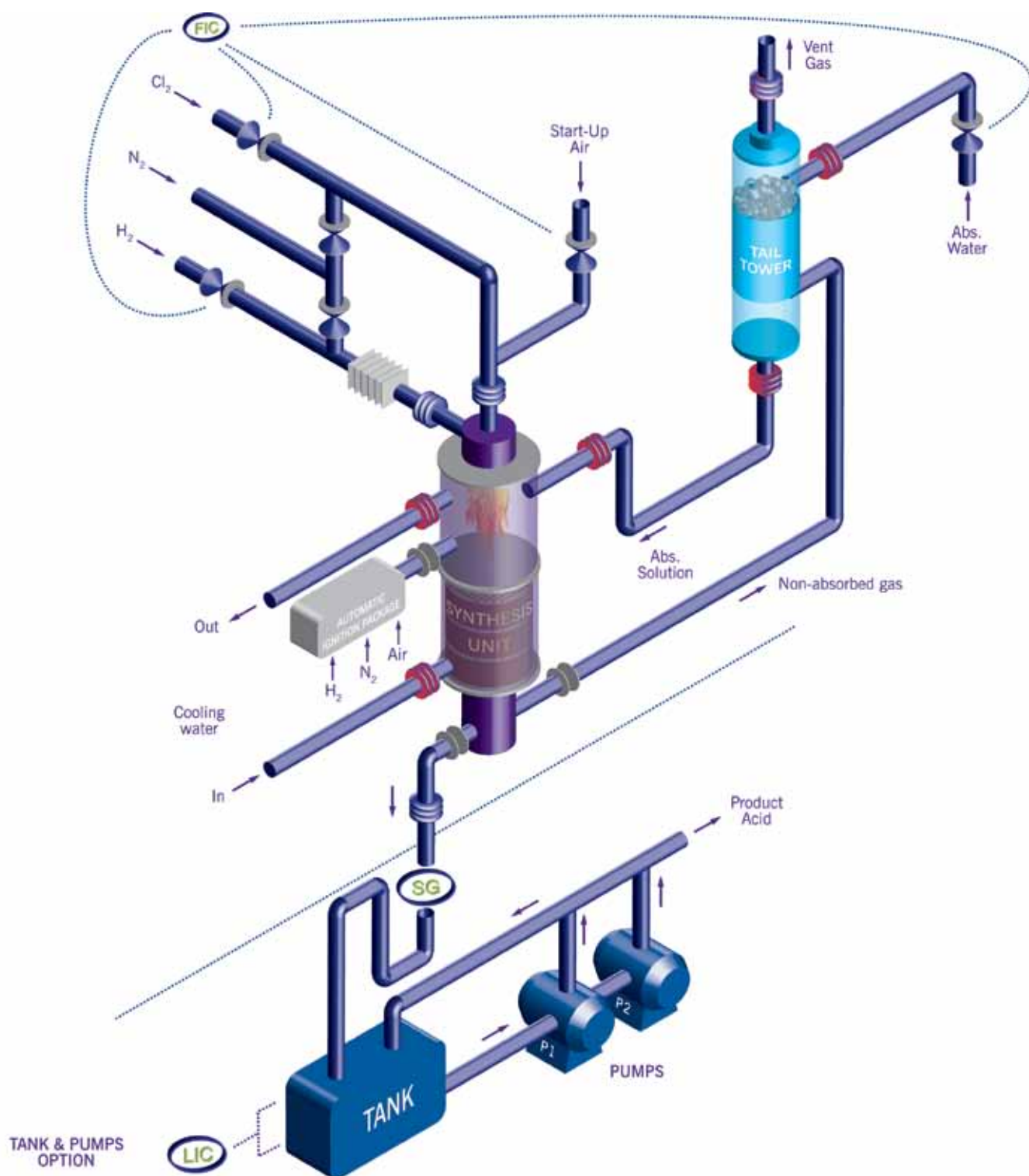
#### Fast delivery and commissioning

- Record: skid delivered within 5 months after order
- Record: less than 3 days to complete the start-up and acceptance on site
- Experienced technical team in our 4 workshops

#### Performance

- The Sintaclor® range includes units capable of producing hydrochloric acid quantities varying from 1.4 to 150t of 100% HCl per day
- HCl concentration (up to 37%) and free chlorine content (1 ppm) in produced acid
- Total combustion of chlorine gas with low hydrogen excess (typically 5%)

## Process for Hydrochloric Acid Production





## OPTION: SKID-MOUNTED SINTACLOR®

The skid-mounted is a flexible offer that matches all your requirements. It covers all the 3 modules of the synthesis unit offer that are pre-assembled in a workshop

- Module 1: Graphite equipment and engineering document
- Module 2: Accessories
- Module 3: Sintaclor® package

### Design

- 3D CAD layout offers views of new skid
- General drawings for equipment
- Installation and maintenance handbooks
- P&ID inc. heat and mass balances at minimum and maximum loads
- Field instruments and valve specifications
- Control and interlock specifications (start-up sequence diagram, narrative description of interlocks and control loops)
- Operator's handbook (including Process description, trouble-shooting guide, operation)
- Isometrics

### Pre-assembly in the factory

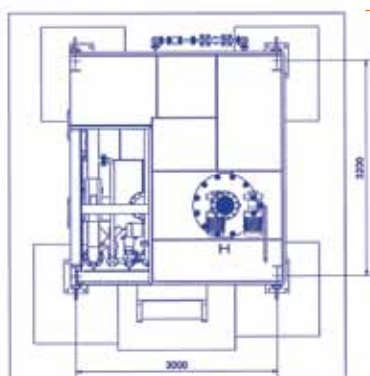
- Sintaclor® skid units are designed to minimize assembly times and errors on site
- The synthesis unit, the tail tower, pipes and all control and safety devices are assembled in a steel frame
- Seal test before shipment on site

### Installation

- A Mersen specialist supervises all operations: erection, pre-commissioning, commissioning and start-up

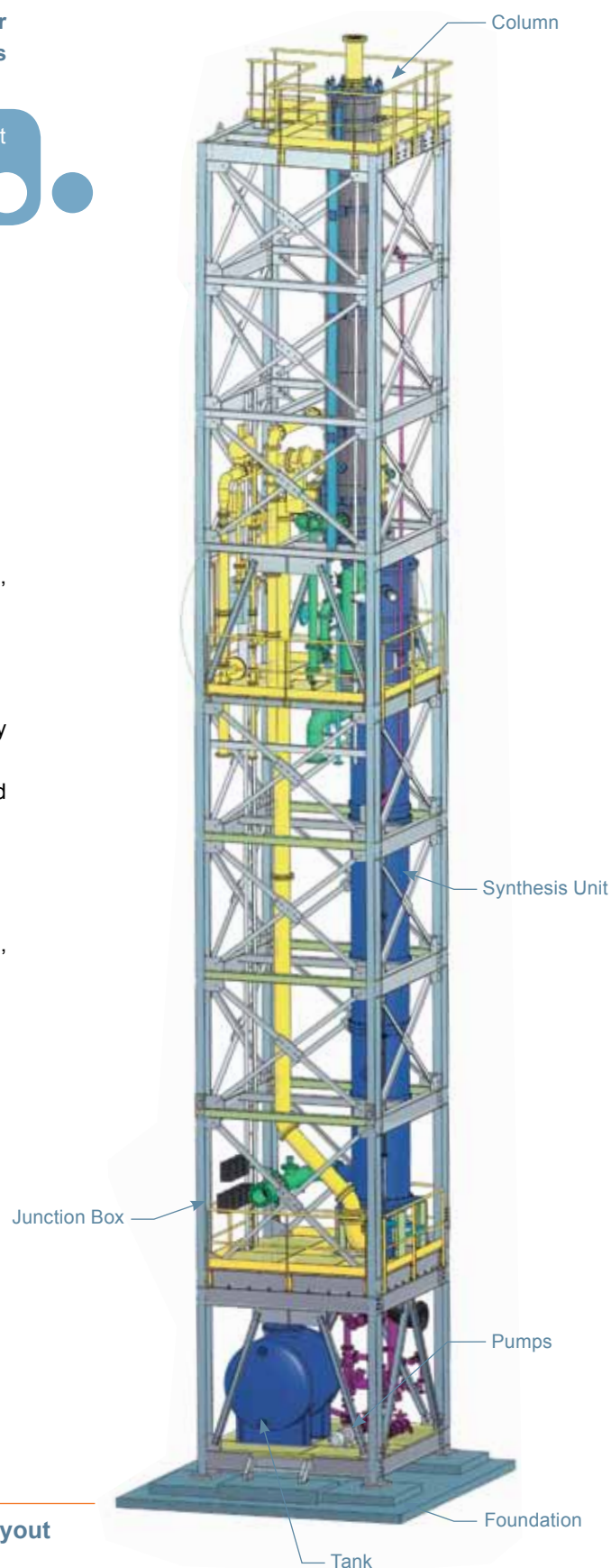
### Control and security

- Automatic system on the skid to control the performance
- Put the installations into safe conditions
- Automatic ignition of the flame with a closed furnace
- Automatic remote start-up from the control room
- Control of the production and the main parameters



Top View

3D CAD Layout

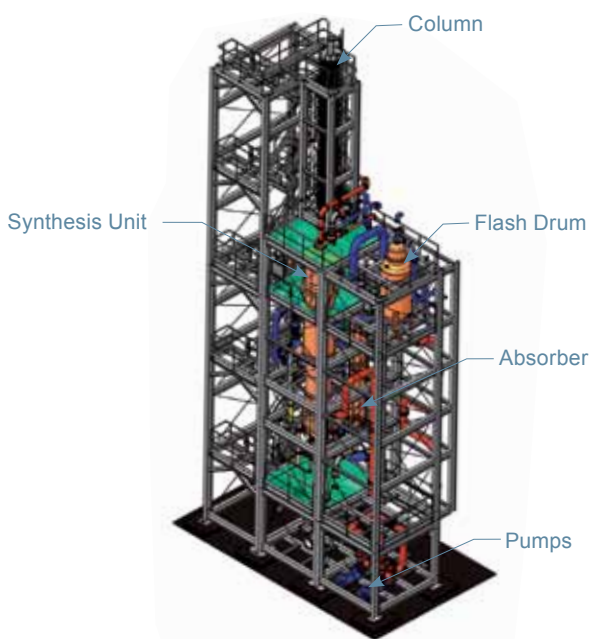


## OPTION: STEAM GENERATION

The steam generation option is a development of the synthesis unit to recover the heat generated from the combustion of hydrogen and chlorine. This can be achieved on a new or existing unit.

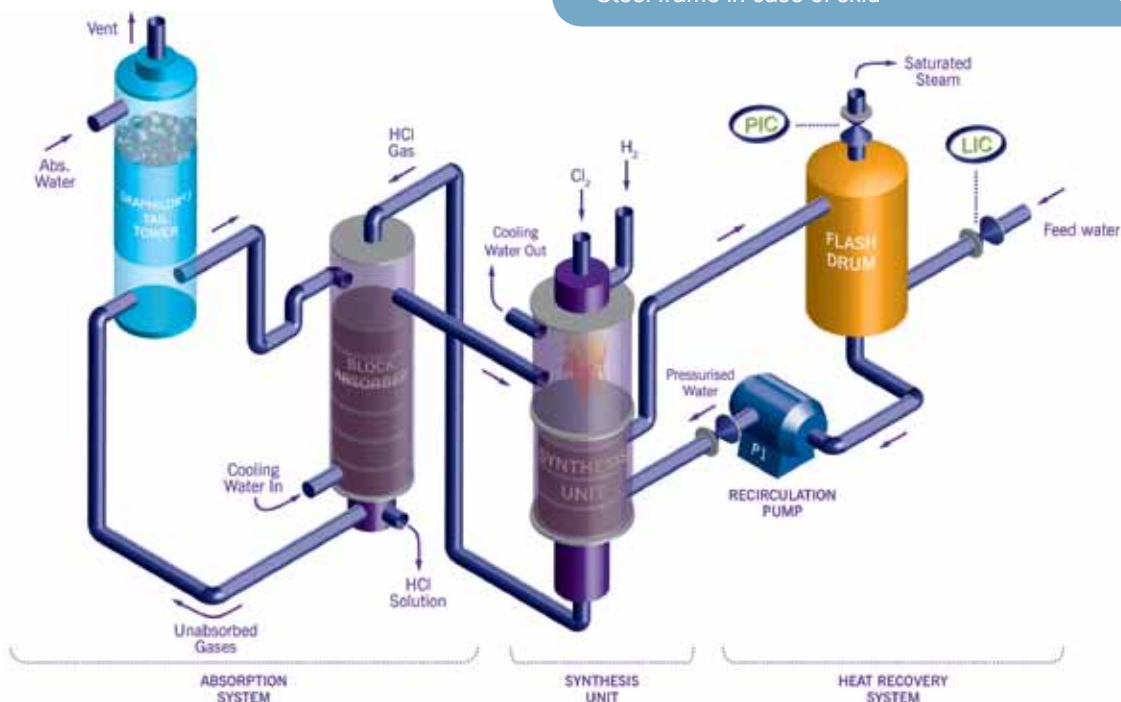
- One furnace-cooler
- One falling-film absorber

The generated steam can reach up to 8 bara with graphite furnace or over 10 bara with carbon steel furnace. Our technical team can advise you according to your process.



### 3 FLEXIBLE MODULES FOR THE STEAM GENERATION OPTION

- **Module 1: Graphite equipment**
  - Gas synthesis unit
  - Absorption unit
  - Tail tower
  - Certificates
  - Basic engineering documentation
- **Module 2: Detailed engineering for steam generation package**
  - General drawings for equipment
  - Installation and maintenance handbooks
  - P&ID incl. heat and mass balances at minimum and maximum loads
  - Field instruments and valve specifications
  - Control and interlock specifications (start-up sequence diagram, narrative description of interlocks and control loops)
  - Operator's handbook (incl. Process description, trouble-shooting guide, operation)
  - Isometrics
- **Module 3: Steam generation full package**
  - One flash vessel (carbon steel)
  - One horizontal centrifugal pump for pressurized water
  - Interconnecting piping between flash vessel and graphite equipment
  - Hand valves
  - Necessary field instruments (flow control valves)
  - Steel frame in case of skid



## HCl ABSORPTION

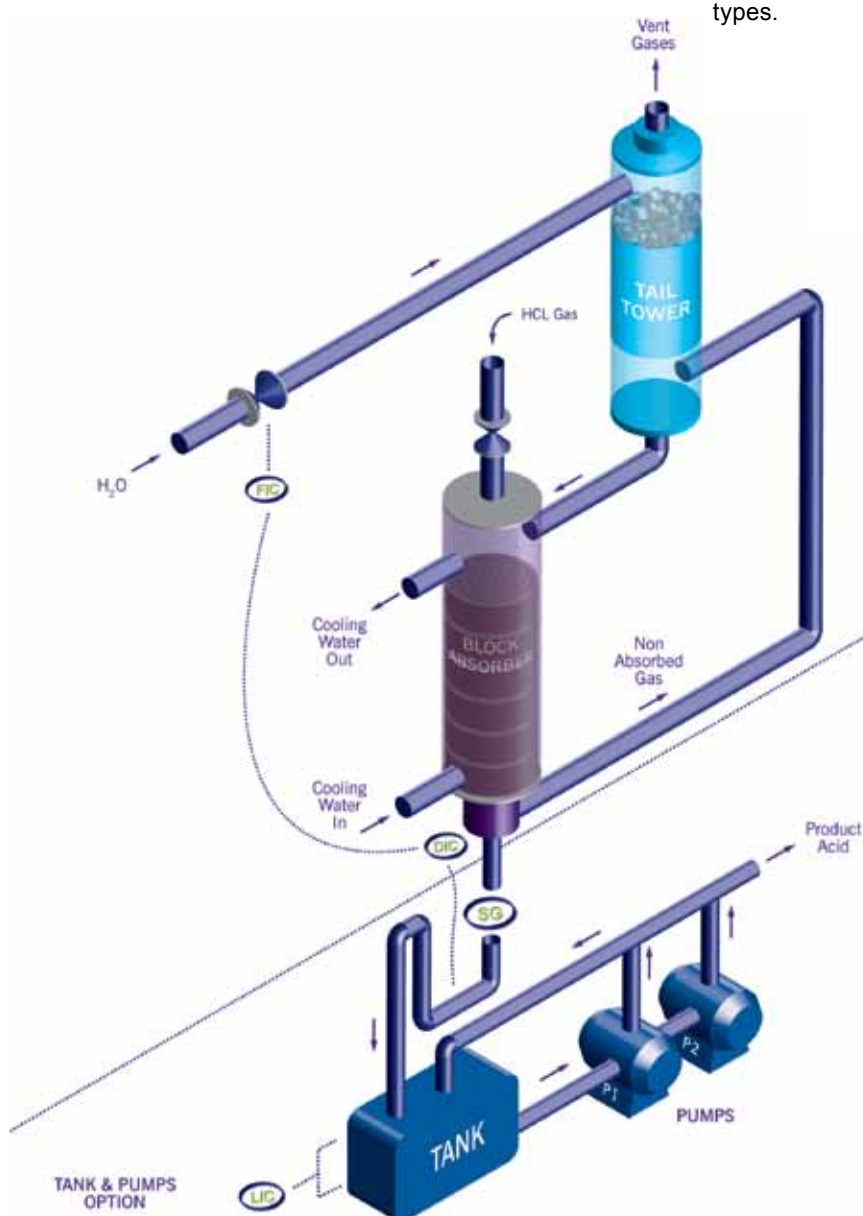
Gases such as HCl gas are dissolved in water in many chemical processes, particularly to store it, purify it or simply to use it in chemical reactions. This operation is called absorption which is an exothermic reaction.

Hydrogen fluoride and hydrogen bromide are also concerned by the absorption process. The absorption is often performed in combining Graphilor®3 heat exchangers and columns. There are 2 HCl absorption processes depending on the HCl concentration in the feed gas.

### Process 1 - Falling Film Absorber.

This process is more suitable in case of higher concentrated HCl gases.

The water or absorption solution forms the falling film that runs along the walls of the ducts inside the Graphilor®3 heat exchanger. Water and HCl gas can be counter or co-current. This film is continuously cooled by removal of heat through the walls of the unit to the cooling fluid. A Graphilor® water scrubber can be added to scrub the remaining vent gases. The absorber can be either in blocks or shell and tubes types.



#### WE OFFER

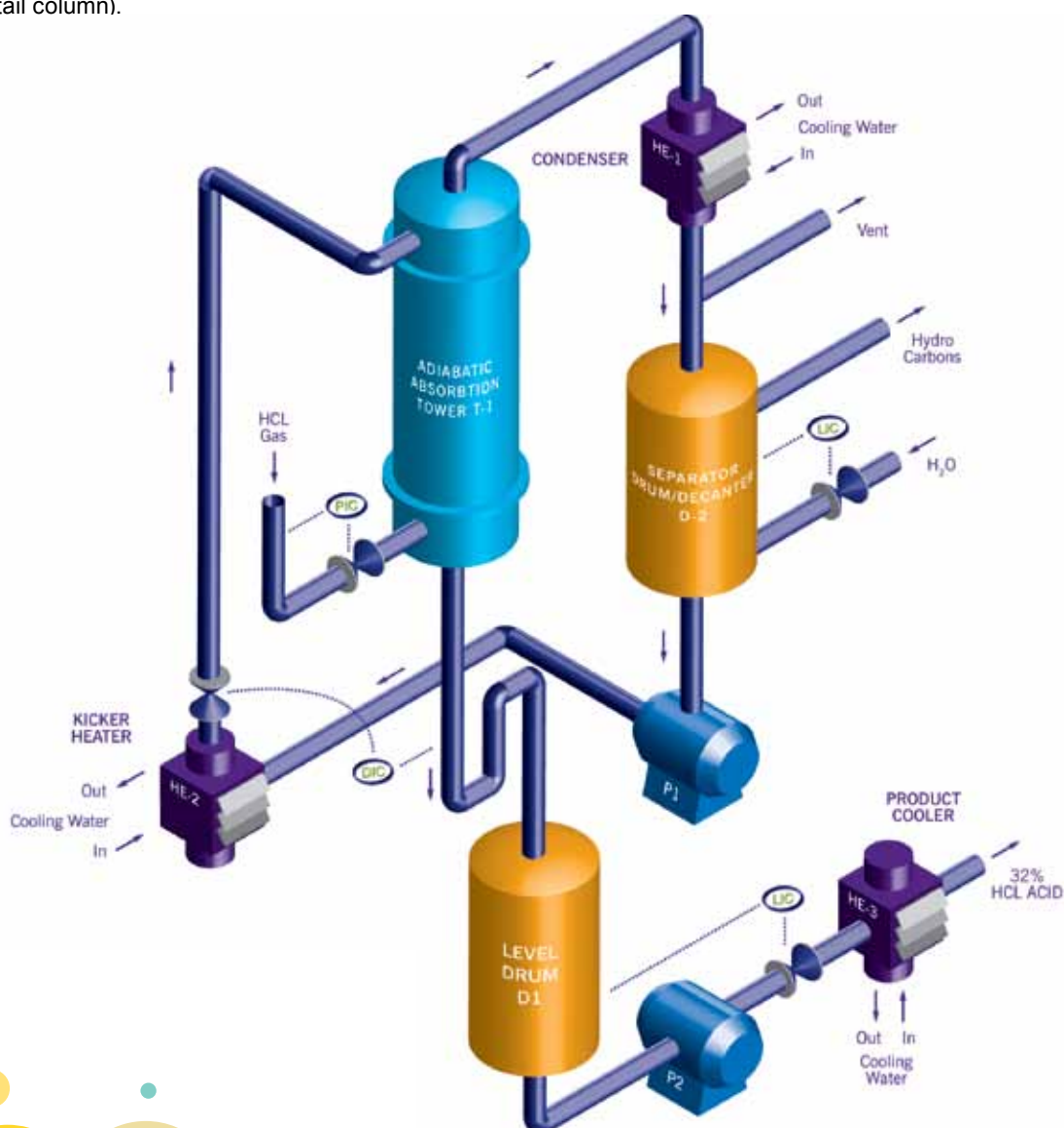
- Equipment
- Process know-how
- Instrumentation
- Piping and valves
- Full skid-package (with steel structure)



## Process 2 - Adiabatic Absorption.

The adiabatic absorption is applied for weak HCl gases. It takes place in **Graphilor®3** or **Armylor®** columns when the phenomenon occurs without heat recovery.

A Graphilor®3 column is used, supplied by the gas to be absorbed and the absorption water at the top. Gas and liquid flow are counter-current to ensure maximum absorption. A solution of hydrochloric acid at temperature close to boiling point, and a mix of water vapour and unabsorbed HCl, are recovered at the bottom. Two additional devices are added, namely an acid cooler and a secondary absorption device (usually a tail column).



## PRODUCTION OF PURE HCL GAS (AHCl) HCl STRIPPING AND HCl SYNTHESIS UNIT

The typical uses of pure HCl gas are

- High purity silicon for solar cell or electronics applications
- Organic chemistry
- Various metallurgical processes

There are 3 main routes to produce pure HCl, depending on the gas pressure, nature and quality of fed stream.

### BY SYNTHESIS UNIT

AHCl is generated by HCl gas synthesis unit.

If  $H_2$  and  $Cl_2$  are available in high quality, the synthesis of  $H_2$  and  $Cl_2$  in Mersen synthesis unit is the most economical and reliable choice to generate AHCl gas at 2 barG max. The HCl synthesis unit is considered as a very safe and proven-in-use system.

### BY STRIPPING

System allows to generate AHCl by distillation of fed concentrated acid. This stripping system can be coupled with a Sintaclor® or HCl absorber.

#### CLASSICAL STRIPPING OPERATING UNDER PRESSURE

In a classic stripping system, we provide all the following equipment, delivered optionally in skid.

- 1-Graphilor®3 Armylor®  
and Tantalum CL-CLad® stripping tower
- 2-Graphilor®3 thermosyphon reboiler
- 3-Graphilor®3 condenser
- 4-Graphilor®3 interchanger
- 5-Graphilor®3 bottom cooler
- 6-Armylor® PTFE piping

The feed acid is heating close to boiling point in interchanger by outgoing azeotropic bottoms acid. The stripping tower (T-1) is operating acid under pressure at normally 3 barG. The reboiler (HE-2) is providing the stripping energy while the 2 condensers (HE-3), (HE-4) and demister (D-1) are removing all  $H_2O$ .

The outgoing azeotropic acid at bottom is used to heat feed acid through (HE-3) and then is cooled to storage tank.

Mersen can supply reliable system that can generate AHCl gas with reliability at pressures up to 5 barG. Refer to page 15.

#### HCL AZEOTROPE BREAKER

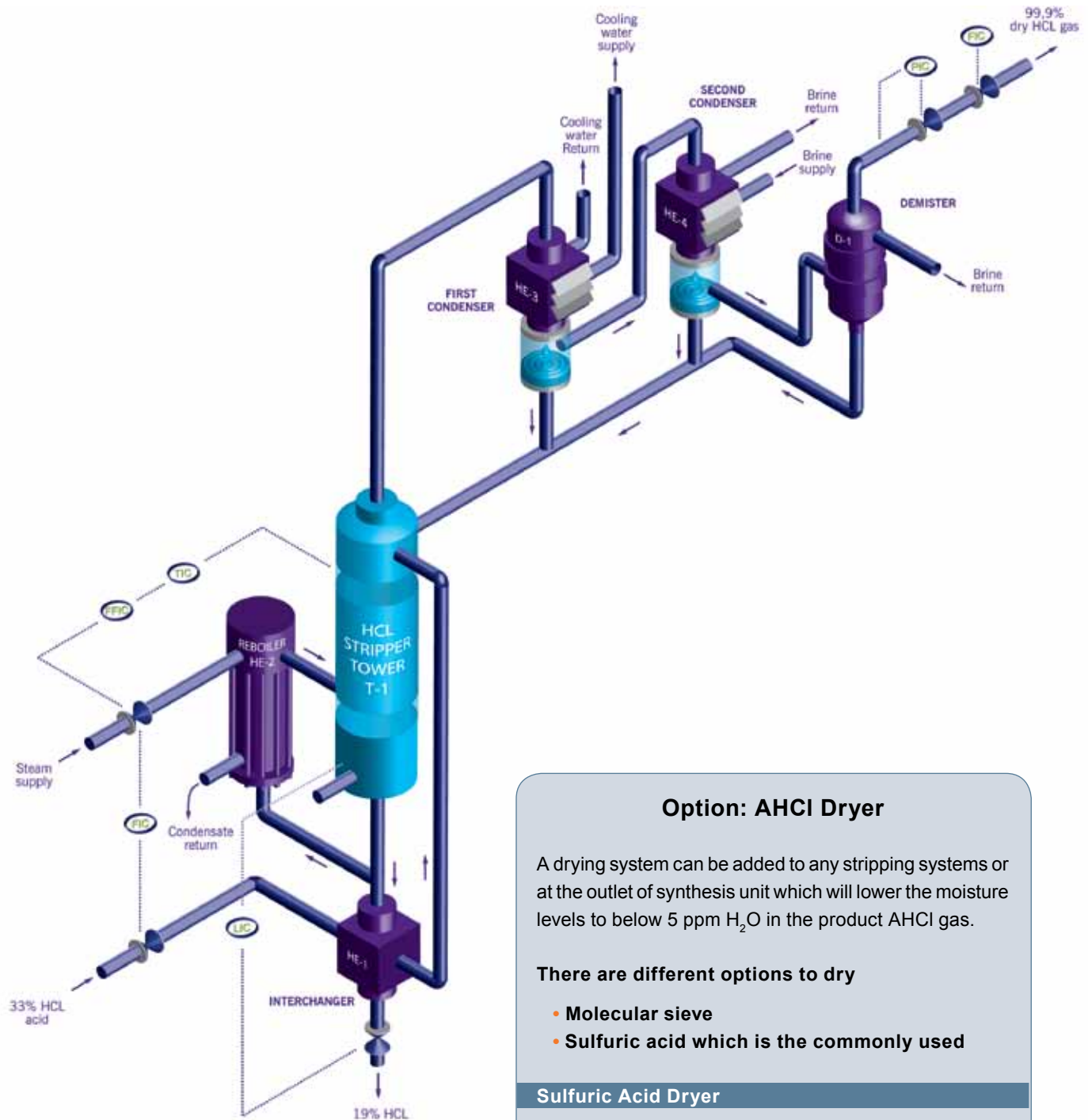
$CaCl_2$  Azeotrope Breaker - Salt effect principle:

At azeotropic concentration, the molar composition of liquid and gas phase are the same.

When you add the  $CaCl_2$  salt, the salt dissociation requires water, so water is "trapped" in the liquid phase. The "normal" vapour-liquid equilibrium is broken. Effectively the boiling point of the water is raised so that most of the "liquid" water falls in the column but the boiling point of the HCl remains the same so its vapour rises in the column and goes "overhead". This system will permit stripping of all HCl content in hydrochloric acid which comes through the stripper.

Other routes are available upon request.

## Stripping System Operating under Pressure



### Option: AHCI Dryer

A drying system can be added to any stripping systems or at the outlet of synthesis unit which will lower the moisture levels to below 5 ppm  $\text{H}_2\text{O}$  in the product AHCI gas.

There are different options to dry

- Molecular sieve
- Sulfuric acid which is the commonly used

### Sulfuric Acid Dryer

Single or double stage systems can be provided. They all use a Brinks style demister as the final demisting element and trace amounts of  $\text{H}_2\text{SO}_4$  will be carried over into the AHCI stream.

## ACID DILUTION SYSTEMS SULFURIC, HYDROFLUORIC, HYDROCHLORIC ACIDS...

### Acid dilution process

The concentrated acid and dilution water are mixed under pressure in a static mixer provided by an **Armylor® dilution tee pipe** connected to the concentrated acid and dilution water feeds. This provides turbulent mixing of the two fluids. The dilution of acid in water generates considerable heat. The hot corrosive mixture then flows through a corrosion-resistant **heat exchanger of Graphilor® impregnated graphite**. On the shell side, this heat exchanger is fed with cooling water which removes the heat and cools the diluted acid to the desired temperature.

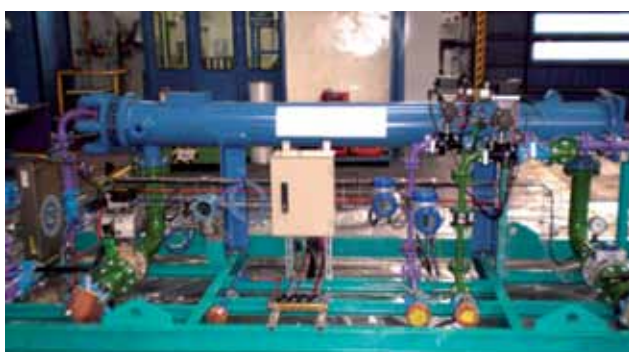
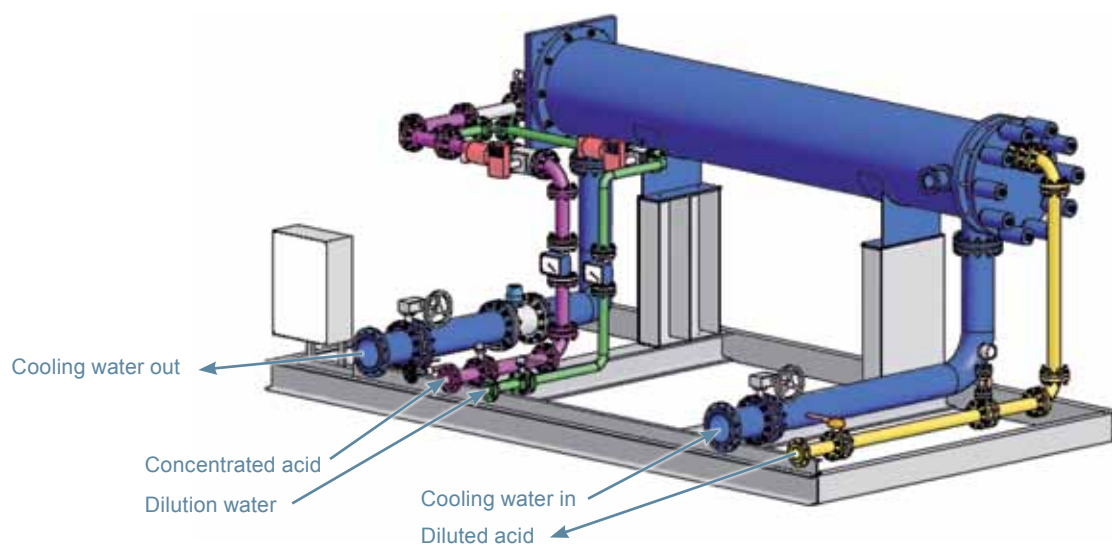
The diluted acid concentration is obtained by adjusting the concentrated acid flow rate with reference to the dilution water flow rate.

### OUR STRENGTHS

- Cost-efficient design
- Optimal material selection and reliable operation
- Fast delivery and commissioning

### Option: the ready-to-use skid-mounted system

All the items such as heat exchanger, dilutor, mixer, piping, instrumentation and cabinet are mounted on a metal frame wired, connected and tested in our workshop. The unit comes as a single turnkey unit, which considerably reduces assembly time on site



**Hydrofluoric Dilution Unit.**  
5 160 kg/h 33% HF



**Sulfuric Dilution Unit.**  
86 333 kg/h 84% H<sub>2</sub>SO<sub>4</sub>



## UNIT FOR HEATING AND COOLING FOR PICKLING BATHS

**The steel pickling industry requires corrosion resistant solutions**

- Corrosion and abrasion resistant heat exchangers
- Corrosion and abrasion resistant recirculation pumps
- Corrosion resistant piping and filters

Mersen is the world leader in supplying heat exchangers for the steel and stainless steel pickling market industry.

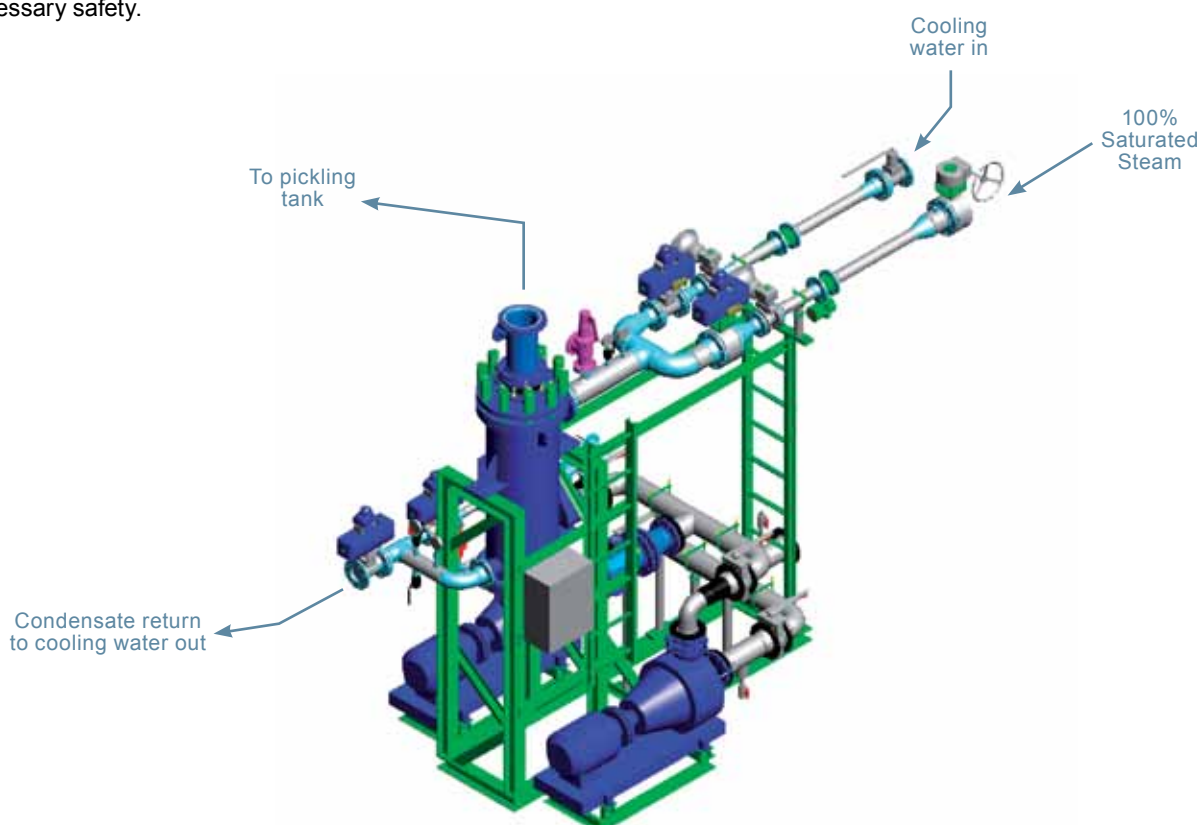
**Our heat exchangers can be manufactured in several corrosion-resistant materials such as**

- Impregnated graphite
- Reactive metals (tantalum, niobium...)

The heat exchangers can be either Graphilor® or reactive metals, depending on the characteristics of the pickling process. Our pickling packages are comprised of acid heat exchanger with a pump and strainer, all coupled to piping systems for both acid and service streams. The instrumentation package includes instrumentation for a temperature control loop for the acid. The package also supplies devices for necessary safety.

### OUR STRENGTHS

- Graphilor® 3 xbs or xth (phenolic or PTFE impregnate for HCl pickling used in the carbon steel plates)
- Graphilor® 3 xth for HF/HNO<sub>3</sub> acid used in the stainless steel plates pickling
- Cost-effective solution for Graphilor® 3 Polybloc®
- Long-lifetime for tantalum or niobium shell and tubes exchangers
- Strong leadership with key producers and engineering
- Worldwide references
- Local repairshops
- Production centers in each continent for graphite and reactive metals.
- Dedicated engineering team to design heat exchangers and systems.



Pickling bath - External Heating Flow Diagram

## MAINTENANCE AND SERVICES

**We do not just deliver equipment, we can also provide support for all products we deliver throughout their life cycle and offer a broad range of services:**

- **Start-up services**
- **Preventative and corrective maintenance**
- **Consulting, upgrade and troubleshooting services**

### **Start-up services**

Start-up is a critical phase, and its success depends on many different factors specific to each item of equipment and each process. Our vast experience in graphite equipment means that we are able to give you the right advice on how to start up equipment successfully.

With complex systems, we can support you from the beginning of the project through to the start-up phase. Acid production systems need meticulous preparation in line with the safety standards. Our team of system specialists can also provide you with support throughout this stage.

### **Preventative & corrective maintenance**

Thanks to our know-how concerning our equipment and related materials, we can give you the best advice for your specific process. We are able to suggest technical improvements to increase returns or extend the life of equipment. Our R&D service and design office are able to develop made-to-measure solutions addressing the specific issues you face. We also deliver spare parts right around the world.



### **Corrective maintenance**

We are keenly aware that halting production has a serious impact on our customers' business. That is why we have a team of installation experts at our 16 after-sales centers around the globe on stand-by to repair defective equipment on site. Thanks to their highly extensive product knowledge, they are able to make the right diagnosis and repair on site or in our local workshops.

### **Consulting, upgrade and troubleshooting services**

Standards are constantly changing, and technical improvements are being made all the time. And so it is crucial for you to have a partner with the product and process know-how to be able to suggest adjustments in line with the latest market requirements. Our team of process experts offer audits of our system installations and can recommend enhancements to keep production running as smoothly and efficiently as possible.

### Project management

More than your order, Mersen manages your project.

*After the signature of the order, a dedicated project manager is appointed to coordinate all the following steps*

- Kick-off meeting
- Engineering and fabrication bar chart
- Basic engineering (P&ID, heat and mass balance, General arrangement drawing, drawing of each equipment, instrument specification package)
- Detail engineering (isometrics drawings, 3D layout, steel structure drawing, foundation drawing)
- Monthly report (clear status of the order)
- Management of our partners (electrical part, instrumentation and steel frame)
- Technical assistance of the team during the project and the commissioning

### Quality Commitment

#### Certifications

- All our systems are CE certified and respect PED and ATEX directive.
- Construction codes  
ASME, Codap or Ad Merck Blatt
- Third - Parties TÜV, Apave





## A GLOBAL PLAYER

Mersen is a global expert in electrical specialties and graphite-based materials.

Global Expert in electrical specialties and graphite-based materials Mersen designs innovative solutions to address its clients specific needs to enable them to optimize their manufacturing process in sectors such as energy, transportation, electronics, chemical, pharmaceutical and process industries.

### **Mersen France Pagny-sur-Moselle**

1, rue Jules Ferry - F-54530 Pagny-sur-Moselle

Tel. : +33 (0)3 83 81 60 81

[info.pagny@mersen.com](mailto:info.pagny@mersen.com)

### **Mersen USA Salem branch**

140 Branch drive VA 24153 - Salem

Tel : +1 540 389-7535

[www.mersen.com](http://www.mersen.com)