4th EDITION | **2023**

Clark Solutions

SULFURIC ACID SOLUTIONS

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CLARK: A SOLUTIONS PROVIDER

Clark Solutions is a Brazilian innovation company with more than 30 years of experience in separation, mass transfer and pollution control applications for various industry segments such as: sulfuric acid, oil & gas, chemicals, sugarcane and ethanol, pulp and paper, bioenergy, and others.

Technical competence, flexibility and commitment to the customer are the main pillars that support Clark Solutions growth, which combined with extensive experience achieved in the execution of thousands of projects in various industries, allow applications suited solutions offering.

From conceptual design to operation, all processes have strict quality standards, always aiming to surpass our client's expectations.

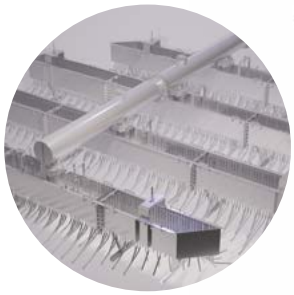
In an optimized structure, Clark Solutions provides flexibility when serving the client and agility to quickly adapt to market demands. We are committed to always find the most satisfactory solution to our partner's needs.

With a portfolio including tower internals, complete systems, modular plants, troubleshooting, debottlenecking and a whole set of technologies, Clark Solutions supplied thousands of projects and equipment in four continents. Our products and services always meet or surpass the most rigorous expectations. Specialized manufacturing workshops and production partners build our portfolio fabricating our products and solutions developed in Brazil and approved throughout the world.

Photo: Industrial Plant - SP - Brazil

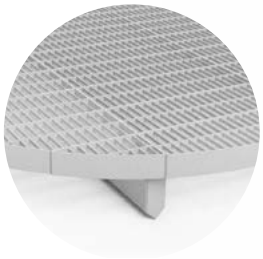
AIR DRYING

Mist eliminators
MaxiMesh.....14



Liquid distributors
MaxiFlow CD.....18

Random packing
MaxiSaddles.....19



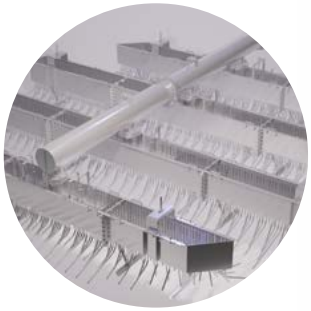
Packing Supports
MaxiGrid.....12

Alloy or Bricklined tower
Towers & Pump Tanks.....21

Drying towers are responsible for conditioning air to further admission in the sulfuric acid plant. Air humidity removal is fundamental to equipment lifespan extension. Dew points of -40ºC or better are expected, reducing acid condensation on plant cold spots such as boilers, gas-gas heat exchangers, furnaces wind box and gas ducts.

Clark Solutions can supply full Drying Towers (CSX™ or brick lined) with high performance internals to achieve the best results in the most challenging scenarios. Sulfuric acid is fed to the tower acid distributor MaxiFlow™ CD, with high irrigation density, free cross sectional area and flowrate flexibility, it irrigates the liquid homogeneously over the ceramic random packing MaxiSaddle™, where liquid forms a film over the packing surface area, allowing mass transfer with the ascending air. Due to the sulfuric acid hygroscopic characteristic, water content is removed from the air, resulting in a more diluted acid. Dried air to the expected quality leaves the packing and passes through a co-knitted meshpad mist eliminator MaxiMesh® to remove entrained liquid.

SO_3 ABSORPTION



Acid distributors
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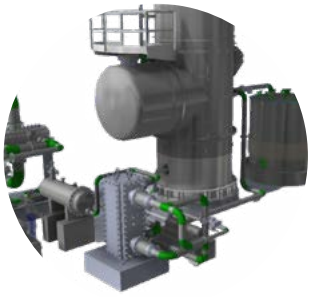


Acid heat recovery
SAFEHR.....8

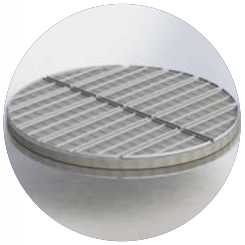
Alloy or Bricklined tower
Towers & Pump Tanks.....21

Absorption tower's main goal is to recover SO_3 converted in the plant reactors in the form of sulfuric acid. Clark Solutions offer either conventional or acid heat recovery configurations, the latter with SAFEHR® patented setup.

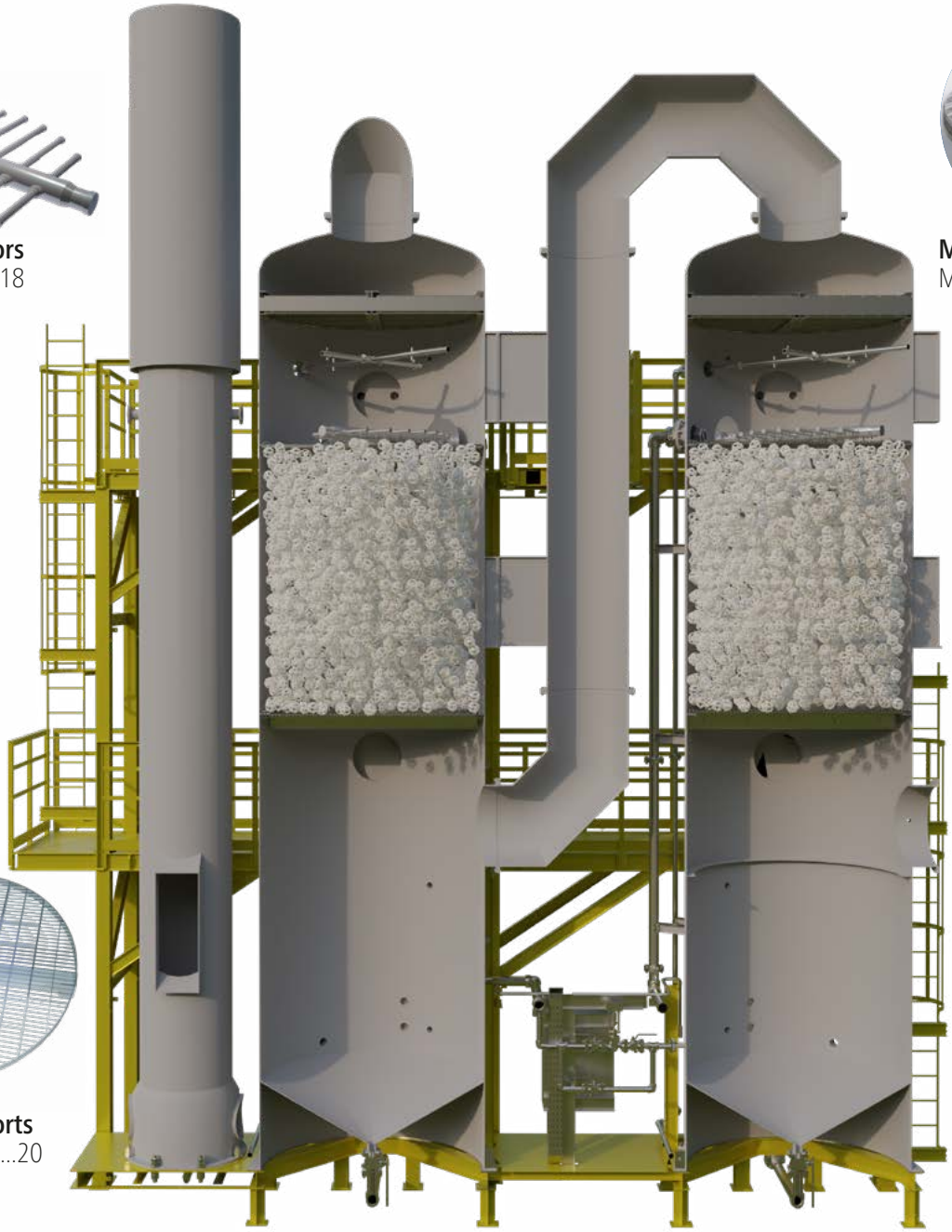
Clark Solutions can design and manufacture full absorption towers (High silicon stainless steel combination or brick lined) with high performance internals to achieve the best results in the most challenging scenarios either with acid recovery or not. Sulfuric acid is fed to the tower acid distributor MaxiFlow™ CD, with high irrigation density, free cross sectional area and flowrate flexibility, it irrigates the liquid homogeneously over the ceramic random packing MaxiSaddle™, where liquid forms a film over the packing surface area, allowing mass transfer with the ascending gas stream. The residual water content from the liquid reacts with the SO_3 from the gas, producing a more concentrated acid. A set of high performance brownian diffusion mist eliminators FiberBed® remove submicronic entrained liquid from gas-liquid interaction in the packing.

TAIL GAS SCRUBBING

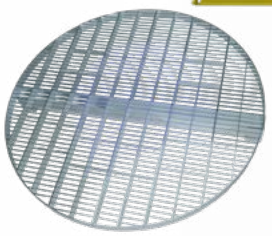
Acid distributors
MaxiFlow.....18



Mist eliminators
MaxiMesh.....14



Random Packings
3-Pack



Packing Supports
MaxiGrid.....20

Residual SO_2 content in the gas stream to the stack must be treated if the concentration is above environmental restrictions treshold, which may occur in single absorption plants, tight environmental restrictions regulations or low conversion plants..

SO_2 may be recovered with co-product generation or not. The former utilizes washing solutions such as caustic soda, hydrogen peroxide, ammonia and others, which reaction with sulfur dioxide generates compounds with high added value. The latter applies regenerative systems with a scrubber (where SO_2 is absorbed) and a stripper (where SO_2 is recovered by thermal desorption), generating virtually no co-product by using low pressure steam.

Clark Solutions can offer a set of different options for desulfurization, comprising both technology and equipment. Internals are carefully designed for each application conditions and corrosion resistance, with MaxiFlow™ liquid distributors, Maxipac® structured or 3-Pack™ random packings and MaxiMesh® meshpad mist eliminators.

ACID CIRCUIT

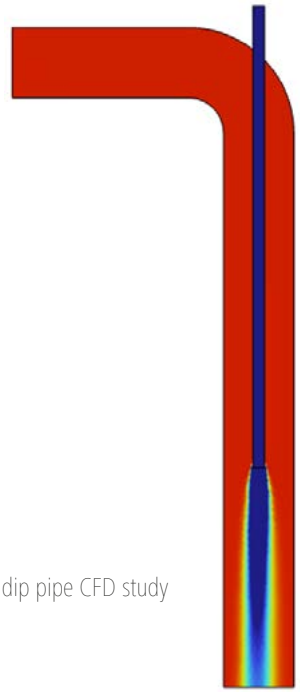
Acid Pump Tanks

Combined acid pump tank in CSX

High silicon stainless steels (HSSS) such as CSX™ have been widely used in sulfuric acid due to its high resistance to corrosion in a wide range of temperatures and acid concentrations while keeping its structural properties.

Alloy sulfuric acid tanks are up to 60% lighter than brick lined options and could be installed in a shorter period, since there is no requirement of coating application on site, which may be crucial in tight maintenance shutdown schedules. On top of that, brick lining application is a very complex job, requiring highly experienced workers.

Acid dilution is toroughly studied by Clark Solutions with computational fluid dynamics evaluations to define the best configuration and position to preserve the tank shell and granting long lifespans equivalent to bricklined options.



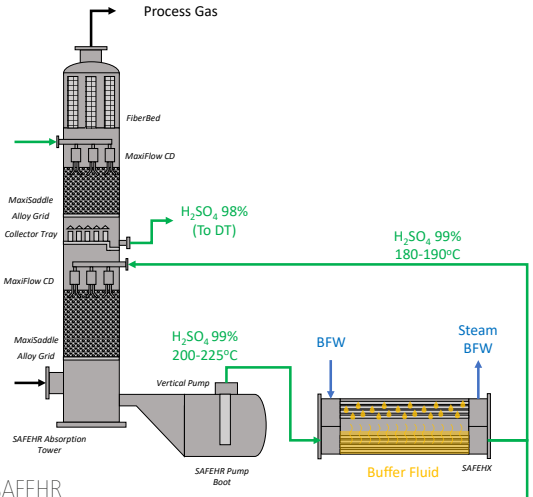
Dilution dip pipe CFD study

Piping & Fittings

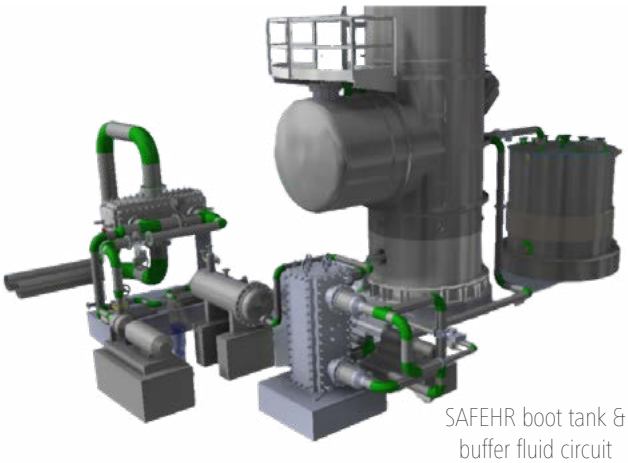
Clark Solution has been successfully substituting cast iron piping by HSSS such as CSX™. Among a myriad of benefits: decrease in acid leakage risks (due to substantial lower flanges quantity), lighter and easy to handle parts (due to thinner thicknesses), better acid product quality (due to lower corrosion rates), easy maintenance (due to weld repairs possibility), decrease in parts inventory (due to no limitation is pieces geometry manufacture), smaller diameters (due to higher applicable velocities).

The key to CSX™ HSSS success is the formation of a very resistant passive layer of silicon oxide on the material's surface in the presence of a strong oxidant. This brings a very high resistance to strong sulfuric acid at typical process temperatures. Which provides additional beneficial properties to the alloy, such as resistance to high pitting, erosion and corrosion, the latter, being especially attractive for piping systems since fittings are more susceptible to erosion damages.

SAFEHR®



SAFEHR Schematic

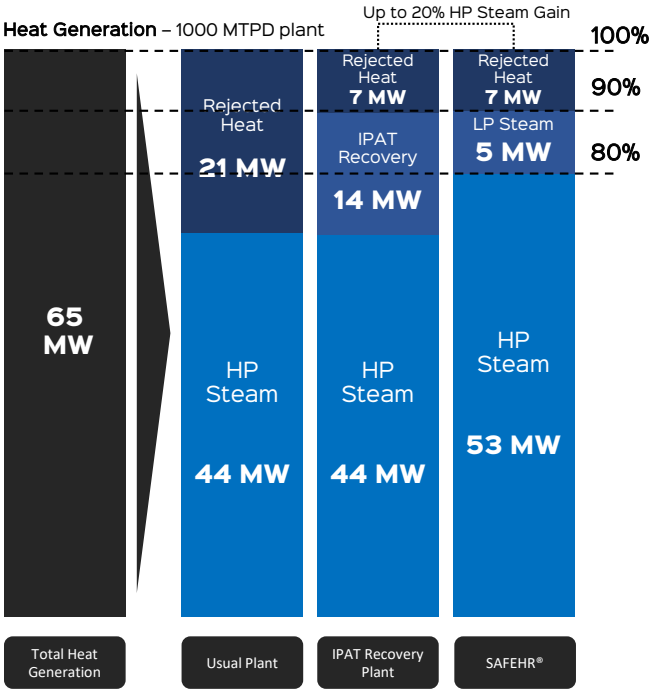


SAFEHR boot tank & buffer fluid circuit

Existing technologies to recover heat from absorption towers use boilers with water and acid in each side. In case of leakage, water (high pressure side) makes direct contact to acid (low pressure side), diluting and heating the leakage point promoting a condition which could lead to emergency shutdowns and hydrogen explosions.

Clark Solution's SAFEHR® system was developed to minimize risks of contact between sulfuric acid and water in absorption tower's heat exchangers by using a family of proprietary inert buffer fluids as an intermediate, generating low to medium pressure steam or pre-heated boiler feed water for high pressure steam operations. Steam generation can be increased in up to 0.3 tons per ton of produced sulfuric acid.

The system comprises a double deck tower, in which high temperature (180-225ºC) and concentrated sulfuric acid (99-99.5%wt) circulates at the lower bed, absorbing SO_3 in an exothermic reaction with energy recovery at SAFEHX heat exchanger. The upper bed is irrigated with cold acid (75-82ºC) in usual concentrations (98-98.5%) to decrease gas temperature and remove any residual SO_3.



SAFEHR technology could be applied for boiler feed water heating, increasing high-pressure steam generation in up to 20%

Benefits

- **Inert buffer fluid**

Fluid is inert to and immiscible with acid and water, also non-toxic, stable, with low vapor pressures, good heat transfer properties, non-flammable, safe to handle and with density in betwen water and acid.

- **Acid leakage detection**

If leakage occurs, it will be detected in the buffer fluid side while water and acid do not get in close and direct contact.

- **Controlled corrosion**

No acid dillution occurs, preventing corrosion rate increase

- **Other applications**

SAFEHR is not restrict to absorption towers, it may be applicable to any operations involving risky fluids.

HEAT EXCHANGERS

Acid Coolers

Sulfuric acid – water heat exchangers are applied in sulfuric acid plants to acid circulation temperature control with cooling tower water. Clark Solutions can supply shell and tubes heat exchangers either anodically protected or manufactured in high silicon stainless steel (HSSS) such as CSX™. The former is a well-stablished technology that uses anodic polarization by managing electrode potential, generating material passivation and allowing cheaper materials application such as 304 and 316. While the latter, does not demand anodic protection, due to the material corrosion resistance characteristic, the equipment is more flexible to operation fluctuations, as the tube wall can reach higher temperatures and concentration oscillations could be better resisted if compared to anodic protection solutions.

Anodically Protected VS Alloy Coolers

- **Operation Window**

Alloy coolers grant more flexibility to operation fluctuations and allow higher temperatures.

- **Auxiliary Equipment**

Alloy coolers do not require any auxiliary equipment such as anodic protection, also demanding minimal operational attention.

- **Maintenance**

Alloy coolers require lower maintenance, since there is no anodic protection system.

- **Investment**

Anodic protection allows the application of less expensive materials

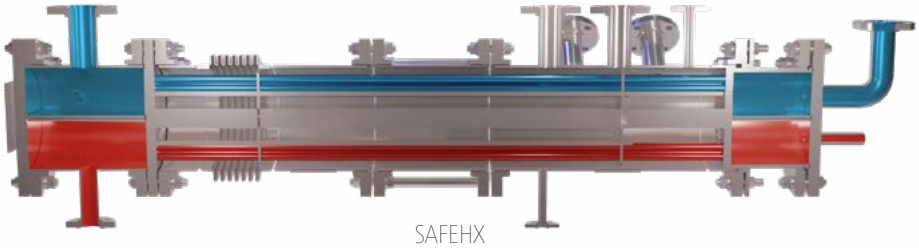
Shell & Tubes SAFEHX

SAFEHX®

SAFEHX is a patented multi-fluid heat exchanger technology, conceived to be a safe, compact and reliable part of SAFEHR operation. Sulfur trioxide absorption heat is recovered in this equipment with low to medium pressure steam generation or high pressure boiler feed water pre-heating.

A disruptive three-fluid shell & tubes heat exchanger in which water flows through the upper tube bundle and sulfuric acid through the lower tube bundle. An inert buffer fluid, enclosed in the shell, forms a pool over the lower bundle and operates in a pressure condition where boiling temperature is below the lowest acid temperature and above the highest water temperature. A boil and condensation loop is closed transferring heat from the hot source to the cold side using latent heat.

The inert buffer fluid is an immiscible barrier separating water and acid in case of a leakage, reducing auto-catalytic dilution effects and eliminating hydrogen generation risks, hence delivering a safe acid heat recovery.



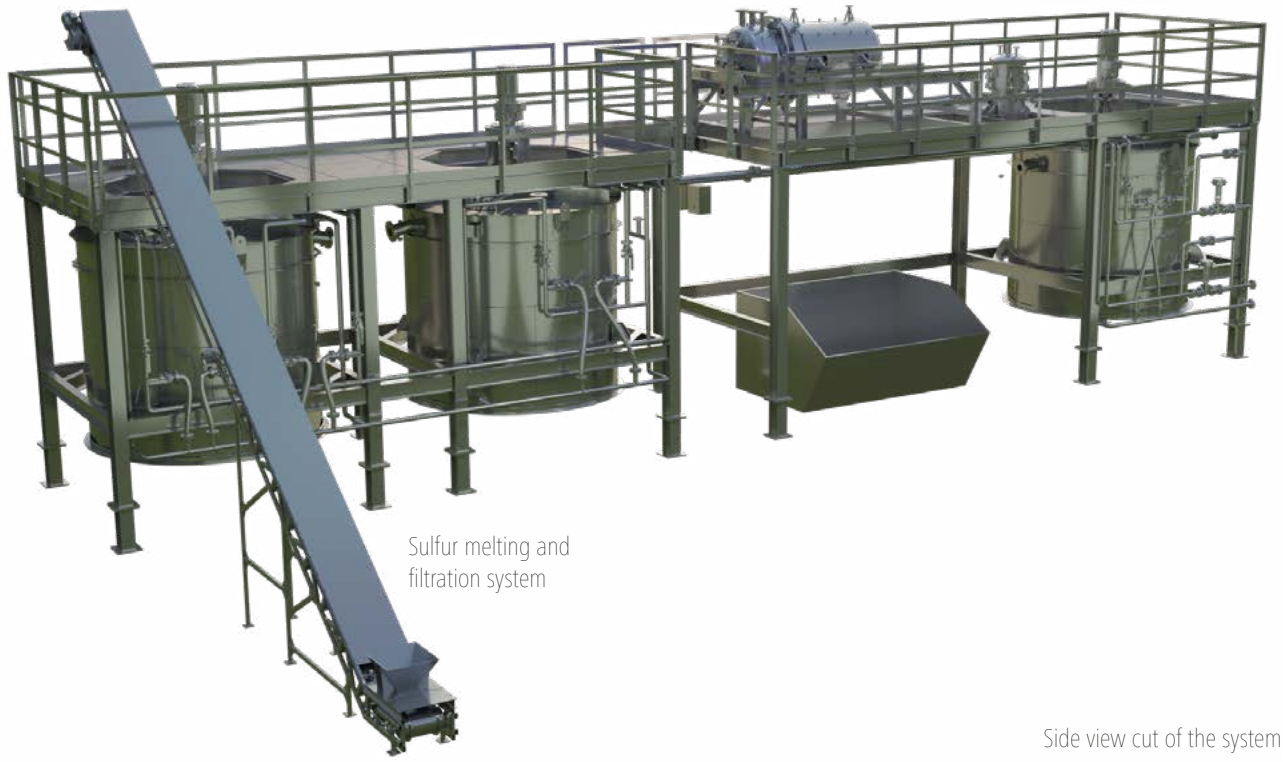
SAFEHX

SULFUR MELTING AND FILTRATION

Sulfur must be properly conditioned prior to admission in the furnace spray gun. Even with high quality solid elemental sulfur supply, ashes content accumulates at catalytic beds decreasing campaign duration if proper filtration is not executed.

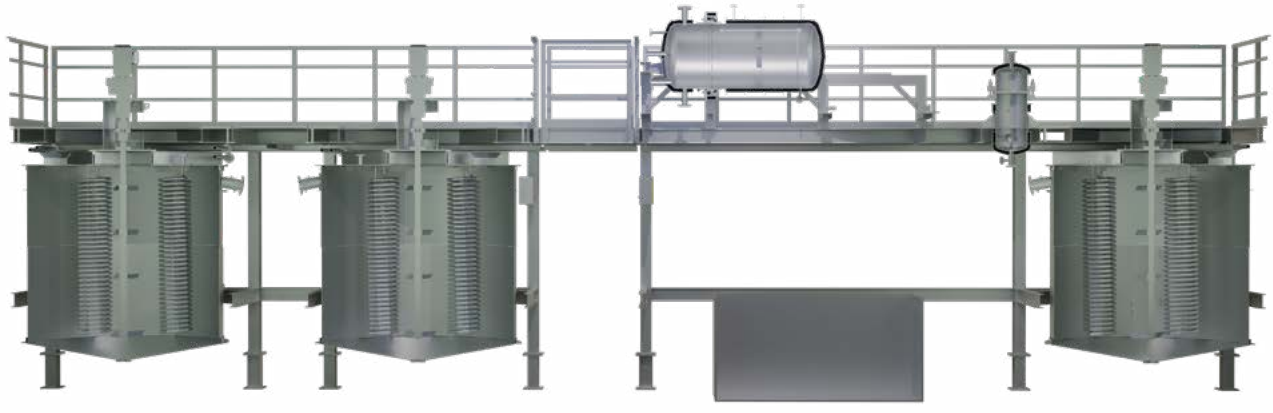
Clark Solutions can design and manufacture the whole sulfur melting and filtration system. Firstly, solid sulfur is fed to the melting tank, which is equipped with a set of heating coils and agitator, maintaining the optimum conditions for sulfur flow. From this tank, sulfur overflows to the melted sulfur tank, maintaining the coarse contaminants at the first tank. The liquid is pumped by a vertical pump through leaf filters where ash content can be decreased down to 20 ppm. To achieve even better results, Clark Solutions apply a polishing filter downstream to decrease ashes content down to 5 ppm. Finally, filtered sulfur is fed to the filtered sulfur tank, which serves as a bridge between the sulfur and sulfuric acid circuits.

The system is fully skid mounted, comprising compact equipment disposition (to decrease jacketed piping lengths), tanks with conical bottom heads (to facilitate maintenance), elevated filters (to facilitate cake removal), vertical pumps (for easier drainage and maintenance), parallel leaf filters (for alternation during cleaning) and polishing filter (to increase catalyst lifespan).



Sulfur melting and filtration system

Side view cut of the system



ENGINEERING SERVICES

With a vast expertise in sulfuric acid market, Clark Solutions has a strong engineering team capable of elaborating process evaluations and complete projects implementations, providing solutions to attend clients issues, aiming for cost efficiency, short delivery time and direct and open communication channels.

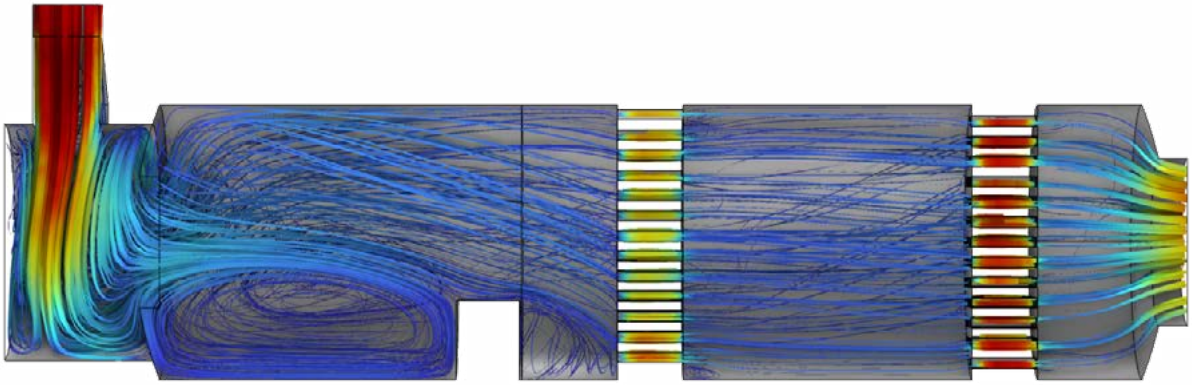
Complete project

Clark Solutions can offer full systems from towers to complete modular sulfuric acid plants. Project steps follow feasibility evaluation, conceptual design, basic engineering, detailed engineering, project management, equipment manufacture and assembly, commissioning, startup and operation.

Problem solving

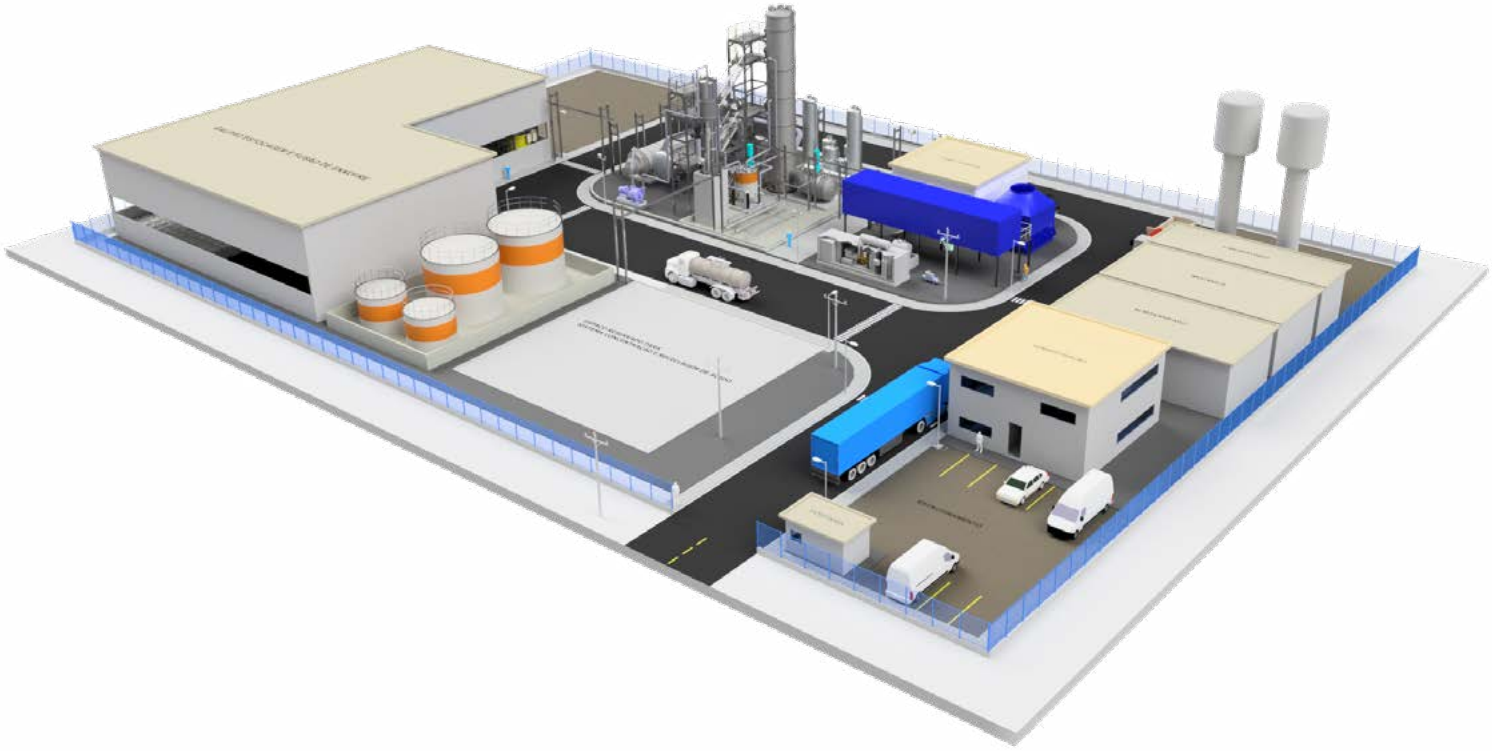
Clark's engineering team is capable of performing studies of: debottlenecking, troubleshoot, optimization and computational fluid dynamics (CFD) evaluations. Delivering a complete analysis with potential root causes and possible solutions.

Mechanical structural calculation for a custom made Fiberbed tubesheet solution



CFD evaluation of gas flow condition in a sulfuric acid plant furnace

MODULAR PLANTS



Clark Solutions has developed a sulfuric acid plant concept built in modules. The plant is set up in skids, each one having a standard container size, which provides simplicity in installation and mobility.

This technology aims to offer a strategic option to industries that use sulfuric acid, mainly when distant from large production centers. It guarantees supply reliability, price predictability and minimizes transport risks.

Features

Modules: Minimal installation on site is required since the skid is assembled in the workshop.

Easy Operation: The highly automated plant optimizes employees demand and could be remotely operated.

Capacity: Range from 50 to 300 metric tons of sulfuric acid manufactured per day.

Reliability: A simpler concept requires fewer and shorter shutdowns, an efficient sulfur filtration allows longer campaigns, special alloys application decreases iron content on acid product and more.

Portability: The modules allow the plant to be road transported, with easy assembly and disassembly in field.

Configurations: Could be applied in a myriad of configurations: sulfur burning, mercaptans feed, metallurgical feed and more.

Flexibility: Plant capacity could vary from 30% to 110%

1.

Stock

Sulfur has many advantages in storage: it can be stored outside and cost & volume of storage are smaller if compared to sulfuric acid.

2.

Cogeneration

Due to single absorption plant high exothermic characteristic, steam generation is maximized in a configuration customly designed for each demand.

3.

Logistics

Each truck of sulfur could produce the equivalent of 3 to 4 trucks of sulfuric acid, decreasing transport carbon footprint and risks.

4.

Emissions

A tail-gas scrubbing system provides the capability of respecting the most strict environmental regulations.

Modules

Sulfur Melting

Consists of a melting tank (where sulfur is transformed from solid to liquid), a set of sulfur filters (considering a polishing filter) to remove ashes below 5 ppm preserving the catalyst integrity, and a filtered sulfur tank.

Sulfur Burning

Consisted of a fire-brick insulated horizontal furnace where molten sulfur is fed through a special sulfur gun, followed by a waste heat boiler. 15 to 45 bar_g saturated steam is generated to process consumption or electricity generation.

Compression

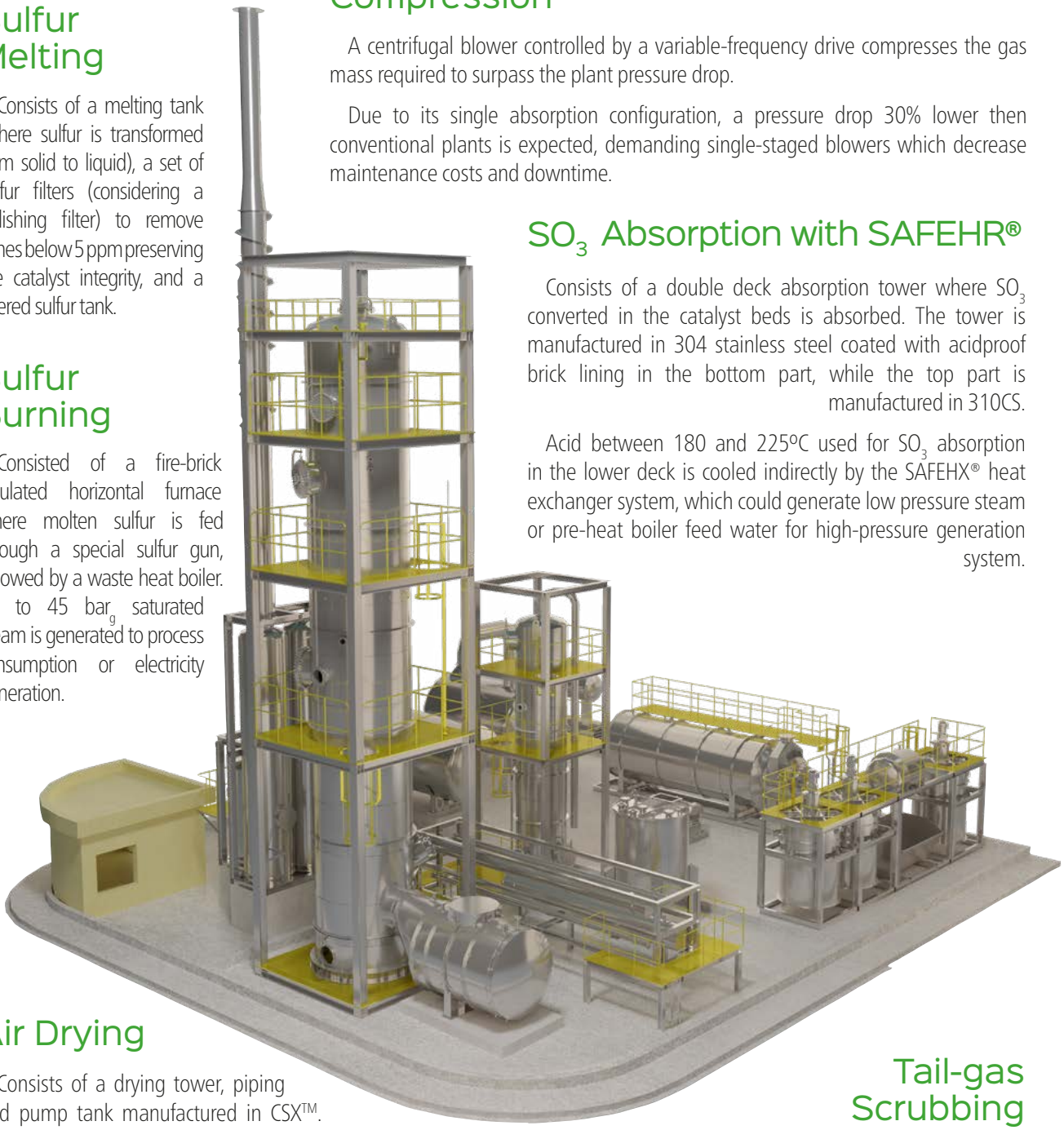
A centrifugal blower controlled by a variable-frequency drive compresses the gas mass required to surpass the plant pressure drop.

Due to its single absorption configuration, a pressure drop 30% lower then conventional plants is expected, demanding single-staged blowers which decrease maintenance costs and downtime.

SO_3 Absorption with SAFEHR®

Consists of a double deck absorption tower where SO_3 converted in the catalyst beds is absorbed. The tower is manufactured in 304 stainless steel coated with acidproof brick lining in the bottom part, while the top part is manufactured in 310CS.

Acid between 180 and 225ºC used for SO_3 absorption in the lower deck is cooled indirectly by the SAFEHX® heat exchanger system, which could generate low pressure steam or pre-heat boiler feed water for high-pressure generation system.



Air Drying

Consists of a drying tower, piping and pump tank manufactured in CSX™. Acid distributor and high efficiency ceramic packing ensure a dew point below -40ºC (-40ºF).

Conversion

Gases from the sulfur burning module feed a four passes horizontal converter, which is designed in CFD (computational fluid dynamics), manufactured in two separate stainless steel vessels.

Catalytic bed cooling can be arranged depending on client's need: steam generations (in pressures from 15 to 45 bar_g) or cogeneration. A setup of economizers, boilers and superheaters is applied depending on the configuration.

Tail-gas Scrubbing

A gas scrubber system guarantees emissions far below the most strict environmental regulations, regardless of the operation condition (startup, high load and shutdown).

Various scrubbing solutions could be selected for the gas cleaning, generating or not a co-product, the most common are: hydrogen peroxide generating dilluted sulfuric acid and caustic soda generating sodium sulfite or bisulfite.

MIST ELIMINATION

MaxiMesh®

Clark Solutions inherited its wire mesh pad manufacturing experience from the oldest developers of such products. Associating product manufacturing with process knowledge, Clark Solutions managed to develop a Maximesh line specifically destinated to the sulfuric acid industry.

Entrained liquid is collected mainly by inertial impaction which occurs when a gas stream carrying liquid particles encounters an obstacle. While gas diverts around the obstacle, the particles with enough inertia are projected out of the gas flow and impact against the obstacle.

Application

MaxiMesh can be applied to drying towers and tail gas scrubbers, protecting blowers, compressors, ducting, furnace and minimizing emissions by virtually eliminating all entrainment generated. Full alloy or co-knitted configurations composed of special alloys or plastics could be applied. Co-knit with PTFE or fiberglass, grant a huge surface area for the most challenging performance requirements.

Models

- **MaxiMesh Style 655**

Designed for sulfur burning plants drying towers. A double layer arrangement offers coarse collection and drainage at the bottom and fine capture at the top.

- **MaxiMesh Style 338**

A PTFE co-knit mesh arrangement with a multifilament structure supported on metal wire is perfect for metallurgical acid plants which present higher mist load and finer particle size distribution.

- **MaxiMesh Style 713M**

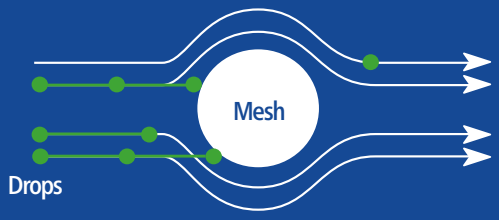
Developed with same principles as the Style 338, it is applicable to metallurgical and spent acid plants where fluorides are not an issue. PTFE is replaced by a denser and thinner filament yarn of chemically resistant glass.

MaxiMesh®

Collection Mechanism

Inertial Impaction occurs when smaller particles inertia project them from the gas against the filter element.

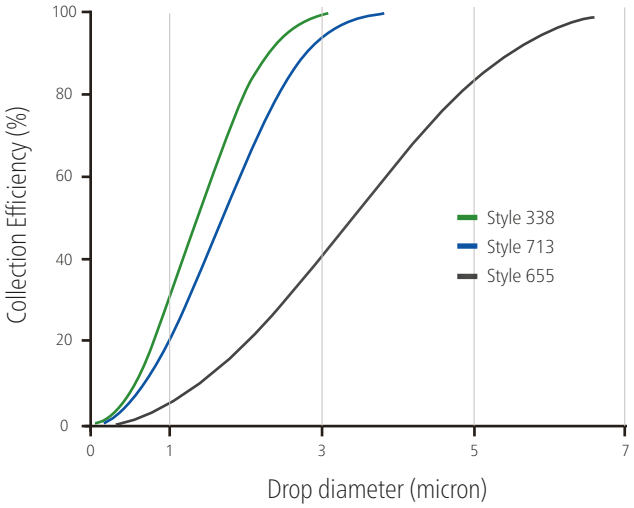
Driving force
=
Particle Momentum



Inertial Impaction

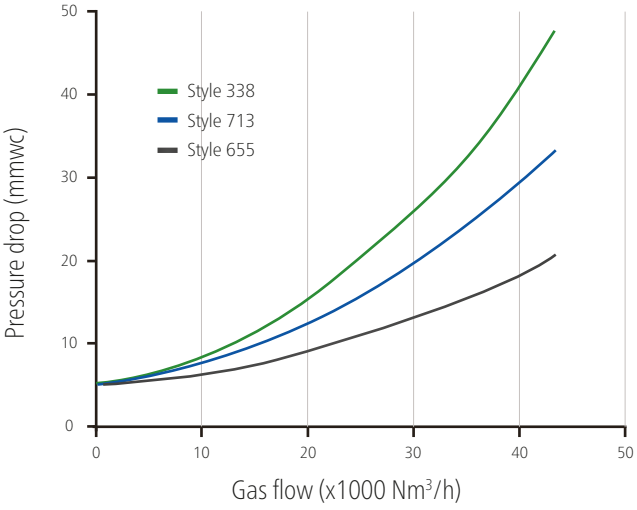
Efficiency

Comparison among different Maximesh® models regarding to droplets retention in a generic scenario.



Preassure drop

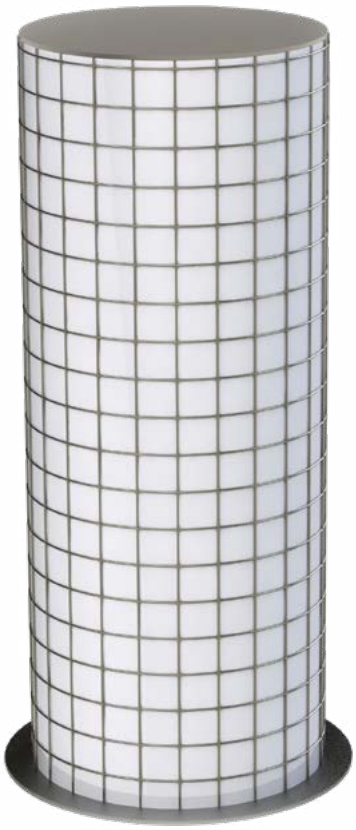
Comparison among different Maximesh® models regarding to pressure drop in a generic scenario.



FiberBed

Fiber bed mist eliminators were developed in late 1950's early 1960's to capture submicronic particles from thermal phosphoric acid plants. These devices extreme high efficiency soon led them to occupy space in many industrial applications where submicronic mist control was relevant; one of these are absorbers in sulfuric acid plants.

Fiberbed® mist eliminators use a collection mechanisms conjunction: inertial impaction, direct interception and brownian movement collection, the latter being responsible for submicronic particles removal since droplets acquire random movement due to collision with gas molecules, requiring enough residence time inside the dense filtering media which explains the mist eliminator candle geometry.



FiberBed® BD

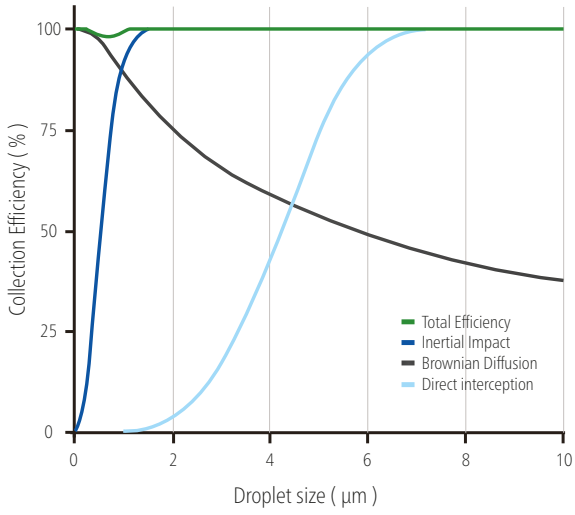
FiberBed® IC

Aplicação

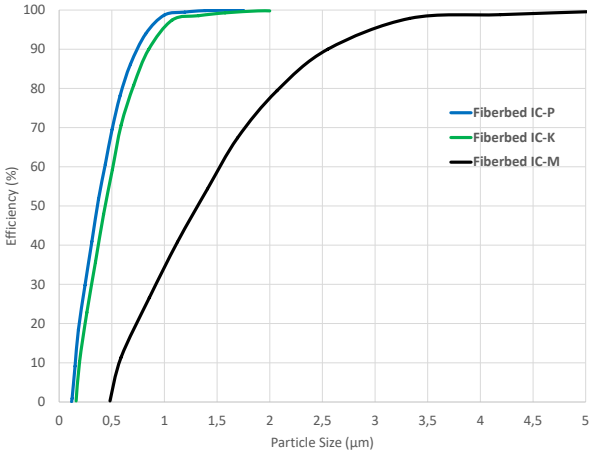
FiberBed can be applied to absorption towers in two types: brownian diffusion (BD) and Impaction Candles (IC).

The former is used either in interpass and final towers, the dense fiberglass media supported between concentric screens captures submicronic entrainment, droplets collected coalesce forming larger ones that drain by gravity and go back to the process through the sealing device. For high capacity scenarios, a dual bed configuration can be selected, which consists of two packed cylinders per candle, increasing area up to 30%.

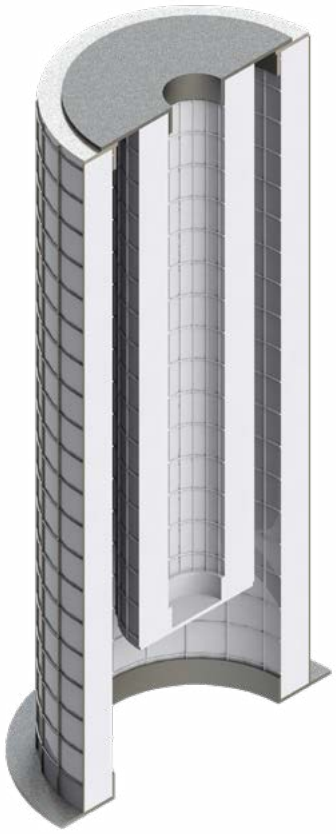
The latter is applied to final towers only, capturing entrainment by inertial impaction using alloy mesh wrapped between cylindrical cages. Filtering media comes in three options: fully metallic (IC-M type), co-knitted (IC-K) and with a fiberglass layer (IC-P). Due to higher velocities supported, smaller sizes elements can be applied.



FiberBed BD collection mechanisms



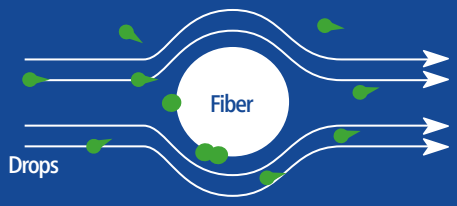
FiberBed IC models efficiency comparison



FiberBed® BD-DB

Collection Mechanism

Brownian diffusion occurs with extremely small particles which acquire a Brownian movement. These submicrometric objects follow gas trajectory, defining residence time. They also move randomly by colliding with gas molecules, determining mean path and probability



Brownian diffusion

DrySeal™

Candle filter mist eliminators are commonly used throughout chemical processes. Although both effective and efficient in capturing liquid droplets, they are usually responsible for non-negligible pressure drops. Therefore, they require proper sealing, which is mostly achieved by sealing cups containing process liquid. Eventually, said liquid needs to be refilled for maintenance, a burdensome task that may present hazards to personnel. These seal cups usually corrode and leak or accumulate corrosion products and plug, hindering them ineffective.

To avoid these issues, Clark Solutions developed a safer alternative for the sealing cup, one that removes the necessity for refill due to its self-draining and auto-sealing capabilities. It is also easy to clean and install and does not require additional set-up steps.

ACID DISTRIBUTION

Proper acid distribution is critical to tower performance. Clark Solutions is specialized in mass transfer researching and has designed drying, absorption, distillation and stripping towers for hundreds of applications with the most distinct requirements.

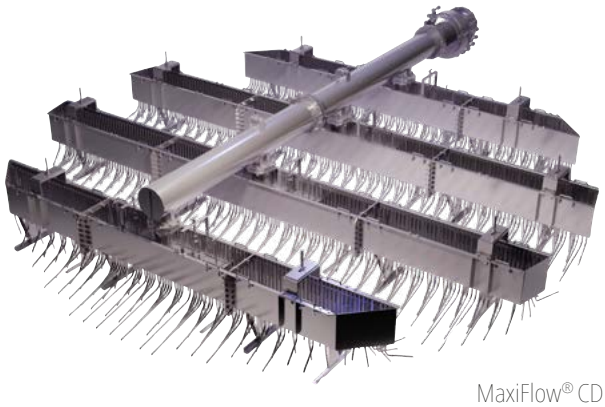
Any liquid distributors must necessarily offer a good and balanced liquid distribution to ensure proper mass transfer.

In sulfuric acid, distributors must be resistant to corrosion and capable of handling debris coming with acid, such as small particles from packing, brick and mortar as well as sulfates generated elsewhere.

As a general rule, for medium to large sized towers, Clark Solutions offers trough and downcomer distributors and pipe distributors.

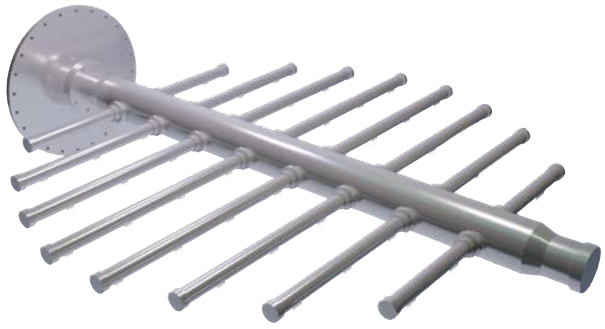
MaxiFlow CD

Trough and downcomer distributors offer from 15 to 45 distribution points per square meter of tower cross sectional area. MaxiFlow CD can handle considerable liquid flow variation and substantial amounts of solids that deposit on trough's bottom. Also, since the downcomers pour liquid in a film and occupy a very small area on the wetting section, a minimal restriction to the gas flow occurs and negligible mist formation takes place, which favors the installation of this kind of distributor in high velocity towers packed with Clark Solutions BPC MaxiSaddles® or MaxiCeramic® structured ceramic packing.



MaxiFlow® CD

MaxiFlow T



MaxiFlow® T

Comprised of a family of pipe type distributors, these look like fish bones, with orifices and/or injectors properly positioned. Since flow through orifices are largely influenced by its diameter and pressure difference between gas and liquid, these distributors are more sensitive to process flow changes, either on gas or liquid side. They occupy a reasonable cross section area and liquid discharge through orifices produces small particles, increasing mist generation. Therefore being recommended to low velocity towers or towers where vertical height need to be minimized.

Acid Distributors Parameters

Criteria	Unit	MaxiFlow CD	MaxiFlow T	Benefits
Irrigation density	pts/m^2	15 - 45	25-45	Higher irrigation density leads to lower packing height requirement
Cross Section Area Obstruction	-	< 5%	< 35%	Lower blockage area decrease mist load
Tower velocity	m/s	< 2.3	< 1.4	Higher velocities allow compact tower design / capacity increase

CERAMIC PACKING

Proper design and good acid distribution is only part of the equation. Adequate packing surface area and low pressure drop guarantee that irrigated acid flows evenly and with enough turbulence to achieve high efficiency. Clark Solutions extensive mass transfer experience help us come with the best solutions to accomplish maximum performance out of each tower.

Our acid resistant ceramic tower packing line offers solutions to each and every situation. With a one-of-a-kind manufacturing process, properly selected raw materials, automated production and controlled firing, Clark Solutions packing take these materials to a higher level, truly extracting the best performance out of the system.

MaxiSaddle

The standard packing for sulfuric acid applications, supplied in a wide range of sizes, with careful raw material selection and computer controlled production, it achieves flawless and guaranteed performance.

MaxiSaddle ®

MaxiSaddle BPC ®

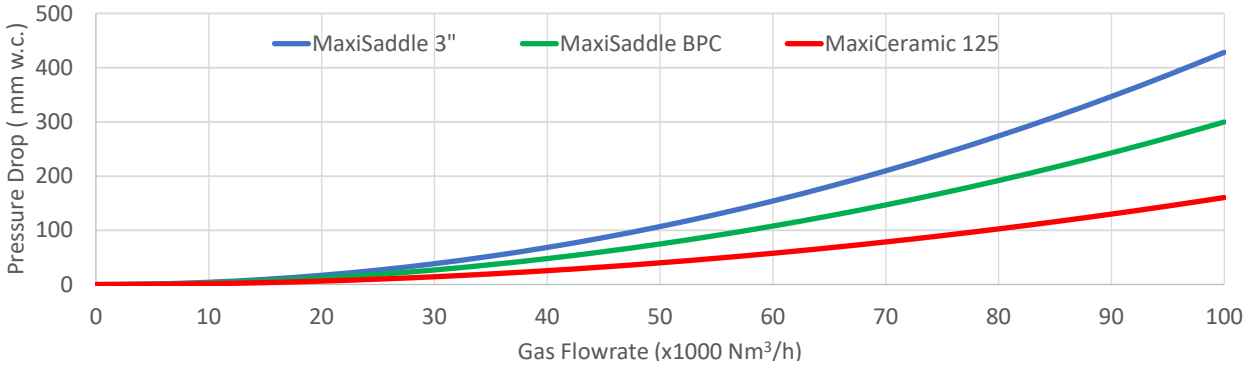
MaxiSaddle BPC

A CFD designed geometry offers about the same mass transfer efficiency as 3" MaxiSaddles at an expense of up to 35-50% less pressure drop. The unique manufacturing process provide unsurpassed mechanical resistance to support even the taller and most loaded beds.

MaxiCeramic

From our long experience in metal structured packing for oil and gas industry we derived Maxiceramic packing. Providing up to 300% more mass transfer surface when compared to 3" MaxiSaddles and lower pressure drop, Maxiceramic is the pinnacle for ceramic tower packing. Clark Solutions Maxiceramic is supplied in blocks designed to minimize gas and liquid channeling, reduce pressure drop on layer transitions and continually provide mixing on down falling film reaching the best result in the industry.

Maxi Ceramic ®



Pressure drop assuming a standard 1000 MTPD plant drying tower with 4000 mm IBD, 12ft packing height, with 10 gpm/ft² irrigation rate

PACKING SUPPORTS

Low pressure drop packing does not perform accordingly if pressure drop in the transition section is elevated. Clark Solutions packing supports guarantee a minimum pressure drop in a smooth transition, minimizing restrictions to ascending gas and descending liquid flow.

Cross partition rings

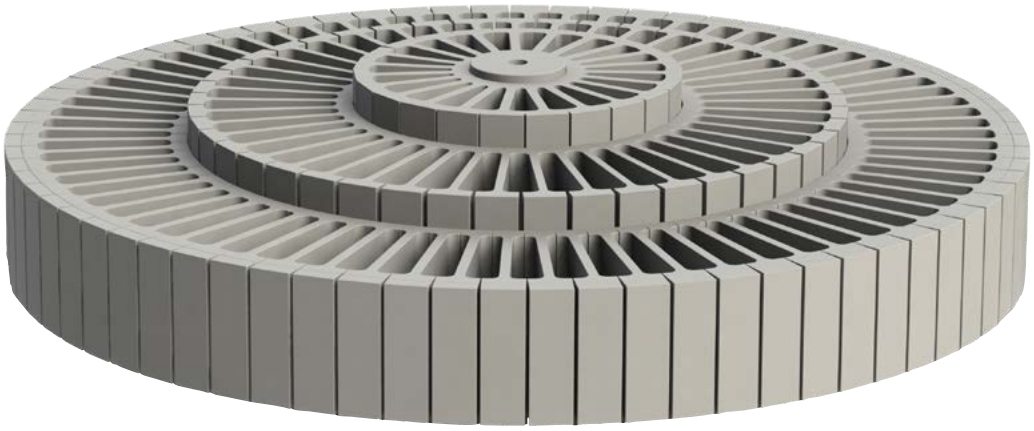
Clark Solutions cross-partition rings have a unique geometry without the central section.

This increases gas and liquid passage areas and reduces pressure drop as well as total tower weight. Images tell more than a thousand words.

Cross-Partition Rings

MaxiDome

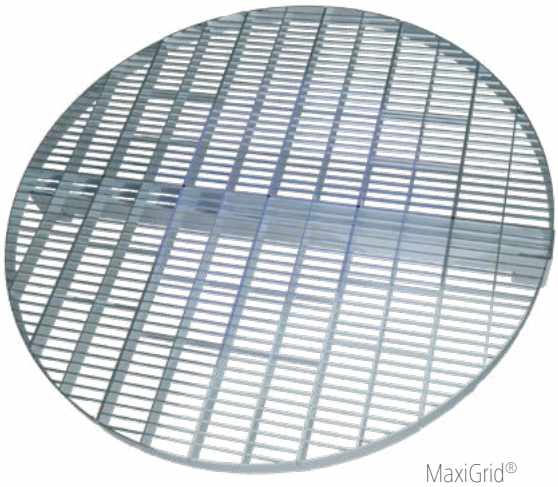
Self-supporting domes are heavy structures that rely on transfering longitudinal efforts into axial efforts. Clark Solutions domes are CFD modelled to each and every application, using inlet gas energy as a start to design a system that will minimize pressure drop and guarantee good and proper gas distribution right from the bottom of the tower.



MaxiDome®

MaxiGrid

Metal towers rely on alloy packing supports. MaxiGrid packing support is designed and manufactured for each specific packing, allowing maximum open area and support capacity while minimizing costs and investment. In comparison with other kinds of packing supports used in acid industry, Maxigrid offers 80+% open area for gas and liquid flow. MaxiGrid tower alloy supports can be manufactured on virtually any metallic material.



MaxiGrid®

TOWERS & PUMP TANKS

Brick-Lined Towers & Pump Tanks

Brick-Lined solutions are carefully designed considering Clark Solutions' protective layers setup to preserve metal surfaces from a wide range of temperatures and acid concentrations.

A multi-layered specification blends PTFE lining, rubber epoxy resin, high quality acidproof bricks and many other solutions characteristics specially formulated to provide a resistant barrier that shields sulfuric acid and tanks for each unique application.

Brick-lined absorption tower

310CS alloy absorption tower

Alloy Towers & Pump Tanks

Alloy towers are manufactured in higly corrosion resistant alloys such as CSX and 310CS allowing a coatlingless tower. Proper venting and dillution devices are carefully designed to minimize corrosion rate and promote a lifespan comparable to brick-lined configurations.

Applying this technology ease of maintenance, assembly costs, downtime reduction and corrosion resistance are achieved.

Benefits

- **Investment + Installation**

Final costs of manufacturing are similar, however alloy configurations have a quicker and cheaper installation.

- **Maintenance**

Maintenance is simpler for alloy configurations.

- **Weight**

Brick-lined solutions are considerably heavier, demanding a more robust civil base

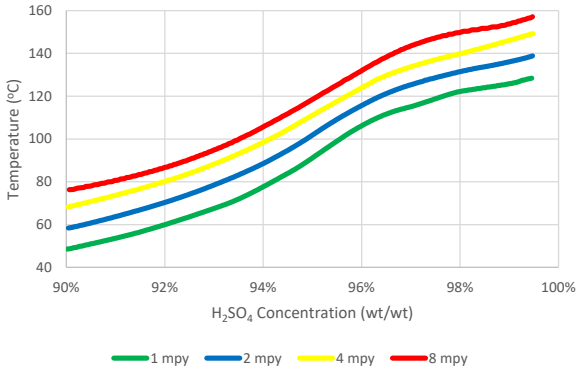
- **Operation Fluctuations**

Alloy configurations demand a more strict process and extreme variations could go beyond their operational safe zone.

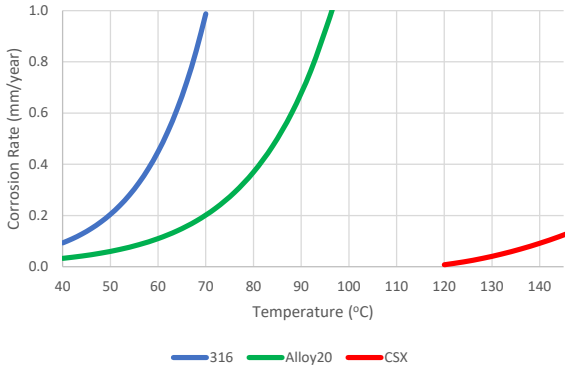
CLARK SOLUTIONS CSX™

Clark Solutions CSX™ was developed to be resistant to corrosion in a wide range of temperatures and acid concentrations, keeping its structural properties.

The key to CSX™ HSSS (High Silicion Stainless Steel) success is the formation of a very resistant passive layer of silicon oxide on the material's surface in the presence of a strong oxidant. This brings a very high resistance to strong sulfuric acid at typical process temperatures. Which provides additional beneficial properties to the alloy, such as resistance to high pitting, erosion and corrosion, the latter being especially attractive for piping systems since fittings are more susceptible to erosion damages.



CSX corrosion rates in static condition for a range of sulfurc acid concentrations and temperatures



Comparision between 316, Alloy 20 and CSX corrosion rates in static condition per temperature in 98% wt/wt sulfuric acid

Benefits

- **Weight**

Equipment manufactured in CSX are thinner, decreasing weight, costs of civil base, assembly and maintenance.

- **Safety**

Due to welding possibility, equipment in CSX are less susceptible to acid leakage since flange quantity is minimized.

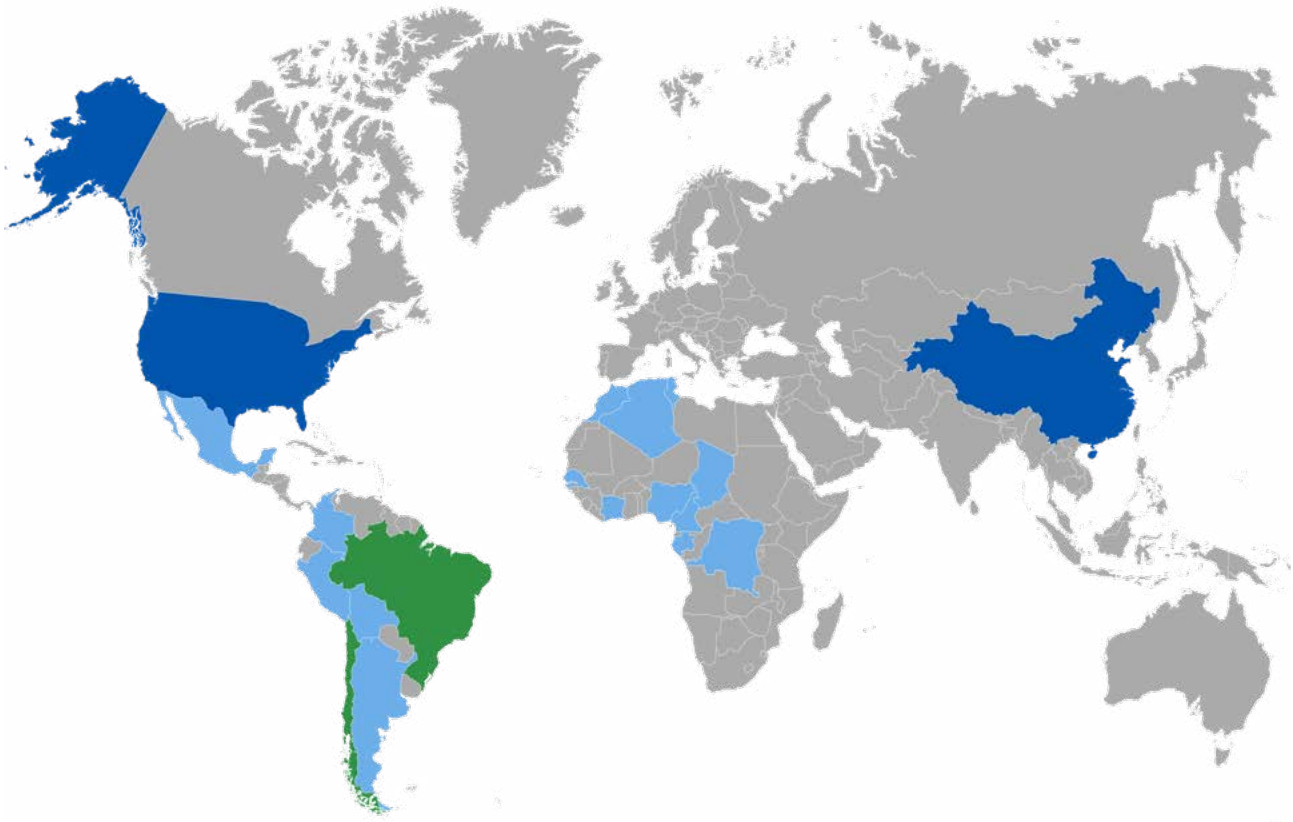
- **Better Acid Product Quality**

Due to negligible corrosion rates, iron content on final product is reduced.

- **Applications**

Piping & Fittings, Mist Eliminators, Towers & Pump Tanks, Acid Distributors and Acid Coolers

OUR PRESENCE



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Office and Workshop

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