Sulphur burning optimization

Optimum equipment for sulphur burning in sulphuric acid plants is not a trivial matter. However, owners and operators can benefit from technology providers with deep knowledge of the process, command of cutting edge analysis tools, and the ability to integrate analytical results with robust equipment designs. Thus, when analyzed by the right industry experts, facility owners can realize improvements that meet and even exceed their goals.

The sulphur furnace in a sulphur burning sulphuric acid plant is generally a large horizontal cylindrical vessel of carbon steel, lined internally with refractory brick. Air and liquid sulphur are fed into the furnace via a sulphur gun equipped with an atomizing spray nozzle or a rotary cup burner. The internals of a sulphur furnace are important to ensure complete combustion of sulphur to sulphur dioxide. The reaction is highly exothermic resulting in a large temperature increase. A waste heat boiler downstream of the furnace is used to remove much of the heat of combustion.

The design of the sulphur furnace must achieve good gas mixing and full combustion of sulphur prior to leaving the furnace and entry to the boiler section. Sulphur droplets impinging on the baffle or checker walls will vaporize immediately and burn to sulphur dioxide. Any unburned sulphur that impinges on the carbon steel surfaces of downstream boilers, ducting and heat exchangers will corrode the steel.

Understanding spray technology

When producing sulphuric acid from molten sulphur, it is critical that the sulphur is atomized into sprayed droplets such that combustion occurs efficiently and within the design parameters of the furnace. Each furnace is designed to accommodate a particular throughput of sulphur to oxidize into sulphur dioxide; however, the form or the size of the sprayed droplets produced becomes a major factor in determining when this combustion occurs.

The spray nozzle needs to handle a bulk mass of fluid that is delivered through it at a specific pressure drop. When this mass of fluid exits the nozzle, it is then converted into a predictable drop size spectrum with a specific spray coverage or distribution inside the furnace. The drop size and coverage required depends on the performance characteristics of the furnace. These include the length and width of the furnace, heat load, amount of oxygen for combustion, placement of baffles, and flow rate of the air through the furnace.

Spraying Systems Co. spray nozzle types

Spray nozzles can be split into two broad categories, either hydraulic or pneumatic (also called air atomizing or two-fluid nozzles). Hydraulic spray nozzles use only the liquid back pressure to determine the flow rate, spray pattern, and droplet atomization. Pneumatic spray nozzles use an additional fluid, typically compressed air, to provide primary liquid breakup. Hydraulic spray nozzles can be further classified into spray pattern types such as hollow cone, full cone, and flat spray patterns.

For sulphur burning, the most common types of nozzles are hollow cone hydraulic nozzles and pneumatic since these typically have larger free passages and create smaller droplets than the other nozzle styles.

The BA sulphur burning nozzle is a commonly used hollow cone spray nozzle for sulphur burning. It produces small to medium size droplets, has a fairly large unobstructed flow passage to minimize clogging, and has a relatively low cost to operate as compared to a pneumatic nozzle since it does not require compressed air.

Pneumatic spray nozzles require compressed air to provide primary atomization. The liquid and the gas can meet either inside or outside of an air cap depending on the design chosen. Pneumatic nozzles can create either a flat spray or a round spray pattern, and they produce the smallest droplets of any of the conventional spray nozzles.

Common problems

Common problems associated with molten sulphur spraying include spray atomization, turndown, plugged nozzles, and sulphur gun design.

The reason that atomization and drop size is so important is that it directly affects the rate of heat transfer between the combustion gas and the sulphur. Too often, spray nozzles are chosen based mostly on their flow rate instead of on their performance. Drop size affects overall surface area. For example, by merely breaking up a single 500 micron droplet into several equally sized droplets of 100 microns each, the surface area can be increased by almost 500%.

However, this is not the way spray nozzles operate. They do not create 100% equally sized droplets. The sprayed volume comprises many different size droplets that make up the drop size spectrum. The volume median diameter is a standard way of characterizing the size droplets that a particular nozzle will produce. However, this number is not useful when dealing with mass transfer applications such as evaporation and combustion. A more useful number is the Sauter mean diameter (D32), which is a means of relating the volume to surface area of a single droplet to the total volume to total surface area of all of the droplets. Another important drop size parameter for applications where residence time is a concern, such as the gas moving through a combustion furnace, is the maximum drop size, since it is this droplet that will take the longest to evaporate or combust. One must account for it as well. When

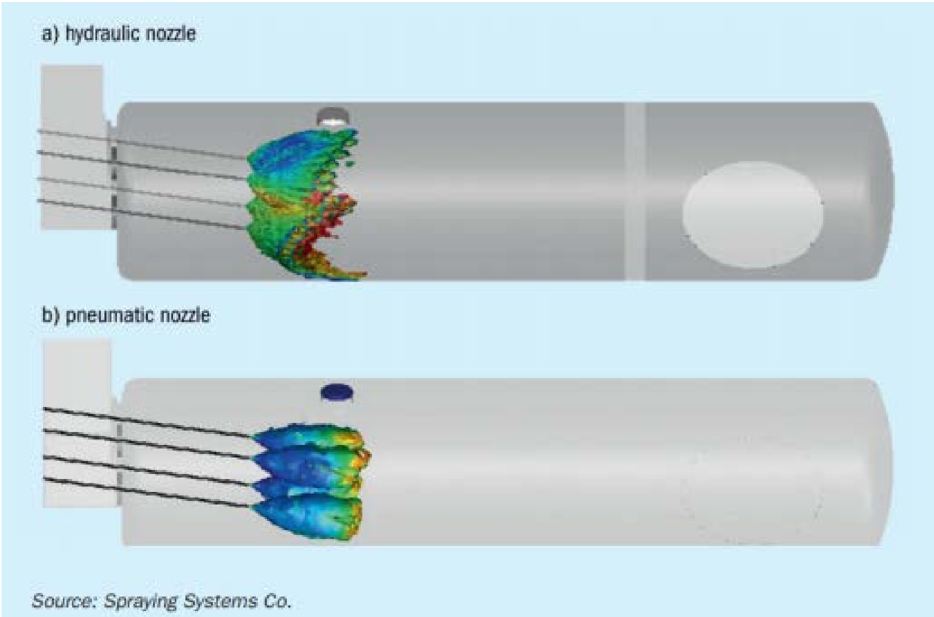


Figure 1: Cross section of furnace and spray coverage for different nozzle types

comparing different spray nozzles, it is important to clarify which drop size parameter you are using.

Figure 1 shows the cross section of a furnace and the spray coverage of a hydraulic and pneumatic nozzle. It can be seen in Figure 1a that the drop size from the hydraulic nozzle is large enough and the spray pattern opens up enough that wetting of the furnace bottom is a concern. None of the spray droplets shown in Figure 1b of the pneumatic spray nozzle impact the wall and it appears that all of the sprayed sulphur is more able to be volatized. Further analysis would show that all of the sulphur was converted prior to the furnace exit.

Atomization is key and is the critical first step as the sulphur is injected into the combustion furnace. Knowing what happens to these spray droplets and how it affects the furnace operation can be enhanced with CFD. Figure 2 shows three different furnace profiles. Figure 2a tracks the combustion gas as it moves through the furnace.

This shows what it looks like without any sulphur injected and can provide valuable information about turbulent spots and low velocity areas. This information can then be used to analyze the spray gun placement. Figure 2b is the temperature profile with the spray guns turned on. And Figure 2c shows the particle tracking of the sulphur itself. All of these can be used to compare actual performance with any maintenance issues or in conjunction with studies to optimize performance of the furnace. Getting to a solution is typically quicker and less costly than repeated online tests, and benchmarks can be set for future analysis as well.

Another problem that producers may encounter is spray nozzle turndown. Turndown of the nozzle refers to the effective operating range of the nozzle, or the ability to turn down the flow rate from peak flow conditions to low flow conditions.

Proper atomization and consistent performance is required during start-up, low flow operation, as well as peak sulphur throughput. Methods used to adjust the flow rate are to use multiple sulphur guns or to adjust the operating pressure of the individual nozzles, or a combination of both. When changing the pressure to obtain different flow rates, it is important to realize that the performance of the respective spray nozzle changes as well. For instance, with a hydraulic nozzle, as you decrease the pressure in order to decrease the flow rate, drop size increases and the spray pattern or coverage collapses. Changes occur with air atomizing nozzles as well; however, the changes are more subtle. This is due to the ability to alter the atomizing air pressure along with the sulphur feed pressure in order to help maintain a more consistent performance across a wider range of flow rates.

Figure 3 shows a BA nozzle spraying 5 gpm and 2 gpm (upper left and lower left pictures, respectively) and then a FM pneumatic nozzle spraying 5 gpm and 2 gpm (upper right and lower right pictures, respectively). It can be seen that as the liquid pressure supplied to the BA nozzle is reduced in order to reduce the flow rate, the spray performance changes. It can easily be seen that the spray pattern is streaky and less uniform and that there are larger droplets being produced at the lower pressure. For the FM pneumatic nozzle, the change is more subtle and no visual difference can be detected.

The performance is more consistent even at the lower flow rate and pressure. Plugged nozzles are yet another concern, and whenever there is a set orifice size, there is potential for something to build up or lodge within that orifice. This is why installing properly sized strainers upstream of the nozzle is important. However,

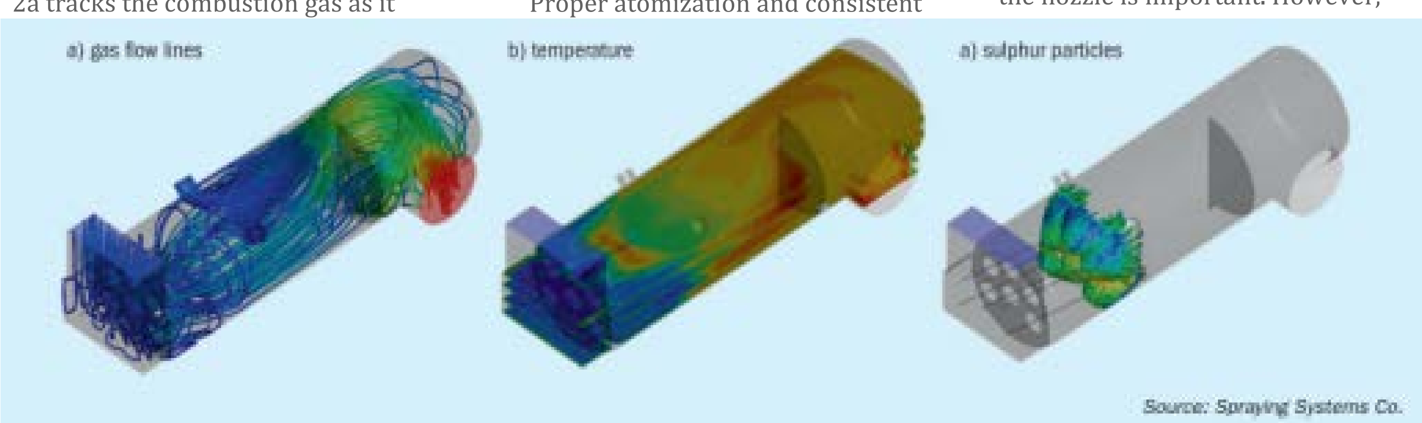


Figure 2: Furnace profiles

3/8" BA WhirlJet hydraulic nozzle
@ 100 psi (7 bar) – flow rate: 5 gpm (19 lpm)

FM5A FioMax® air atomizing nozzle
@ 50 psi (3.5 bar) – air pressure – flow rate: 5 gpm (19 lpm)

3/8" BA WhirlJet hydraulic nozzle
@ 20 psi (1.5 bar) – flow rate: 2 gpm (8 lpm)

FM5A FioMax® air atomizing nozzle
@ 35 psi (2.4 bar) – air pressure – flow rate: 2 gpm (8 lpm)

Figure 3: Spray performance

Figure 4: Hybrid sulphur gun

plugged nozzles can also occur due to certain operating conditions. Contaminants, such as carsul, in the sulphur may be a problem. Also, during low flow conditions or when sulphur guns are removed, the molten sulphur no longer has the velocity it did at higher pressures/flow rates, and the molten sulphur is allowed to solidify inside the nozzle itself. Some possible remedies are to use a sulphur gun that has a cleanout port, purging with steam or air, or use air atomizing nozzles so that the atomizing air pressure will continually move any low flow sulphur through the gun. Merely attempting to use the largest possible orifice can lead to poor atomization issues with hydraulic nozzles, since larger orifices require less pressure drop, which means larger droplets and a more limited turndown.

Sulphur gun design is more of a mechanical issue, although it can affect performance if it is not designed properly. The sulphur gun must be designed to allow for thermal expansion without damaging any internal feed pipes in the gun or any joints.

Steam jackets are typically used to cool the gun and help maintain proper molten sulphur temperatures inside the gun. During the design phase, code compliance such as with ASME B31.3 is suggested, and during manufacture, certified welders should be used and relevant non-destructive examinations should be performed. Furthermore, there are sulphur guns that provide operators the ability to use either a pneumatic spray nozzle or hydraulic, which provides the flexibility to conduct testing with minimal changeover time and less cost than purchasing a second gun. Figure 4 is an example of a spray gun that is designed to ASME B31.3 specifications and has a steam jacket. The bellows is used to allow for thermal expansion without damaging the gun internals. This particular design also accepts either a pneumatic spray nozzle (as shown) or with an adapter accepts a hydraulic nozzle.

MECS furnace design

New products, technologies, and design tools are changing the way sulphuric acid plant furnaces are designed, operated, and maintained. Modern technologies are now combining experience with sophisticated design tools. The result is a holistic view of the furnace's operation and the opportunity to craft highly customized designs, targeted at solving specific problems for owners and operators.

Capturing this opportunity requires analyzing furnace designs with a combination of detailed sulphuric acid process knowledge as well as modern tools like CFD modelling, in order to obtain an in depth understanding of the challenges at hand, the process environment, and the key variables that can be manipulated. Once an analysis is complete, technology providers must make critical design choices. In doing so, it is advantageous to have access to highly customizable and adaptable technologies in order to take full advantage of the analysis that was performed.

For example, it is useful to run a CFD model to identify improvement opportunities for a furnace with three baffle walls. However, if the analysis reveals the existence of "dead zones" in the furnace, the analysis is of very little value without the existence of a tool that can solve this problem. MECS® VectorWall™ ceramic furnace internals are a highly customizable furnace technology capable of being engineered in a variety of different ways in order to align its performance with both the needs of owners and operators as well as the implications of a thorough analysis.

MECS® VectorWall ceramic furnace Internals are constructed from a series of hexagonal blocks that stack together without mortar and remain fully supported on all six surfaces, as shown in Fig. 5a.

Each individual block can be fitted with a vector tile in order to create custom flow patterns inside of the furnace, as shown in Fig. 5b. Thus, flow fields can be manipulated using this technology in order to create the desired combustion environment and to ultimately help facility owners to meet their various objectives.

Reduced pressure drop

CFD analysis shows that furnace pressure drops can be reduced by using a single MECS® VectorWall in place of a conventional baffle wall design while maintaining sufficient levels of mixing to allow for complete combustion.

Figure 6 shows the typical pressure drop improvement associated with the MECS® VectorWall design, as compared to a furnace with a baffle wall design.

In 2015, a sulphuric acid plant owner sought a replacement for their existing furnace, and selected a MECS® furnace design, utilizing a single VectorWall in place of conventional baffle walls. In this particular case, the use of VectorWall ceramic furnace internals

Figure 5: MECS® VectorWall ceramic furnace internals

proved to be even more advantageous than indicated by the general analysis above.

The furnace was designed to burn enough sulphur to raise gas strength and temperature in a 4.5% SO_2 stream to autothermal conditions for the converter. The roaster gas flow is split into three streams – one used as combustion "air" for the sulphur burner, and the other two mixed with the resulting hot gas upstream of the 2nd and 3rd baffle in the furnace. Each acid gas duct is equipped with a damper to control flow, and facilitate mixing. Net pressure drop of the system as a whole ranged from 15 to 25" wc.

With the VectorWall in place, the furnace operated well with the first damper open much farther than previously, and even the 2nd and 3rd could be opened somewhat more, while still controlling net temperature and gas strength. A temperature set point for the sulphur flow was reduced in keeping with the modified flow pattern, and the plant is still fine tuning this arrangement. An early combined pressure drop reduction closer to 10" vs. the 2" savings in the furnace alone has been observed. Temperature and gas strength control are as good as ever, and even flame stability is not compromised by the revised flow pattern. The plant is hopeful that in the long run there is a marginal capacity increase available as well.

Increased capacity

A sulphur furnace can be thought of as a plug flow reactor. Such a reactor is designed for a certain target average residence time. Thus if one can identify the total gas flow rate, the size of the furnace can then be selected to match the target average residence time. If done properly, the actual average residence time of the furnace will be equal to the target average residence time.

However, the average residence time is an average of the many different residence times that individual particles will have as they pass through the furnace. In a conventional baffle design, some particles will miss the baffles and have residence times that are less than the average; some particles will hit the baffles and have residence times that are larger than the average.

In optimizing the performance of a furnace, it is useful to be able to analyze the distribution of these various residence times in order to see what portion of the particles in the furnace are exiting the furnace too quickly and what portion of the particles are in the furnace for longer than they need to be.

Figure 7 compares the residence time distribution associated with a typical brick baffle design to the residence time distribution associated with a VectorWall design. Note that the narrower residence time distribution associated with VectorWall design causes an increase in the overall furnace efficiency. The narrower residence time distribution achieved by the VectorWall design indicates that a higher percentage of particles pass through the furnace in an amount of time that is closer to the design point than would have been the case with a conventional design. Thus, VectorWall technology can be implemented in a way that allows for higher throughput in debottlenecking projects.

In one such case, in 2015, the owner of a sulphuric acid plant sought to replace a furnace with a larger furnace that would allow future capacity increases at the site. However, a larger furnace is more expensive, particularly for retrofits where plot space is limited and the window of time for installation is tight. In this case, a VectorWall design was used in order to narrow the residence time distribution and use the overall furnace volume more efficiently; the installation is currently in operation and is shown in Figure 8.

Reduced capital, operating, and maintenance expenditure

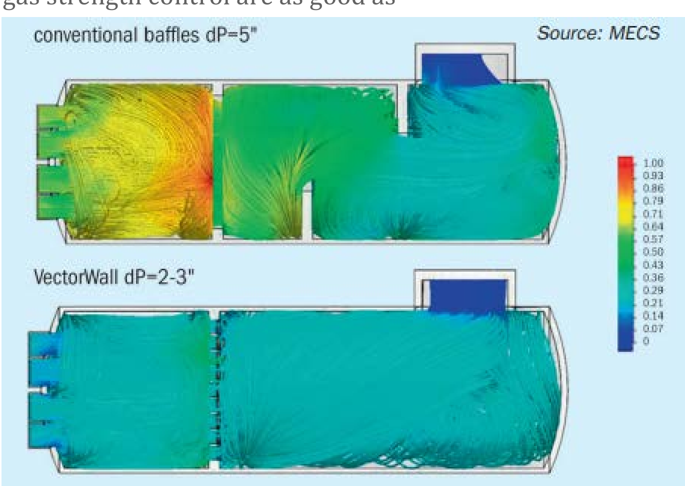


Figure 6: Pressure drop for 3 baffle walls vs 1 VectorWall

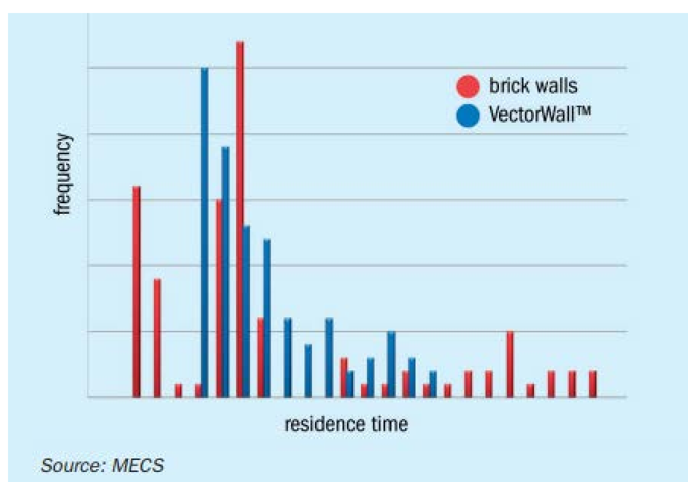


Figure 7: Residence time for 3 baffle walls vs 1 VectorWall

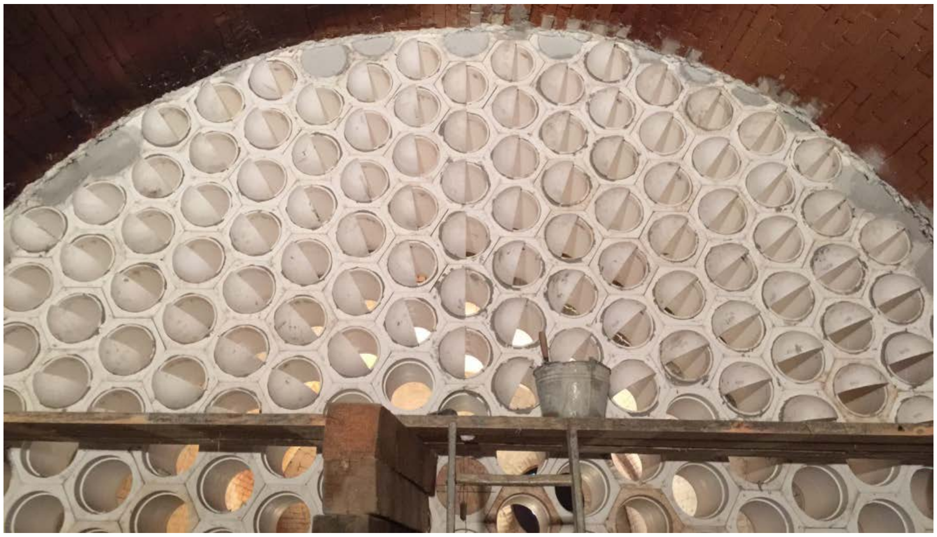


Figure 8: Recent VectorWall installation for narrower residence time distribution

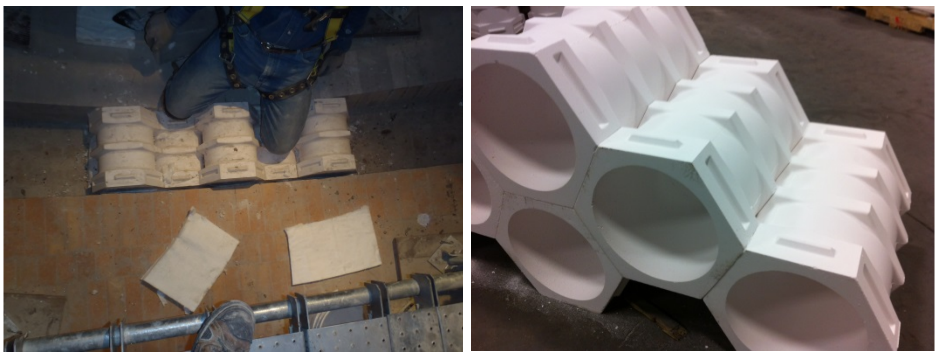


Figure 9: MECS® HexWall Installation

While it is true that the ability to eliminate furnace "dead zones," reductions in pressure drop, and reduced residence time distributions all impact the performance of an existing furnace, it is also true that these realities can impact capital and operating expenses substantially.

For furnace replacement projects at existing facilities, there are many costs that enter into the project budget. Material and labor costs associated with building and bricking a furnace are obvious elements of this equation that can be reduced using an MECS® VectorWall design. By using a more efficient furnace that can achieve complete combustion in a smaller space, material and assembly costs can be reduced. Table 1 shows an example of the savings that are possible with a 10% reduction in furnace volume, using VectorWall ceramic furnace internals to reduce installation time (thus reducing installation costs).

Less obvious furnace replacement costs include downtime, plot space, and hidden start-up costs, such as the fuel gas required for refractory cure-out.

In 2013, a sulphuric acid production facility owner sought to replace an existing furnace with a HexWall furnace in order to leverage many of these factors in a way that facilitated the execution of a challenging furnace replacement project on an ambitious schedule.

Due to timing and footprint constraints, the new furnace was to be fully bricked prior to the plant shutdown and then moved into place during the plant turnaround. To execute such an ambitious plan, proper planning, analysis, and mechanical stability of the furnace were key. While proper bricking is an important aspect of mechanical stability, the HexWall design includes additional attributes that enhance overall mechanical stability.

Conventional baffles are made out of brick and mortar and are susceptible to cracking. Thus, it is not uncommon for facility owners to rebuild conventional baffle walls on a regular basis. Additionally, the stability of a conventional brick baffle wall can vary substantially depending upon the skill of the installer.

By contrast, MECS® HexWall ceramic furnace internals are keyed into the brick lining of the furnace, and stacked together without mortar. The resulting furnace baffle walls are both sturdy and flexible, much like a well-built bridge. The advantage to the facility owner is a sturdier structure that can be erected in a fraction of the time it would take to build a conventional baffle wall. This results in reduced installation costs and avoided future maintenance and repair work. Figure 9a illustrates how the HexWall is keyed into the furnace lining and stacked together without mortar (Figure 9b).

In this case, the facility owner was able to execute an aggressive turnaround plan which not only preserved the mechanical integrity of the new furnace, but even enhanced it. Additionally, the HexWall was installed in approximately one-third the time it

	Price using conventional baffle design ($1,000)	Price using VectorWall design ($1,000)
Steel shell (materials only)	115	105
Brick lining and baffle/VectorWall installation (including materials and labor)	1,150	900
VectorWall	0	150
Total	1,265	1,155

Source: MECS

Table 1: Capital savings for a 10% reduction in furnace size (US Gulf Coast Pricing basis)

would have taken to install conventional brick baffle walls, resulting in substantial savings in turnaround costs.

NORAM sulphur burner technology

NORAM supplies two types of sulphur burner system: pressure atomization and air atomization. Table 2 compares pressure atomization and air atomization for sulphur burners

Air atomized sulphur burners

NORAM-Cellchem CF Sulphur burners

The Cyclone-Flame (CF) technology was developed for systems that require small amounts of SO_2. These systems typically burn 0.5 to 8 t/d of sulphur (i.e. producing 1 to 16 t/d of SO_2).

Two sizes of the CF burners are available as standard. Practical operating capacity ranges are 0.5-4 and 1-8 t/d of sulphur respectively. At this scale, heat recovery from the sulphur combustion gases is typically not economical and a quench cooling system is normally utilized.

The NORAM-Cellchem designs can be engineered in skid-mounted sections, which reduces the total plot space required, reduces shipping costs, and allow for easy installation on site. The skid-mounted sections can be assembled and integrated into the site equipment much faster than conventional designs. One skid contains the sulphur melter, filters and sulphur pumps. Another skid contains the CF burner, the gas cooling tower, strainers, pump and cooler for the circulating water. The units have the size of a standard container.

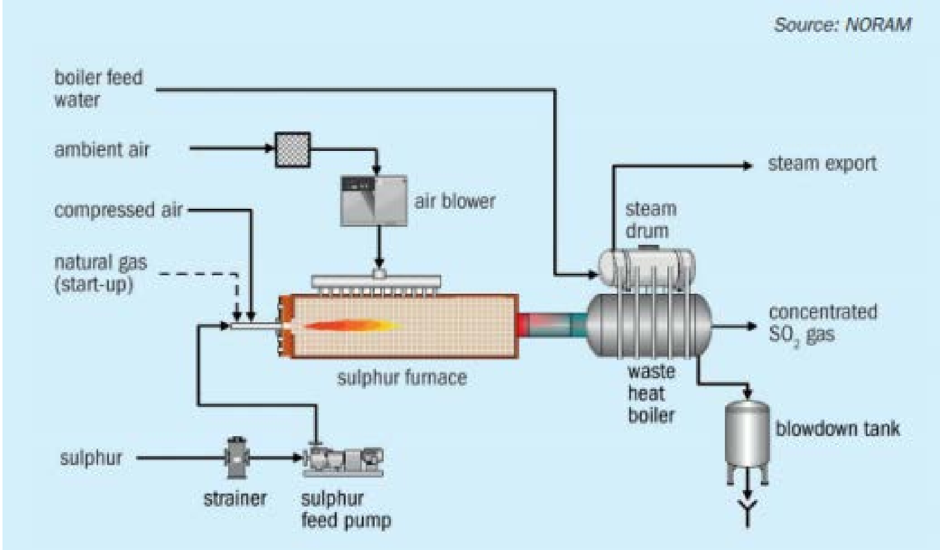


Figure 10: NORAM-Cellchem SO2 production system with an SF burner and heat recovery system

NORAM-Cellchem SF Sulphur burners

The Spiral-Flame (SF) technology was developed for systems that require larger amounts of SO_2. These systems typically burn 5 to 600 t/d of sulphur (i.e. producing 10 to 1200 t/d of SO_2).

The Spiral Flame™ (Type SF) sulphur burner first introduced in 1960 required only one third of the volume of conventional burners. High-velocity combustion air is introduced tangentially to the combustion chamber, imparting a spiral path to the flame. The turbulence resulted in very effective mixing of the gas reactants, and a downstream afterburner made concentrations of up to 19+% SO2 attainable without risk of sulphur carryover.

At medium scale, energy recovery can become economically attractive. When the cost of fuel is high, or when the plant site requires additional steam, energy recovery can be utilized at even smaller scales. For this reason many SF burner systems are equipped with a waste heat boiler to produce high pressure steam. This steam can be utilized for process heating or for production of electricity on site. Figure 10 shows a schematic representation of a typical SF sulphur burner system. The product is hot concentrated SO2 gas. A quench tower can be installed downstream to cool the gas further. The system can be tailored to deliver pressurized gas or to use oxygen enrichment for maximum product SO_2 concentration.

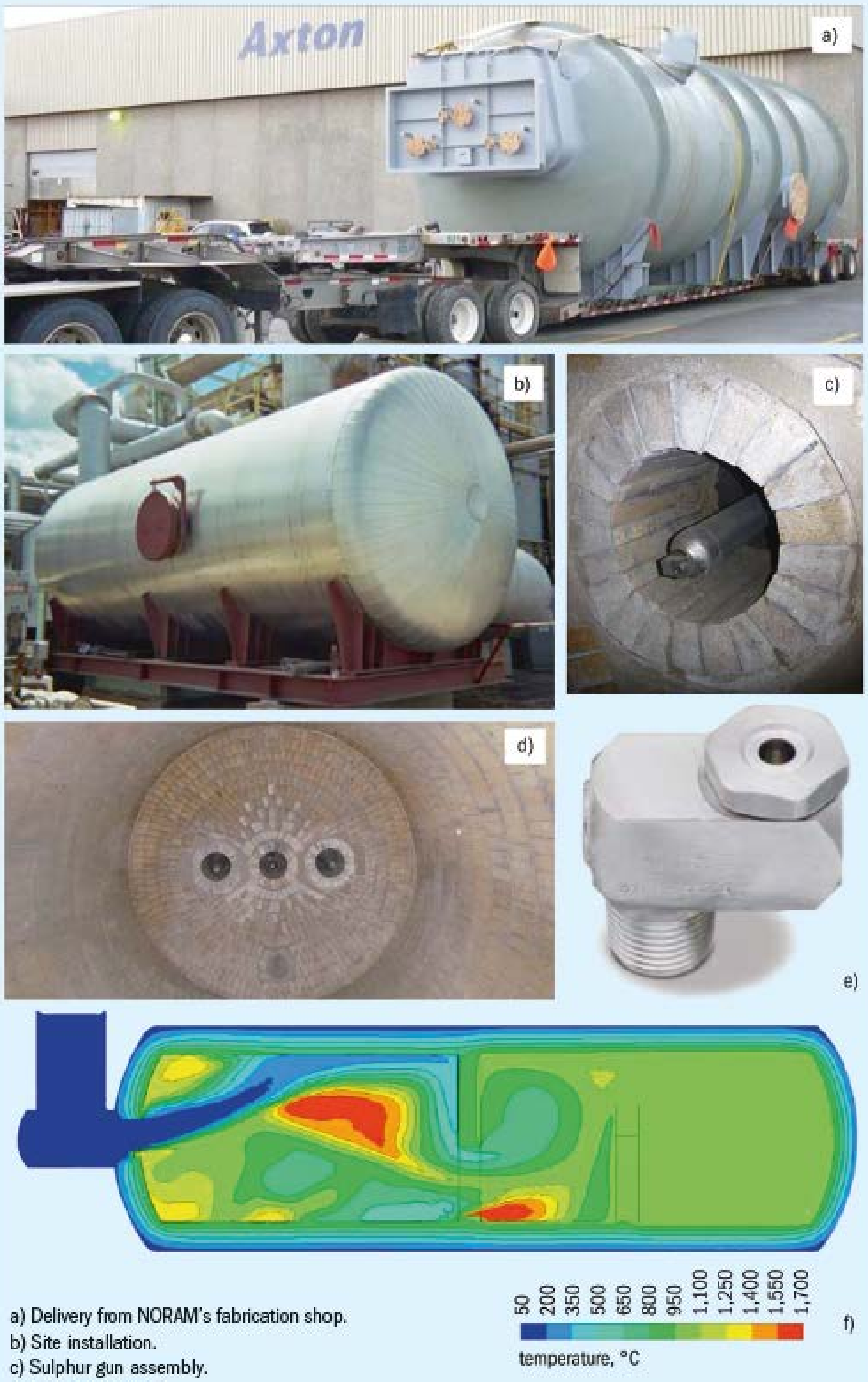
Pressure atomized sulphur burners

Sulphur burners utilizing pressure

	Pressure atomization	Air atomization (CF and SF burners)
Technology	NORAM sulphur burners utilizing pressurized sulphur guns	NORAM-Cellchem sulphur burners utilizing air atomized nozzles
Sulphur capacity, t/d	33 to 1,000+	0.5 to 600
Equivalent SO_2 Capacity, t/d	66 to 2,000+	1 to 1,200
Equivalent H_2SO_4 capacity, t/d	100 to 3,000+	1.5 to 1,800
SO_2 concentration using air*	up to 17% SO_2	up to 19+% SO_2 using combustion air. 95+% SO_2 can be produced utilizing oxygen enrichment
Required size of sulphur burner and sulphur pumps	larger	smaller
Required furnace residence time, seconds	1 to 3	0.3 to 1 seconds
Liquid sulphur pressure	7-12 bar(g)	Sulphur pressure: 1 bar(g) Atomization is achieved by adding pressurized air at 1-4 bar(g)
Minimum turndown rate, %	70 for a typical gun. Further turndown requires multiple guns in service	8 to 12.5
Sulphur droplet diameter, mm	~ 1	~ 0.1

** Delivery of pressurized SO_2 gas is also available.* *Source: NORAM*

Table 2: Comparison of pressure atomization and air atomization for sulphur burners



a) Delivery from NORAM's fabrication shop.
b) Site installation.
c) Sulphur gun assembly.
d) Refractory lining.
e) Sulphur gun nozzle.
f) Computational fluid dynamic simulation of sulphur furnace temperature.

Source: NORAM

Figure 11: NORAM pressure-atomized sulphur burners

atomization are common in the sulphuric acid industry. The pressure atomized technology was developed for systems that require large amounts of SO_2. These systems typically burn 33 to 1000+ t/d of sulphur (i.e. producing 66 to 2000+ t/d of SO_2).

Figure 11 shows some details of NORAM's pressure atomized sulphur burners.

Outotec® LURO2 sulphur burning system

The LURO burner with rotary cup technology has been a core element of Outotec's sulphuric acid plants based on sulphur combustion for more than five decades.

Recently, Outotec® LURO2 sulphur burner (see Figures 12 and 13), a new burner model has been introduced to the industry to address the changes the global markets have been undergoing for example in terms of environmental regulations and energy efficiency not to mention a constantly changing competitive landscape.

The atomization technology with a rotary cup is completely different from traditional nozzle technology and comes with numerous advantages. The burner is fed with molten sulphur at 145°C via steam-heated piping. When it reaches the rotary cup atomizer, the molten sulphur is directed into a conical rotating cup, which is the heart of the atomizer. On the cup's inner surface, a homogeneous sulphur film is formed and atomized by an axial air stream as it leaves the edge of the cup.

On the basis of this rotary cup atomizing technology the Outotec® LURO sulphur burner family comes with the following operational and maintenance benefits:

- formation of ultra-fine droplets regardless of plant load;
- uniform heat distribution;
- prevention of sulphur carry over from furnace downstream;
- elimination of steam leaks within the sulphur combustion furnace;
- easy and fast removal of burner;
- single burner configuration;
- no changes in burner configuration throughout whole operation window including pre heating phase.

These benefits have been incorporated in every LURO sulphur burner since its introduction in 1964, but current market demands and today's technology have allowed Outotec and its partner SAACKE, a German company with an 80-year tradition of providing combustion technology to the global market, to make enhancements which increase the performance and expand the burner's general capabilities.

The targeted increase in capacity was achieved through a 40% boost of the nominal sulphur burning capacity reaching 35 t/h of sulphur burned by a single unit.

The LURO2 can also be used during start-up processes when the sulphur furnace and converter are heated with diesel fuel. The oil atomization during

Figure 12: Outotec ® LURO2 sulphur burning system

start-up is also achieved using air and the rotating cup technology – no additional equipment is needed. As an alternative, natural gas can also be used as pre-heat fuel.

The burner's drive has been modified so that a flange motor is now in place with a magnetic coupling to the burner shaft thus eliminating the need for a belt drive with wear parts such as the V-belt. Replacing the rotary cup's belt drive with a frequency-controlled direct drive and a magnetic coupling device enables also the sulphur film thickness to be controlled precisely allowing an operation window with extended load conditions from 15-110%.

In addition, an automatic grease lubrication system has replaced the old oil system as well as the burner management system (BMS) associated with it to ensure a reliable and safe operation. Also noteworthy is that with the LURO there is no steam cooling inside the combustion chamber which prevents leakages.

The new burner still includes classic features such as excellent sulphur distribution and atomization, turndown flexibility, a small combustion chamber, low sulphur feed pressure and online load changes which translate to zero down time for nozzle replacement.

Besides the enhanced burner, the system typically includes a primary air blower, pipe racks for instrument air and liquid sulphur as well as an ignition device. Completing Outotec's burner system is the BMS for the machine control cabinet, a local control box and a secondary air windbox, which helps achieve an efficient combustion at low emission levels.

Due to its atomization of sulphur into ultra-fine droplets regardless of the plant load, the burner allows the furnace size to be minimized and limits the effects from thermal shocking to the refractory lining. Typically a LURO-equipped furnace has a 2-3 times smaller combustion chamber than a conventional one and the use of an internal baffle wall is obsolete. With its high performance in the partial-load operational range the burner requires no mechanical adjustments such as a nozzle replacement when the plant is operating at lower loads. To meet operator's plant control approach, the LURO2 burner operation can be fully integrated into a plant's DCS with the option of a supplementary condition monitoring system.

Customers who are using a lance equipped furnace and are evaluating a capacity increase of their sulphuric acid plant will find that switching to Outotec's LURO2 burner translates to benefits in operation, maintenance and furnace size. The efficient combustion makes it possible to achieve a higher throughput with the same furnace. Thus, costs and shut down time associated with a revamp can be minimized with Outotec's LURO2 as the upgrade solution.

Figure 13: Outotec® LURO2 burner

The windbox which has undergone a redesign and standardization procedure is equipped with a set of guide vanes. With a small sight glass integrated it allows as supplement to the furnace sight glass the flame monitoring from the burners position. The pipe racks located on the burner platform serves for the safe media supply according to the international standards. To ensure smooth maintenance, the LURO2 burner is mounted on a moving unit allowing easy access to the rotary cup atomizer unit.

Outotec® LURO sulphur burner family main features can be summarized by:

- single burner capacity up to 35 t/h of liquid sulphur
- operational range up to 15 to 110% of the nominal sulphur load
- high operating quality also during load changes
- small furnace due to excellent atomization
- easy and fast removal of burner
- atomization with primary air from drying tower by rotating cup.

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