

COVERING MAINTENANCE SOLUTIONS FOR THE INDUSTRY

Sulfuric Acid

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Sulfuric acid industry evolves over 20 years

By: April Kabbash

The past 20 years have been a time of great change, both in the sulfuric acid industry and the world. Through it all, *Sulfuric Acid Today* has been there, helping readers navigate an increasingly evolving global marketplace. To celebrate the 20th anniversary of the magazine, we asked several clients who have been with us from the beginning for their thoughts about the last two decades, and what they hope is on the horizon. From new technology to environmental stewardship, safety enhancements to information sharing, it's been an impressive two decades in sulfuric acid production. Here are just a few ways our advertisers have seen the changes first hand.

Comprehensive maintenance

For many years, the old adage “if it ain't broke, don't fix it” applied in acid plants. Time and money were not spent on comprehensive, preventative maintenance programs. When something failed (often catastrophically), it was fixed quickly, so that production could resume as soon as possible. Otherwise, maintenance was done during scheduled turnarounds, and not given much consideration in between. But technological advances have changed all that.

“Twenty years ago, many customers struggled to operate on a continuous twelve-month run between catalyst screenings,” Jack Harris, president of VIP International, said. “Today, with improved, shape-optimized catalyst, many customers run 30 to 36 months between catalyst screenings. The extended runtime has promoted maintenance planners to consider more comprehensive preventive maintenance programs. As converter runtimes are extended, other equipment must be examined to assure reliability throughout the campaign. Sophisticated and knowledgeable inspections must be maintained. In the early 1990s, we would respond to as many as a half a dozen catastrophic failures in towers per year. Today, through comprehensive inspections and preventive maintenance practices, these catastrophic failures are typically avoided.”

Ed Knoll, president of Acid Piping Technology, added, “with more emphasis on safety and preventative maintenance, plants no longer run piping to the point of failure.”

These longer cycles and focus on preventative maintenance mean that



The exchange of best practices between plants increases the knowledge base of the industry as a whole. George Wang of Solvay, right, shares his company's experiences during the flow control panel discussion at the 2013 Sulfuric Acid Roundtable. Also chairing the panel are, from left, Jerry Johnson of Tesoro and Frank Ybarra of Phillips 66.

there are more pieces to juggle at each turnaround, as well. Plant management wants to get the most out of each facility, optimizing both efficiency and time during an outage. “Clients require a much more sophisticated work breakdown schedule for the turnaround as the focus on asset utilization is much greater,” Doug Royster of Central Maintenance and Welding, Florida, said.

Changing relationships

One of the most significant changes noted in our interviews was the business relationship between the sulfuric acid producer and the service contractor. Contractors weren't always viewed as part of the “team,” but as a necessary evil required to perform the tasks the producer was unwilling or unable to complete with plant personnel.

“Twenty years ago, the contractor was viewed as an outside entity and, many times, as an expendable labor force,” said Harris. “As one old, crusty maintenance manager told me, ‘Son, you have to realize you have two strikes against you when you come through the gate as a contractor. If you were worth your salt, you would be working for a plant like we are.’”

Luckily, attitudes are changing, providing a more productive, collaborative and safer workplace for everyone involved. “In the past, the contractor was generally evaluated on the end result and was left to his own devices as far as procedure,” said Harris. “Today, turning a blind eye to contractor protocol has been replaced with collaboration in examining every aspect of the work to assure mutual safety and productivity. Drawing upon the strength and expertise from each side in an effort of cooperation and respect has transformed

an adversarial role into one of mutual success.”

Another relationship that has changed over the years is that between plants, suppliers and contractors when it comes to information sharing. Gone are the days of secrecy, thanks to global conferences and workshops where problems and best practices are shared, often leading to unexpected solutions.

“Consolidation of companies has led to increased cooperation and collaboration between plants and suppliers. The industry has improved itself through the sharing of experiences,” said Bob Braun, director of engineering at Weir Minerals Lewis Pumps. “Conferences and seminars around the world have facilitated significant and valuable information transfer. This was unheard of prior to 1990. As companies and individuals throughout the industry share their ideas, experiences, triumphs and setbacks, the entire industry benefits and grows.”

“Conferences allow a free exchange of information, ideas and best practices to be shared globally throughout the industry,” Harris said. “This magazine, *Sulfuric Acid Today*, has without a doubt had the largest effect on the network of information.”

Chris Bailey, president of Roberts, a frequent attendee at industry conferences, shared these sentiments. “Our industry is one of continuous learning and improvement,” Bailey said. “My hope would be that there continues to be communication of best practices among sulfuric plant operators because it is through continuous learning, and sharing of best practices, that safer and more efficient protocols can be developed.”

Focus on environmental stewardship

Another major change over the past two decades has been a trend toward environmental awareness and green practices. While spurred by stricter government regulations, many of these initiatives, including energy recovery and cogeneration projects, have in turn become money savers for facilities, while also helping to safeguard the environment.

“With more stringent government regulations, plant designs are far more efficient. Single absorption plants are almost a thing of the past, being replaced by low emission facilities that were thought to be unachievable only a few decades ago,” Harris said. “Some plants have further enhanced environmental preservation by converting waste heat into cogeneration



Relationships between contractors and plant personnel have improved greatly over the past 20 years, creating a win-win situation for everyone. Jack Harris of VIP International, right, explains the neutralization process to Bob Meisch, left, and Rick Bywater of Cornerstone Chemical Co.

power plants, thereby reducing the need for fossil fuel.”

“Energy efficiency has gone up to 95 percent on most plants with heat recovery systems,” said John Horne, sales director, MECS, Inc. “There were about 10 reference HRS plants in the mid 1990s, compared to 85 plus now.”

Stricter environmental regulations have also led to innovative technological advances that might not have otherwise been developed. “The demand for lower emissions has allowed our R&D to develop and bring new catalysts and technologies to market that would not have had much demand unless plants were being forced to reduce emissions,” Frands E. Jensen, sales manager, environmental for Haldor Topsøe A/S, said. “And lower SO₂ emissions requirements will most likely continue.” There are currently no overall international environmental regulations in place. Each country has its own regulations, and in some countries specific requirements are established for each individual plant. The European Union is, however, in a process aimed at establishing binding common rules for the whole of the European Union valid for a number of important industrial sectors.

Steve Puricelli of the MECS Technology Group also credits new technologies with helping reduce emissions. “SO₂ emissions have been squeezed down to 1-2 pounds per ton, with scrubbers (DynaWave®) and regenerative scrubbers (SolvR™) getting the number down to 20 ppm. And acid mist emissions have been reduced from 0.15 pounds per ton to 0.075 pounds per ton.”

The industry must continue to change and adapt, in order to take advantage of new technology and meet new challenges head-on. “As fossil fuels become more expensive, sulfuric acid production will

become a coveted source of energy. For this reason many new plants will be constructed with ‘built-in’ energy recovery features,” said John V. Orlando, P. Eng., senior project manager/sales for NORAM Engineering and Constructors Ltd. But suppliers must be ready to adapt quickly to changing needs and environmental standards. “Technology providers will be called upon to provide acid plants that are proven and reliable to operate. To achieve these goals, more innovative designs and modern technologies will need to be developed and implemented.”

These changes won’t stop any time soon, either. “We expect the continuation of lower emission levels for all types of plants and the need to expand existing plant capacity through improved plant, process and catalyst design,” said Mike Fenton, Chemetics Senior BD Manager for Acid Proprietary Equipment. “There will also be a need for continued improvement in heat recovery in sulfur burning acid plants, and greater recognition that the overall lifecycle costs of a plant and its equipment are of prime importance.”

When all of this is taken together, from stricter emissions standards to power cogeneration to constantly improving technology, the end result is a win-win for the sulfuric acid industry and the environment. “The improved energy efficiency has resulted in additional power cogeneration allowing sulfuric acid producers to reduce energy costs, while continuing to be good stewards of the environment,” said Bailey.

Economies of scale

The past two decades have brought about many changes affecting plant size, as well. From consolidation within the industry to cost concerns, the result is that facilities are getting bigger. “The last 20 years have seen a significant increase in the physical size of the plants. A typical plant used to produce 2,500 to 3,000 tons per day, whereas today the new plants are producing 4,500 tons per day,” said Doug Royster of Central Maintenance and Welding, Florida.

MECS’ Horne echoed this sentiment. “In the 1990s, 3,500 STPD was considered a world class plant. Today, world class is closer to 5,500 STPD.”

“The economy of scale trending toward larger plants for phosphate fertilizer production and quicker turnaround times have changed the landscape of the sulfuric acid market within the past decade,” said Mike Graeff, president of Koch Knight LLC.

Dr. Hannes Storch, vice president, sulfuric acid/off-gas of Outotec, agrees.

“Economy of scale has resulted in larger and larger plant sizes to keep the production costs down.” And Storch predicts that further economic pressure will result in even larger units.

As with any other major change, larger plant size affects suppliers, too, demanding different solutions and new equipment. “Increased plant capacity has led to the development of larger pumps,” said Janey Marie Hartzell, marketing specialist, Weir Minerals Lewis Pumps. “This has spawned research and development efforts into new designs as well as the investigation of new materials. As the industry changes, so must any supplier hoping to stay at the top.”

New products and technologies

Along with larger plants and more complete maintenance schedules comes a need for new products and technologies. Many of our client companies have kept pace with the changes in the industry, meeting the demands and exceeding the expectations of facilities worldwide. Here, in their own words, are some of their most important advances over the last two decades.

VIP International

VIP International has long served the sulfuric acid industry by solving turnaround maintenance problems. In the last 20 years the VIP employees have performed almost 4,000 tower inspections. During that same time they have handled over 160,000,000 liters of sulfuric acid catalyst. With this much experience under their belts, they may not have seen it all, but when it comes to acid plants they’ve seen more than anyone else.

Combining experience and innovation, VIP has focused on reducing downtime while providing superior service, safety, experience and productivity. The company continues to provide new and creative maintenance solutions for everything from converter maintenance to tower inspections and repair; mist eliminator removal, cleaning and installation to



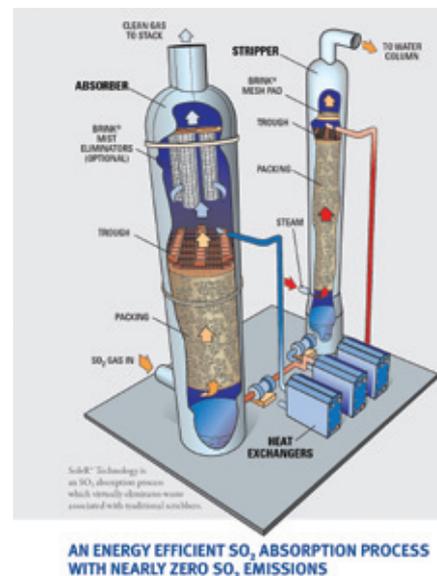
A major advancement in catalyst handling is VIP’s patented dust-free loading system.

exchanger tube cleaning and sleeving; and catalyst handling and NO_x removal to acid and sulfate neutralization. VIP is also relied on for SO₂ and SO₃ scrubbing, packing removal, tower demolition, distribution repair and replacement and high temperature entry.

MECS Inc.

The MECS® HRS™ system has made practical the recovery of the last 25 percent of the energy generated by the sulfuric acid process as medium pressure steam. The more than 80 units in operation are a testament to the ease of use and robustness of this technology.

The MECS® SolvR™ technology has opened doors to waste-sulfur recovery. Many flue gas streams contain sulfur, but are too dilute to recover as a usable product. SolvR™ technology now provides a way to recover the SO₂ and process it in a conventional sulfuric acid plant. When SolvR™ technology is used instead of alkali based scrubbers, waste is converted into a useful product.



MECS® SolvR™ Technology can be integrated into new sulfuric acid plant designs to achieve ultra-low SO₂ emissions and high energy recovery with virtually zero waste.



MECS® ZeCor® Alloys have made tower replacements a more manageable task during a routine shutdown and provides the potential for easier maintenance repairs over the life of the tower.

There have been three significant improvements made to MECS® Catalyst over the years. The shapes have been optimized to reduce pressure drop and to accommodate a greater build-up of dust. The activity has improved, allowing for better conversion, greater acid production or lower catalyst loadings. And thirdly, new formulations have allowed for lower operating temperatures, which translate to higher conversion or the ability to process higher concentrations of SO₂.

Mist eliminator technology has also been improved. The MECS® Brink® XP™ element and Brink® AutoDrain™ features are the first major steps forward in new mist eliminator design. These elements are more efficient, operate at lower pressure drop and significantly reduce maintenance and operating issues by eliminating seal cups and drain legs.

MECS® ZeCor® Alloys have opened the door to innovative distributor designs like the UniFlo® Acid Distributor that improves the performance of sulfuric acid towers and at the same time reduces maintenance. ZeCor® has also made tower replacements a much more manageable task during a routine shutdown and provides the potential for easier maintenance repairs over the life of the tower.

MECS® Operator Training Simulators (OTS) for sulfuric acid plants have brought operator training into the 21st century. MECS has created a suite of training simulators that are considered the ‘best-in-class’ method to prepare operators for real world situations such as emergency scenarios, troubleshooting and process optimization. The benefits of the OTS include greater student interest and participation, as well as a significant increase in long-term knowledge retention. All of these equate to a greater return on the customer’s investment in training time.

Haldor Topsøe

On the catalyst side, Haldor Topsøe has developed and introduced several new types of catalysts to meet the needs of facilities around the world.

VK69™, the first cesium catalyst type tailored for lean gases, has with its



Topsøe’s VK-701 LEAP5™ catalyst.



Topsøe WSA plant at Yunnan Riches Chemical Industry Co. Ltd., Kaiyuan, Yunnan, People's Republic of China. With start-up in 2008, the WSA plant cleans sour gases from a coal gasification plant and produces 83 MTPD of sulfuric acid.

unsurpassed performance helped numerous clients achieve lower emissions and higher production.

The VK-WSX™ catalyst was developed as a low-temperature catalyst for the last bed of wet sulfuric acid (WSA) plants, meaning that up to 99.7 percent conversion can be achieved in single contact WSA plants. VK-WSX™ is installed in several WSA plants.

The VK38™ 25 mm Daisy dust protection catalyst allows bigger penetration depth of dust particles into the 25 mm Daisy layer. The resulting higher dust capacity yields significant savings in blower energy and allows plants to lengthen the campaign compared to standard size catalyst.

After installing cesium catalyst, our VK-701 LEAP5™ is the next step for achieving even higher conversion. VK-701 LEAP5™ uses the new LEAP™ technology to circumvent the transport deficiencies in the molten phase and improve the amount of vanadium in the V+5 form.

On the technology side, the development of the WSA-DC™ (double condensation) has been one of our major achievements in recent years. The WSA-DC™ is a double condensation wet gas technology that allows combining the high energy efficiency of the WSA technology with very high SO₂ conversion efficiency of the double contact principle. WSA-DC™ plants can be designed for as high as 99.99 percent conversion efficiency.

Outotec

For higher efficiency, the company has been developing technologies such as



Outotec constructed the world's largest sulfuric acid plant for Ma'aden in Saudi Arabia.



Codelco's Mina Ministro Hales sulfuric acid plant in northern Chile was constructed by Outotec.

Outotec® LUREC™ strong gas processing technology and Outotec® HEROS™ low pressure steam heat recovery. To increase lifetime, Outotec has also worked on equipment such as stainless steel converters, CORD™ gas heat exchangers and SX™ solutions. Our goal is to make sure that we are always ready to respond to changing requirements.

NORAM Engineering and Constructors

NORAM has also brought several new technologies to market over the last two decades. One of these products is the NORAM HP™ (High Performance) low pressure drop ceramic saddles packing. By choosing NORAM HP™ packing, clients can debottleneck their acid plant and increase production rate or reduce energy consumption. HP™ packing has been proven to reduce pressure drop across the packing in acid towers and increase gas flow throughput in the tower by 25 percent.

NORAM has also developed the Split Flow™ radial flow gas heat exchanger to



Stainless steel converter designed and supplied by NORAM.



Large diameter SX acid towers and SX pump tank were designed and supplied by NORAM.

address problems of corrosion in cold gas exchangers due to condensation of the gas at cold zones of the exchanger, typically at the bottom tube sheet. For more than 15 years this patented product has improved the reliability and life-cycle of cold gas heat exchangers, SO₃ coolers, pre-heaters and tail-gas re-heat exchangers.

NORAM's pipe-type acid distributors have also been well received by the industry because of their low cost and easy installation. These distributors promote uniform acid distribution into the packing as no leveling is required, unlike that of competitor products. Additionally, the design features external access ports, which provide added safety to service personnel.

Chemetics

Although Chemetics was the first to introduce silicon stainless steels (SARAMET® alloy) to the industry in 1982, the 1990s and early 2000s were a period of acceptance by industry for this alloy in all strong acid systems—towers, tanks, distributors and piping—over traditional brick lined vessels and cast iron. Chemetics improved its mechanical designs and modernized its fabrication facilities to meet the increasing competition from global sourcing. We have led in the supply of modular gas exchangers and stainless steel converters to lower the overall cost and risk for overseas projects. As the acid plants have been getting bigger, we have continued to lead in the development of acid coolers, pushing the limits of cooler size, water and acid temperatures while ensuring reliability.



Chemetics delivered the world's largest acid cooler for JSC Kazakhmys in 2007. Since then, similar sized coolers have also been supplied to other Chemetics clients.

Acid Piping Technology

In addition to completing several major projects around the globe, including the U.S., Australia, Morocco and Jordan, Acid Piping Technology (APT) has improved the options available to plants in a number of ways.

Mondi™ piping alloy has undergone major improvements in metallurgy and casting techniques. Thanks to these improvements, piping will now last the life of the acid plant.

APT has partnered with ASC Valve Company to provide excellent gas duct valves and jug valves at competitive prices. ASC is one of the few, perhaps only, manufacturers offering tight shutoff, high temperature, low pressure valves.

In recent years, APT has also developed low pressure drop, high efficiency tower saddle packing.



Acid Piping Technology has been providing products for the sulfuric acid industry since 1991. Pictured is APT's line of high performance ceramics.

Koch Knight LLC

Koch Knight has challenged the market by producing multiple product advancements over the past 20 years with the introduction of our PYROFLEX™ acid resistant sheet lining 500 for tower membranes, FLEXERAMIC™ ceramic structured packing for more efficient mass transfer, LPD™ random packing for lower pressure drop in towers and advancements in our KNIGHT-WARE™ ceramic dome supports to replace outdated support arches.



Koch Knight transports a completely brick lined final absorption sulfuric acid tower.

Central Maintenance and Welding

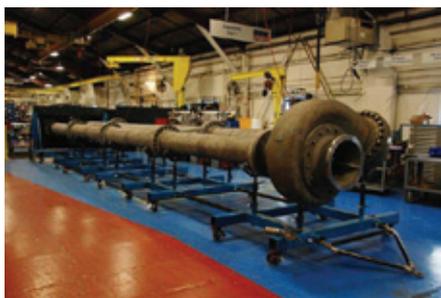
CMW's process has incorporated computer generated parts to be cut on CNC equipment, which has increased the accuracy and efficiency of vessel and duct fabrication. Many developed parts that once would have been cut long for shop fit and trim can now be cut exactly with great confidence and accuracy. Stitch cut and pre-cut developed openings decrease layout errors and speed the fit-up process. The computer-generated and CNC-cut parts fit for a more uniform profile which speeds welding and increases weld quality.



Installation of Koch Knight's proprietary PYROFLEX™ acid resistant sheet lining.

Weir Minerals Lewis Pumps

As a supplier, our focus is on answering or anticipating the needs of the industry. As a result, we have developed several new pump sizes. The largest is the 18H pump, capable of delivering 11,000 gallons per minute against 128 feet of head. Designed for both standard acid applications and HRS facilities, this pump quickly gained popularity among our customers. We also developed our longest pumps to date—at more than 40 feet—for the concentrated solar power market. We continue to adapt our existing products and develop new products to meet the needs of our customers around the world.



Weir Minerals Lewis Pumps size 18H vertical centrifugal pump.

Roberts

With more than 35 years of experience, The Roberts Company (now Roberts) offers turn-key engineering, fabrication and installation services. Technological advances over the last 20 years, including improved welding processes allowing consistent high-quality tube to tube sheet joint welds, have enhanced the products Roberts can offer its customers. Some of their recent projects include the design for the replacement of two plate and frame heat exchangers with a ZeCor-Z® acid cooler. This project also included a cost analysis of the ZeCor-Z® acid cooler versus an anodically protected acid cooler, as well as



Mosaic Fertilizer's New Wales 02 HRS Tower set in preparation by Central Maintenance & Welding for the Spring 2014 turnaround. The field assembly was partially completed, awaiting insulation and platform placement.



Central Maintenance and Welding sets the 200-foot sulfuric stack for Mosaic Fertilizer's New Wales 04 plant during their Spring 2014 turnaround.

the fabrication and installation of the acid cooler with new piping. The company also completed the fabrication and installation of a converter and new ductwork for a plant in Alabama, including demolition of the old converter.

Sulfuric Acid Today is proud to have been a part of the past 20 years in the sulfuric acid industry, and we look forward to the next 20. The companies and people who make up this thriving industry will continue to surmount any obstacles and meet any goals set out for them, adapting as they go. We look forward to helping that happen. □



Roberts replaces an outdated carbon steel converter with a new stainless steel model.



A carbon steel, brick-lined tower was recently converted by Roberts to a MECS ZeCor® Alloy tower in Louisiana.

20 years of *Sulfuric Acid Today* milestones

November 1994

The first issue of *Sulfuric Acid Today* is published. The 16-page newsprint tabloid featured Magma Metals' new 3,400 tons per day capacity third train with Monsanto Enviro-Chem (now MECS Inc.) state-of-the-art design on the cover and VIP International's innovative turbo turnarounds expertise.



Winter 1997

Sulfuric Acid Today is printed in all color on glossy paper.



October 1998

Sulfuric Acid Today hosts its first conference, the Sulfuric Acid Regeneration Maintenance



Workshop, in Baton Rouge, La., with more than 40 professionals from the acid regeneration industry.

May 2002

Sulfuric Acid Today hosts its first Australasia Sulfuric Acid



Workshop in Melbourne, Australia with over 50 sulfuric acid professionals from 13 countries. Since then we have hosted seven biennial Australian workshops throughout the country.

March 2009

Sulfuric Acid Today assumes all responsibility of the Phosphate Maintenance Roundtable (PMR), changing the name to the 'Sulfuric Acid Roundtable (SAR)'.

Started in 1991 by Lou Doerr and John War Hoover, Sr, of Lewis Pumps and Dever Biggerstaff, the first PMR was held in a small meeting room at the Peace River Country Club in Florida with approximately 20 people in attendance.

In 1999, the roundtable was moved to Plant City, Fla., and began to grow and was later moved to Lakeland, Fla.



The first Sulfuric Acid Roundtable sponsored by *Sulfuric Acid Today* magazine was held in Galveston, Texas. Since then, we have hosted two more Roundtables: 2011 in Pinehurst, NC, and 2013 in Scottsdale, AZ which was attended by 180 industry professionals.