Detail of the HexWall™ baffle tied into the hotface brick lining showing the open vs closed blocks in the baffle

Timely furnace replacement at Burnside

J. Bolebruch of Blasch Precision Ceramics, **B. Lamb** of MECS and **M.D. Harris** of J.T. Thorpe & Son, report on the successful recent spent acid furnace upgrade in which HexWall™ ceramic furnace internals enabled DuPont Burnside to conduct a complete furnace replacement in a matter of days.

The DuPont sulphuric acid plant in Burnside, Louisiana, in the USA is a large and versatile facility with a history of pioneering technology and world- class maintenance and operational practices. It is a 2,300 t/d plant capable of producing everything from standard industrial grades of acid to more specialized products like alkylation grade sulphuric acid, oleum and liquid SO3. Not only is its size and product slate impressive, but the site also has access to shipment via boat, rail and truck, making it a site of high strategic importance to DuPont.

Commissioned in 1964, the site has a long history of improvements, capital investments, new technologies and continuous improvement. It was the first DuPont sulphuric acid plant to retrofit from single absorption to double absorption in 2009. It was also the first DuPont sulphuric acid plant to replace older generation burner technology with a modern, fully integrated burner management system. In keeping with its tradition and history as an early adopter of modern technologies and an implementer of innovative solutions, in December of 2013, the Burnside plant undertook a major project to replace and upgrade its spent acid furnace using the MECS® HexWall™ ceramic furnace internals.

MECS, Inc. (MECS) entered into an agreement with Blasch in late 2011, appointing MECS as the exclusive distributor of Blasch HexWall ceramic furnace internals, and engineered ceramic boiler ferrules for use in sulphuric acid plants and vessels worldwide. MECS had recently become a wholly owned subsidiary of DuPont at that point, and the decision to partner with Blasch was based on a history of successful use of HexWall ceramic furnace internals at a pair of DuPont acid plants dating back to 2007, as well as a vision of what could be achieved with the newly fielded VectorWall™ product.

The need for this retrofit at the DuPont Burnside sulphuric acid plant arose out of the world-class preventative maintenance program incorporated at DuPont. Using rigorous inspection protocols, fitness for service tools, and good MIQA practices, DuPont was able to get a 15-year service life out of the furnace, and still retire it before having a catastrophic failure. Upon realizing the need for a furnace replacement, DuPont set out to replace the existing furnace efficiently, but also using modern technology to its best advantage.

The first item of interest for DuPont with regard to furnace design was that

of pressure drop, which is a significant concern for sulphuric acid plants because a high pressure drop can lead to plant bottlenecking and/or high energy consumption for main blower operation. Since the furnace volume was fixed, the only way for DuPont to reduce the furnace pressure drop was to reduce the total number of baffle walls inside the furnace.

A reduction in the number of baffle walls had positive implications from the standpoint of pressure drop, but there was a legitimate concern about getting the proper level of mixing inside the furnace in the absence of the previous baffle con- figuration. In order to evaluate the effect, DuPont performed CFD modelling and consulted with a variety of industry leading experts. The result was that by using Hex- Wall™ ceramic furnace internals, DuPont could reduce the total number of baffle walls without having a material impact on the mixing inside the furnace.

The final item to be considered in the new furnace design was that of mechanical stability. In this area, HexWall technology provided a clear and proven advantage. With mechanical support around the entire inner circumference of the furnace and an unblemished "no wall fall" record, the MECS® HexWall system presented a simple, cost effective and proven means of accomplishing this goal.

HexWall™ system installation

DuPont employed the services of JT Thorpe & Son, North America's largest industrial refractory contractor, to install the system. JT Thorpe & Son has a long history of pro- viding design and installation services and expertise to DuPont and has itself a long history of being on the cutting edge of new technology in its own industry.

JT Thorpe & Son worked closely with DuPont to optimize the refractory lining at furnace penetrations, end-wall construction and HexWall and VectorWall integration. This coordination resulted in a refractory lining that took advantage of the latest material and design technologies while also improving constructability, thus providing for a cost-effective installation. JT Thorpe & Son was very familiar with the VectorWall system, having installed this design in new installations, as well as upgrading existing furnaces during maintenance outages. The VectorWall™ was installed in approximately one-third the time normally required for a comparable brick baffle/checker wall.

A tight schedule and a tight footprint

This compressed timeline proved to be crucial due to an extremely tight window for replacement of the furnace. The existing furnace was located in an area that had seen considerable encroachment over the years, and consequently there was not enough real estate to place the new furnace in a location that would allow it to be incorporated into the train quickly upon completion of the refractory installation. It was going to be necessary to cut out the old furnace prior to the siting and lining of its replacement. The problem was that there was not time to accomplish all this work.

Meetings were held, and options weighed, and a bold idea was presented. Why not line the entire furnace and then lift it into place ready to go? This approach was sometimes used with much smaller furnaces, but the new furnace was large by anyone's standards, at nearly 20 feet in diameter, and greater than 60 feet in length. The weight of the furnace and refractory was estimated to exceed 1.1 million pounds. This made it a heavy lift that could only be accomplished by a very small number of people.

Solidifying the decision was the fact that the HexWall ceramic furnace baffles were tied into the lining and were mechanically engaged through a series of tabs and slots on all six sides of each block, while not being mortared together. Thus, the HexWall Ceramic Internals could tolerate a certain amount of movement without the threat of damage.

Once the installation was complete, the time required from the point the existing train was brought down until the new furnace was fired up was 11 days.

While this was going on, extensive modelling was underway to optimize the spent acid decomposition furnace design through the use of the VectorWall mixing checkerwall.

Furnace design optimization

The VectorWall is a variation of the HexWall baffle that utilizes a series of mixing inserts in each wall to create very specific flow patterns in the decomposition furnace. The VectorWall has been used with great success in the thermal stage of the Claus process for sulphur recovery in refineries and gas plants, and it was felt that many of these same advantages could be realized here.

Part of Blasch's experience in the Claus process showed that it was possible to configure the VectorWall in such a way as to create distinctly different zones within the same furnace, and to include a secondary stream entering the furnace behind the wall. This capability made it possible to greatly increase the volume and efficiency of ammonia destruction accomplished within the furnace. This split flow, or staged combustion approach would prove to be of great interest to the decomposition furnace community as well.

Prior decomposition furnace designs at MECS incorporated the use of a series of partial brick walls, as many as

four, with alternating open areas designed to create a high degree of mixing as spent acid and air passed through the furnace. Combustion of spent acid is a complicated and difficult process and mixing is critical to the efficiency of the process. The down-side of this baffle design is that it creates relatively high pressure drop and its broad residence time distribution drives furnace design to longer furnaces with greater cost and real estate requirements.

Modelling results indicate that decom- position furnaces can be designed using a combination of HexWall baffles and VectorWall systems that ultimately serve to reduce the total number of furnace walls required, while preserving (and often improving) the requisite level of mixing. Further to that, DuPont and MECS have used various combinations of HexWall baffles and VectorWall systems in the design of decomposition furnaces in conjunction with secondary air addition to create a staged combustion environment. This approach to decomposition furnace design has demonstrated the ability to reduce furnace size as well as have a significant impact on NO_x formation.

The design of the HexWall™ Baffle incorporates the use of a counter bore at the round opening on either side of the block. It is this counter bore on the upstream side that accepts the plugs which form the solid portion of the HexWall baffle. These plugs may be removed without dismantling the wall and replaced with a series of vector tiles on the downstream side, or a combination of plugs and vector tiles may be used concurrently, thus forming specific flow configurations in the walls.

The HexWall baffle installation at the Burnside plant is just one example of DuPont and MECS implementing cutting-edge technology within an age-old industry to challenge the status quo and to drive continuous improvement. Through MECS' partnership with Blasch Precision Ceramics, VectorWall technology continues to evolve. By leveraging Blasch's knowledge and experiences in Claus applications, and applying the technology in the sulphuric acid industry, sulphuric acid plant owners and operators can be the beneficiaries of significant operational and maintenance-related improvements.