DuPont Wurtland High Performance Drying Tower Goes On-line

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DuPont's Wurtland, Ky. plant produces a number of the building-block chemicals utilized in many consumer and industrial products. Here the operating tower is pictured visible from the center rear.

The DuPont plant in Wurtland, Ky., manufactures sulfuric acid, oleum, sulfur trioxide and chlorosulfonic acid — all vital building block chemicals found in many consumer and industrial products. The plant is a sulfur-burning facility, with the processing units designed for a nameplate 625 tons per day of acid production.

In Oct. of 2000, DuPont began the final planning to replace the 40-year-old drying tower in the acid plant. Replacing this tower was the final step of an overall plant upgrade of the acid towers that began in 1997 with a rebuild of the oleum tower and replacement of the absorbing tower.

The new tower was to be located on an existing structure that once supported the plant's original mist eliminator vessel. This location was selected during the early planning in order to keep the plant compact and easily accessible from a maintenance standpoint. This location also had safety, health and environmental impact because it removed the last active tower from over the control room and allowed for ground water protection facilities to be installed under the equipment.

The tower bid package included process design, mechanical design, fabrication and erection of the new drying tower, platforms and ladders on existing foundation and structure. Piping, ductwork and acid handling issues such as heat exchangers and pumps were not included in the scope of work for the new tower. These items were addressed in separate contracts managed by DuPont.

DuPont's objectives in executing the tower replacement project included:

— Safe execution of the project in the operational plant.
— Supply the plant's dry air process requirements (-60°F dew point).
— Minimize the life maintenance costs of the facility.
— Purchase a technologically advanced drying tower.
— Incorporate the new tower into the existing plant footprint.
— Place single-source responsibility for the tower fabrication, erection, lining and process internals design with one vendor.
— Minimize plant downtime during the tower change out.
— Have a successful startup and operation of the new tower.
— Acquire this project in the most economical package possible.

Because of the reduced tower size, Koch Knight was able to utilize a novel approach to construction on the DuPont job and line the tower in-house at the company's Canton, Ohio facilities.

Based on the above requirements, Koch Knight LLC, of East Canton, Ohio, was selected to supply and install this tower.

The tower's design operating conditions are shown in Table 1.

Meeting all these objectives in a high technology package that offered capital cost savings and project risk reduction was a tall order for the bidders. During the technical evaluation process DuPont explored all the available mass transfer technologies that are in use in sulfuric acid applications.

After thorough evaluation of the technical presentations and the bids, DuPont selected Koch Knight LLC to design, fabricate and erect the drying tower. Application of FLEXERAMIC® Ceramic Structured Tower Packing to the process parameters defined in Table 1 allowed Koch Knight to meet DuPont's needs with a tower that was significantly smaller in diameter than the other options offered. Koch Knight has a list of over 30 successful FLEXERAMIC packing installations since 1995. Operating installations have shown little increase in pressure drop after operating for five years or more.

The reduced tower size allowed DuPont and Koch Knight to consider a whole new range of construction options including lining the tower in Knight's shop in Canton, Ohio, and shipment of the lined tower over the road to the Wurtland plant where it would be lifted into place. Over many years, Knight has developed the ability to ship large acid proof chemical process vessels to client facilities, fully lined and ready for onsite erection and internals installation. Recent shop-lined jobs included a quench/scrubber vessel supplied to DuPont in 1999 and an 11.75-foot diameter absorber tower supplied in 2000 to another central U.S. sulfuric acid producer.

Replacing the drying tower with another in the 14-plus-foot diameter range would have required the unit to be erected and lined in place in the operating plant. Even though the new tower could be built in the operating plant and tied in later, on-site construction would have exposed the plant operation to the disruptions and risks that are always a part of a major construction project.

The design DuPont accepted for the Wurtland plant includes a number of state of the art process components and construction techniques. These included:

— A combined carbon steel-stainless steel vessel shell, fabricated and hydrotested before the lining was installed.
— Knight FLEXERAMIC 88 Ceramic Structured Tower Packing.
— KNIGHT-WARE self-supporting packing support dome.
— DEMISTER® mist eliminator, supplied via Koch Knight from the Otto York Division of Koch-Glitsch.
— A Knight high efficiency acid distributor for maximum bed irrigation.
— Knight PYROFLEX® proprietary corrosion proof sheet membrane, including a DuPont Teflon® sheet overlay.
— KNIGHT-WARE custom shape acid proof brick lining system.
— Alloy nozzle liners, strainers, etc., per DuPont specifications.
— Brick lining of the tower at Koch Knight's facility in Canton, Ohio.
— Supply of the brick lined tower by truck to the Wurtland site.
— Setting the lined tower in the plant, by Knight's subcontractor ENERFAB Inc. of Cincinnati with Knight oversight and supervision.
— Packing and internals installation by Knight field crews after the tower arrived in Wurtland.

Table 1: Drying Tower Design Conditions

PARAMETER	INLET	OUTLET
Acid Rate (gpm)	1,100	1,100
Acid Density (lb/ft^3)	112	112
Acid Temperature (°F)	104	117.5
H_2SO_4 Conc. (%)	99	98.7
Flow Rate (scfm) bone dry	43,300	43,300
Gas Rate (lb/hr)	211,750	208,835
Gas Density (lb/ft^3)	.0714	.0690
Gas Temperature (°F)	89	104
Gas Pressure (psia)	14.696	14.262
GAS COMPOSITION (VOL%)		
Sulfur Dioxide (SO_2)	0	0
Sulfur Trioxide (SO_3)	0	0
Oxygen (O_2)	20.5	21.0
Nitrogen (N_2)	77.3	79.0
Water (H_2O)	2.2	44 ppm

— Fabrication and installation of ladders and platforms by ENERFAB personnel.

Each of these parts of the total drying tower package contributed important constructability, maintainability or production capabilities to the drying tower project. Several of these items are described here in further detail.

PROCESS DESIGN – TOWER INTERNALS

PACKING

The benefits of FLEXERAMIC Ceramic Structured Tower Packing in this tower design result from the high surface area and low flow resistance configuration of the FLEXERAMIC packing. The arrangement of the corrugated sheets in each FLEXERAMIC element allows for uniform liquid flow, enhancing gas to liquid contact and improving moisture removal from the incoming air.

The FLEXERAMIC Structured Packing installation was designed to eliminate gas/liquid mal-distribution problems possible in the packed bed. Table 2 gives the packing information and expected results. With an engineered, structured packing providing significantly more open area and lower liquid hold up than random packing, DuPont anticipates reduced settling in the packed bed and less sulfate buildup, leading to lower pressure drop operation of the tower over a longer time.

Table 2: Drying Tower Packing and Performance Projections

PARAMETER	FLEXERAMIC 88 COLUMN
Tower Diameter	Less than 12 feet
Packed Bed Height (feet)	Less than 12 feet
Tower Packing	Type 88 FLEXERAMIC Tower Packing Packed
Bed Δp at 43,300 scfm, "w.c.	Less than 5
Total Δp across tower, "w.c.	Less than 15
Dryness, mg H_2O/scf	1 max (~ -60 °F dew point)

LIQUID DISTRIBUTION

The tower includes a Knight High Efficiency Acid Distributor. The distributor provides a 50-plus percent open area trough-type design with four to six drip points per square foot. This efficient distribution pattern also slows the flow rate of the acid at each drip point, generating less splashing and mist generation as the acid enters the packing.

The distribution pattern provides a 90-plus percent wetted cross-sectional area at the top of the packing. The parting boxes introduce liquid into the troughs to provide a uniform liquid gradient with a point-to-point flow variation less than 5 percent. The distributor is mechanically hung from the mist eliminator support system with the troughs providing support to the parting boxes and feed pipe.

GAS DISTRIBUTION

Gas distribution is critical to any tower's operation. Based on a fluid flow analysis of the gas inlet nozzle design and the tower below the packed bed, the old brick pier packing support system was replaced by a Knight Self Supporting Dome packing support. The dome support has better gas flow distribution, is more mechanically sound and is more economical than a standard pier and bar design, both at initial construction and in maintenance dollars over time. The dome offers a significantly lower standard deviation in cross sectional gas velocity as compared to the grid bar and block design.

MIST CONTROL

Above the packed bed and distributor is a mesh pad mist eliminator supplied by Koch-Otto York Division of Koch-Glitsch LLC. The DEMISTER® Mesh Pad Style 221-mist eliminator should deliver a removal efficiency of 96.66 percent for all mist larger than three microns, with an expected pressure drop of 1" w.c.

MECHANICAL DESIGN

ENERFAB, from Cincinnati, was the Knight subcontractor for the vessel fabrication and field erection activities. The vessel was shop fabricated per ASME specifications plus DuPont requirements. The vessel combined an A516 Grade 70 carbon steel shell with a 316L stainless steel mist elimination section and gas outlet. The tower includes a dished bottom head and the protective lining with a goal to reduce future maintenance due to buckling of the brick floor. The tower exterior was painted to DuPont specifications before shipment to the Knight lining shop.

ENERFAB managed lifting the lined tower, with primary crane service by a contracted 650-ton DEMAG A.C. 1600 crane. Ladders and platforms were supplied and installed by ENERFAB crews.

VESSEL LINING

The acid-proof lining installed in this vessel is in two parts, the corrosion proof inner membrane and the protective ceramic brick outer liner. The membrane is PYROFLEX® acid-proof sheet membrane, a carbon-based, cross-linking polymer sheet fused to the vessel wall for a homogeneous barrier impervious to acid penetration.

For added protection, a DuPont Teflon® fluoropolymer sheet overlay was incorporated into the PYROFLEX membrane. The ceramic lining is KNIGHT-WARE® fire clay acid brick, including three layers of custom-shaped KNIGHT-WARE head brick and KNIGHT-WARE sleeves for all nozzles. The gas inlet nozzle is sized to the specified gas flow to even out the gas distribution across the packed bed. Acid nozzle liners and the outlet vortex breaker were provided in LEWMET® alloy.

CONSTRUCTION PLAN

This project was formulated around minimizing construction operations in DuPont's facility. With the permanent structure located within the heart of the on-line operating unit, it was vital to limit the number of lifts into the permanent location and the number of hours that construction personnel were onsite in the plant.

Knight installed the lining system at their Canton facility. The reduced diameter of the high-performance tower allowed for over-the-road-transport of the lined vessel. Field crews had limited exposure during the internals and packing installation.

Knight managed their subcontractors during the onsite rigging, lifting and platform installation to minimize the onsite time. All safety issues involved with the vessel transport, the lift plan, the shop lining and field packing installations were addressed during pre-job meetings and managed to DuPont satisfaction.

As befits a partnership of world class performers, there were no accidents on this job or the associated offsite work.

The FLEXERAMIC® ceramic structured packing is installed.

Koch Knight has procured a reputation over the years as a very able contractor in the realm of shipping and delivery. As with the Wurtland job, the company has the capability to construct off site and deliver the goods to a customer fully lined and ready for installation.

RECAP

DuPont Wurtland now has a high-performance drying tower supplying the plant's sulfur burner air requirements. The design, construction and installation of the tower was performed safely, on time and on budget. All the parties involved in the design and construction of the tower expect excellent service from this low maintenance vessel during a long lifetime.

To date, the tower operation has lived up to expectations. Analysis over the next few months and years will prove the success of the project from an operational perspective.

The finished product is placed into position at the Wurtland, Ky. facility with the assistance of Koch Knight's subcontractor ENERFAB Inc. of Cincinnati.

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