Don't Stop THE PRESSES

A pulp & paper mill needed to rebuild or replace its RTO, but shutting down the system was not an option.

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The combustion chamber is insulated and enclosed.

In today's capital conscious industrial environment, manufacturers are eager to reduce both costs and interruption of operations or production. A southeastern U.S. pulp and paper mill needed to rebuild the regenerative thermal oxidizer (RTO) used for controlling emissions from their black liquor oxidation exhaust that were high volume, low concentration. The stripper off gases and concentrated non-condensable gases were high concentration, highly corrosive streams. The rebuild had to be completed during the scheduled mill outage, which required 24/7 construction.

Project assessment

Although not the original equipment manufacturer, Nestec Inc., Douglassville, Pa., was approached by the customer to assess the equipment and provide a comprehensive quotation for rebuilding it. After initial meetings and site visits, the RTO manufacturer recommended the company remove and replace the existing combustion chamber, followed by the reinstallation of the top platform, burner, injection nozzles, piping and wiring. Furthermore, they suggested externally insulating and cladding the combustion chamber to prevent condensation of corrosive materials on the skin of the chamber by maintaining an elevated skin temperature.

They also recommended removal of the existing media and fabrication of new heat recovery baskets and adding new media. This would be followed by installing insulation on the lower section externally and internally. The mill would provide the labor, equipment and materials to build a sloped floor in the outlet of the oxidizer. The design, fabrication and installation of a new rotor wash system would be provided by the RTO manufacturer.

The old ceramic media had broken down and needed removal.

One major change made to the system was to replace the original water-quench nozzle with a cold-air quench to prevent over temperature conditions in the combustion chamber. This change included designing a new purge-air fan system and integrating the control of this valve into the existing RTO controls. The RTO manufacture offered to design, provide and install a modified control system for the burner. All welds in contact with the process stream required 100 percent Liquid Penetrant Testing for quality control.

Because the RTO contractor was not original equipment manufacturer, dimensional measurements for fabrication had to be quickly collected and transferred to drawings. The entire project scope was aggressively scheduled for completion in a total of 12 weeks, with a scheduled two-week RTO outage for completion of the work. Upon issuance of the purchase order and completion of any required fabrication drawings, the long lead time items were ordered. To finish the project in the time allotted, 24-hour workdays were scheduled.

Project commencement

Upon arrival at the mill, a walkthrough and safety review was completed. Regulations required the RTO combustion chambers be treated as a confined space, even without the top of the chamber installed. Due to welding, burn permits were obtained. As with any project, worker safety was a prime consideration and reaffirmed by daily safety meetings prior to commencement of each day's efforts.

As with any complex equipment rebuild project, the contractor was concerned about unseen conditions and damage leading to rapid adjustments in the field. While the initial electrical removal started well, all the existing wires and conduits showed signs of exposure to excessive heat, with both the conduit and fittings corroded and fused. The initial scope of supply was to remove and return the original wire but the discov-

The old ceramic media is removed from the heat-recovery baskets.

ered damage would now require new materials. Another challenge was that the eight hours that were initially estimated to remove media were inadequate. However excellent contractors and clear communication with mill management meant these initial issues were quickly and successfully addressed.

Removal of the combustion chamber, transition duct, media and media baskets was completed in the first three days. The new combustion chamber provided was fabricated from ¼-inch thick, 253-MA alloy steel with 310 stainless steel refractory anchors, and was comprised of two sections located above the heat-recovery chambers. The oxidation chamber was designed and constructed with a bolted and davited access door for routine inspection of the burner and internal insulation. Upon final install, the chamber's flange connections were bolted and gasketed to ensure airtight construction. This effort was followed by the reinstallation of the top platform, burner, injection nozzles, piping and associated wiring.

Project construction

The combustion chamber required internal and external insulation. Internally, a module soft ceramic blanket fiber, utilizing a 253-MA alloy steel anchoring stud and 310-SS reinforcement and mounting hardware was shop installed and inspected prior to shipment. The ceramic insulation was seven inches thick, 10# density block and capable of operating at 2,400ºF. Due to the potential condensation of corrosive materials, the chamber was externally insulated with 1-inch K FRAX SR insulation with 0.024 embossed 300 series SS cladding. Caps made from the same cladding material bridged each stiffener. The combination of the internal and external insulation formed a system that would maintain an internal steel temperature between 475ºF and 575ºF with internal operating temperatures of 1,500ºF and 1,700ºF respectively. The outer surface temperature would remain below 150ºF.

After removal of the eight heat recovery baskets, new heat recovery baskets, fabricated from 16-gauge, 253-MA alloy steel, were installed. The baskets were filled with ceramic heat recovery media consisting of a combination system of 25-cell monolith ceramic block regenerative heat recovery media stacked 4 feet high, followed by 1 foot of 32-cell monolith ceramic block regenerative heat recovery media.

The installed media was specified to be chemically and thermally stable for rapid heat up and cool down of the system. The media would greatly reduce the previous pressure drop, as well as reduce the resultant stresses on the combustion chamber, valves and fans. Due to its cell sizes, the media was much more tolerant to particulates. The media change had the positive effect of reducing the pressure drop by approximately 10 inches wc. The top 12 inches of media, which would be subjected to temperatures above 1,100°F, consisted of Ceram CR20 ceramic block. CR20 provides alkali resistance and posses a proven reliability record in this process environment. The lower levels used Ceram NT ceramic block, which also provided alkali resistance at lower temperatures.

Similar to the combustion area, the lower section was modified with modules of soft ceramic blanket fiber capable of operating at 2,400ºF with 253-MA alloy steel reinforcement and mounting hardware. All internal insulation was shop installed and inspected prior to shipment. The ceramic insulation was 6 inches thick, 10# density block and capable of operating at 2,400ºF. Prior to cladding, the walls were power washed and neutralized. The cladding was fabricated from 16-gauge 253-MA alloy steel, and was field cut and welded into place. The lower chamber was modified to provide a sloped floor at the outlet of the oxidizer, the floor fabricated and installed from the same materials and in the same manner as the cladding.

The heat-recovery baskets were rebuilt and reloaded with new media.

The rotor wash system used a manually operated, fixed-position nozzle to clean the valve rotor. A system fabricated from 253-MA alloy material was designed, manufactured and installed. The system included a 3-inch coupling for connection to a water supply, a ball valve and the fixed nozzle.

The original design of the purge fan removed air from the chamber being purged, directing it to a point just downstream of the forced draft fan. Over time the pressure differential across the heat recovery media increased to a point equal to or greater than the positive pressure the purge fan was capable of providing, resulting in minimal or no purge volume. Additionally, the fan was experiencing problems with the bearings and the variable frequency drive (VFD).

While the new media returned the pressure drop to its original operating condition, rerouting the purge system directly to the combustion chamber increased reliability. The new purge system consisted of a tap from the existing purge duct located downstream of the purge fan, and the addition of a new tee arrangement. One leg of the tee would direct the purge air to its original point, while the other leg would direct the purge air to the combustion chamber.

System components consisted of two new 253-MA alloy steel two-position dampers with pneumatic actuators and open/closed limit switches. The damper for the combustion chamber was installed as close as feasible to the combustion chamber injection point. Integrating the system into the original controls used the existing VFD to modulate the flow through the purge system, controlling the RTO exhaust to a temperature range between 455°F and 475°F. Rerouting the purge volume from the inlet directly into the combustion chamber, functionally increased the remaining capacity of the fan due to the lower pressure drop. Additionally, the system could act as an inlet bypass, thus increasing the exhaust temperature and reducing corrosion caused by condensation.

In an effort to enhance energy consumption, a modified control system was designed and installed for the burner. It included removing the existing valves and replacing them with separate variable ratio regulators (one each for the independent propane line and natural gas lines). The system could be operated by modulating combustion air based upon combustion chamber temperature using a 4-20 ma signal. The natural gas or propane was then indirectly modulated into the burner based upon pressure at the supply side of the combustion air pipe.

Overall, fabricated components and other supplies were effectively managed to arrive in the needed sequence and appropriately staged for minimization of disruption to ongoing mill operations and the need for efficient material flow.

Project completed

The project was completed successfully within in the scheduled downtime. During the complex process, the rebuild team continually worked diligently with vendors and fabricators to maintain the scheduled completion date in spite of unexpected conditions, which added incremental delays. As of August 2011, the rebuilt equipment has been operating efficiently and problem free for six months. ***PE***

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