Reactor replacement

Hollie Wall reports on a challenging reactor replacement that required sophisticated engineering and one of the world's largest cranes.

The 1940s-era reactor weighed 850,000 pounds and required lifting lugs and tailing rigging for the lift and laydown of the old reactor and installation of the new reactor.

A 1940s-era reactor at an oil refinery in southern Illinois needed replacement. The fluid catalytic cracking reactor measured 90 feet tall, 23 feet in diameter and weighed approximately 850,000 pounds. The owner decided to replace the entire unit following years of maintenance and refurbishment. In addition to the reactor replacement, other site upgrades were performed. The decision was made to remove the entire reactor and internals in one huge lift to expedite the schedule. Ruby+Associates Structural Engineers designed and detailed lifting lugs and tailing rigging for the lift and laydown of the massive reactor. Two lifting lugs were located at the elliptical head transition to the cylinder at the top of the reactor. A tailing sling was located at the cone and standpipe intersection at the bottom of the reactor. The reactor consisted of ¾-inch thick steel plate and refractory lining at each of the three lift locations.

Due to the age and probable deterioration of the refractory, the refractory strength was neglected during analysis. Safety factors were utilized to account for the unknown weight of internals, location of internals and any deterioration of the reactor steel shell.

Huge lifting lugs

Each lifting lug was approximately 9 feet tall by 3.5 feet wide and was continuously welded to the shell. The large lug size was required to spread and reduce the stresses in the shell during lift and tailing of the reactor. The vessel's ¾-inch plate was relatively thin compared to the weight of the entire reactor. A twin-path synthetic sling was used to provide the required bearing area to tail and lay down the reactor. RISA3D software was used extensively by Ruby's engineers in analyzing the vessel and lifted loads.

Challenges at the beginning of the project included tight clearances, welding to an operating unit that was upwards of 900 degrees Fahrenheit and avoiding additional holes in the reactor shell. Preparations for the lift had to be in place well in advance to reduce overall turnaround time and to allow for the equipment to be back in operation.

There were many engineering iterations developed in deciding on the optimal solution to lay down the vessel including tailing from a large existing manway, a single tailing lug and a tailing sling.

The thin shell made the manway idea impractical and the chromium steel at the lower portion of the reactor made welding unworkable. The last option, to wrap a sling around the lower standpipe, was decided as the best solution, but localized >48

Deep South Crane & Rigging provided a 2,500-ton capacity VersaCrane TC-36000, one of the largest cranes in the world, to perform the reactor lifts.

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stresses and crushing of the standpipe were major concerns for the engineering team. Many configurations were analyzed to determine the ideal location of the sling to reduce stresses in the standpipe.

Huge main crane

Deep South Crane & Rigging provided a VersaCrane TC-36000, one of the largest cranes in the world, to perform the heavy lift. The 2,500-ton capacity crane was rigged with 420 feet of main boom and 619,000 pounds of counterweight and auxiliary counterweight of 1,950,000 pounds. The two lifts, removing the old reactor and installing the new reactor, were made at a radius of 210 feet.

The tailing crane was a Liebherr LR-1600/2 in the SDB configuration. It was rigged with 217 feet of boom, and as rigged, had a capacity of 237 tons.

The lifting procedure took about 16 hours to complete. With tight clearances and the crane boom unable to compensate for drift due to the actual center of gravity, the initial lift out of the existing steel structure proved challenging and required some structures to be removed for the reactor to clear. Once the structure was removed, the crane was able to boom up into more favorable crane charts in order to allow slew operations.

The tailing crane was a Liebherr LR-1600/2 in the SDB configuration.

Pasadena, TX-based Madison Industrial Services Team Ltd. was the contractor for the project, providing fabrication and installation of the large lift lugs as well as planning, managing and performing other operations during the turnaround. Ruby's team provided construction engineering to Madison for other turnaround work, including removal of an unused flue gas duct (in sections up to 80 inches in diameter and 120,000 pounds), staging sections of the new 53-inch diameter, 100-foot tall riser and removal of the old riser. A flying platform and rolling cart were used for lifting and staging riser sections within the structural steel tower prior to the turnaround. ■