TESTED, TRUSTED PUMP TECHNOLOGY KEEPS REFINERY POISED FOR HIGH PERFORMANCE

THE CHALLENGE

Unloading Crude With All Due Speed, Lower Energy
Can an oil refinery needing to pick up rail unloading speed while lowering its own embedded energy costs accomplish the twin goals with one solution? For a PADD 1 refinery, the answer, partnering with CIRCOR, was a resounding "yes."

A large independent refiner in North America railed advantaged crude oil from Western Canada to its East coast facility for offloading. The location, with sour crude coking capability, ran this lower-cost heavy crude oil and also owned its own onsite rail discharging. Controlling this infrastructure helps to reduce operating costs per barrel compared to relying on third parties.

As with everything in the oil industry, time is important, so efficient unloading of the cargo upon arrival takes high priority. And there can be a financial consequence of exceeding a predetermined time window: demurrage, or the fees a railcar company may charge for failure to unload the products within the agreed-upon window.

In addition, the Pipeline and Hazardous Materials Safety Administration of the U.S. Department of Transportation has issued final rules requiring rail cars transporting crude oil to observe new maximum speeds of 50 mph, or 40 mph when traveling through defined high-threat urban areas, unless all tank cars meet or exceed enhanced design standards.

For all practical purposes this means that unloading 20-railcar trains must occur as speedily as possible within the bounds of safety practices. At 10 feet high and with a capacity of 30,000 gallons, the first 25,000 gallons are the easiest to discharge. But the final 5,000 gallons at the bottom of the tank requires complex process engineering to recover as much of the raw product as possible.

Increasing the complexity, today's inbound crude trains may not have the same characteristics as tomorrow's or next month's. Well operated refineries adapt their feedstock to the marketplace, necessitating flexibility in their unloading processes. Heavy, sour Canadian crude today may be light, sweet Bakken crude tomorrow and efficiently managing this variability is paramount.

In prior years, this refinery utilized steam injection and nitrogen blanket processes along with a single-speed CIRCOR GTS twin-screw pump to unload crude. Running this steam system requires immense amounts of energy, and without a variable speed drive the pump was unable to adapt to changing head conditions throughout the unloading process. A change of approach was necessary, and the process to scope out the solution needed to be fast tracked.

THE SOLUTION

A Versatile Twin-Screw Houttuin Pump Reporting for Duty
Having a strong working relationship with CIRCOR's sales engineer Mark Blair and application expert Dan Pessel, the refinery's operations manager turned to CIRCOR for an improved solution. The parties had previously begun talks to incorporate a smaller, lower-flow rate pump for a separate unloading station at the refinery. The discussion shifted to evaluating the more urgent unloading need so that the scope of the proposal could be quickly outlined.

After careful analysis, CIRCOR submitted an initial proposal for its engineered Houttuin pump with an expedited delivery option – an estimated four-week reduction in standard lead time. Over the course of the ensuing month, working closely with CIRCOR engineers at their Warren, Massachusetts, manufacturing facility, the specifications were modified twice more to deliver the most suitable system design.

Primary design goals were now eliminating steam injection and limiting the nitrogen blanket on the rail cars most distant from the pumping station for heavy crude unloading. However, the successful design was constrained by the requirement to also unload light crudes. Balancing the net inlet pressure required (NIPR) for heavy Canadian crude with the elevated fluid vapor pressure challenges of lighter, more volatile, Bakken crude yielded the final design.

The customer ordered two of CIRCOR's Houttuin 300.350 twin-screw carbon steel pump skids with integral steam jackets, 900 horsepower motors and forced circulation lube oil ancillary systems capable of handling up to 200°F. The design accommodated viscosities ranging from 50 to 200 cST and included a variable speed drive to manage a NIPR range of approximately 2.5-3.5 psi.

The Houttuin twin-screw pump is a self-priming rotary positive displacement pump originally designed for the rigors of the Dutch coal industry. The pumps have a worldwide reputation for quality, energy savings and cost effectiveness in heavy-duty service conditions. Their complex screw shafts are machined to the extremely high tolerances necessary for duty conditions of the pumps.

Because of the special screw profiles, in which two pairs of opposed screws efficiently convey liquid to the center of the pump where the discharge port is located, the liquid is efficiently pumped with very minor backflow, and it possesses good suction qualities. The hydraulic forces generated are opposite and equal, so the rotor is axially balanced hydraulically and wear of metal parts minimized over the life of the pump.

THE RESULTS

Better Metrics on Unloading Speeds and Demurrage
The refinery's pump system was delivered and ready for action just 26 weeks after the submittal of final certified drawings. CIRCOR received high marks for the ultimate pump selection and the solution's ability to optimize energy consumption. The customer also maintained top unloading speeds longer and controlled demurrage.

Since first put in operation in July 2014, the pump performance and unloading rates have in many instances exceeded expectations and reduced production run times by as much as 35 percent. Pump efficiencies have remained consistent, with no reported loss of or reduction in flow due to internal pump wear.

In addition to reduced unloading or "unit train" turnaround times, the pump system was also designed to allow greater control and management of auxiliary support systems for heat soaking and blanketing of the railcars. Having this added flexibility for control of these utility systems further enhances the overall design benefit related to reductions in cycle time and cost.

The flexibility in design of the pump system for handling a variety of feedstocks positions the refinery to respond to fluctuating market conditions, and to take advantage of rail-transported domestic shale and heavy Canadian crude oils for many years to come.

From conceptualization through overcoming facility start-up challenges, the pumps and auxiliary systems solution was a true collaboration in both engineering system design and implementation.

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