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Optimizing Performance for Pumps & Compressors in Renewable Diesel Refining

By Sundyne's Helene Balligand, August 5, 2022

Renewable feedstocks are less harmful to the environment and less expensive.

During the pandemic, 11 refineries in the U.S. were shuttered due to the declining demand for transportation fuels of all kinds. This year, four of these refineries are coming back online, and they are being converted to renewable diesel refineries. Each refinery has a wide range of pumps and compressors that have been used for decades to refine traditional fuels. As these refineries return, they are being modernized to handle different, and greener, feedstocks. This provides operators with the perfect opportunity to update equipment. A wide range of pump and compressor upgrades are currently being implemented in these plants to meet new requirements and optimize efficiency.

An Update on Renewable Diesel

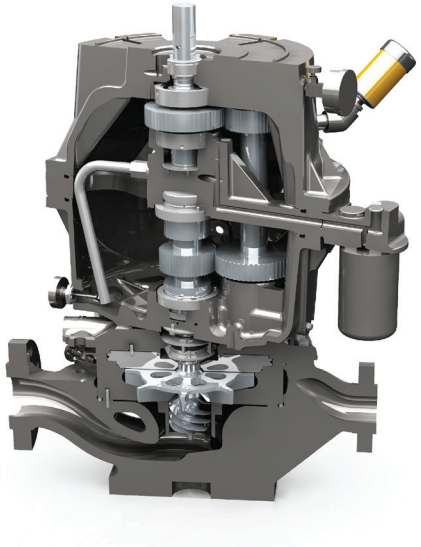
Approximately 50% of crude oil used around the globe is refined into transportation fuels, which contribute to greenhouse gas emissions. Biomass is a renewable energy source that can be mixed with crude oil and converted into liquid transportation fuels

Like Ethanol, which is mixed with crude to make unleaded gasoline, there is a wide range of renewable materials that can be used as feedstocks for diesel. These include plant-derived oils, such as soybean and palm oil. Additional green feedstocks, such as jatropha and algal oils, are also being evaluated as candidates to help meet the growing demand for renewable diesel around the globe.

There are two primary reasons why renewable diesel refining is expected to grow in the future:

1. Renewable feedstocks are less harmful to the environment.
2. Renewable feedstocks are less expensive than crude oil, which can improve a refinery's operating margins.

The refining process starts by pumping feedstocks at high pressures into multi-stage catalytic reactors, where they are saturated and de-oxygenated. Effluent from the reactor is separated to remove carbon dioxide (C02) and other low molecular-weight hydrocarbons. The result is mixed with additional Hydrogen gas and then routed to a second catalytic reactor, where diesel fuel and a branched paraffin byproduct are produced. At this stage, hydrogen is separated via conventional gas/liquid separators. Compressors recycle excess hydrogen back to the reactor, and pumps move the liquid to a distillation process, where byproducts (such as propane and naphtha) are separated, and a series of cold-flow



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properties in the diesel are adjusted to meet required specifications.

Renewable diesel refining is similar to traditional refining. However, the feedstocks blended into the process have different properties, and the equipment moving these materials must operate at different flows and pressures.

The pumps typically used in refining include American Petroleum Institute (API) integrally-geared single-stage and multistage pumps as well as between bearings multistage pumps. What is the best way to ensure that pumps are optimized to run at peak efficiency? It starts with sizing the pump properly for the required task. This is accomplished with advanced analytics and computer-tailored hydraulics, which place the best efficiency point (BEP) at, or slightly below, the rated point, resulting in optimum efficiency. This enables smaller drive sizes to be used, which can still deliver the required output while saving energy.

For refiners making the shift to renewable diesel, pumps and compressors handling renewable diesel feedstocks should be re-rated to keep them operating within the API limits (ideally between 80% and 100% of BEP). Rotating equipment operating above or below rated flow can result in cavitation, seal failures, high vibration and motor overloads.

Pump or compressor failures of any kind result in poor mean time between repair (MTBR), plant downtime and increased maintenance costs. Preventing this domino effect is critical as maintenance and operational costs can make up as much as 80% of the total life cycle costs.

An Opportunity for Plant Operators to Upgrade

Enhancements in manufacturing, combined with customer feedback from operators in refineries, have identified the following 10 areas for optimizing pump and compressor performance, extending maintenance intervals, and reducing total cost of ownership (TCO):

1. Pump & Compressor Upgrades

Outdated compressors/pumps in the field can be upgraded without changing out the major components, such as the casing, housings and foundation.

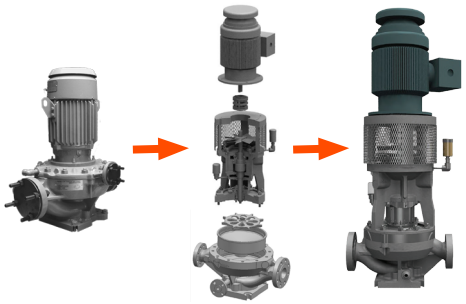
2. Rerates

When process conditions change, pumps and compressors should be rerated to tailor flow and head to the new process requirements. Efficiency improvements are achievable without requiring a new motor, footprint or piping. Some rerates have been able to provide 30% additional head with 10% power savings.

3. Seal Replacements

New materials have improved seal performance and extended seal life. Modifications to seal housings improve fluid flow-through and remove high-point vapor pockets, which improves seal life.

4. Cartridge Seal Upgrades



These facilitate error-free replacements for pump shaft seals. Self-contained cartridge seals include a shaft sleeve, seal and gland plate, and they are fitted onto the pump shaft as a single assembly.

5. Inboard & Outboard Bearings

The latest generation of bearings offers better rotor stability over a wider operating range. They also dampen and reduce vibration and extend seal longevity.

6. Bearing Frame Upgrades

Power-end replacements enhance reliability and ensure compliance with current API 610 bearing life requirements.

7. Gearbox Conversion Kits

These deliver up to 10 design improvements via an interchangeable, bolt-on package that delivers an estimated minimum five-year mean time between maintenance (MTBM). Gearbox exchanges provide better bearing life and include stronger gear sets that facilitate higher load levels.

8. Compressor Inlet Guide Vanes (IGVs)

These are a series of blades arranged at the inlet of a compressor that pre-swirl gas flow entering the impeller. IGVs increase

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a compressor's turndown while reducing the amount of work needed from the main driver.

9. High Efficiency Compressor Impellers

Recent impeller design improvements enable compressors to produce the same amount of flow, using up to 20% less power than previous designs.

10. Instrumentation

Updated instrumentation for monitoring vibration and temperature gives operators peace of mind that rotating equipment is operating at BEP.

The R.O.I. of Upgrades Vs. Purchasing New Equipment

These upgrades cover almost 90% of the maintenance requirements for rotating equipment. Upgrading the key components can add decades of service life. They also eliminate the cost of installing a new pump or compressor, which in refineries involves a customized process that can require unique foundations, complex piping runs and teams of welders, concrete workers and crane operators.

Each of these aftermarket updates can be accomplished in a matter of days, during a standard turnaround, at a fraction of the cost of buying new equipment. The benefits that come with these upgrades include:

- Lower operating costs: Ensuring that pumps and compressors are operating at their BEP minimizes vibration and reduces energy costs.
- Lower maintenance costs: Upgrading the key components with new parts that are warrantied extends maintenance intervals and reduces overall maintenance costs.
- Increased plant uptime: In the months ahead, refining capacity around the globe will increase. Many refineries run operations around the clock, and plant uptime is the true measure of all optimization efforts.

Over the last two years, much of the regularly scheduled maintenance in refineries (and plants of all types) has been pushed back due to labor constraints and declines in demand during the pandemic. Today, demand for diesel fuel is skyrocketing. Unfortunately, inventories of refined diesel are at their lowest level since 1990, and prices have risen to all-time highs.

As a result, refineries are expanding their operations to meet demand, and many refineries are incorporating renewable diesel into their processes. The analyst firm International Info Resources (IIR) is currently tracking 119 planned renewable diesel unit additions around the globe. The majority of these will be incorporated into existing refineries.

Either one of these scenarios—increasing capacity or incorporating a new process—provides an opportunity to rerate and upgrade pumps and compressors.

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