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WHITE PAPER / **WASTEWATER HANDLING**

ADDRESSING WASTEWATER IN THE RENEWABLE DIESEL SECTOR

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Understanding the unique challenges of wastewater generated from renewable diesel production is critical to avoid unexpected issues during a renewable diesel refining transition project.

New regulatory standards and incentives, coupled with environmental benefits and inherent operating advantages, are driving fast growth in the renewable diesel sector. Categorized as a drop-in fuel, renewable diesel can be produced from several biomass-based feedstocks that correspond to existing petroleum-derived fuels specifications. Drop-in fuels can be directly substituted for fossil fuels while removing the need for blending or engine modifications associated with other biofuels. The U.S. capacity to produce renewable diesel is forecasted to increase from the current 0.6 billion gallons per year to more than 5 billion gallons by the end of 2024.

The high-temperature and high-pressure processes used to refine petroleum are similar to the processes used for renewable diesel refining, driving many refiners to consider petroleum-to-renewable diesel refinery conversions to capture this new market opportunity. Given the federal Renewable Fuel Standard (RFS), California Low-Carbon Fuel Standard (LCFS) and available tax credits, the time is right to evaluate a transition.

While petroleum refining processes are generally conducive for renewable diesel production, challenges associated with handling wastewater from renewable feed pretreatment processes must be considered. An early understanding of the considerable differences in wastewater generated from renewable diesel production facilities can mitigate risks to project scope, compliance and cost.

KEY WASTEWATER PLANNING CONSIDERATIONS

Petroleum refineries have a range of systems and equipment for wastewater handling. However, these processes need to be reevaluated when considering renewable diesel refining because of the dramatic differences in wastewater streams that may result after the transition.

Renewable diesel refining includes two major process steps — the pretreatment unit (PTU) and hydrotreating in the renewable diesel unit (RDU). The PTU is used to reduce contaminants in raw materials that will be optimized in the RDU. The RDU converts the pretreated feedstock into renewable diesel and other products.

Both PTU technology selection and the variability of untreated renewable diesel feedstocks create unique wastewater streams that are difficult to effectively treat without improvements to existing refinery wastewater treatment systems. Refineries that convert to renewable diesel without adequate consideration of the unique characteristics of wastewater effluent can adversely affect project budgets, create processing inefficiencies and negatively impact the environment.

PRETREATMENT: PLANNING FOR VARIABILITY

Determining a feedstock strategy is a critical part of project planning. Refineries need to decide if raw waste feedstock or pretreated feedstocks will be used for renewable diesel refining.

Feedstocks for renewable diesel production include animal fats (e.g., beef tallow, poultry fat and white grease), vegetable oils (e.g., soy, canola and corn) and used cooking oils. Due to the growth in renewable diesel production, demand for triglyceride feedstocks is increasing. As a result, refiners need to be flexible in their pretreatment requirements, depending on what is available in the marketplace.

Pretreatment of feedstock must meet stringent specifications to remove impurities, metals, chlorides, phosphorous and other contaminants. Removal of these contaminants is largely dictated by the need to prevent fouling or deactivation of the catalysts used in the downstream hydrotreating unit.

Pretreated feedstock is available to source but is priced at a premium. If pretreated feedstock is economically viable or preferred, refiners can use the raw material as soon as it arrives at the renewable fuel refinery. However, many refiners choose an on-site PTU to improve operational flexibility and overall processing economics. By understanding feedstock selection, refiners can identify the proper pretreatment steps and appropriate pretreatment technologies.

Due to pretreatment requirements and the resulting wastewater, refiners must be aware of and plan for high concentrations of wastewater contaminants and variability as part of the refinery energy transition.

Accordingly, the cost of wastewater handling in any petroleum-to-renewable diesel refining conversion can be high, accounting for up to 15% of the total project cost.

PRETREATMENT: PLANNING FOR CHARACTERISTICS

Wastewater is characterized by identifying the constituents in the waste streams, including the quantity of organic compounds present. These organic loads largely dictate the wastewater treatment requirements, which are based on the oxygen demand needed for decomposition. Oxygen demand is detrimental to receiving bodies of water, as it will deplete levels and impact aquatic life. This pollutant load can be quantified by various parameters and must be reduced prior to discharge.

- **Chemical oxygen demand (COD)** quantifies the amount of oxygen required to chemically oxidize the organic pollutants in a waste stream.
- **Biochemical oxygen demand (BOD)** is used to approximate the amount of oxygen needed by microorganisms to biologically break down organic contaminants.

Renewable feedstock processing creates high-strength wastewater, with high COD and BOD content, due to the concentrated presence of organic compounds, phospholipids, metals and other impurities. Additionally, the changing quality of feedstocks (from vegetable oils to animal fats) can result in different organic loadings and other characteristics that need to be treated and accommodated on a continuous basis.

The impact of organic loadings, and the resulting strength of various renewable waste streams, can be up to 100 times greater than typical refinery wastewater. As a result, refiners must plan for the right wastewater handling strategies to avoid negative environmental and economic impacts. Unfortunately, because renewable diesel production is relatively new, treatment of this type of wastewater is a topic that is not well understood by many project planners and contractors.

REFLECTING ON RENEWABLE DIESEL

An interchangeable fuel substitute, renewable diesel is produced from renewable feedstocks. It does not require blending and can be used in all diesel engines. In addition, renewable diesel burns cleaner, performs better and can be stored without impact to quality.

The unit operations required to process renewable diesel are similar to petroleum refining, but the feedstock and wastewater streams are considerably different. Therefore, to most effectively transition from fossil fuel to renewable fuel refining, these characteristics need to be evaluated:

- **Feedstock:** Renewable diesel is produced from used cooking oils, animal fats, greases and plant oils. These feedstocks have a wide variation in raw materials characteristics, resulting in widely variable wastewater streams with high pollutant loads.
- **Pretreatment Unit (PTU):** All feedstocks must be pretreated to remove impurities. A PTU is not typical for hydrocarbon refineries and selection and design require careful attention. Pretreatment requirements are usually defined by catalyst life expectations in the renewable diesel unit. Typical PTU processes target the removal of impurities, metals, chlorides, phosphorous and other contaminants. A PTU must be carefully designed to remove impurities while effectively managing the changing levels of feedstock quality.
- **Renewable Diesel Unit (RDU):** The RDU is functionally similar to a typical refinery diesel hydroprocessing unit, with a special focus on removing oxygen as opposed to sulfur. Hydrotreating renewable feedstocks requires large amounts of hydrogen, and special considerations are required to control the exothermic reactions. A dewaxing stage is often required to improve renewable diesel cold flow properties.

PLANNING FOR PRETREATMENT

Effective feedstock pretreatment is critical for reliable RDU operation. Bringing pretreatment on-site at a refinery offers the advantage of more cost-effective procurement of a wider range of available feedstocks and a stronger ability to react to volatile feedstock market changes. However, the selection of a pretreatment unit (PTU) can be complex and requires attention during project planning.

Steps to select a pretreatment unit:

- **Develop the business case for a PTU at the outset of project planning to lower risk and raise awareness of any potential impacts to schedule and cost.**
- **Identify feedstock suppliers, sources and quality requirements to help steer PTU technology decisions.**
- **Plan for potential future PTU modifications to be well-positioned to adapt to changes in feedstock sources and types.**
- **Define wastewater treatment requirements, required infrastructure, process changes and existing assets that can be leveraged to maximize project efficiency and success.**

CONCLUSION

Petroleum-to-renewable diesel refinery conversion can present a compelling business case for refiners. With awareness and understanding of the differences in wastewater streams from renewable diesel production, refiners can develop plans that address this critical area and reduce project and production execution risk. Upfront consideration of wastewater planning helps refiners leverage existing assets, determine the right treatment processes, identify the most effective technologies and maximize current and future opportunities.

Burns & McDonnell is supporting multiple refineries to map out and execute a transition to renewable fuels. Our approach is comprehensive, from feedstock selection to wastewater management, permitting and everything between.

BIOGRAPHIES

ADAM BOGUSCH is a senior project manager with Burns & McDonnell. He has extensive experience in wastewater treatment and design with a focus on biological treatment systems, including both aerobic and anaerobic processes. Throughout his career, he has filled the roles of project manager, design manager, project engineer and developer on traditional design-bid-build (DBB) and alternative delivery projects valued at more than $100 million.

JEFF CROUCH is a project manager with Burns & McDonnell. He has more than 20 years of experience serving in process engineering and project management roles on domestic and international projects in the refining, chemical and power generation industries. Specifically, his experience pertains to the development, optimization, design and troubleshooting of new and existing processes. He has experience with mechanical design, fabrication, nondestructive evaluation and methods of testing, inspection and metallurgical issues.

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