Solutions for heat tracing in renewable diesel production

The production and processing of renewable diesel require careful heat management throughout different steps of the refining process

Mike Allenspach, Jeff Fabry and Pele Myers
nVent

Introduction

With global decarbonisation strategies and sustainability requirements, renewable diesel has emerged as a promising alternative to conventional fossil fuels. The US Energy Information Administration (EIA) predicts a 30% increase in renewable diesel production in 2024 and 2025 (*US EIA, 2024*).

Renewable diesel, derived from biological materials, offers significant environmental benefits such as reduced greenhouse gas emissions and decreased reliance on non-renewable resources. However, its production and processing present unique challenges, especially in process heat tracing. This article delves into these complexities and presents innovative solutions to address them.

Comprehending renewable diesel

What is renewable diesel?

Renewable diesel, also known as hydrotreated vegetable oil (HVO), is a biofuel produced from renewable resources like vegetable oils, animal fats, and waste cooking oils. Unlike biodiesel, which is made through transesterification, renewable diesel is produced through hydrotreating. This process removes oxygen and creates a fuel that is chemically similar to petroleum diesel.

Benefits of renewable diesel

The advantages of renewable diesel are manifold. It offers a drop-in replacement for conventional diesel, meaning it can be used in existing diesel engines without any modifications. Renewable diesel also boasts superior performance characteristics, such as higher cetane numbers and better cold-flow properties. Additionally, it significantly reduces greenhouse gas emissions and particulate matter, contributing to improved air quality and public health.

Role of process heat tracing

Importance of heat tracing

In industrial processes, maintaining the proper temperature of fluids is crucial to ensure efficient operation and product quality. Heat tracing is the process of applying heat to pipes, vessels, and other equipment to maintain or raise their temperature. This is especially important in cold climates or processes involving high-viscosity fluids, where the risk of solidification or freezing is high.

Challenges in renewable diesel feedstocks

Renewable diesel feedstocks, such as vegetable oils and animal fats, present unique challenges for heat tracing. These feedstocks have higher viscosity and lower pour points than comparable petroleum-based feedstocks, making them more prone to solidification at lower temperatures. Secondly, the presence of impurities and variability in feedstock composition can further complicate the heat tracing process. Finally, as with petroleum-based feedstocks, plant oil and animal waste feedstocks for renewable diesel may arrive at the refinery via rail, ship, truck, or pipeline. To ensure flow, these feedstocks require a prescribed temperature maintenance from unloading and distribution areas to storage facilities 100% of the time.

Figure 1 Raychem heating cable with HPR technology

Innovative solutions for heat tracing challenges

Addressing the challenges of renewable diesel feedstock requires a comprehensive heat management system (HMS). This system includes engineering, power distribution, electric heat trace products, control and monitoring, thermal insulation, and instrument winterisation.

Designing an HMS solution for the feedstock area of a renewable diesel refinery depends on the location of the feedstock unloading system and the availability of power distribution to support electrical heat tracing. For instance, unloading feedstocks from a ship may involve long piping distribution systems from piers and jetties, while unloading from a truck or in-plant railcar may offer closer access to the operating refinery. When the feedstock delivery system is near the refinery, self-regulating (SR) technology is ideal for heating cables.

Self-regulating heating cables

SR heating cables are an effective solution for maintaining consistent temperatures for the movement and storage of renewable diesel feedstock. These cables adjust their heat output based on the surrounding temperature, ensuring energy efficiency and preventing overheating. Their ability to provide uniform heating makes them ideal for use in pipelines and storage tanks.

Since sustainability is a key component of the energy transition, Raychem SR heating cable with high power retention (HPR) technology and a 30-year design life, ensures the performance and long product design life to meet critical sustainability requirements.

Electrical contractors typically prefer to work with SR heat tracing cables whenever possible because they are easy to design and install. This is a result of the unconditional T ratings and cut-to-length installation. The process maintain temperatures of the typical feedstocks in this industry are also a great fit for the power temperature curves of the high-temperature SR heating cables displayed in **Figure 1**. In this case, 277V is the optimum power, if available, to ensure maximum designed circuit lengths while minimising the impact on the overall power distribution of new or retrofit refinery operations.

Figure 2 Raychem longline heating system

Longline heating systems

When the renewable diesel feedstock delivery points are on ship docks or from distant railway access, this often means greater distances between the delivery point and the refinery itself. Due to the heat management requirement of the feedstocks, the piping distribution systems in these scenarios are best designed using longline heat tracing technologies like Skin-effect Tracing Systems (STS), which can carry heating power longer distances, as shown in **Figure 2**.

STS systems can be designed to operate for up to 50 km from a single power point. The critical solution that this heat tracing technology brings to this industry is the opportunity to provide the feedstock process temperature maintenance desired with little power distribution required, often from a single power point location. If the long pipeline from the ship unloading to the refinery were heat traced with SR technology, multiple power circuits would be required, which means more breakers, power distribution cabling, resistance

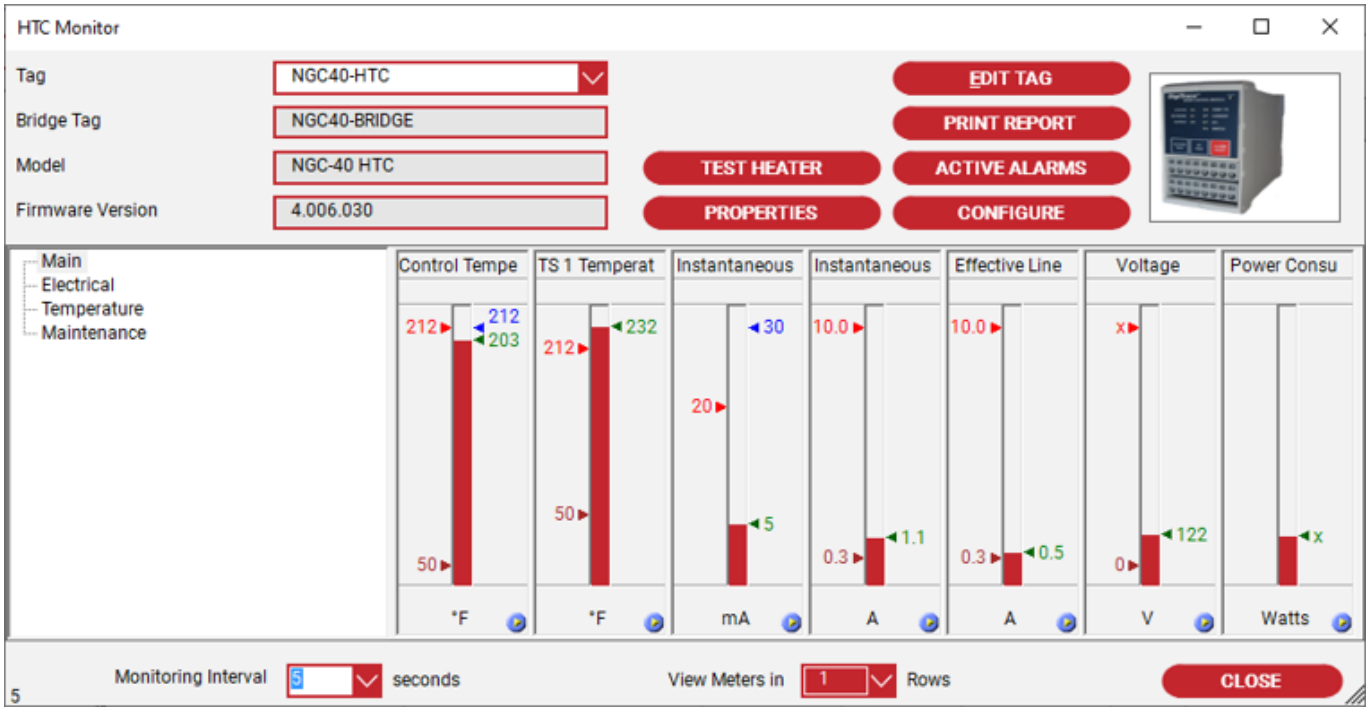

Figure 3 Raychem Supervisor software graphical user interface

temperature detectors (RTDs), controllers, and SR connection kits.

Integration with process control systems

SR and longline heating technologies both depend on connected advanced electrical heat trace (EHT) control and monitoring systems to ensure operational reliability, maintenance, energy efficiency, and performance. Process temperature maintenance control of the feedstocks can be achieved using RTDs for line sensing process control or thermocouples for direct process temperature control. One challenge not referenced is the potential variability of the feedstocks being delivered to a renewable diesel refinery. Delivery of plant oils, animal fats, and waste will certainly vary, and this could result in the need for unique process maintenance temperatures depending on the feedstock and the feedstock mix.

Integrating heat tracing systems with advanced process control systems can significantly enhance their effectiveness. Process control systems can monitor temperature, flow rates, and other critical parameters in real-time, allowing for precise adjustments to heating output. This not only ensures optimal process conditions but also reduces energy consumption and operational costs.

Raychem Supervisory Software (see **Figure 3**) can be programmed to manage the heat required for varying batches and recipes of the incoming feedstocks.

There is also the option to manually adjust process maintenance temperatures remotely from the control room or other location as different feedstocks are delivered (see **Figure 4**).

> “Supervisory software programs certainly offer a lot more capabilities as part of the heat management system at a renewable diesel refinery, including maintenance and operational activities like alarm management”

Supervisory software programs certainly offer a lot more capabilities as part of the HMS at a renewable diesel refinery, including maintenance and operational activities like alarm management.

For longlines, Raychem Pipeline Supervisor (RPS) is a temperature monitoring software solution that offers remote monitoring of long pipelines with critical fluids. This software utilises distributed temperature sensing (DTS) data that is continuously captured from fibre optic sensors 24/7 along the entire length of the pipeline.

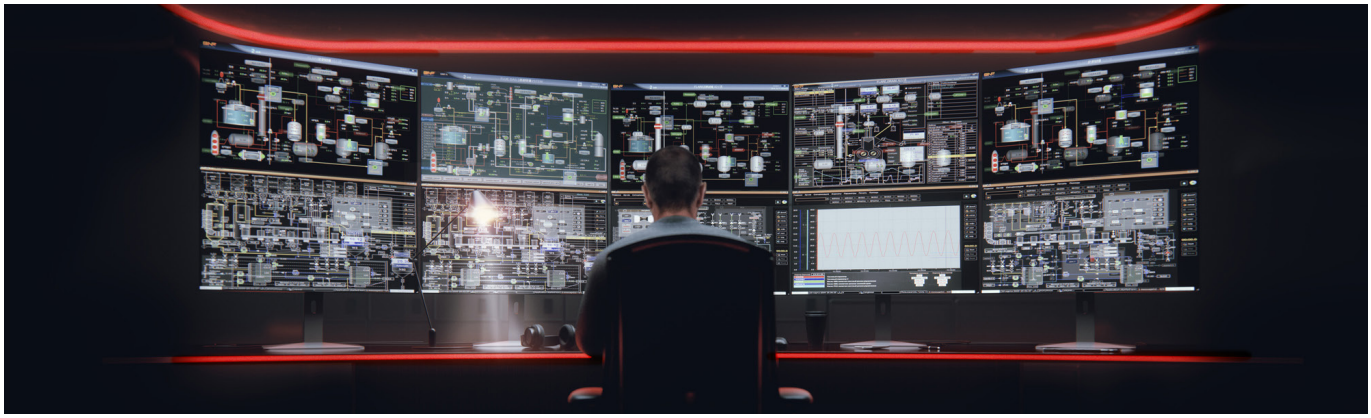

Figure 4 Advanced control and monitoring

The RPS software utilises advanced algorithms, developed based on actual pipeline events, to provide operators and maintenance personnel with pending threats such as the formation of hot and cold spots, time-to-freeze prediction, and location of pipeline plugs.

This unprecedented access to pipeline performance trends provides rich, actionable data so that maintenance staff can keep pipelines operating safely and efficiently.

Case study and real-world application

Gulf Coast US refinery conversion to renewable diesel requires 1.6 km (1 mile) underground feedstock pipeline

In this unique refinery conversion challenge, chicken fat and oil are feedstocks delivered by rail car to the refinery at a rail unloading terminal that is 1.6 km away from the refinery. Routing of the heated transfer pipeline required most of the line to be underground at depths ranging from 3m to 30m. The owners of this project had significant civil and mechanical challenges designing and planning for the construction of an underground heated line to deliver chicken fat from the rail terminal to the refinery. The chicken fat and oil must be maintained at a process temperature of 120°F (50°C) to keep them in liquid form.

The customer's mission-critical objective for the heat management solution included finding the optimal heated pipeline system design for this project that would keep critical processes running under all scenarios. Additionally, engineering solutions were provided in response to contractor challenges for construction and the future reliable operation of this underground heated line.

Raychem engineers specialise in longline heated pipeline applications that address solutions where power distribution is limited in supply. These experts determined that a STS was the ideal solution for this project (see **Figure 5**) because they could bundle several adjacent technologies for optimum heat management system performance, such as:

- STS heating with a single power connection at one end of the pipeline.

Figure 5 STS longline heated pipeline

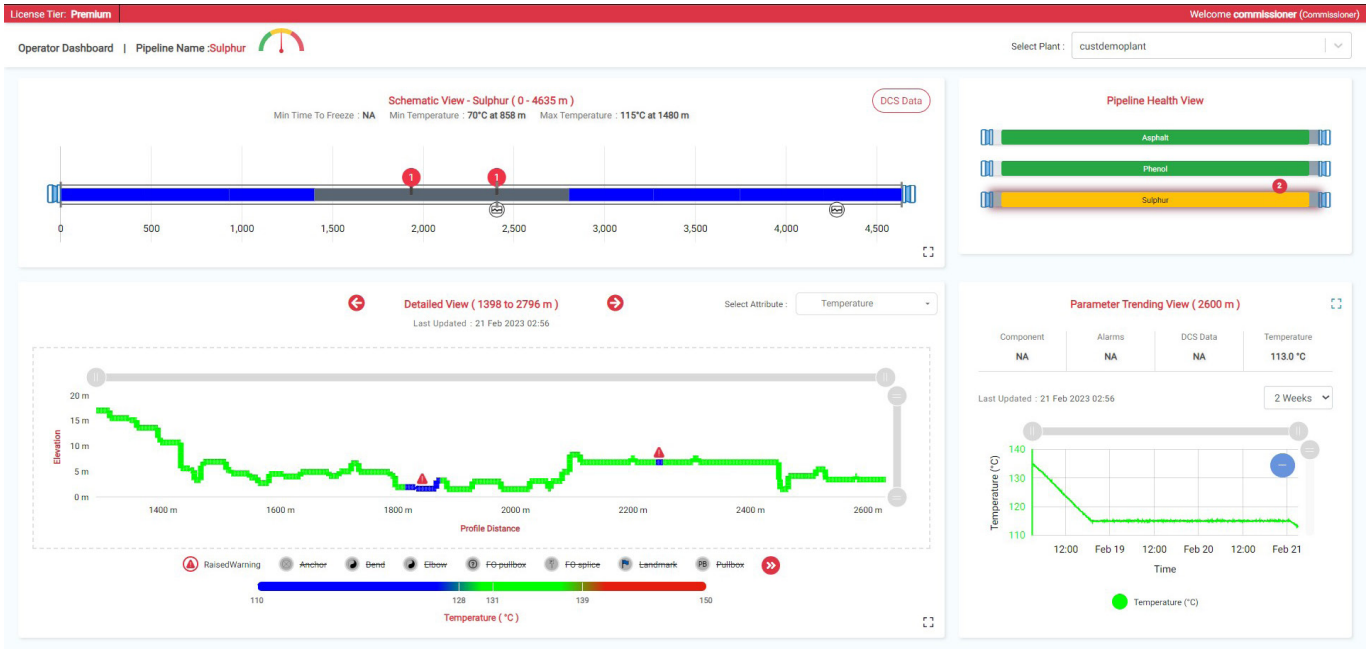

Figure 6 Raychem Pipeline Supervisor DTS fibre optic technology captures data points along the entire length of the pipeline

- Pre-insulated/prefabricated piping systems that offer superior thermal insulation reliability and underground integrity by providing a homogeneous temperature profile for the entire length of the pipeline.
- Fibre optic DTS to measure the temperature of the underground pipeline every metre along its underground routing.
- Raychem RPS predictive analytics software for comprehensive control and safe management of temperature-critical pipelines.

This key feedstock line was constructed using mostly horizontal directional drilling to install the 1.6 km, pre-insulated, STS heated underground.

The pipeline temperature is monitored every metre along its length using DTS fibre optic technology (see **Figure 6**). Raychem RPS software ensures feedstock flow assurance by monitoring the entire pipeline and providing the real-time data required for operations to confirm that this underground line is functioning as designed.

Conclusion

This case study highlights the challenges the renewable diesel industry faces, not only in processing new feedstocks but also in transporting them to refineries. The energy transition has brought significant attention to biofuels, including biodiesel, renewable diesel, and sustainable aviation fuel (SAF), all of which use similar feedstocks. This creates new challenges for maintaining process temperatures, regardless of delivery methods.

New renewable diesel refineries will integrate HMS into their feedstock handling areas. Retrofitted refineries will need to add HMS to manage feedstocks in areas lacking heat tracing or thermal insulation and may face power distribution challenges. We strongly recommend involving a heat management integrator early in the design process for both new and retrofit renewable diesel projects to ensure the most reliable feedstock HMS possible.

> “Retrofitted refineries will need to add a heat management system to manage feedstocks in areas lacking heat tracing or thermal insulation and may face power distribution challenges”

VIEW REFERENCES IN ONLINE ISSUE

Mike Allenspach
Mike.Allenspach@nVent.com

Jeff Fabry
Jeff.Fabry@nVent.com

Pele Myers
Pele.Myers@nVent.com

Reference

US EIA, 2024. EIA: Renewable diesel production to expand by 30% annually in 2024, 2025. *Biodiesel Magazine*. Feb 7. [Online] Available at: https://biodieselmagazine.com/articles/eia-renewable-diesel-production-to-expand-by-30-annually-in-2024-2025.