Reduced emissions and enhanced operations stability in energy efficiency project for ORLEN Unipetrol

Unipetrol is a leading refining and petrochemical group in the Czech Republic, and a major player in Central and Eastern Europe.

ORLEN Unipetrol primarily supplies motor fuels, fuel oils, bitumen, liquefied petroleum products, oil hydrogenates, other refinery products, olefins and aromatics agrochemicals, carbon black, sorbents, and polyolefins (high-density polyethylene and polypropylene). The company demonstrates an increased focus on protecting the environment, reducing raw material consumption, and minimizing energy demands.

Challenges & Solution

This focus led to the search of a tailored solution as one of the most suitable technologies to address multiple corporate goals, including increased efficiency, reduced emissions, enhanced operational stability, and improved operational safety.

The target of the project was to equip Unipetrol's furnace with new measurements for accurate and fast analysis of operating parameters. Based on the determined values, the CombustionONE system controls the furnace with the minimum possible excess of oxygen (in the range of 0.8 - 1.4%) in the flue gas while eliminating the emitation of CO. This increased the operation stability of the furnace and the economy of operation.

The CombustionONE solution is a perfect fit for any type of Olefin furnace. The fuel savings and emission reduction benefits generate sufficient OPEX savings to justify a CAPEX investment with a payback in < 24 months, even for units already operating below 2% O2 in the flue gas.

Yokogawa provided a turnkey project. The core team has been responsible for the initial evaluation, detailed design, and implementation. Yokogawa supplied a single point of contact to address all concerns and incorporate all requirements into the final solution. This includes accommodations for existing 3rd party equipment and services, tapping into site knowledge

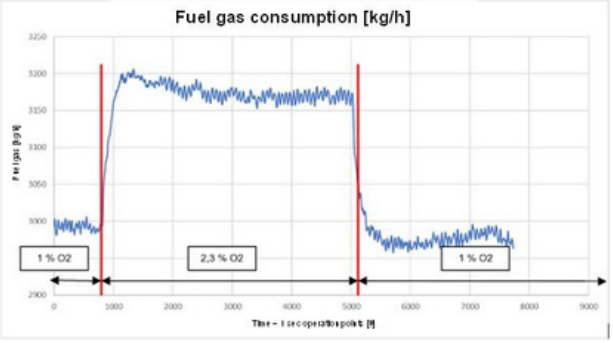
and expertise from all stakeholders, and adhering to the plant schedule and milestones.

Project benefits

Tangible benefits come from the stability of operation and increased efficiency, as the solution allows the furnace to safely operate closer to the CO breakthrough point without concerns of entering a fuel-rich environment. The combination of CO overriding functionality and cross limited functionality (in this case on an induced draft furnace, but also proven on natural, forced, and balanced draft furnaces) enhances the safety of operation by quick response to any disturbance factors.

The pilot project benefitted by having CombustionONE regulatory control logic and APC (implemented separately by the end user). These complementary applications optimized process parameters, specific consumption, and yield while enhancing safety. The actual operating standards were adjusted to better reflect the different conditions during start and end of the run.

During the Heater Assessment Study (a detailed thermodynamic model was created and validated for actual operational conditions), the **estimated fuel savings were compared with post-implementation results, and fell within 4% of predicted improvements**. Considering the process aspects having influence (feedstock ratio between C2/C3/C4, fuel composition, ambient conditions, etc.) on the furnace liberation duty and efficiency, the ROI determined justified further CombustionONE projects on the remaining furnaces.



Fuel savings	
Average fuel consumption with O2 excess 1%	2990 kg/h
Average fuel consumption with O2 excess 2,3%	3 185 kg/h
Fuel savings	195 kg/h

Other soft and hard benefits recognized:

- Throughput increased
- Stabilization improved concurrently with a reduction of crossover temperature
- Coking deposits decreased
- Asset lifespans should improve due to reduced temperature swings
- Predictability of the propylene/ethylene ratio improved

Detailed solution

To ensure maintainability and sustainability, the solution utilizes a Yokogawa logic solver that connects to the underlying existing 3rdparty DCS. This allows yearly fine tuning and the addition of Orlen selected new features without impacting the base combustion controls. All improvements inherent to CombustionONE can be implemented at any time, and activated by Operators without the need to restart the existing DCS system. Once improvements are installed, Operations simply and bumplessly turns CombustionONE on or off.

In 2018, Yokogawa executed a Conceptual Engineering Assessment, which led to a Heater Assessment Study. This defined the scope and deliverables for a pilot project, and provided a clear understanding of the solution's impact and return on investment. The pilot project ultimately led to a study of the entire Olefins plant. A pilot project started in 2019, and after a successful implementation, 3 additional Olefin furnaces were implemented by 2021. The remaining 6 Olefin furnaces and a CCR unit in the refinery are to be implemented in the next phase, which has begun.

Although many appear the same, each fired asset has unique characteristics, so the CombustionONE solution is tailored slightly for every heater.

Context

The global Olefin industry produces ~ 200 million metric tons of ethylene annually, with a continuous increase in worldwide production capacity and decrease in price since 2015. To produce this amount, different types of feedstock are used (ethane, LPG, naphtha, VGO, etc). Based on our experience with varying technology and licensors, we estimate that the overall industry is consuming more than 3.9 billion GJ of fuel and generating more than 210 million of metric tons of CO2 emissions annually, which is ~20% of CO2 generated by the entire chemicals sector.