Reducing CO_2 and plant OPEX with Qpinch Heat Transformer

Figure 1: Heat transformer unit based on revolutionary Qpinch technology: commercial unit in Antwerp to demonstrate capabilities of technology as well as scale-up potential for wider Borealis operations and technologies

Summary of demonstration case

The Qpinch Heat Transformer (QHT) transforms low temperature heat from an exothermic ethylene polymerization reactor and a low-pressure steam vent into valuable medium and high pressure steam (MPS & HPS). This is a unique technology that functions as a heat transformer and therefore only requires 3-5% of the thermal output power as electricity. This is wildly different from standard heat pump technology where electricity consumption is far greater. On top, the QHT is able to generate temperature lifts of residual heat close to 80 degrees. This lifts waste heat above the plant's pinch point, turning waste heat into valuable steam at no OPEX.

The unit operates by using three different residual heat sources that are combined via an intermediate hot water loop that feeds the QHT unit. This heat is lifted to steam at 3 to 10 bar g. The LDPE reactor produces over 40 different recipes and therefore emits highly fluctuating residual heat temperatures and output. Therefore, the QHT has to show a lot of flexibility, reliability and ease of operation in order to harvest all available residual heat and produce stable MPS or HPS, ranging from 400 kW to 1.3 MW. The unit is installed as an add-on on the current reactor setup with minimal integration efforts. The QHT can re-value close to 50% of the

"This collaboration points to the enormous potential of open innovation between like-minded technology pioneers. We are confident that this project will be the first of many successes built on co-operation with Qpinch. For Borealis, the start-up of this unit is a landmark achievement in our mission to re-invent for more sustainable living."

Erik Van Praet, Borealis Vice President Innovation and Technology

waste heat that is offered to the unit. This brings value to Borealis in 3 ways. One, there is a significant direct energy cost saving on MPS and HPS since Qpinch produces this without Opex. Two, the CO_2 emissions of the site directly declines since the steam boilers need to produce less MPS and HPS and at last, Borealis shows that it knows how to act in a changing environment and is a leader in sustainable innovation in a conservative industry.

The QHT unit is installed at the Zwijndrecht site of Borealis with a footprint of 4 x 6 metres and a height of 15 metres. The unit can easily be switched on and off without causing any harm to reactor operations. **Figure 2** schematically shows the working principle of the QHT, while **Figure 3** shows its integration at Borealis.

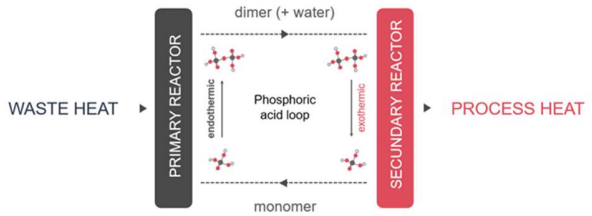

Figure 2: Schematic overview of the waste heat transformer. Oligomerization of phosphoric acid in transforming waste heat into covalent bond chemical energy. This energy is released upon reversing the reaction in the secondary reactor.

Operating experiences

Borealis has known a production increase thanks to free and carbon neutral steam from the QHT unit, and this without requiring expensive electrical infrastructure to drive the heat recovery. Furthermore, a cooling debottlenecking by 50 % net reduction on specific cooling demand was achieved.

Special learnings

Per installed MW, the QHT can produce 1.7 ton/h carbon neutral medium pressure steam. Each year, this avoids ~2,000 ton CO2 emissions (~1,500 ICE cars) and saves 190,000 € EU ETS credits.

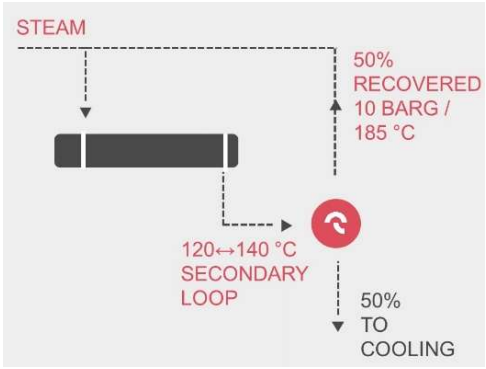

Figure 3: Integration of the QHT at Borealis, the values for a single operating point are given

FACTS ABOUT THE CASE

Intallation year: 2020
Operating hours: 2500 hours
Working fluid used: phosphoric acid (H_3PO_4)
Compressor technology: n/a, heat-driven heat transformer
System manufacturer: Qpinch
Performance in design point:

- **Heat source:** 80°C to 135°C, water and steam
- **Heat sink:** 140°C to 185°C, saturated steam
- **Heat supply capacity:** 2.9 MW
- **$COP_{heat\text{-}transformer}$:** up to 0.45 (for a heat transformer, COP is defined as the ratio of process heat to waste heat, see **Figure 2**)

Estimated annual CO_2 savings: 2,200 t/a

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All information were provided by the supplier without third-party validation. The infomation was provided as an indicative basis and may be different in final installations depending on application specific parameters.