Progress report

Institute for Sustainable Process Technology

Progress report (Public)

1. Acknowledgement

Het project is uitgevoerd met Topsector Energie subsidie van het Ministerie van Economische Zaken en Klimaat, uitgevoerd door Rijksdienst voor Ondernemend Nederland. De specifieke subsidie voor dit project betreft MOOI-subsidie ronde 2020

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Secretary and authors	This report has been drafted by Richard Cooper (Shell), Helene Launey (Dow), Robert de Boer (TNO) Paco Rutten and John Harinck (ISPT - Secretary to the project).

2. Introduction

The e-missi0n MOOI project is part of the ongoing development of electrified cracking technology, where Shell and Dow joined forces with TNO and ISPT. The goal of this project is to research two routes that will lead to the electrification of the steam cracking process. The first route investigates an electrical heating concept, which potentially can be retrofitted into existing furnaces. The second route uses first principles to identify the ideal electrical furnace. Both routes include the optimization of heat integration of the furnace section, and a study towards the system integration of the technology can potentially reduce CO_2 emissions by up to 3.4 million tons per annum.

3. Update on the project

For the first activity, all experimental work and CFD modelling work has been completed for the testing of an electrical heating concept that can be retrofitted to existing furnaces. The tested concept was able to meet the required heat flux at the targeted temperature. The validated CFD model can now be used as a starting point for the scale up and design of a larger pilot unit.

Alternative cracking tube materials were tested in the lab in simulated steam cracking conditions. Test conditions were varied and optimized to obtain high conversions with these new materials, making them suitable for future application in novel electrified cracking reactor concepts. Similar product mixtures were obtained, with low coking formation rates compared to ‘real world’ data.

Heat integration concepts to enhance the overall energy efficiency of the electric cracking process target to increase the recovery and re-use of high temperature heat of the cracked gas, and apply it for preheating the feedstock. Laboratory test on simulated heat transfer conditions indicated limitations on the operational temperature range of selected heat transfer fluids. The first group of heat integration concepts were adapted to account for these limitations and additional concepts were developed using alternative heat transfer fluids. The stability and limitations of these new fluids were assessed, as well as some knowledge gaps and experiments are prepared to determine the thermal and chemical stability as well as their corrosivity.

A test program was carried out on the selected material to confirm that it could meet the durability requirements for a steam cracking furnace. The activity has been completed. The tested material had been selected during a materials’ evaluation study based on its ability to endure high temperatures and high heat fluxes. The outcome of these tests provided conclusive evidence that the tested material is currently unable to meet the defined durability criteria for use in steam cracking furnaces. The causes of the sub-optimal performance are investigated.

The activity related to a novel approach for transferring electrical heat to the reactor has been completed. Experimental units were designed and built, and testing programs and CFD modelling were executed to validate the concept and develop a novel reactor design and geometry.

The last activity of the project assesses the system impact of and requirements for integration of electrified cracking technology in the variable renewable energy system. Energy and electric cracking systems have been modeled and analyzed through methodology called 'techno-economical assessment of complex option spaces. Preliminary results were produced related to key determinants of techno-economics of e-cracking and potential for flexible operation.

4. The contribution to society

The project is strongly recognized in the innovation missions of the Climate Agreement, specifically within 'MMIP 8' innovation target 8.4.d 'development and piloting of electrification of high temperature furnaces, for example for the manufacturing of olefins and aromatics. The topic of this project heavily contributes to the achievement of that target. Potential spin-offs and benefits that revolve outside this target are currently not yet identifiable.

5. Further information and grant acknowledgement

Results, news items and scientific articles that will be published for external use can be found on the project page of e-missi0n MOOI. This website also contains contact information for further questions.