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Pulsed Compression II: Ethylene production by compressive activation of methane

The goal of this project is to produce ethylene from methane using pulsed compression technology in a hydrogen rich environment and to determine the feasibility for industrial applications.

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Project number SI-20-08

Partners Dow Benelux, Encontech, ISPT, Shell, University of Twente (UT)

Budget 1 700 k€

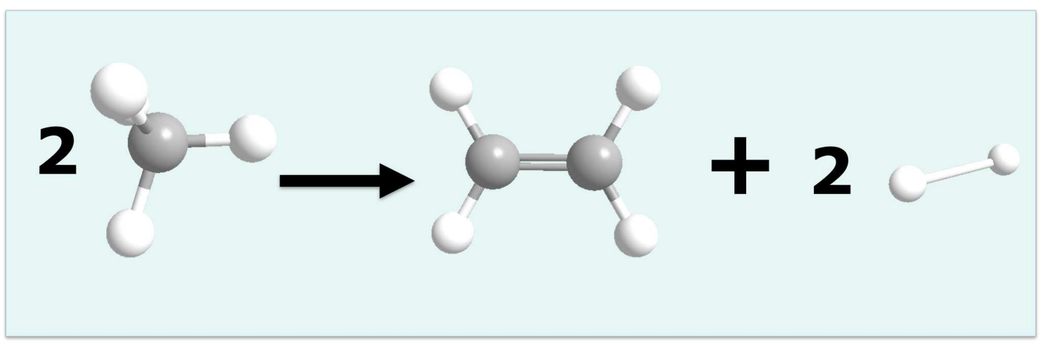
Duration 2019-2023

Incentive

There is a high demand for cleaner carbon sources and fewer CO_2 emissions. The pulsed compression technology saves energy and emissions compared to conventional ethylene production. On top of that it can use methane as a carbon source, while producing hydrogen as a by-product. A big advantage can be the localized production of liquid fuels near remote gas fields.

Objective

The production of ethylene with pulsed compression technology for industrial applications.



Status

- Proven to produce syngas from methane in previous experiments [1]. Ethane, ethylene and acetylene were found as by-products.
- Currently the use of hydrogen as a diluting gas is investigated.

Applicability

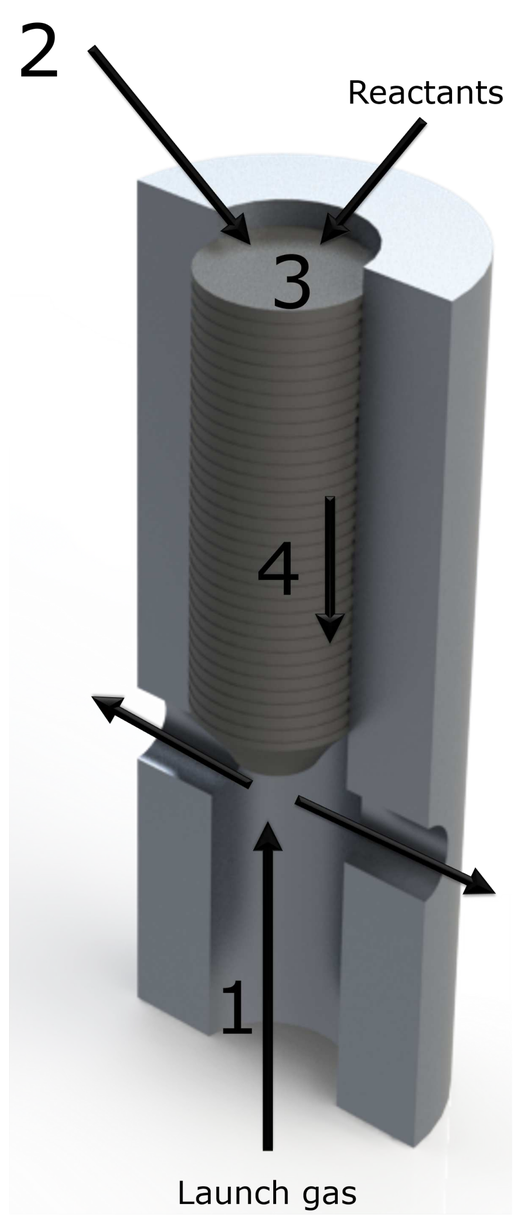
- Can save up to 30% of energy compared to the conventional process.
- Syngas production by partial oxidation is an exothermic process, whilst the methane to ethylene reaction is endothermic. This poses a major challenge for continuous operation.

[1] Roestenberg, T. , Glushenkov, M. J. , Kronberg, A. E. , Verbeek, A. A. , and Meer, T. H. vd Experimental study and simulation of syngas generation from methane in the Pulsed Compression Reactor. *Fuel* **2011**, 90, 1875–1883.

Batch concept

1. A single piston is launched to compress the reactant gas up to 1/40 times its original volume.
2. The temperature and pressure rise quickly.
3. Methane reacts towards ethane, ethylene and acetylene.
4. Before it can react further to higher hydro-carbons and soot, the piston moves back and the mixture is rapidly cooled (10^7 K/s).

The quenched gasses can be extracted and analyzed. The aim is to maximize ethylene production and minimize soot formation.



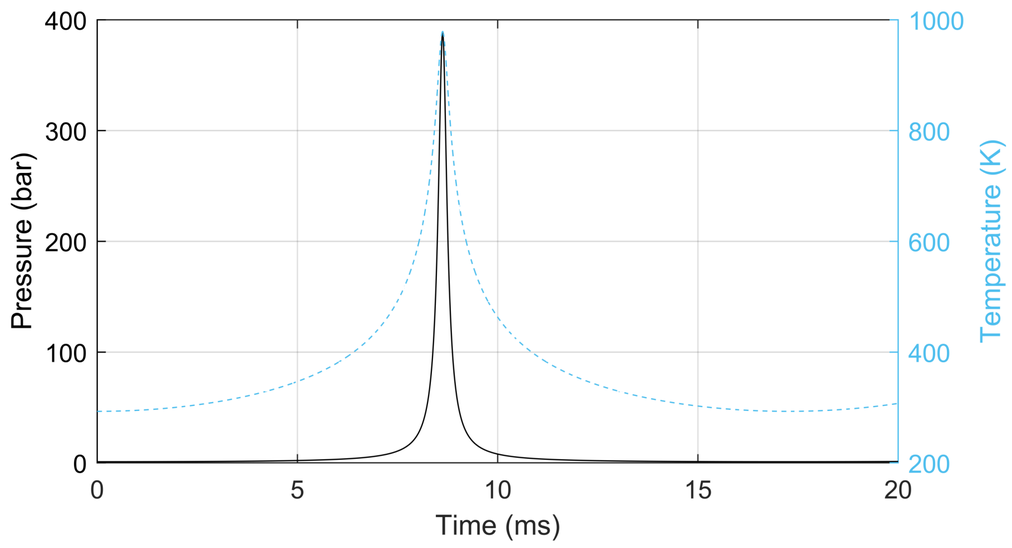


Figure showing the modelled temperature and pressure during a compression.

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This project is co-funded with subsidy from the Topsector Energy by the Ministry of Economic Affairs and Climate Policy.