

# Virtual functional product development of a micro steam methane reformer

## Detailed evaluation of the oxidation of hydrogen by catalytic combustion supported by CFD simulations

The demand for increased energy efficiency leads to new concepts in the private heating sector. Decentralized highly flexible micro co-generation (electricity and heat) devices based on fuel cells give known, highly developed technologies a new perspective.

The operating conditions of a  $\mu$  steam methane reformer are quite different from industry setups. Heat integration is directly connected to the electrical efficiency of the process (Fig.1).

For the virtual development of a highly complex product, it is necessary to build upon a validated set of sub functions.

In order to analyse and to lock-in a kinetics approach, a reactor was designed based on a 2D rotary symmetric simulation (Fig.2). The boundary conditions of the simulation were recreated in the experimental setup (Fig.3). Fig. 4 shows the validation of the heat transport. The simulation of the reactor showed good agreement with the experimental results. This setup can be used to evaluate a chemical reaction as shown in Fig. 5.

After the validation of the catalytic combustion and the reformer unit, both can be combined and optimised by means of computation aided designs.

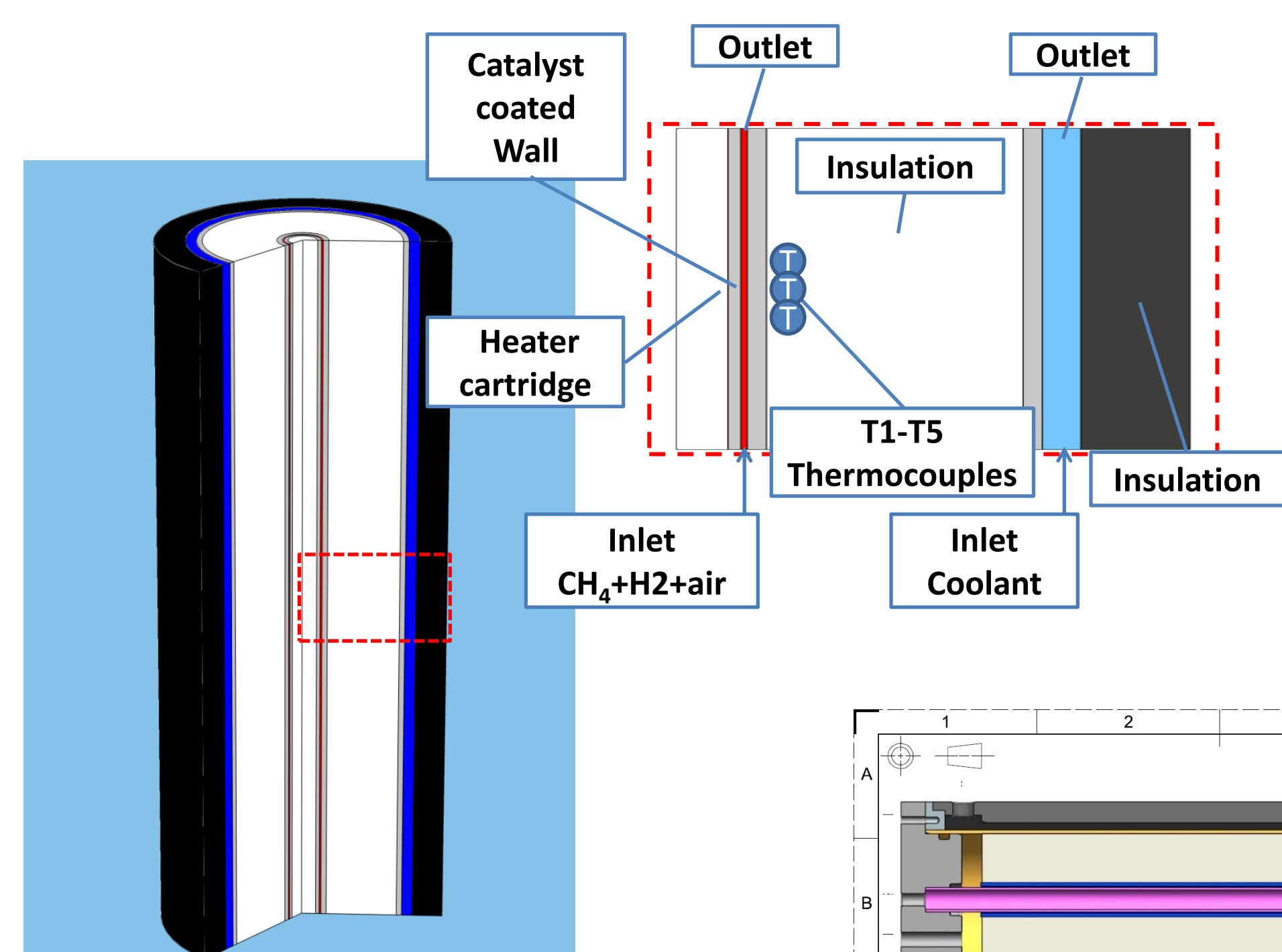


Fig. 2: Computation domains of the catalytic combustion channel.

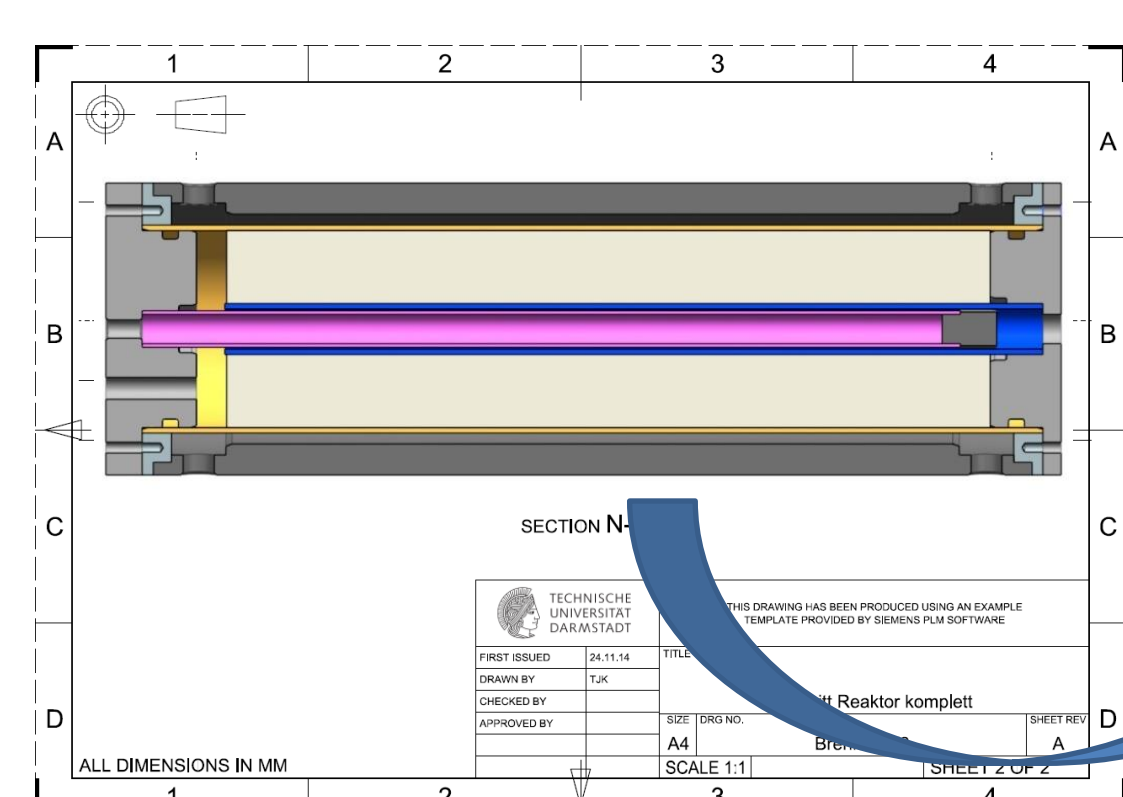


Fig 3.: Design of experiment based on boundary conditions of the simulation.

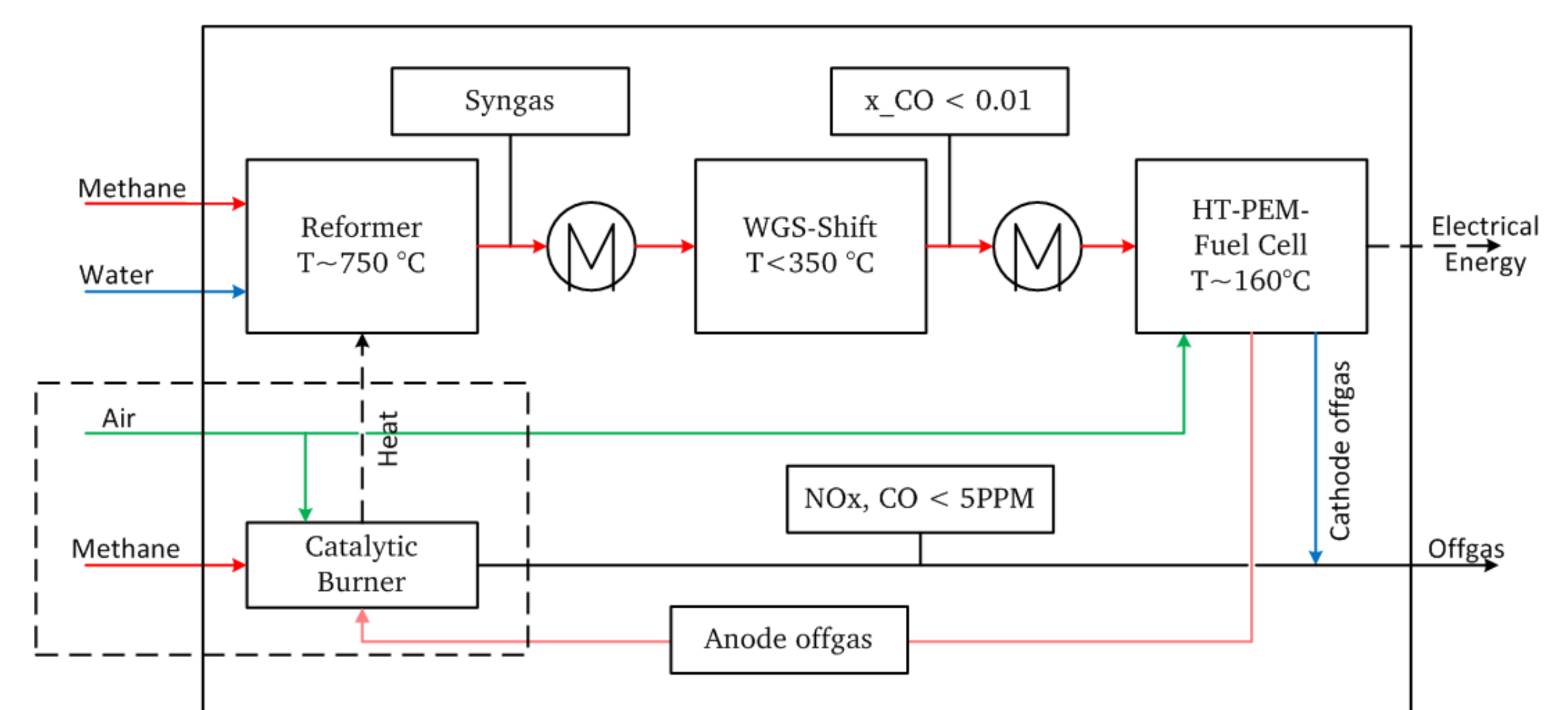


Fig. 1: Flow chart of the steam reforming - fuel cell process

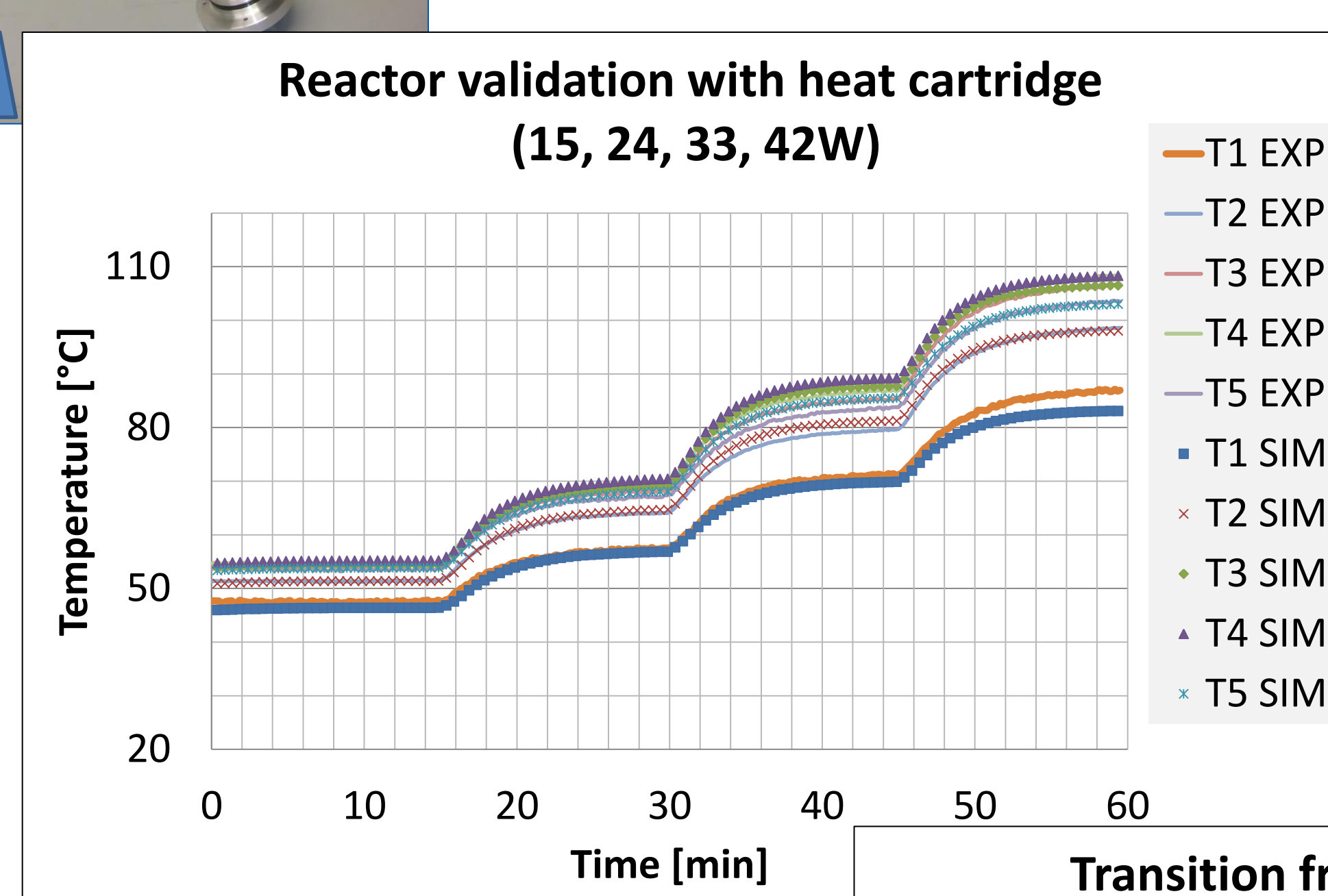


Fig. 4: Validation of the heat transport with a heat cartridge instead a chemical reaction.

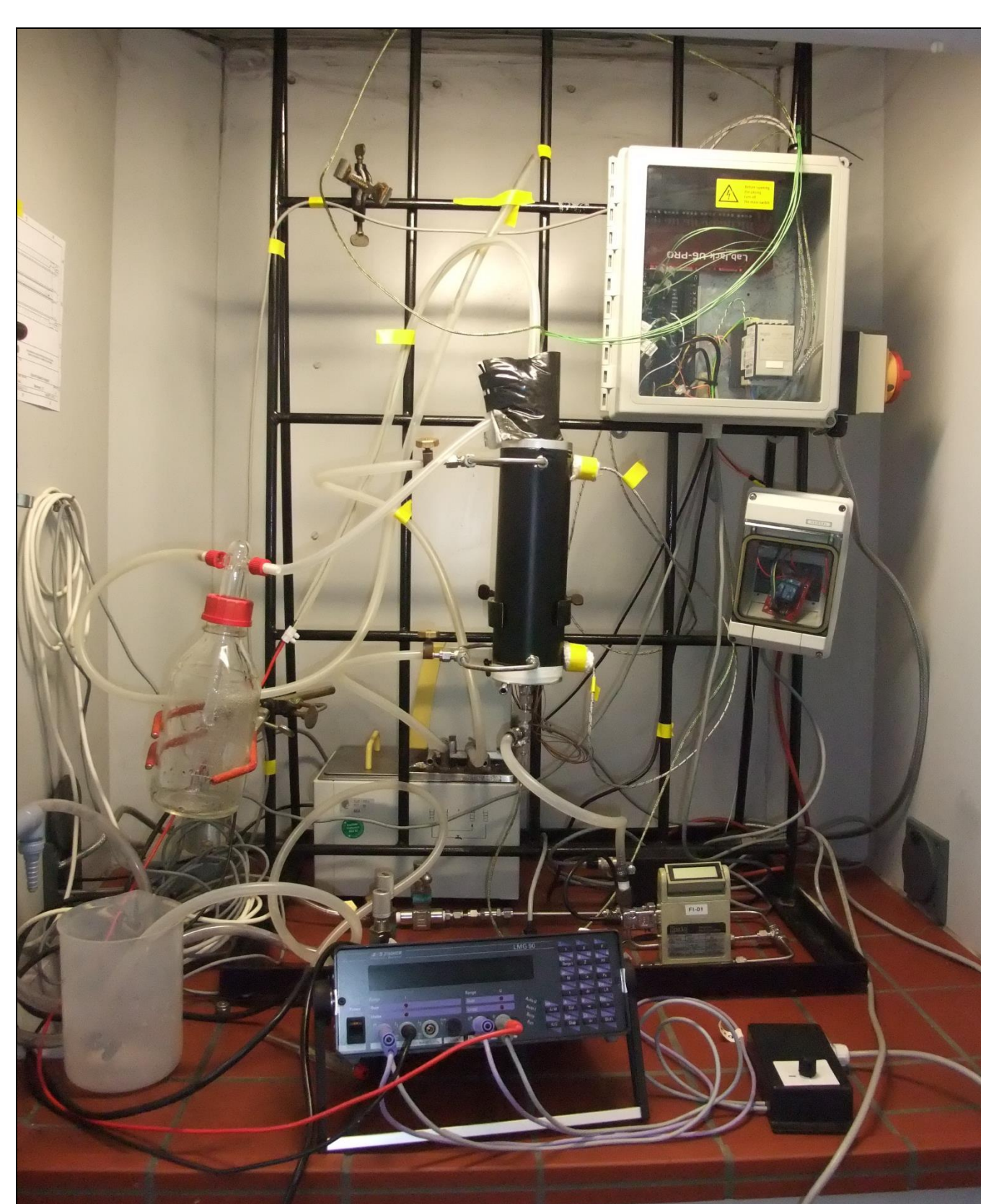


Fig.6: Features:  
12 Thermocouples  
2 Mass flow controller  
Coolant: 20 – 90°C  
Heater: 0 – 350W  
Temperature: 50 – 900°C  
Variable gap size < 1000 $\mu$ m  
exhaust gas analysis by gas chromatography

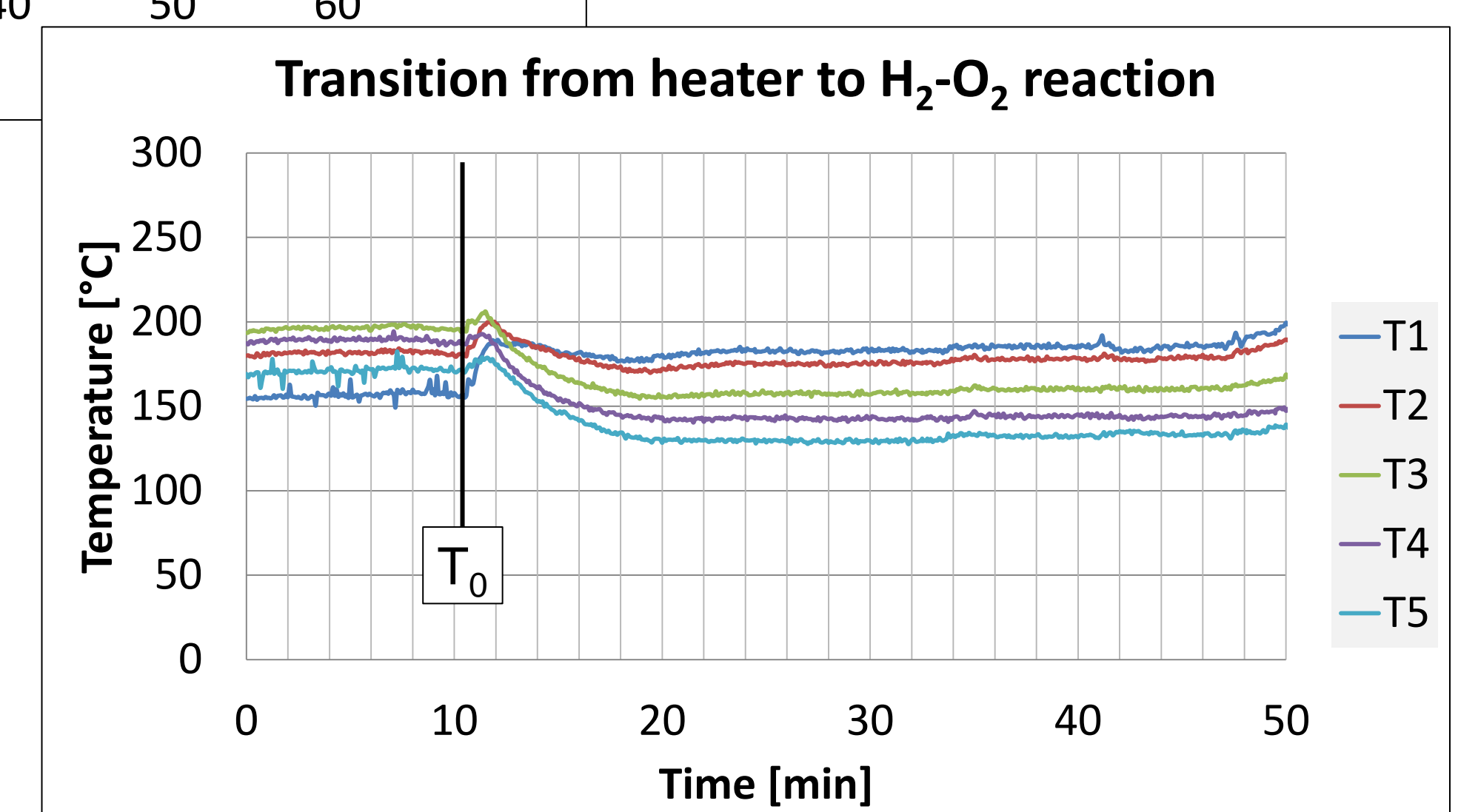


Fig.5: The location of the maximum temperature changes when switching from heater to reaction

