

Modeling of HTPEM Fuel Cell Start-Up Process by Using Comsol Multiphysics

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Introduction: HTPEM fuel cells have enhanced electrochemical kinetics at an operation temperature of 160-180°C comparing to LTPEM fuel cells. But starting fuel cells from room temperature to operation temperature is a challenge. In this work, using preheated air to heat up the fuel cell through gas channel, cooling channel, or their combinations with ohmic heating are investigated.

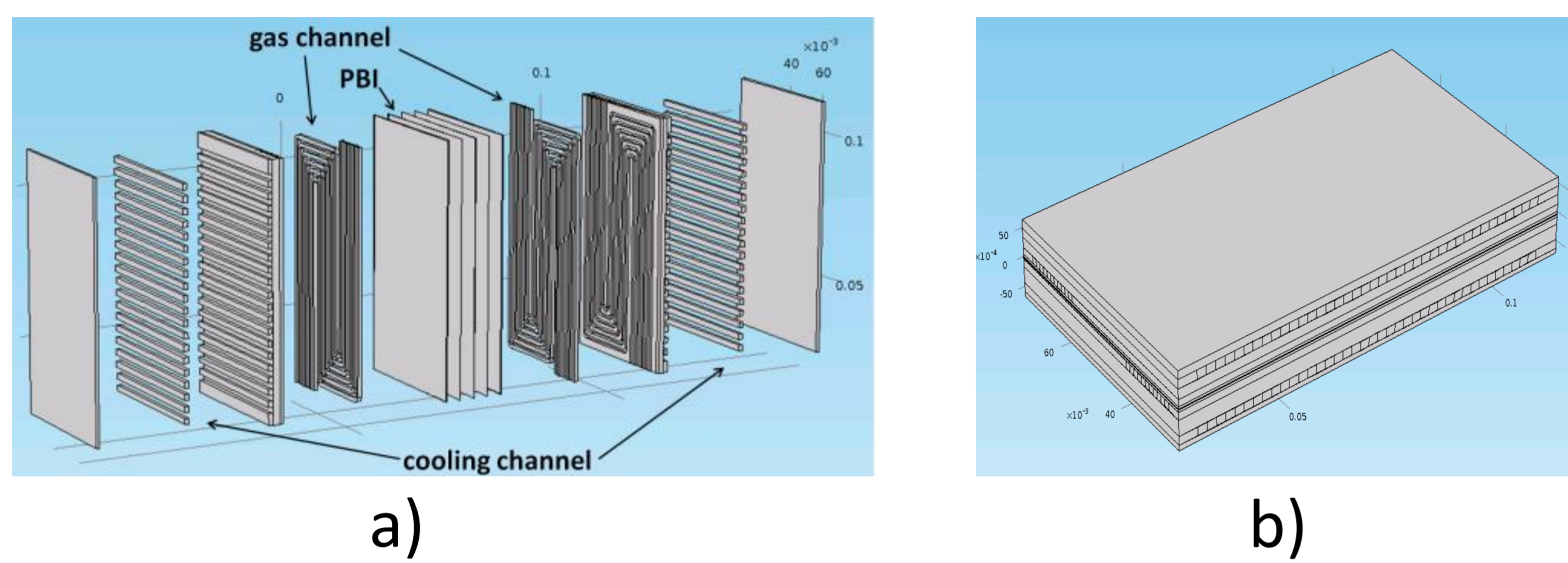


Figure 1. HTPEM fuel cell structure a) single cell with different components, b) integrated single cell

Boundary conditions: Initial cell temperature: 20°C; input air temperature: 160°C; fuel cell insulated from environment.

Results: Start-up by cooling channel is much faster than gas channel with same flow rate. Flow rate influences gas channel heating more than cooling channel heating. Ohmic heating speeds up heating process. Its combination with cooling channel heating can stabilize the cell temperature at coolant temperature.

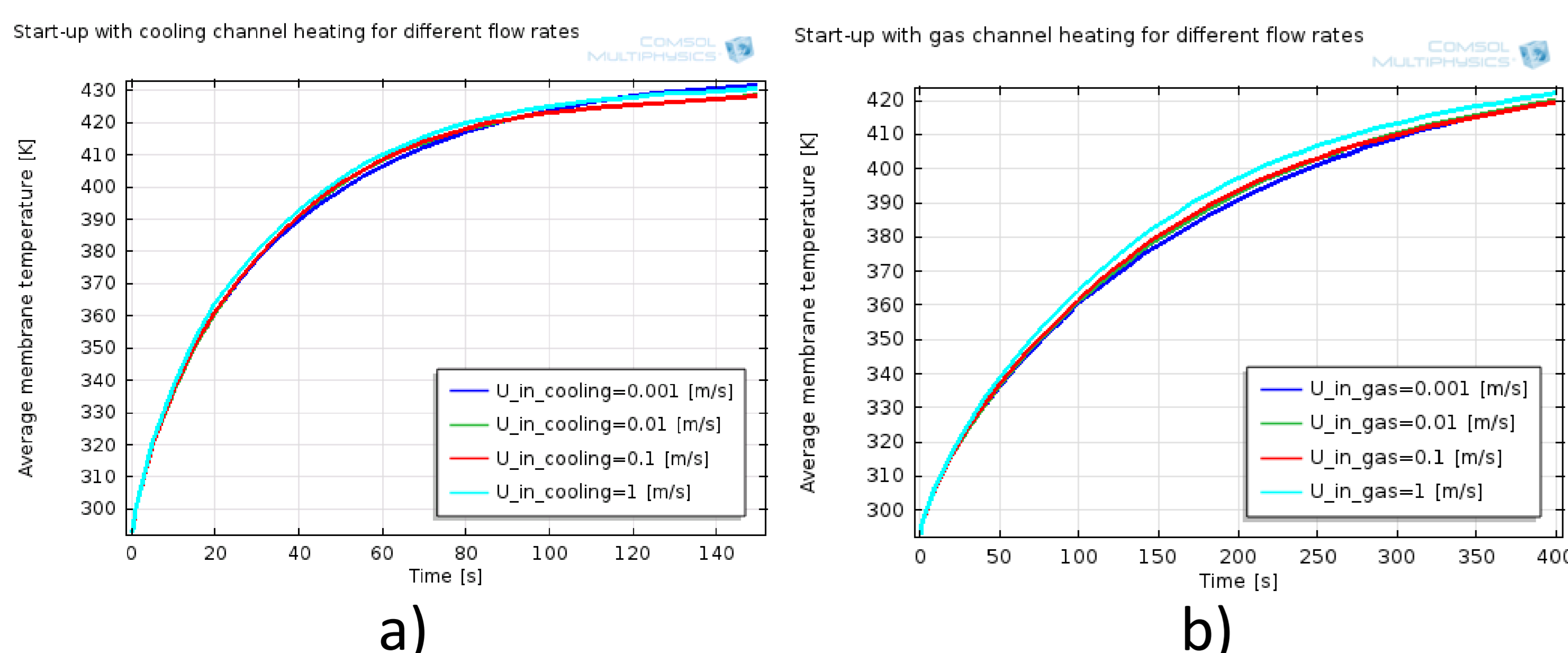


Figure 2. Start-up a) by cooling channel heating, b) by gas channel heating for different flow rates

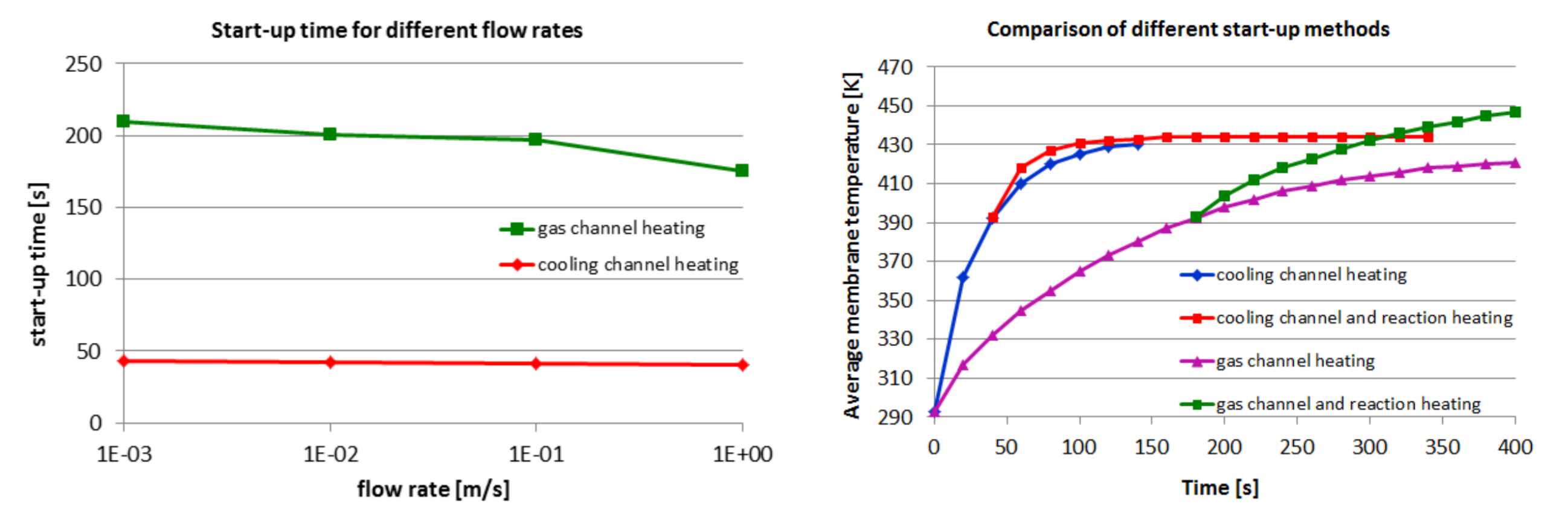


Figure 3. Start-up with different flow rates

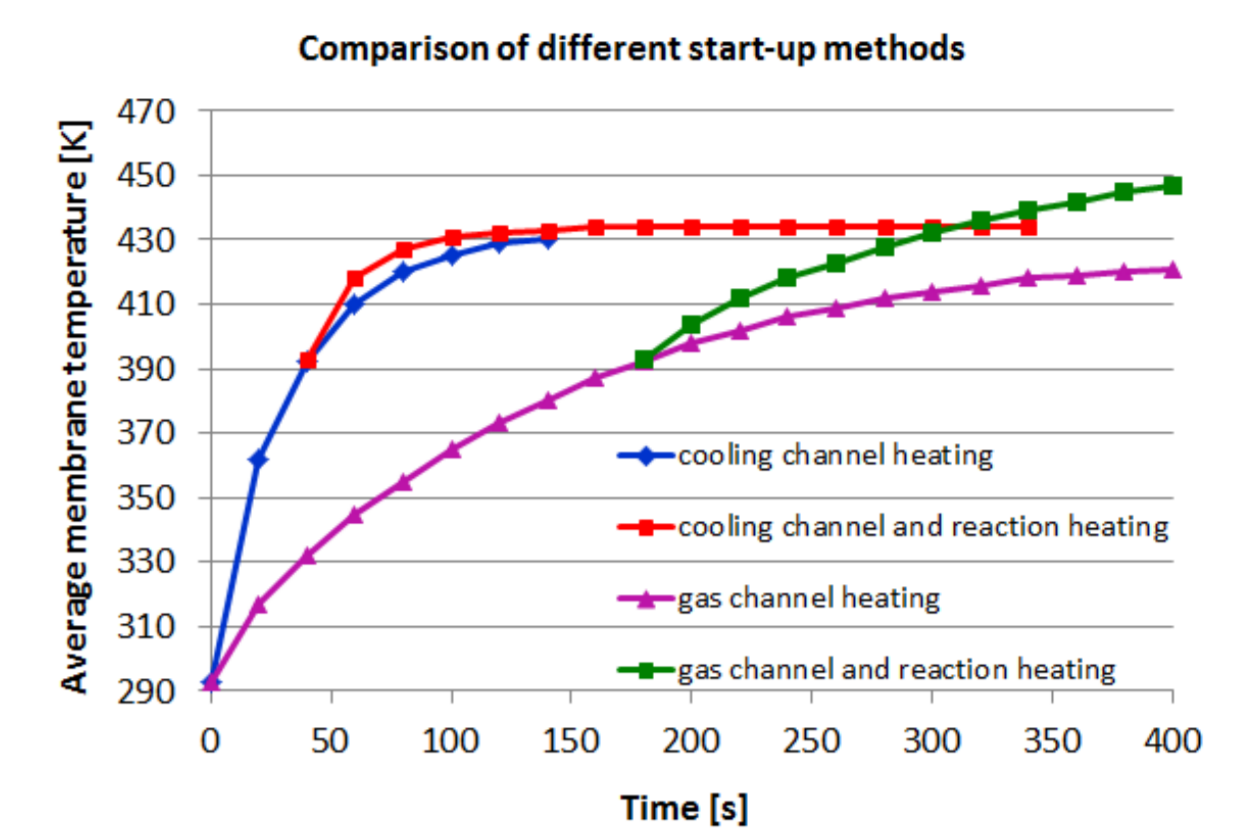


Figure 4. Start-up with different methods (0.5 m/s)

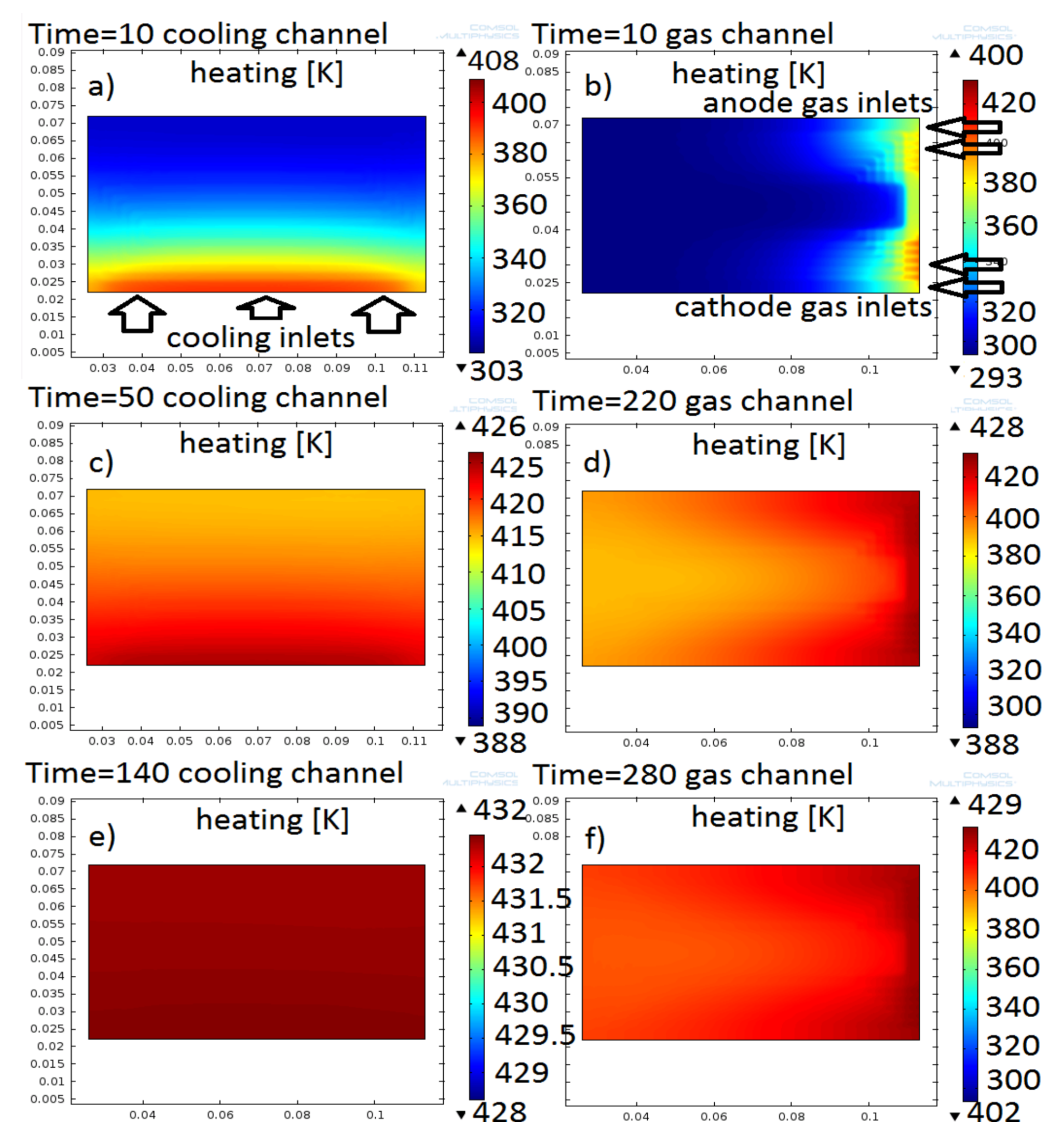


Figure 5. Start-up by cooling channel (left), by gas channel (right) (0.5 m/s)

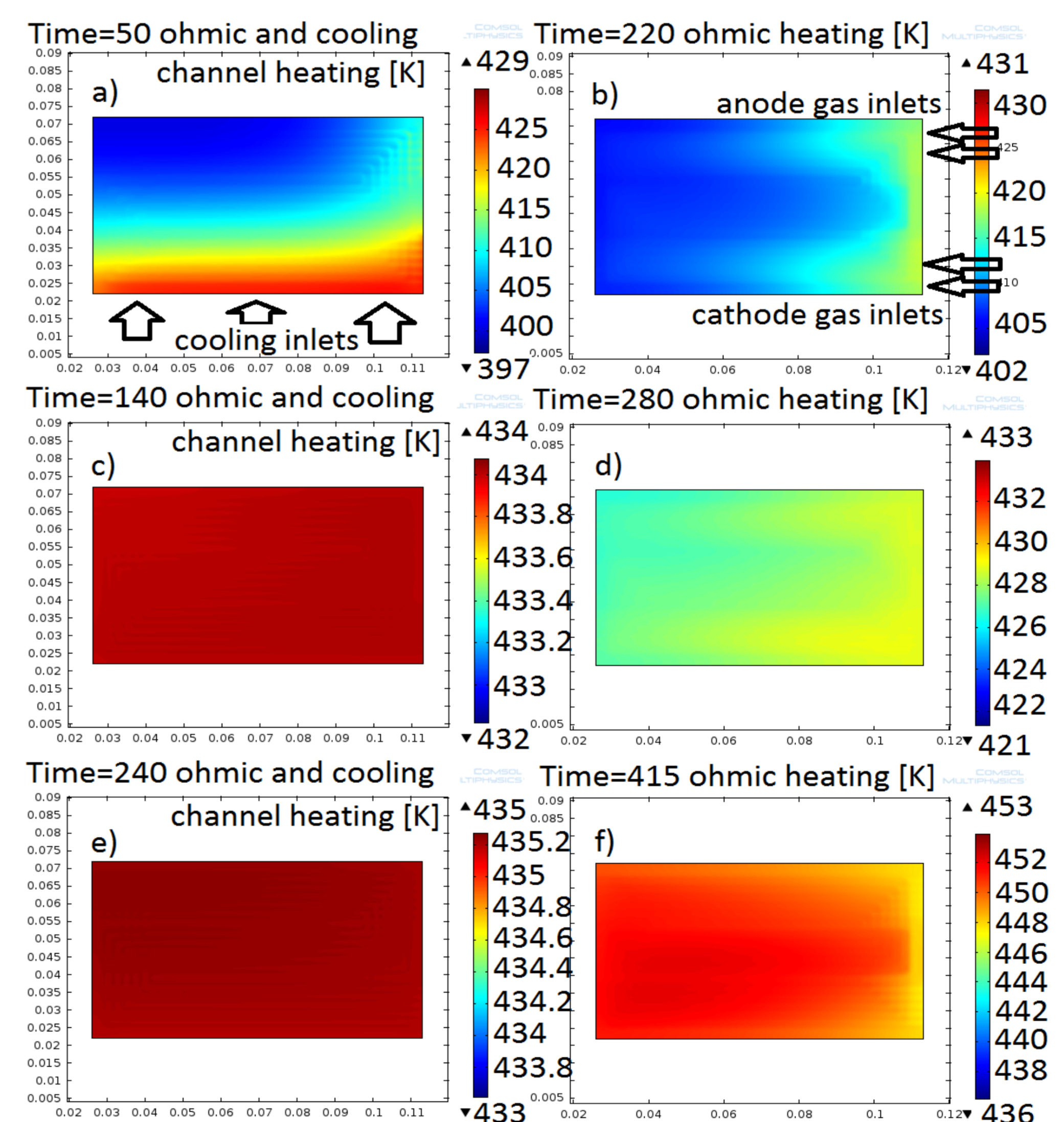


Figure 6. Start-up by reaction and cooling channel (left), only by reaction (right) (0.5 m/s)

Conclusion: The combination of ohmic and cooling channel heating is the optimal start-up process.