DTU Energy
Department of Energy Conversion and Storage

Validation of a Gas Network Model through the simulation on the Danish Transmission System

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A non-isothermal, multicomponent and steady state fluid-dynamic model of gas networks has been applied to the Danish Transmission System and validated using real data provided by Energinet.dk . The model is able to simulate gas pipeline networks including non-pipeline elements (compressors and MR stations). It has been thought for multi-injection frameworks where the injected gases have different composition [1]

Testing System

- ✓ **multi-injection**
- ✓ **non-pipeline elements**
- ✓ **looped structures**
- ✓ **data availability**
- ✗ **dynamic grid structure**
- ✗ **Highly transient gas physiscs**

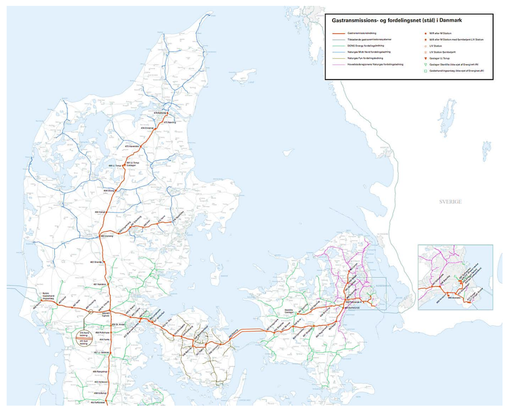


Fig. 1 – Map of the Danish Transmission Grid [2]

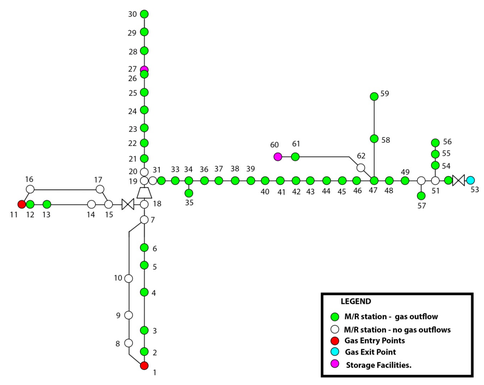


Fig. 2 – Schematics of the Danish Transmission Grid

Data Sets

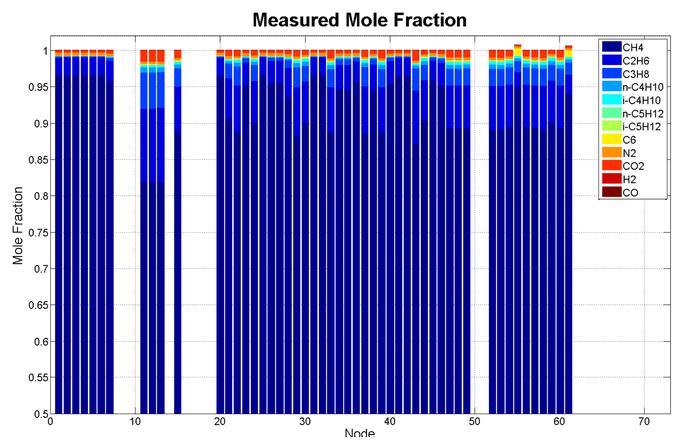
- Pipelines Technical features
- Compressor characteristics
- Regulation station
- Exchanged Gas Flow
- Pressure
- Temperature
- Composition

INPUT to the model:

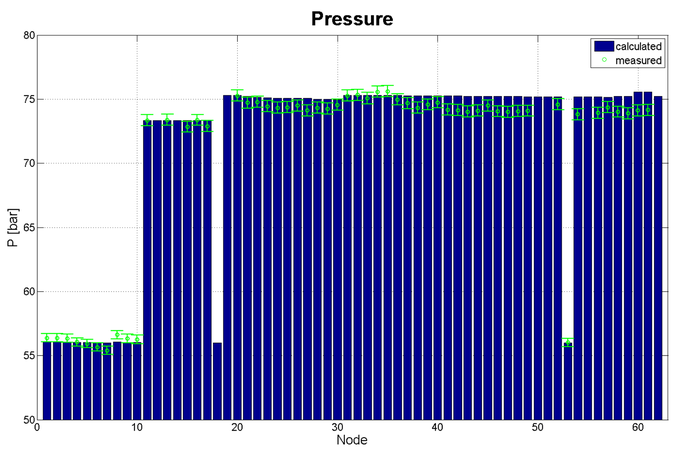
- Gas Flows, Pressure and Temperature in **one node**,
- Composition at **injection points**,
- **Guess Value** of Pressure, Temperature for each node.

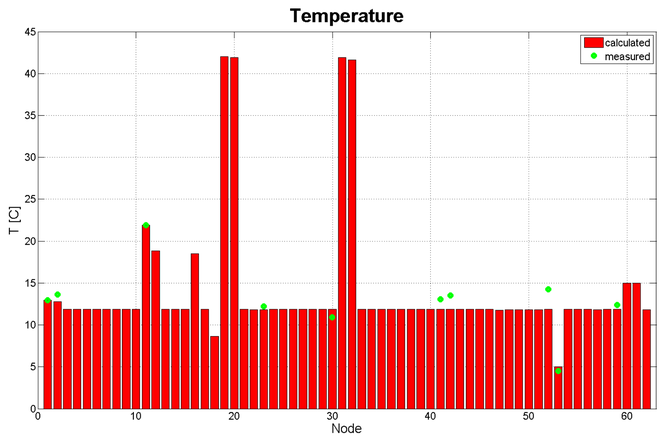
Simulation Assumptions

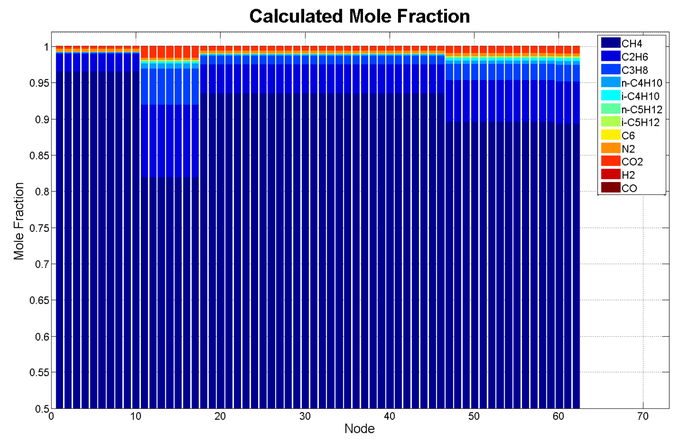
- Because of the **dynamic behaviour** of the grid structure, an **average investigation** was **not suitable**.
  - *Complex Compression Station Management*
  - *Coexistence of Charging and Discharging Phase at the Storages*
  - *Changeable Grid Structure*
- A **"moment in time"** (one hour) in which the grid might be considered in a **steady state condition** has been chosen.
  - *Stability in the Linepack variation*
  - *Compressors: ON; Storages Operational Phase: Steady*
  - *Constant Composition of injected gas*
  - *Fixed Grid Configuration*

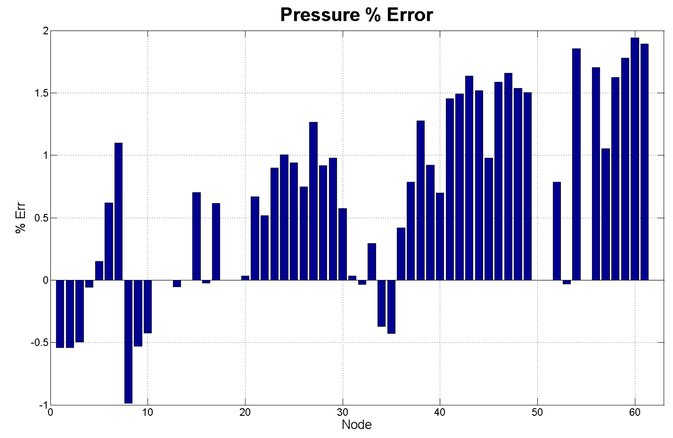


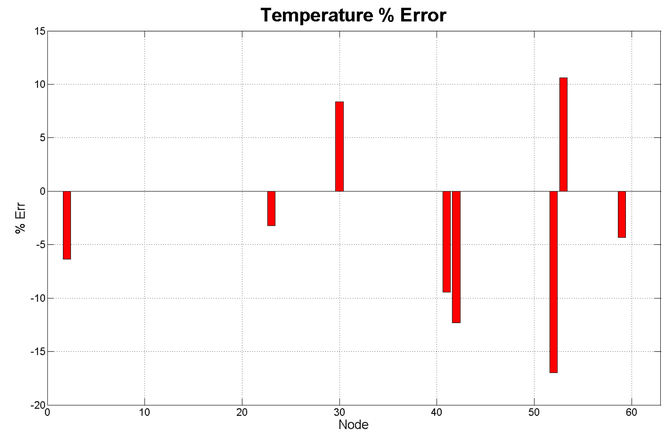
Results

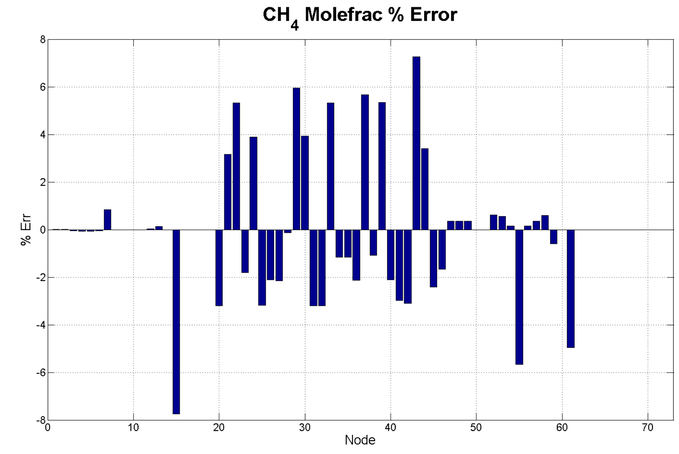












Conclusions

- **Pressure & Temperature Prediction :**
  deviations slightly higher than literature [3].
  To be considered the highly dynamic features of both the gas flow and the non-trivial grid management.
- **Composition Prediction :**
  satisfactory results in the tracking and the mixing of the Natural Gas species;
  the oscillatory pattern of the deviation in neighboring nodes might be explained considering the measuring device position at the M/R station and the way SIMONE calculates the composition.

Future developments

- **The model is best suited to applications on steady-structure grids** (long term average assessments).
- **It will be applied on the distribution network of Søndeborg Municipality** to assess the distributed injection potential of the grid.
- **An extension to a dynamic model might be considered**

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[1] – S. Pellegrino, A. Lanzini, and P. Leone, Greening the gas network - The need for modelling the distributed injection of alternative fuels, Under review Renewable & sustainable Energy Reviews, 2016.
[2] – Data and Picture from Energinet.dk
[3] – M.Chaczykowski, A.J. Osiadacz – Comparative Assesment of Steady-State Pipeline Gas Flow Models, Arch. Min. Sci., Vol. 57 (2012), No 1, p. 23–38