Flexible Power Generation – ETN Webinar Series – 4th episode

PUMP-HEAT
Innovative concept to increase flexibility of combined cycle power plants and gas turbines

Tuesday, January 12, 2020 • 12:00am – 01:00 pm

Heat Pump Digital Twin and Model Predictive Control

Speaker: Adrien Réveillère
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This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N. 764706

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Digital Twin

- **Digital twin**
  - *"a dynamic virtual representation of a physical object or system across its lifecycle, using real-time data to enable understanding, learning and reasoning"*
  - Bolton, R., McColl-Kennedy, J., Cheung, L., Gallan, A., Orsingher, C., Witell, L. and Zaki, M. (2018), "Customer experience challenges: bringing together digital, physical and social realms", Journal of Service Management, Vol. 29 No. 5, pp. 776-808.

- **System dynamic models**
  - Developed with Simcenter Amesim
    - 1D system simulation Tool
  - Libraries used
    - Thermal, Thermal-hydraulic, Two-Phase Flow, Gas Turbine Engines, Signal (control)

- **Direct usage**
  - Concept validation
  - **Control system validation**

PreDesign Phase

Thermo dynamic cycles, steady state powers
Temperature & pressure levels

Design Phase

Subsystems datasheets from suppliers for calibration

Test Phase

Transient test results for calibration

Operational Phase

Measurements for validation
troubleshooting if necessary

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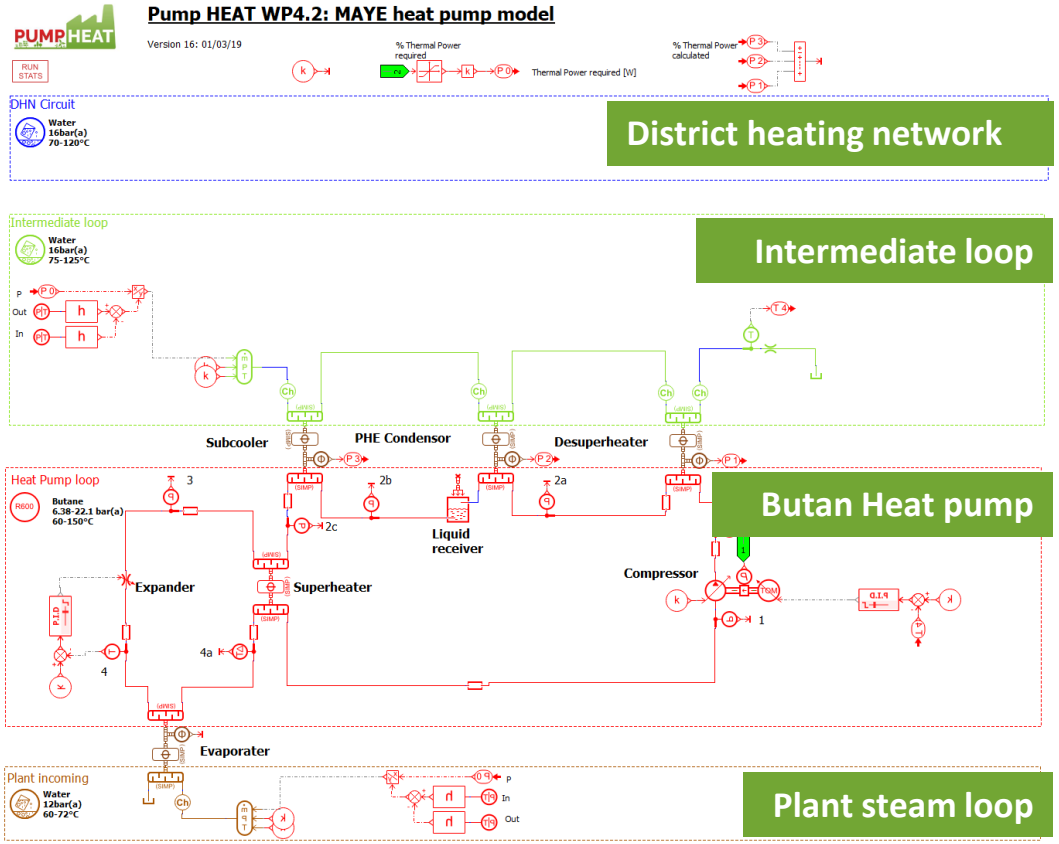
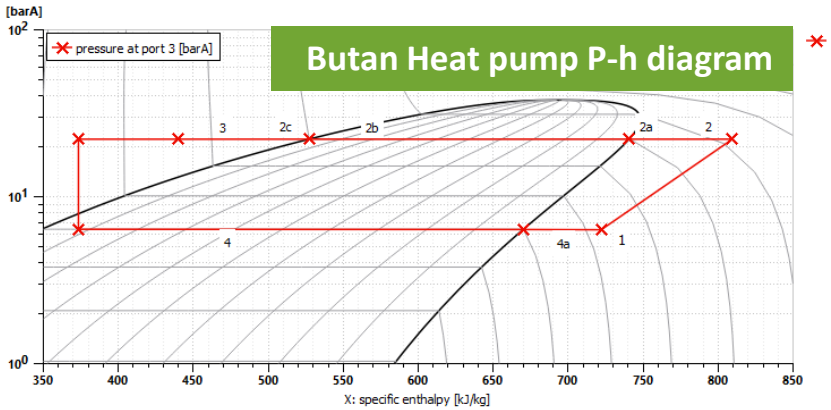
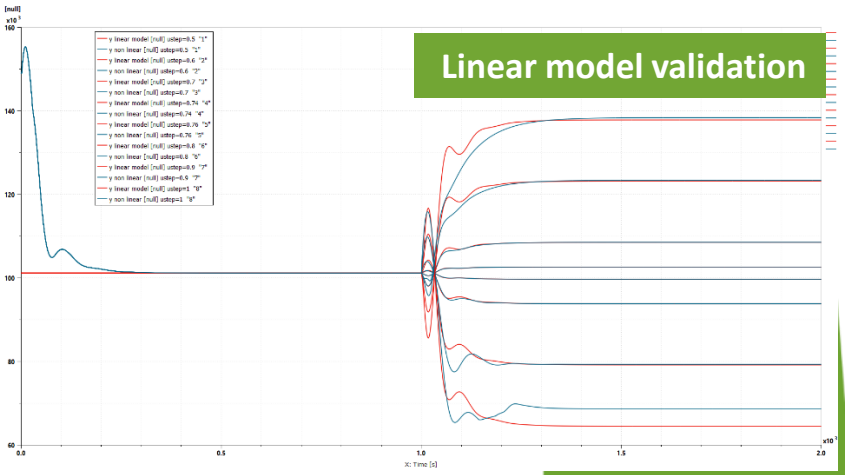
Amesim Model







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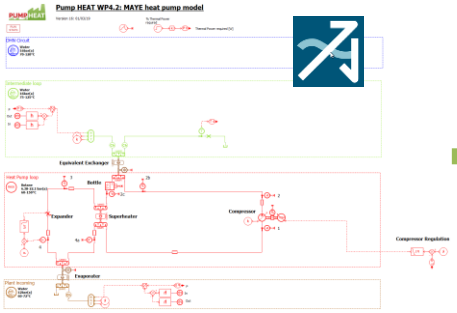
Model integration in the Model Predictive Control (MPC)

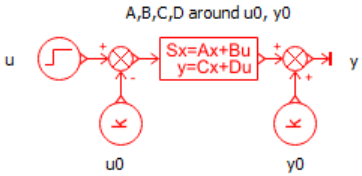
Amesim Model
- Heat Pump R600
- Validated against supplier data

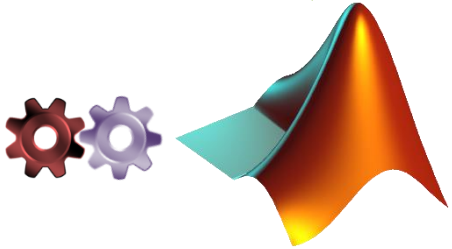
Linear Model
- Linearized Amesim model around an operating point
- $\begin{cases} \dot{X} = A.X + B.U \\ Y = C.X + D.U \end{cases}$
- Validation against the non-linear model

MPC Integration
- A, B, C & D matrices injected in MPC algorithm (Simulink)
- MPC will call the model every second to predict the system response

MPC Validation (MiL, SiL & HiL)
- Validation of the MPC control strategies
- MPC code exported and integrated in Amesim (MiL)
- Cosimulation Amesim-Simulink (SiL)







Thank you for your attention

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