Presentation, Validation and Application of the *DistrictHeating* Modelica Library

Loïc Giraud [1] Roland Bavière[1] Mathieu Vallée[1] Cédric Paulus[1]

[1] CEA, LITEN, Univ. Grenoble Alpes, France, `roland.baviere@cea.fr`

District heating (DH) systems are a relevant solution for reducing CO2 emissions, especially in densely populated areas where the average thermal performance of the building stock is low. Due to heavy investment costs, there is a great interest in simulation and software solutions to optimize DH systems. In this paper, we describe how we designed, validated and used a library of fast, precise and robust components for DH systems.

In the first part, we describe the design of our *DistrictHeating* library. We give an overview of the packages and we focus on two essential models: pipes and substations. We detail two pipe models developed using two different numerical methods. One of them provides a reduction by a factor of 40 of the number of equations compared to *Modelica.Fluid DynamicPipe*. We also give an overview of several substation models for which details can be found in (Giraud *et al*, 2015).

In the second part, we present the validation process, focusing on pipe models. For this validation we use experimental data available in the open literature (Ciuprinskas *et al*, 1999). Figure 1 plots the experimental and the numerical results for two pipe models of our library. The numerical results are comparable to those obtained by other research group (Gabrielaitiene *et al*, 2008) relying on non-Modelica tools. The reasons invoked by (Gabrielaitiene *et al*, 2008) to explain the remaining numerical vs. experimental differences are challenged and a new explanation is proposed.

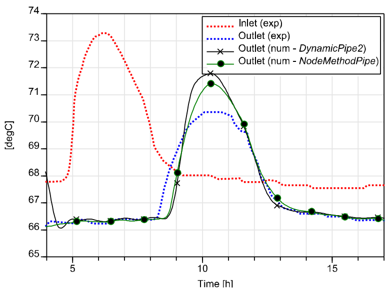

Figure 1. Numerical vs. experimental comparison of the temperature evolutions at both ends of an horizontal district heating pre-insulated pipe, 470 m in length.

In the third part, we present the application of the *DistrictHeating* library for computing an optimized supply temperature for a realistic DH network. Due to the non-linear influence of supply temperature on the network behavior, we perform this optimization in an iterative process, thanks to the computational efficiency of our library. In our example, we obtain a reduction of heat losses of about 18% compared to a standard control. Our next step will be to develop a model-predictive control approach for supply temperature optimization, with regular heat load predictions updates.

References

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