Transient model of a panel radiator

Ph.D. student Christian Brembilla, *Department of Applied Physics and Electronics, Umeå University, christian.brembilla@umu.se*
Dr. Mohsen Soleimanni-Mohseni, Department of Applied Physics and Electronics, Umeå University, mohsen.soleimanni-mohseni@umu.se
Prof. Thomas Olofsson, Department of Applied Physics and Electronics, Umeå University, thomas.olofsson@umu.se

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Introduction

This paper shows a detailed transient model of a panel radiator considered as a system of multiple storage elements. The experiment records the temperature surface of the panel in the process of heating up. The qualitative results of the experiment suggest the more appropriate technique for modelling this technology. The transient model performs the modelling with horizontal thermal capacitances connected in series. This model calculates the temperature of exhaust flow, heat emission towards indoor environment, temperature gradient on panel surface, dead and balancing time identified numerically on the chart.

Experiment

The aim of the experiment is to investigate how the panel radiator performs the charging process at the step of supply flow. Lenhovda MP 25 500 is the panel radiator adopted for this test [1]. **Figure 1** shows clearly the qolitative results of the charging process. The panel is charged from right to left with this type of connections of supply and exhaust flow. However, it is visable a hot area in the lower part of the radiator. This means that, a fraction of supply flow recirculates inside the panel due to some residual air that does not let the correct charging of the unit.

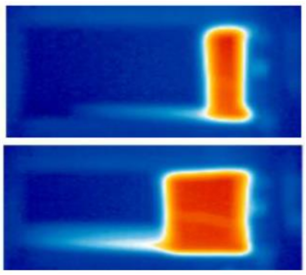

Figure 1: Experiment results

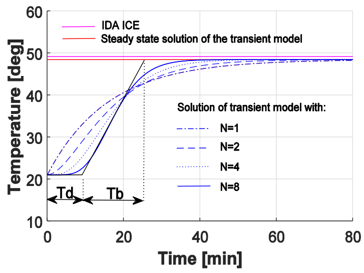

Figure 2: Temperature of exhaust flow

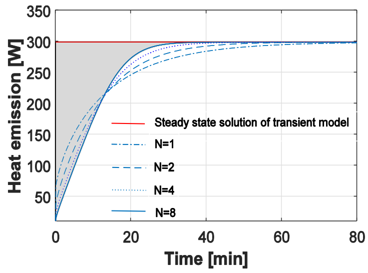

Figure 3: Radiator heat emission

Model

The model simulates the response of the radiator to the step of supply flow in terms of heat emission and temperature of exhaust flow. The transient model is based on the heat balance between the water side, the heat stored in the thermal capacitances and its heat emission. The modelling divides the radiator in equal elements. The elements, or radiator capacitances, are connected in series and the supply temperature of the following capacitance is the exhaust temperature of the previous one. Newton-Raphson method is the solver used for resolving the system of differential equations [2]. **Figure 2** shows the temperature of exhaust flow of the panel in the transient phase when the radiator is modelled with 1, 2, 4 and 8 capacitances, its static and IDA ICE solutions. Dead and balancing time (T_d ,T_b) are identified for the model with 8 capacitances. **Figure 3** shows the heat emission of the radiator modelled as previously. The grey area is the amount of energy overestimated from the steady state models. This area is about 50 Wh.

Conclusions and Outlook

Radiator performance is an essential information in order to obtain better model of heat emission towards the indoor environment. The modelling of a panel radiator with several heat capacitances linked in series achieves a temperature gradient of the supply heat flow, an accurate heat emission during the transient phase, dead and balancing time. This information is essential for controlling purposes and it is the first step for the modelling of ventilation radiators.

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References:

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[2] Stephan W.; System simulation, Specification: radiator, International Energy Agency; Annex 10; University of Stuttgart.