Modeling Transient Heat Transfer in Small-Size Twin Pipes for End-User Connections to Low-Energy District Heating Networks

The low-energy district heating concept has the potential of increasing the energy and exergy efficiencies of heat supply systems and of exploiting renewable energy, provided technical solutions for its wide application can be developed and implemented. This paper investigates the dynamic behaviour of district heating branch pipes in low-temperature operation (supply temperature 50-55°C and return temperature 20-25°C). We looked at state-of-the-art district heating branch pipes, suitable for the connection of a typical single-family house to a substation equipped with a heat exchanger for domestic hot water preparation. Experimental measurements of the supply temperature profiles at the outlet of the pipe, i.e. at the inlet to the substation, were compared with detailed simulations based on the finite volume (FV) method. A programming code was developed to model these profiles, and this was validated against experimental measurements and compared to the results of an analytical formula and the FV simulations. The model proved accurate, since it gives results that well represent the outlet temperature profiles measured in the experiments and calculated in the FV simulations, both where there was a step change of the inlet temperature and where there was a sinusoidal inlet temperature profile. The model could be used for the development of improved substation concepts and enhanced control strategies.