Modification of the Shape of Thermal Insulation of a Twin-Pipe Pre-Insulated Network

Tomasz Janusz Teleszewski [1, a)] Miroslaw Zukowski [2, b)]

[1,2]*Department of HVAC Engineering, Faculty of Civil and Environmental Engineering, Bialystok University of Technology, Wiejska 45A, 15-351 Bialystok, Poland*

[a)]Corresponding author: t.teleszewski@pb.edu.pl
[b)]m.zukowski@pb.edu.pl

Currently, twin-pipe pre-insulated networks are becoming increasingly popular. The advantage of this type of network is lower construction costs. Heating pipes in the common insulation should be placed at a suitable distance from each other, so that there is not too much heat exchange between the supply and return pipes. The smaller ~~the~~ distance of the pipe from the outer surface of the insulation affects the increase of heat loss. Circular insulations are most commonly used (Fig. 1a). There are also known shapes of double insulation of egg-shaped pre-insulated ducts in which the supply line is characterized by a larger layer of insulation than the return duct (Fig. 2a).The use of egg-shaped insulation allows you to reduce heat losses by 7.41% compared to circular insulation types twin-pipes with the same cross-sectional area of the cross-section insulation. Figure 2 shows the schematic and boundary conditions for the circular insulation.

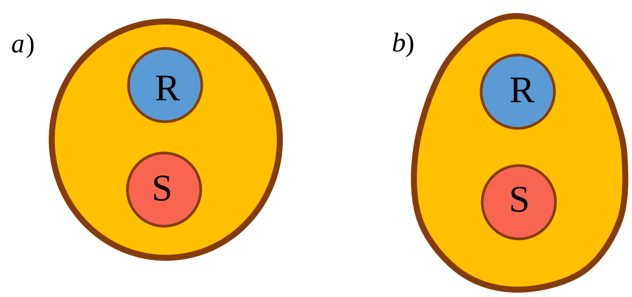

FIGURE 1. Selected shapes of twin-pipes type (S-supply pipe, R-return pipe): (a) round, (b) egg-shaped

The paper proposes a shape of insulation defined by the Cassini oval function. In order to determine heat fluxes, the equation of two-dimensional heat conduction for the cross-section of a twin-pipes pre-insulated network was solved:

$$k\left(\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}\right)=0, \tag{1}$$

where k is the thermal conductivity coefficient of insulation

The unit heat loss through the pre-insulated double duct is the sum of heat loss from the q_S ~~power~~ supply pipe and the return pipe q_R:

$$q = q_S + q_R \text{ [W/m]}, \tag{2}$$

The heat flow from the return pipe consists of a negative heat flow from the supply pipe to the return pipe q_{R1} and a positive heat flow from the return pipe to the insulation q_{R2}:

$$q_R = q_{R2} - q_{R1} \text{ [W/m]}, \tag{3}$$

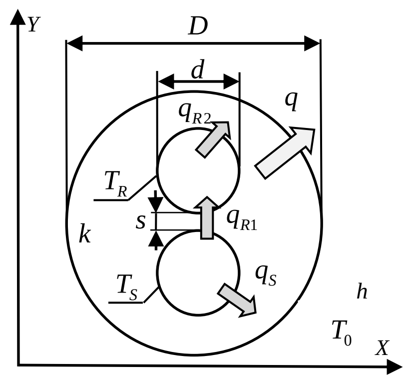

FIGURE 2. Geometry and boundary conditions.

It was assumed that the heating network is located underground where Robin's boundary conditions may apply. Simulations were made using the boundary element method. In order to verify correctness of results of BEM calculations, they were compared with known numerical solutions.

Figure 3 presents the isotherms solution and heatlines for the twin pipe in circle insulation for the Robin condition. With the decreasing distance between the supply and return lines, the heat exchange between these pipes increases. The heat flux field exchanged between the supply and return pipes is highlighted in gray.

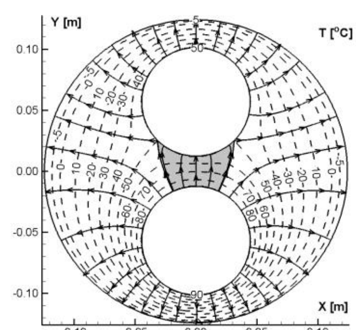

FIGURE 3. Heatlines and isotherms in an exemplary twin pipe.

ACKNOWLEDGMENTS

This work was performed within the framework of Grant No. S/WBIIS/4/2014 of Bialystok University of Technology and financed by the Ministry of Science and Higher Education of the Republic of Poland.