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NOMENCLATURE

L	pipe length, m
r	pipe radius, m
U	mean fluid velocity m.s^{-1}
c_p	specific heat of the fluid, J.kg^{-1}.K^{-1}
q''	heat flux at the pipe wall, W.m^{-2}
h	heat transfer coefficient, W.m^{-2}.K
Nu	Nusselt number
k	thermal conductivity of the fluid, W.m^{-1}.K^{-1}
T_w	pipe wall temperature
T_0	inlet fluid temperature
T_m	mean temperature on pipe cross sections

T_s	soil temperature
T_d	fluid temperature in the downward pipe
T_u	fluid temperature in the upward pipe

Greek symbols

α	thermal diffusivity of the fluid, m^2.s^{-1}
α_s	thermal diffusivity of the soil, m^2.s^{-1}
μ	dynamic viscosity of the fluid, kg.m^{-1}.s^{-1}
ρ	density of the fluid, kg.m^{-3}

Subscripts

w	pipe wall
m	mean value
s	soil
d	downward pipe of the exchanger
u	upward pipe of the exchanger