Nomenclature

Symbol	Meaning	Units
α	Angle used in determining area	radians
ε	Emissivity of insulation lagging	-
r_1	Outer radius of process fluid pipe	m
r_2	Outer radius of steam tracer pipe	m
r_{pinn}	Inner radius of process fluid pipe	m
L_{ai}	Length of insulation between annulus and air for bare tracer	m
L_{act}	Length of insulation between annulus and air for cemented tracer	m
Q_{ta}	Energy transfer between tracer and annulus	J
Q_{al}	Energy transfer between annulus and air	J
Q_{pl}	Energy transfer between process pipe and air	J
Q_{ca}	Energy transfer between cement and annulus	J
Q_{cp}	Energy transfer between cement and process fluid pipe	J
Q_{tl}	Energy transfer between bare tracer and air	J
Q_{cl}	Energy transfer between cement and air	J
A_{ta}	Effective area of tracer exposed to annulus	m^2
A_{al}	Effective area of annulus exposed to air	m^2
A_{pl}	Effective area of process pipe exposed to air	m^2
A_{ca}	Effective area of cement exposed to annulus	m^2
A_{cp}	Effective area of cement exposed to process fluid pipe	m^2
A_{tl}	Effective area of tracer exposed to air	m^2
A_{cl}	Effective area of cement exposed to air	m^2
D_t	Diameter of tracer pipe	m
t_{ins}	Insulation thickness	m
c_t	Cement thickness	m
T_s	Saturated steam temperature	K
T_p	Process fluid temperature	K
T_{ann}	Annulus temperature	K
T_{amb}	Ambient design temperature	K
T_{surf}	Outer surface temperature	K
T_{ins}	Average insulation temperature	K
V_m	Wind velocity	m/s
P_s	Saturated steam pressure	kPa

q_t	Overall heat transmittance from cemented tracer to process fluid pipe	W/m^{2}K
h_c	Heat transfer coefficient in still air	W/m^{2}K
h_o	Heat transfer coefficient at surface	W/m^{2}K
k_w	Thermal conductivity of pipe wall	W/mK
k_{ins}	Thermal conductivity of insulation	W/mK
m	Mass flow rate of steam	kg/h
n	Amount of bare or cemented tracers	tracers
L	Length of tracer connected to pipe	m