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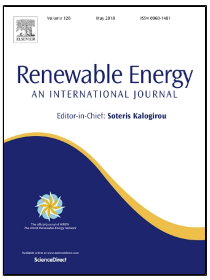

A detailed mathematical model for thermal performance analysis of a cylindrical cavity receiver in a solar parabolic dish collector system

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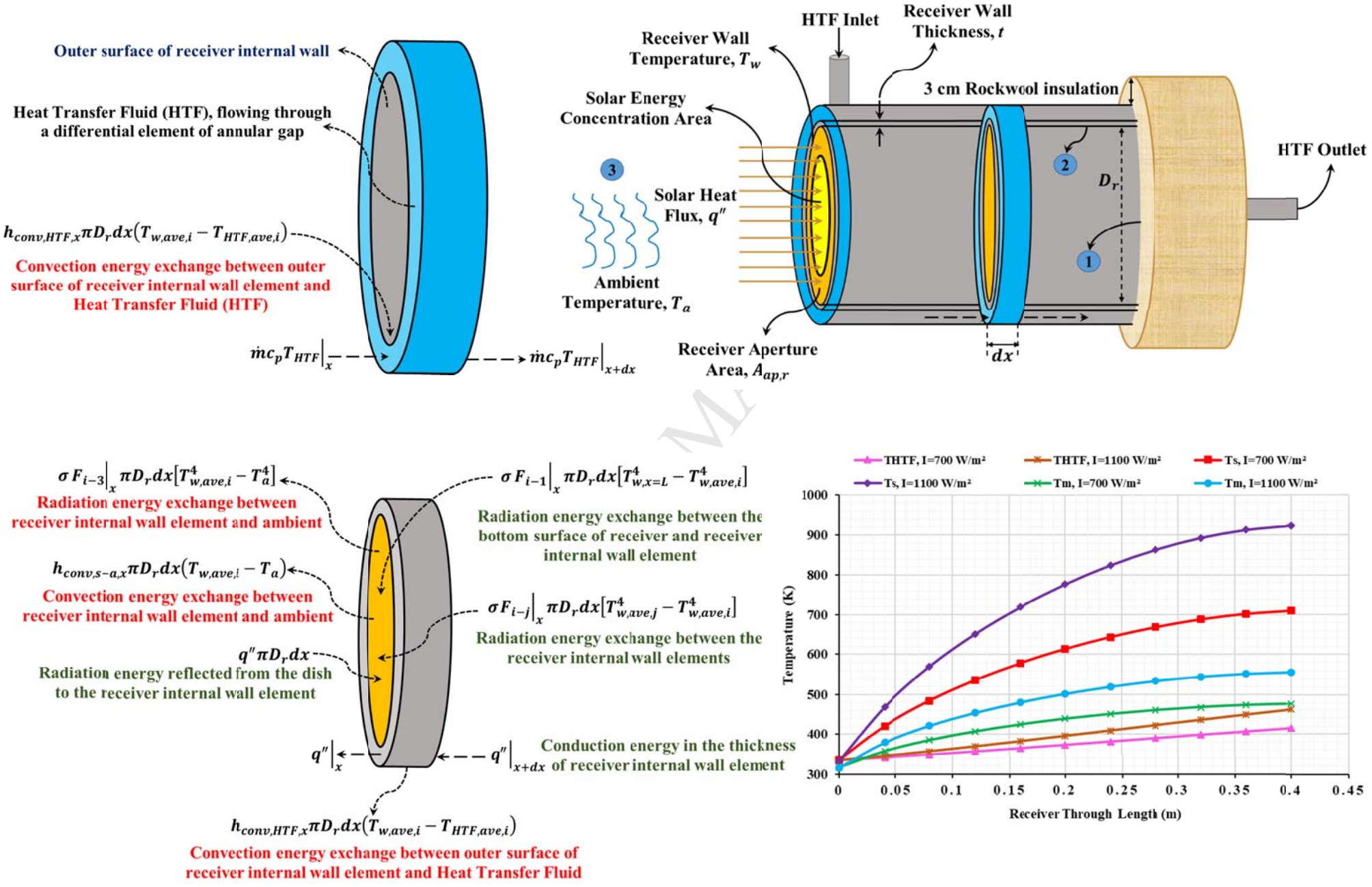
Outer surface of receiver internal wall
Heat Transfer Fluid (HTF), flowing through a differential element of annular gap
$h_{conv,HTF,x}\pi D_r dx(T_{w,ave,i} - T_{HTF,ave,i})$
Convection energy exchange between outer surface of receiver internal wall element and Heat Transfer Fluid (HTF)
$\dot{m}c_p T_{HTF}\big|_x$
$\dot{m}c_p T_{HTF}\big|_{x+dx}$
HTF Inlet
Receiver Wall Thickness, t
Receiver Wall Temperature, T_w
3 cm Rockwool insulation
Solar Energy Concentration Area
HTF Outlet
Solar Heat Flux, q''
Ambient Temperature, T_a
D_r
dx
Receiver Aperture Area, $A_{ap,r}$
$\sigma F_{i-3}\big|_x \pi D_r dx[T^4_{w,ave,i} - T^4_a]$
Radiation energy exchange between receiver internal wall element and ambient
$\sigma F_{i-1}\big|_x \pi D_r dx[T^4_{w,x=L} - T^4_{w,ave,i}]$
Radiation energy exchange between the bottom surface of receiver and receiver internal wall element
$h_{conv,s-a,x}\pi D_r dx(T_{w,ave,i} - T_a)$
Convection energy exchange between receiver internal wall element and ambient
$\sigma F_{i-j}\big|_x \pi D_r dx[T^4_{w,ave,j} - T^4_{w,ave,i}]$
Radiation energy exchange between the receiver internal wall elements
$q''\pi D_r dx$
Radiation energy reflected from the dish to the receiver internal wall element
$q''\big|_x$
$q''\big|_{x+dx}$
Conduction energy in the thickness of receiver internal wall element
$h_{conv,HTF,x}\pi D_r dx(T_{w,ave,i} - T_{HTF,ave,i})$
Convection energy exchange between outer surface of receiver internal wall element and Heat Transfer Fluid
THTF, I=700 W/m²
THTF, I=1100 W/m²
Ts, I=700 W/m²
Ts, I=1100 W/m²
Tm, I=700 W/m²
Tm, I=1100 W/m²
Temperature (K)
Receiver Through Length (m)
1000
900
800
700
600
500
400
300
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45

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