

Temperature Profile in Homogenous Stationary Pipe Flow Analytical Ramey @model

Motivation

Analytical model of temperature step-response in a Homogenous Stationary Pipe Flow with account for the heat exchange with surroundings  Unknown macro: 'single-cite'.

Model equally works for wellbore flow, ground, on-ground and bottom-water pipelines.

Outputs

$T(t, l)$	Along-hole Temperature Profile
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where

t	Flowing duration
l	Length along pipe

Inputs

T_s	Intake temperature	$T_e(l)$	Background temperature of the surroundings
$\dot{m}$	Mass flowrate	U	Heat Transfer Coefficient (HTC) between pipe fluid and surroundings
a_e	Thermal Diffusivity of the surroundings	r_f	Flowing pipe radius
λ_e	Thermal Conductivity of the surroundings	r_w	Wellbore radius

Equations

(1) $T(t, l) = T_e(l) - R(t) G_e(l) + \left[T_s - T_e(0) + R(t) G_e(l) \right] \cdot e^{-l/R(t)}$	(2) $G_e = \frac{dT_e}{dl}$	(3) $t_D(t) = \frac{a_e t}{r_w^2}$
(4) $R(t) = \frac{\dot{m} c_p}{2\pi \lambda_e} \cdot \left(T_D(t) + \frac{\lambda_e}{r_f U} \right)$	(5) $T_D(t) = \ln \left[e^{-0.2 t_D} + (1.5 - 0.3719 e^{-t_D}) \sqrt{t_D} \right]$	

Assumptions

Intake Flowrate is constant in time	Intake Temperature is constant in time
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$q_s(t) = q_s = \text{const}$	$T_s(t) = T_s = \text{const}$
Thermal diffusivity of the surroundings is constant along-hole	Thermal Conductivity of the surroundings is constant along-hole
$a_e(l) = a_e = \text{const}$	$\lambda_e(l) = \lambda_e = \text{const}$
Flowing pipe radius is constant along-hole	Wellbore radius is constant along-hole
$r_f(l) = r_f = \text{const}$	$r_w(l) = r_w = \text{const}$
Heat Transfer Coefficient (HTC) between pipe fluid and surroundings is constant along-hole	
$U(l) = U = \text{const}$	

See Also

[Physics](#) /
 [Fluid Dynamics](#) /
 [Pipe Flow Dynamics](#) /
 [Pipe Flow Simulation](#) /
 [Temperature Profile in Pipe Flow @model](#) /
 [Temperature Profile in Homogenous Pipe Flow @model](#)

References


 Unknown macro: 'cite-summary'