

Temperature Profile in Pipe Flow @model

Motivation

One of the key challenges in [Pipe Flow Dynamics](#) is to predict the along-hole [temperature](#) distribution during the [stationary fluid transport](#).

[Pipeline Flow Temperature Model](#) is addressing this problem with account of the varying [pipeline trajectory](#), [pipeline](#) schematic and [heat transfer](#) with the matter around [pipeline](#).

The practical time scales in [stationary fluid flow](#) allow considering the cross-phase as thermodynamically equilibrium and all phases are at the same temperature:

(1) $T_{\alpha}(t, l) = T(t, l)$

Outputs

$T(t, l)$	along-pipe temperature distribution and evolution in time
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Inputs

$\mathbf{r}(l)$	pipeline trajectory , $\mathbf{r}(l) = \{x(l), y(l), z(l)\}$	$\rho(T, p)$	fluid density
$A(l)$	pipeline cross-section area	$\mu(T, p)$	fluid viscosity
$T_0(t)$	intake temperature	$T_{e0}(l)$	initial temperature of the medium around the pipeline
p_0	intake pressure	$c_p(l)$	specific heat capacity of the medium around pipeline
q_0	intake flowrate	$\lambda_e(l)$	thermal conductivity of the medium around pipeline
$U(l)$	heat transfer coefficient based on pipeline schematic		

Assumptions

Stationary fluid flow	Axial symmetry around the pipe	Homogenous fluid flow
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Equations

$(2) \quad \rho c \frac{\partial T}{\partial t} = \frac{d}{dl} \left(\lambda \frac{dT}{dl} \right) - \left(\sum_{\alpha} \rho_{\alpha} c_{\alpha} v_{\alpha} \right) \frac{dT}{dl} + \frac{2\lambda}{\lambda_e} \cdot \frac{r_f}{r_w^2} \cdot U \cdot [T_e(t, l, r_w) - T]$	$(3) \quad \rho_e c_e \frac{\partial T_e}{\partial t} = \nabla(\lambda_e \nabla T_e)$
$(4) \quad T(t = 0, l) = T_{e0}(l)$	$(5) \quad T_e(t = 0, l, r) = T_{e0}(l)$

(6)	$T(t, l = 0) = T_0(t)$	(7)	$T_e(t, l, r \rightarrow \infty) = T_{e0}(l)$
(8)	$2\pi \lambda_e r_w \left. \frac{\partial T_e}{\partial r} \right _{r=r_w} = 2\pi r_f U \cdot \left(T_e \Big _{r=r_w} - T \right)$		

Approximations

[Temperature Profile in Homogenous Pipe Flow @model](#)

See Also

[Physics](#) / [Fluid Dynamics](#) / [Pipe Flow Dynamics](#) / [Pipe Flow Simulation](#)

[\[Homogenous Pipe Flow Temperature Profile @model \]](#)[\[Pipe Flow Temperature Analytical Ramey @model \]](#)

References