Temperature Profile in Homogenous Stationary 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.

In many practical cases the along-hole temperature distribution during the stationary fluid flow can be approximated by homogenous fluid flow model.

Outputs

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

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

Equations

(1) $\rho \, c \, \frac{\partial T}{\partial t} = \frac{d}{dl} \left(\lambda \, \frac{dT}{dl} \right) - \rho \, c \, v \, \frac{dT}{dl} + \frac{U}{r_w} \cdot \big(T_e(t, l, r_w) - T \big)$	(2) $\rho_e \, c_e \, \frac{\partial T_e}{\partial t} = \nabla (\lambda_e \nabla T_e)$
(3) $T(t=0, l) = T_{e0}(l)$	(4) $T_e(t=0, l, r) = T_{e0}(l)$
(5) $T(t, l=0) = T_0(t)$	(6) $T_e(t, l, r \rightarrow \infty) = T_{e0}(l)$
(7) $2 \pi \, \lambda_e \, r_w \, \frac{\partial T_e}{\partial r} \bigg|_{r=r_w} = 2 \pi \, r_f \, U \cdot \left(T_e \bigg|_{r=r_w} - T \right)$	

Approximations

Temperature Profile in Homogenous Stationary Pipe Flow Analytical Ramey @model

See also

Physics / Fluid Dynamics / Pipe Flow Dynamics / Pipe Flow Simulation / Temperature Profile in Pipe Flow @model

[Heat Transfer][Heat Transfer Coefficient (HTC)]

[Stationary Isothermal Homogenous Pipe Flow Pressure Profile @model] [Pipe Flow Temperature Analytical Ramey @model]

References

https://en.wikipedia.org/wiki/Darcy_friction_factor_formulae

https://neutrium.net/fluid_flow/pressure-loss-in-pipe/