# 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 |

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 |
| $\lambda_e$ | 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 |
|---|---|

| | |
|---|---|
| $q_s(t) = q_s = \text{const}$ | $T_s(t) = T_s = \text{const}$ |
| **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'