

Multiphase Pipe Flow

Outputs

$\{s_\alpha\}_{\alpha=1..n}$	phase holdup
$\{q_\alpha\}_{\alpha=1..n}$	phase volumetric flowrate

Inputs

A	pipe cross-sectional area
$\{\dot{m}_\alpha\}_{\alpha=1..n}$	phase mass flowrates
$\{\rho_\alpha\}_{\alpha=1..n}$	phase densities

Solver

(1)	$s_\alpha = \frac{\dot{m}_\alpha}{\rho_\alpha u_\alpha} \cdot \left(\sum_\beta \frac{\dot{m}_\beta}{\rho_\beta u_\beta} \right)^{-1}$
(2)	$q_\alpha = s_\alpha u_\alpha A$

Derivation

Given the multiphase flow of n phases: $\alpha = 1..n$ and mass flowrates $\dot{m}_\alpha$

(3)	$\dot{m} = \sum \dot{m}_\alpha$
(4)	$A = \sum_\alpha A_\alpha$
(5)	$s_\alpha = A_\alpha / A$
(6)	$\sum_\alpha s_\alpha = 1$
(7)	$u_m = \sum_\alpha s_\alpha \cdot u_\alpha$
(8)	$q_\alpha = \dot{m}_\alpha / \rho_\alpha = A_\alpha u_\alpha \Rightarrow \dot{m}_\alpha = \rho_\alpha A_\alpha u_\alpha$

For homogeneous pipe flow: $u_\alpha = u_m, \forall \alpha \in [1..n]$ and volumetric shares are going to be:

(9)	$s_\alpha = \frac{\dot{m}_\alpha}{\rho_\alpha} \cdot \left(\sum_\beta \frac{\dot{m}_\beta}{\rho_\beta} \right)^{-1}$
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