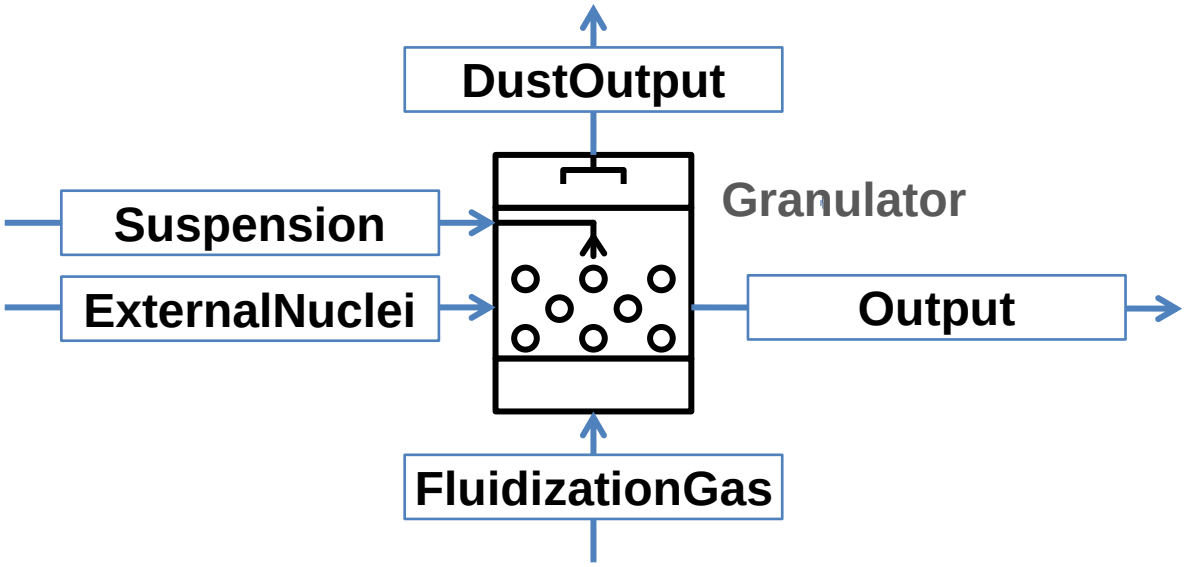
Granulator

General description



This unit represents a simplified model of a fluidized bed granulation reactor. The model does not take into account attrition of particles inside the apparatus and does not keep properly any secondary distributed properties except size.

$$\frac{dq_{3,i}}{dt} = -G_e \frac{q_{3,i} - q_{3,i-1}\left(\frac{d_{p,i}}{d_{p,i-1}}\right)^3}{\Delta d_i} + \frac{\dot{m}_{in}}{M_{tot}} q_{3,i}^{in} - \frac{\dot{m}_{out}}{M_{tot}} q_{3,i},$$

$$G_e = \frac{2\dot{m}_e}{\rho_{s,susp} \cdot A_{tot}},$$

$$A_{tot} = \frac{6M_{tot}}{\rho_s} \sum_i \frac{q_{3,i} \cdot \Delta d_i}{d_{p,i}},$$

$$\dot{m}_e = \dot{m}_{susp,s}(1 - K_{os}),$$

$$\dot{m}_{out} = \dot{m}_{in} + \dot{m}_e,$$

$$\dot{m}_{dust} = \dot{m}_{susp,s} \cdot K_{os} + \left(\dot{m}_{susp} - \dot{m}_{susp,s} + \dot{m}_{fl,g}\right)$$

- q_3 is the mass density distribution of particles inside apparatus
- q_3^{in} is the mass density distribution of external particles from *ExternalNuclei* stream
- Δd is the class size
- d_p is the diameter of particles in a class
- $\dot{m}_{in}$ is the mass flow of input nuclei
- $\dot{m}_{out}$ is the output mass flow of the product
- $\dot{m}_{dust}$ is the output mass flow from the *DustOutput*

- $\dot{m}_{susp}$ is the total mass flow of the suspension
- $\dot{m}_{susp,s}$ is the mass flow of the solid phase in the *Suspension* inlet
- $\dot{m}_{fl,g}$ is the mass flow of the gas phase in the *FluidizationGas* inlet
- $\dot{m}_e$ is the effective mass stream of the injected suspension
- M_{tot} is the holdup mass
- $\rho_{s,susp}$ is the density of solids in the suspension
- ρ_s is the density of solids in the holdup
- G_e is the effective growth rate
- A_{tot} is the total surface of particles in the granulator
- K_{os} is the overspray part in the suspension

Unit parameters

Name	Symbol	Description	Units	Valid values
Kos	K_{os}	Overspray part in the suspension	[-]	0 ≤ Kos ≤ 1
RTol		Relative tolerance for equation solver	[-]	0 < RTol ≤ 1
ATol		Absolute tolerance for equation solver	[-]	0 < ATol ≤ 1

State variables

Name	Symbol	Description	Units
Atot	A_{tot}	Total surface of particles in the granulator	[m^2]
Mtot	M_{tot}	Total mass of all particles in the granulator	[kg]
Mout	$\dot{m}_{out}$	Output mass flow of the product	[kg/s]
Mdust	$\dot{m}_{dust}$	Output mass flow of dust	[kg/s]
G	G_e	Effective growth rate	[m/s]
PSDi	$q_{3,i}$	Mass density distribution of particles	[1/m]

Requirements

- Solid phase
- Liquid phase
- Gas phase
- Particle size distribution

Application examples

- *Example Flowsheets/Units/Granulator.dlfw*
- *Example Flowsheets/Processes/Granulation Process.dlfw*

References

S. Heinrich, M. Peglow, M. Ihlow, M. Henneberg, L. Mörl, Analysis of the start-up process in continuous fluidized bed spray granulation by population balance modelling, Chem. Eng. Sci. 57 (2002) 4369-4390.