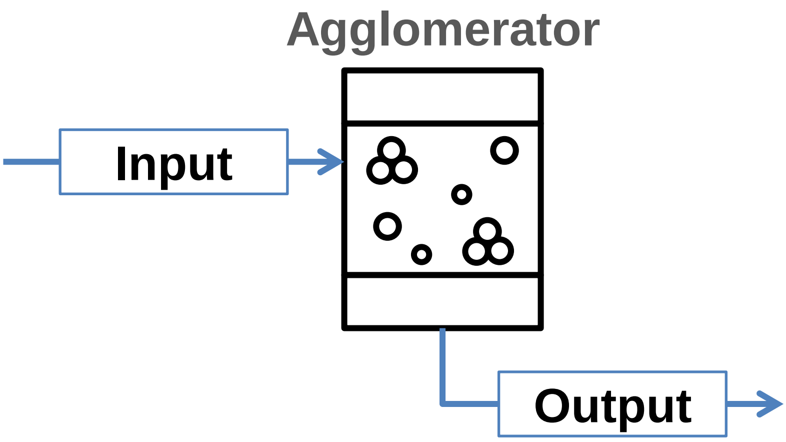
Agglomerator

General description



This unit represents a simplified model of agglomeration process. The model does not take into account attrition of particles inside the apparatus and does not keep properly any secondary distributed property except size.

Mass related density distribution of output stream is calculated according to equation:

$$\frac{\partial n(v,t)}{\partial t} = B_{agg}(n,v,t) - D_{agg}(n,v,t) + \dot{n}_{in}(t) - \dot{n}_{out}(t),$$

$$B_{agg}(n,v,t) = \frac{1}{2}\beta_0 \int_0^v \beta(u,v-u)n(u,t)n(v-u,t)du,$$

$$D_{agg}(n,v,t) = \beta_0 n(v,t) \int_0^\infty \beta(u,v)n(u,t)du$$

$$\dot{m}_{out}(t) = \dot{m}_{in}(t)$$

- v and u are volumes of agglomerating particles
- $n(v,t)$ is the number density function
- $\dot{n}_{in}(t)$ and $\dot{n}_{out}(t)$ are the number density distributions of inlet and outlet streams, correspondingly
- $B_{agg}(n,v,t)$ and $D_{agg}(n,v,t)$ are the birth and death rates of particles with volume v caused due to agglomeration
- β_0 is the agglomeration rate constant, dependent on operating conditions but independent from particle sizes
- $\beta(v,u)$ is the agglomeration kernel describing the agglomeration frequency between particles of volumes v and u, which produce a new particle with the size $(v+u)$
- t is time
- $\dot{m}_{in}$ is the mass flow in the input stream

– $\dot{m}_{out}$ is the mass flow of the output stream

The method of calculating $B_{agg}(n,v,t)$ and $D_{agg}(n,v,t)$ is determined by the selected solver via unit parameter Solver.

Agglomeration kernels

Number	Name	Kernel
0	Constant	$\beta(u,v) = 1$
1	Sum	$\beta(u,v) = u + v$
2	Product	$\beta(u,v) = uv$
3	Brownian	$\beta(u,v) = \left(u^{\frac{1}{3}} + v^{\frac{1}{3}}\right)\left(u^{-\frac{1}{3}} + v^{-\frac{1}{3}}\right)$
4	Shear	$\beta(u,v) = \left(u^{\frac{1}{3}} + v^{\frac{1}{3}}\right)^{\frac{7}{3}}$
5	Peglow	$\beta(u,v) = \frac{(u+v)^{0.71}}{(uv)^{0.062}}$
6	Coagulation	$\beta(u,v) = u^{\frac{2}{3}} + v^{\frac{2}{3}}$
7	Gravitational	$\beta(u,v) = \left(u^{\frac{1}{3}} + v^{\frac{1}{3}}\right)^2 \left\lvert u^{\frac{1}{6}} - v^{\frac{1}{6}}\right\rvert$
8	Kinetic energy	$\beta(u,v) = \left(u^{\frac{1}{3}} + v^{\frac{1}{3}}\right)^2 \sqrt{\frac{1}{u} + \frac{1}{v}}$
9	Thompson	$\beta(u,v) = \frac{(u-v)^2}{u+v}$

Unit parameters

Name	Symbol	Description	Units	Valid values
Beta0	β_0	Size independent agglomeration rate constant	[-]	0 < Beta0 ≤ 1e+20
Step		Maximum time step of internal DAE solver. Set to 0 for default value.	[-]	0 ≤ Step ≤ 1e+9
Solver		Solver used to calculate birth and death rates	[-]	-
Kernel		Agglomeration kernel type. Must be an integer	[-]	0 ≤ Kernel ≤ 9
Rank		Rank of the kernel (applied for FFT solver only). Must be an integer	[-]	1 ≤ Rank ≤ 10

Requirements

- Solid phase
- Particle size distribution

Application examples

- *Example Flowsheets/Units/Agglomerator.dlfw>*
- *Example Flowsheets/Processes/Agglomeration Process.dlfw*

References

V. Skorych, M. Dosta, E.-U. Hartge, S. Heinrich, R. Ahrens, S. Le Borne, Investigation of an FFT-based solver applied to dynamic flowsheet simulation of agglomeration processes, Advanced Powder Technology 30 (3) (2019) 555-564.