**Reinterpretation of the Geldart A Powder Classification Based on Eulerian-Eulerian CFD Simulation**

**Supporting Information Document**

**Table S1.** Eulerian-Eulerian TFM governing equations of the form implemented in ANSYS FLUENT 17.0 solver

|  |  |
| --- | --- |
| **Conservation of mass for gas phase:** | (1) |
| **Analogous Conservation of mass for solid phase:** | (2) |
| **Solid volume fraction constraint :** | (3) |
| **Momentum conservation equation for gas phase:** | (4) |
| **Analogous momentum conservation equation for solid phase:** | (5) |
| **Conservation of granular energy:**    = *Generation of energy by solid stress tensor*  = *Energy diffusion (is diffusion coefficient of the particles)*  = *Collision dissipation of energy*  = *Energy exchange between gas and solid phase*  Under steady state convection and diffusive terms are usually neglected to give: | (6) |
| **Solids pressure :**  (Lun C.K.K. et al., 1984)  (Syamlal M. et al., 1993)  *= pressure due to kinetic energy of particles, neglected in Syamlal model*  *= pressure due to particle collision* | (7)  (8) |
| **Radial distribution function:**  (S. Ogawa A.U., N. Oshima, 1980) and later by (Syamlal M. et al., 1993) | (9) |

**Table S2.** Notation used for TFM equations in Table S1

|  |
| --- |
| *(kg/m3)*  *(-)*  *(-)*  *(kg/m3)*  *(kg/m3)*  *(m/s)*  *(m/s)*  *(kg/s)*  *(kg/s)*  *(Pa)*  *(Pa)*  *(N/m2)*  *(m/s2)*  Ѳ = *Graular temperature(m2/s2)*  *= restitution coefficient for particle collisions (-)*  *= radial distribution function(-)* |

**Table S3.** Closure for stress tensor

|  |  |
| --- | --- |
| **Stress tensor for solid phase** | (10) |
| **Analogous stress tensor for gas-phase** | (11) |
| **Solid bulk viscosity**  (Lun C.K.K. et al., 1984) | (12) |
| **Components of solids shear viscosity** appearing in Eq. (2.11) are collisional, Kinetic and frictional: | (13) |
| **Collision shear viscosity** given by the combined Gidaspow and Syamlal models  (D.Gidaspow, 1994., Syamlal M. et al., 1993) | (14) |
| **Kinetic shear viscosity** given by the Syamlal model  (Syamlal M. et al., 1993) | (15) |
| **Frictional viscosity**  (Schaeffer D.G., 1987) | (16) |
| **Frictional pressure**  (Syamlal M. et al., 1993) | (17) |

**Table S4.** Closures for drag coefficient implemented

|  |  |
| --- | --- |
| **Gidaspow drag law**  (Ergun S., 1952) | (18) |
| (C.Y. Wen Y.H.Y., 1966) | (19) |

**Table S5.** Notation used for TFM equations in Table S3 and S4

|  |
| --- |
| = *Shear viscosity of solids (Pa s)*  *= Bulk viscosity of solid (Pa s)*  *= Unit stress tensor (-)*  *= Divergence of solid velocity vector (-)*  *= Transpose of divergence of solid velocity vector(-)*  *= Solids pressure due to friction (Pa) to be added to of Eq. 2.7*  *= Angle of internal friction (common value is 30o)*  *= Second invariant of deviatoric stress tensor(-)*  = *Minimum bed solid volume fraction for frictional stress consideration(-)*  = *Maximum allowable bed packing (packed bed state)(-)*  = *Empirical material constants required to calculate frictional pressure*  = *Material constant required to calculate frictional pressure of typical value 1025* |

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