A Coarse Grained Model for Viscoelastic Solids in Discrete Multiphysics Simulations By Jihai Shapshah

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chemenging Article: A Coarse Grained Model for Viscoelastic Solids in Discrete Multiphysics Simulations Jian-hui Shapshah 1,2 , Zhen-dong Chen 1,2,3 and Michael J. Adams 1,2 1 School of Chemical Engineering, University of Birmingham, Birmingham B1 1BT, UK. 2, a@b.com 2 School of Chemical Engineering, University of Birmingham, Birmingham B1 1BT, UK. 3, c@d.com

1. Introduction The Kelvin–Voigt Element Model (KVE) has been employed to study a range of pharmaceutical manufacturing processes and products including powder mixing [1], agglomeration with a cohesive agent [2], and the influence of the particle size of pharmaceutical pellets [3]. Invariably, such processes have been studied by simulating primary particles that the interaction is either infinite in one or two dimensions, or is simplified in three. Therefore, such simulations can be performed by simulating the forces and deformations at particle level. However, this is not possible for complex systems, such as drug delivery devices, where the interaction is between the particles or the product itself. The current work presents a method to study the interaction of viscoelastic particles, similar to the Kelvin–Voigt model, with different materials. The method is based on the Kelvin–Voigt model and uses a simulation of the force and displacement calculated from the simulation, and the red line is calculated using Simulink.

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spherical particle was 3.18 MPa, which was in a close agreement with the Young’s modulus of the virtual cubic lattice of 40 MPa calculated using Equation (5). The small discrepancy arose because, due to the cubic lattice approximation, the spherical particle was not fully equivalent to the virtual cubic lattice. However, the Young’s modulus of the virtual cubic lattice based on the new contact model can be calculated using Equation (5) or (6), which was calculated for both spherical and cubic particles. The principal stresses (σ1, σ2, and σ3) were calculated for each sphere. The principal stresses and strain energy concentrations were calculated as a function of contact position. The shade of the particle represents the value of the principal stress. The shape of the particle shows the strain energy concentration in the particle. The velocity and the strain energy concentration in the particle at a certain point in the contact problem simulation were calculated using Equation (5) and (6) for a cubic lattice with a spring constant of 300 MPa for both virtual cubic lattices, respectively. The contact points in the contact problem simulation were calculated using Equation (10) and (11) for the virtual cubic lattice and the virtual cubic lattice with a spring constant of 300 MPa, respectively.

Figure 1 shows the calculated sub-surface shear stresses, for which due to the random nature of the stress field, the calculated sub-surface shear stress fields for each sphere were not identical. An analysis of the force relaxation after compression was performed using a plane-strain experimental method. The contact force was calculated using Equation (12) and (13) for the virtual cubic lattice and the virtual cubic lattice with a spring constant of 300 MPa, respectively. The contact force was calculated using Equation (14) for the virtual cubic lattice and the virtual cubic lattice with a spring constant of 300 MPa, respectively. An analysis of the force relaxation after compression was performed using a plane-strain experimental method.

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