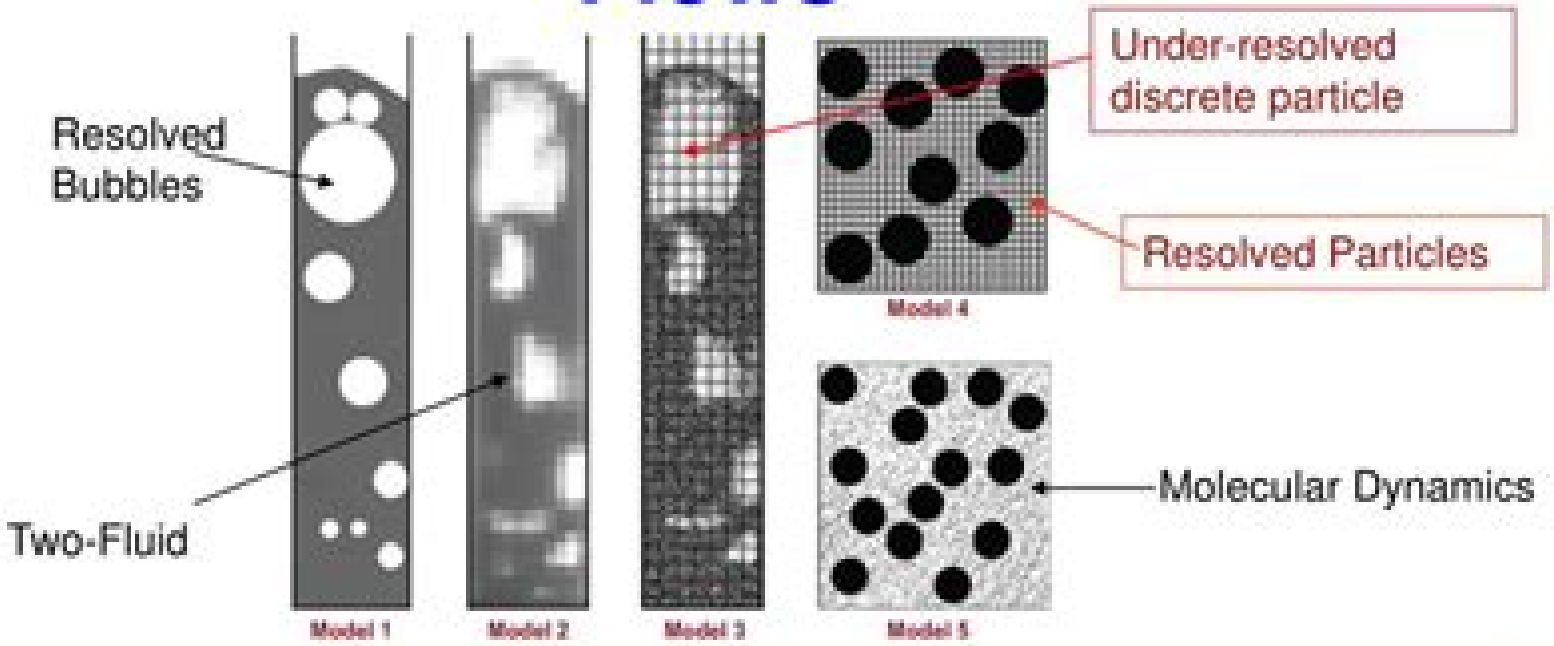
Simulation Techniques: Particulate Flows



	Name	Gas phase	Solid phase	Gas-solid coupling	Scale
1.	Discrete bubble model	Lagrangian	Eulerian	Drag closures for bubbles	Industrial (10 m)
2.	Two-fluid model	Eulerian	Eulerian	Gas-solid drag closures	Engineering (1 m)
3.	Unresolved discrete particle model	Eulerian (unresolved)	Lagrangian	Gas-particle drag closures	Laboratory (0.1 m)
4.	Resolved discrete particle model	Eulerian (resolved)	Lagrangian	Boundary condition at particle surface	Laboratory (0.01 m)
5.	Molecular dynamics	Lagrangian	Lagrangian	Elastic collisions at particle surface	Mesoscopic (<0.001 m)

Van der Hoeff et al. Annual Review of Fluid Mechanics, 2008

Particulate Flows

M. Uhlmann

Particulate Flows:

An Introduction to Modeling and Simulation of Particulate Flows T.I. Zohdi,2007-07-19 Describes basic models and physically based computational solution strategies for simulating flowing particulate media **Particulate Flows** Donald A. Drew,Daniel D. Joseph,Stephen L. Passman,2012-12-06 This IMA Volume in Mathematics and its Applications PARTICULATE FLOWS PROCESSING AND RHEOLOGY is based on the proceedings of a very successful one week workshop with the same title which was an integral part of the 1995 1996 IMA program on Mathematical Methods in Materials Science We would like to thank Donald A Drew Daniel D Joseph and Stephen L Passman for their excellent work as organizers of the meeting We also take this opportunity to thank the National Science Foun dation NSF the Army Research Office ARO and the Office of Naval Research ONR whose financial support made the workshop possible A vner Friedman Robert Gulliver v PREFACE The workshop on Particulate Flows Processing and Rheology was held January 8 12 1996 at the Institute for Mathematics and its Applications on the University of Minnesota Twin Cities campus as part of the 1995 96 Program on Mathematical Methods in Materials Science There were about forty participants and some lively discussions in spite of the fact that bad weather on the east coast kept some participants from attending and caused scheduling changes throughout the workshop Heterogeneous materials can behave strangely even in simple flow sit uations For example a mixture of solid particles in a liquid can exhibit behavior that seems solid like or fluid like and attempting to measure the viscosity of such a mixture leads to contradictions and unrepeatable experiments Even so such materials are commonly used in manufacturing and processing An Introduction to Modeling and Simulation of Particulate Flows T. I. Zohdi,2007-01-01 The relatively recent increase in computational power available for mathematical modeling and simulation raises the possibility that modern numerical methods can play a significant role in the analysis of complex particulate flows An Introduction to Modeling and Simulation of Particulate Flows focuses on basic models and physically based computational solution strategies for the direct and rapid simulation of flowing particulate media Its emphasis is primarily on fluidized dry particulate flows in which there is no significant interstitial fluid although fully coupled fluid particle systems are discussed as well An introduction to basic computational methods for ascertaining optical responses of particulate systems also is included The successful analysis of a wide range of applications requires the simulation of flowing particulate media that simultaneously involves near field interaction and contact between particles in a thermally sensitive environment These systems naturally occur in astrophysics and geophysics powder processing pharmaceutical industries bio micro and nanotechnologies and applications arising from the study of spray processes involving aerosols sputtering and epitaxy Audience written for computational scientists numerical analysts and applied mathematicians it will be of interest to civil and mechanical engineers and materials scientists It is also suitable for first year graduate students in the applied sciences engineering and applied mathematics who have an interest in the computational analysis of complex particulate flows **Adhesive Particle Flow** Jeffery S.

Marshall,Shuiqing Li,2014-03-31 This is targeted at professionals and graduate students working in disciplines where flow of adhesive particles plays a significant role Mesoscale Simulations of Particulate Flows with Parallel Distributed Lagrange Multiplier Technique ,2010 Fluid particulate flows are common phenomena in nature and industry Modeling of such flows at micro and macro levels as well establishing relationships between these approaches are needed to understand properties of the particulate matter We propose a computational technique based on the direct numerical simulation of the particulate flows The numerical method is based on the distributed Lagrange multiplier technique following the ideas of Glowinski et al 1999 Each particle is explicitly resolved on an Eulerian grid as a separate domain using solid volume fractions The fluid equations are solved through the entire computational domain however Lagrange multiplier constrains are applied inside the particle domain such that the fluid within any volume associated with a solid particle moves as an incompressible rigid body Mutual forces for the fluid particle interactions are internal to the system Particles interact with the fluid via fluid dynamic equations resulting in implicit fluid rigid body coupling relations that produce realistic fluid flow around the particles i e no slip boundary conditions The particle particle interactions are implemented using explicit force displacement interactions for frictional inelastic particles similar to the DEM method of Cundall et al 1979 with some modifications using a volume of an overlapping region as an input to the contact forces The method is flexible enough to handle arbitrary particle shapes and size distributions A parallel implementation of the method is based on the SAMRAI Structured Adaptive Mesh Refinement Application Infrastructure library which allows handling of large amounts of rigid particles and enables local grid refinement Accuracy and convergence of the presented method has been tested against known solutions for a falling sphere as well as by examining fluid flows through stationary particle beds periodic and cubic packing To evaluate code performance and validate particle contact physics algorithm we performed simulations of a representative experiment conducted at the University of California at Berkley for pebble flow through a narrow opening Scientific and Technical Aerospace Reports ,1989 Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database Pressure Driven Particulate Flows ,1996 Numerical simulations of pressure driven particulate Stokes flows are performed in cylindrical and rectangular conduits using a parallel boundary element code Spherical particles are randomly placed in the conduits and a pressure drop between the ends of the conduits is imposed by the boundary conditions to induce a Poiseuille like flow field The instantaneous velocities of the particles are then calculated as well as the additional pressure drop necessary to maintain a constant flow rate Because the results depend on the spatial distribution of the particles several random configurations of particles are examined for each case Depending on two different interpretations of the numerical results the solid phase can be represented as either leading or lagging the fluid phase Both of the analyses and interpretations are presented

Liquid-solid Flows, 1991 M. C. Roco,Tadashi Masuyama,1991 Numerical Simulation of Particulate Flows and

Turbulent Wavy Core-annular Flows Taehwan Ko,2001 Multiphase Particulate Systems in Turbulent Flows Wioletta Podgorska,2019-09-17 Multiphase Particulate Systems in Turbulent Flows Fluid Liquid and Solid Liquid Dispersions provides methods necessary to analyze complex particulate systems and related phenomena including physical chemical and mathematical description of fundamental processes influencing crystal size and shape suspension rheology interfacial area of drops and bubbles in extractors and bubble columns Examples of mathematical model formulation for different processes taking place in such systems is shown Discussing connections between turbulent mixing mechanisms and precipitation it discusses influence of fine scale structure of turbulence including its intermittent character on breakage of drops bubbles cells plant cell aggregates An important aspect of the mathematical modeling presented in the book is multi fractal taking into account the influence of internal intermittency on different phenomena Key Features Provides detailed descriptions of dispersion processes in turbulent flow interactions between dispersed entities and continuous phase in a single volume Includes simulation models and validation experiments for liquid liquid gas liquid and solid liquid dispersions in turbulent flows Helps reader learn formulation of mathematical models of breakage or aggregation processes using multifractal theory Explains how to solve different forms of population balance equations Presents a combination of theoretical and engineering approaches to particulate systems along with discussion of related diversity with exercises and case studies **A Lagrangian Particle Method for the Simulation of Dense Particulate Flows** ,1994 A new approach to the simulation of multi phase dense particulate flows has been developed based on taking the best of Eulerian Eulerian and Eulerian Lagrangian formulations This new approach uses a modern Particle In Cell method that has been extended to multi phase flows The method was accurate mappings from Lagrangian particles to and from Eulerian space so that continuum intergranular stress formulations can be incorporated in the modeling The result is a new model that can handle particulate loading ranging from dense to dilute a distribution of particle sizes and a range of particulate materials This paper describes the new method and results from a one dimensional implementation The Lagrangian particulate formulation is well suited for a massively parallel environment with a coupled high speed calculation of the underlying Eulerian gas phase governing equations The new simulation method has important applications in Fluidized Bed Combustion Catalytic Cracking processes and many other granular flows Extension of the method to two and three dimensional flows with parallel computation means that we can offer a comprehensive methodology for dense granular flows **Reliable Flow of Particulate Solids** ,1985 **Modeling Particulate Flows in Conduits and Porous Media** Chu-Hsiang Wu,2018 Particulate flows exist in a wide range of engineering applications such as drilling and completion operations from hole cleaning to well stimulation to sand control The operations involving particulate flows typically focus on achieving either 1 efficient particle transport or 2 effective particle retention both of which require a deep understanding of particulate flow behavior under different flow conditions This dissertation presents novel approaches for modeling particulate transport with the intent to optimize

operational efficiency in specific important oilfield applications The first half of this dissertation focuses on modeling particle transport inside a wellbore A typical example of such an operation is the pumping of proppant diverter slurry during a hydraulic fracturing treatment During the treatment the particles are moved in a carrier fluid from the wellbore through the perforations and finally into the fractures The motion of the particles is primarily influenced by the interactions between the fluid phase and the solid phase and therefore a precise description of the particle fluid interactions is essential for modeling the process The coupling of computational fluid dynamics with the discrete element method CFD DEM approach is adopted for this task The investigation begins with evaluating the particle transport efficiency PTE through a perforation in a horizontal wellbore under various downhole flow conditions A comprehensive study on the effect of casing perforation solid and fluid properties on PTE is presented On the basis of the study empirical PTE correlations are derived and integrated into a multi cluster hydraulic fracturing model to simulate proppant diverter transport at a wellbore scale Simulation results show that because of its high inertia the transport of proppant is generally much more difficult than the transport of carrier fluid through the perforations By assuming a simple jamming criterion based on local proppant concentration near the perforations the heel biased treatment distribution commonly observed in the field can be accurately reproduced by the model Recommendations on fracturing job design for promoting an even treatment distribution are also discussed The second half of the dissertation focuses on modeling particle retention in sand control completions with a special focus on multi layered metal mesh screens and gravel packs A DEM based approach is developed to evaluate the pore throat size distribution PoSD of the sand retention media Simulation results show that for a multi layer plain square mesh PSM screen the overlap alignment and relative pore size between individual layers all have a significant impact on the screen s PoSD In contrast only the intra layer overlap of the filter is important for controlling the PoSD of a multi layered plain Dutch weave PDW screen For gravel packs simulation results show that the largest and smallest pore throat sizes are about 1 5 and 1 10 of the effective gravel size for typical gravel sizes used in the field By using the computed PoSD as an input an analytical model and a Monte Carlo model are developed to predict sand production through gravel packs The modeled PoSD and sand production agree reasonably well with field observations and experimental data Our approach enables completion engineers to tailor gravel pack designs for different combinations of formation sand size distribution PSD and wellbore geometry in a cost efficient manner *Computational Methods in Viscous Flows* W. G. Habashi,1984 Investigation of the Fundamental Behavior of Particulate Flows with Continuous Size Distributions Steven Raymond Dahl,2004 **AIAA 73-659 - AIAA 73-705 (With omissions in numbering)** ,1973 New Results on the Simulation of Particulate Flows M. Uhlmann,2004 **Direct Numerical Simulation of Particulate Flows** Veeramani Chidambaranathan,2007 **Simulation of Particulate Flows on Multi-processor Machines with Distributed Memory** M. Uhlmann,2004 **First Experiments with the Simulation of Particulate Flows** M. Uhlmann,2003

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