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Discrete Element Simulations of Granular Flow in a Pebble Bed Nuclear Reactor GARY S. GREST, Sandia National Laboratories, CHRIS H. RYCROFT, MARTIN Z. BAZANT, M.I.T., JAMES W. LANDRY, BAE Systems
— Pebble-bed reactor technology, which is currently being revived around the world, raises fundamental questions about granular flow in silos. The reactor core is composed of spherical billiard-ball sized (6cm diameter) graphite fuel pebbles containing sand-sized uranium fuel particles. The fuel pebbles drain very slowly through the core as a continuous refueling process. In some designs, a dynamical central column is formed from graphite moderator pebbles, physically identical to the fuel pebbles without any fuel. The total number of pebbles is of order 440,000 in a cell approximately 3.5m in diameter and 8.5m tall. Using discrete element (molecular dynamics) simulations we have studied a full scale model of the system. We find that the interface between the fuel and moderator particles remains sharp, as there is very little horizontal motion of the pebbles as they flow through the reactor. We measure mean velocity profiles and compare to various continuum models. We also investigated the feasibility of a bi-disperse core, containing smaller moderator pebbles, with the same size fuel pebbles, which could improve performance by focusing helium gas flow on the hotter fuel region. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04- 94AL85000.

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