World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:18, No:12, 2024

Review of Numerical Models for Granular Beds in Solar Rotary Kilns for Thermal Applications

Authors : Edgar Willy Rimarachin Valderrama, Eduardo Rojas Parra

Abstract : Thermal energy from solar radiation is widely present in power plants, food drying, chemical reactors, heating and cooling systems, water treatment processes, hydrogen production, and others. In the case of power plants, one of the technologies available to transform solar energy into thermal energy is by solar rotary kilns where a bed of granular matter is heated through concentrated radiation obtained from an arrangement of heliostats. Numerical modeling is a useful approach to study the behavior of granular beds in solar rotary kilns. This technique, once validated with small-scale experiments, can be used to simulate large-scale processes for industrial applications. This study gives a comprehensive classification of numerical models used to simulate the movement and heat transfer for beds of granular media within solar rotary furnaces. In general, there exist three categories of models: 1) continuum, 2) discrete, and 3) multiphysics modeling. The continuum modeling considers zero-dimensional, one-dimensional and fluid-like models. On the other hand, the discrete element models compute the movement of each particle of the bed individually. In this kind of modeling, the heat transfer acts during contacts, which can occur by solid-solid and solid-gas-solid conduction. Finally, the multiphysics approach considers discrete elements to simulate grains and a continuous modeling to simulate the fluid around particles. This classification allows to compare the advantages and disadvantages for each kind of model in terms of accuracy, computational cost and implementation.

Keywords : granular beds, numerical models, rotary kilns, solar thermal applications
Conference Title : ICHTE 2024 : International Conference on Heat and Thermal Energy
Conference Location : Paris, France
Conference Dates : December 30-31, 2024