Multi-Dimensional Simulation of Flows Inside Mono and Polydisperse Packed Beds

R. Gregory Schunk[1], J. C. Knox[1], K. Son[2], R. F. Coker[1]

[1]NASA Marshall Space Flight Center, Huntsville, AL, USA

[2]NASA Marshall Space Flight Center, Huntsville, AL, USA; Purdue University, West Lafayette, IN, USA

Abstract

An analysis to quantify the flow inside the narrow channels of an ISS (International Space Station) CDRA (Carbon Dioxide Removal Assembly) adsorbent bed is presented. The CDRA contains two pelletized adsorbent beds to remove CO2 respired by the crew. Heaters and associated fins inside the adsorbent beds form many small parallel channels which are rectangular in cross section. The channels are filled with a polydisperse distribution of spherical adsorbent pellets such that each channel span may only contain 4-6 pellets across. At this small size wall effects from the enclosing heaters and fins may be laterally felt in the channel domain and affect axial pressure drop, heat transfer and sorbent performance.

COMSOL Multiphysics® software is utilized to model a truncated sorbent channel in three dimensions in order to investigate the suitability of empirical relations for pressure drop and heat transfer in one dimensional bed models as well as provide additional insight into the nature of the flows. Geometries developed (via an external granular discrete element method code) for the pellet distributions inside a packed bed are imported into COMSOL software for the assessments. The small size of a single adsorbent bed channel provides a unique opportunity to attack this low Reynolds number, three dimensional flow problem directly. Results from the three dimensional COMSOL simulations are presented and contrasted against empirical pressure drop and heat transfer correlations for packed bed flow under conditions of combined vacuum and thermal desorption.

Figures used in the abstract

Figure 1

Figure 2

Figure 3

Figure 4