Fluid dynamics simulations for an open-sorption heat storage drum reactor based on thermophysical kinetics and experimental observations

To gain insight into the involved thermodynamic processes of open sorption systems and aid in layout and development of future designs, two different methodologies are presented for the numerical description of adsorption reactors using moving beds. In accordance to earlier laboratory measurements, the molecular sieve Köstrolith 4AK was selected as sorption material and thermo-physical measurements using thermogravimetry with simultaneous differential scanning calorimetry were presented to extract the necessary interpolation functions for modelling the kinetic behaviour. Using discrete particle models in a Navier Stokes CFD Solver and particle simulations based on LIGGGHTS, the mixing characteristics of the rotating drum setup were accessed. Adsorption based on the thermo-physical measurements was implemented into the discrete particle model. Finally, a parametric study with different temperatures and water content in the inflow air was performed using a transient porous volume approach based on the adsorption implementation and different mixing algorithms. Whereas in a simple adsorption kinetic implementation, the volume averaged temperature of the reactor was already significantly reduced after 1.5 h, more realistic implementations showed a prolonged reaction time with a temperature peak at around 15 min. The temperature gap between the temperature of the particles and the usable temperature level for the energy extraction was reduced by introducing a mixing algorithm. In the simulations, zeolite temperature yields could be reached between 15 K and 28 K, corresponding to air temperatures above the material between 21 K and 33 K, which compared well to the experimental observations, where temperature shifts of the process air of up to 36 K were reported. The presented simulation methodology is able to identify partly unused areas in reactors. Numerical optimisation of the flow field and enhancing the particle mixing lead to improved reactor solutions.

General information
State: Published
Organisations: Austrian Institute of Technology, Austria Solar Innovation Center, Austrian Institute of Technology
Contributors: Reichl, C., Lager, D., Englmair, G., Zettl, B., Popovac, M.
Number of pages: 14
Pages: 994-1007
Publication date: 2016
Peer-reviewed: Yes

Publication information
Journal: Applied Thermal Engineering
Volume: 107
ISSN (Print): 1359-4311
Ratings:
BFI (2018): BFI-level 2
Web of Science (2018): Indexed yes
BFI (2017): BFI-level 2
Scopus rating (2017): CiteScore 4.14 SJR 1.505 SNIP 1.837
Web of Science (2017): Impact factor 3.771
Web of Science (2017): Indexed yes
BFI (2016): BFI-level 2
Scopus rating (2016): CiteScore 3.78 SJR 1.438 SNIP 1.851
Web of Science (2016): Impact factor 3.444
Web of Science (2016): Indexed yes
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 3.32 SJR 1.683 SNIP 1.884
Web of Science (2015): Impact factor 3.043
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 2
Scopus rating (2014): CiteScore 3.16 SJR 1.539 SNIP 2.187
Web of Science (2014): Impact factor 2.739
Web of Science (2014): Indexed yes
BFI (2013): BFI-level 2
Scopus rating (2013): CiteScore 3.31 SJR 1.466 SNIP 2.469
Web of Science (2013): Impact factor 2.624
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 2
Scopus rating (2012): CiteScore 2.7 SJR 1.492 SNIP 2.422
Web of Science (2012): Impact factor 2.127
ISI indexed (2012): ISI indexed yes
Web of Science (2012): Indexed yes
BFI (2011): BFI-level 2
Scopus rating (2011): CiteScore 2.83 SJR 1.338 SNIP 2.186
Web of Science (2011): Impact factor 2.064
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 2
Scopus rating (2010): SJR 1.385 SNIP 2.012
Web of Science (2010): Impact factor 1.826
BFI (2009): BFI-level 2
Scopus rating (2009): SJR 1.393 SNIP 2.105
Web of Science (2009): Indexed yes
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 1.151 SNIP 1.617
Scopus rating (2007): SJR 0.884 SNIP 1.495
Scopus rating (2006): SJR 1.191 SNIP 1.585
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 1.14 SNIP 1.43
Web of Science (2005): Indexed yes
Scopus rating (2004): SJR 0.969 SNIP 1.243
Scopus rating (2003): SJR 0.862 SNIP 1.105
Scopus rating (2002): SJR 0.875 SNIP 1.001
Scopus rating (2001): SJR 0.964 SNIP 1.107
Scopus rating (2000): SJR 0.943 SNIP 1.04
Scopus rating (1999): SJR 0.903 SNIP 0.89
Original language: English
Keywords: Computational fluid dynamics, Particle modelling, Rotating drum reactor, Open sorption process, Renewable heat, Seasonal storage
DOIs:
10.1016/j.applthermaleng.2016.06.119
Source: FindIt
Source-ID: 2306203180
Research output: Research - peer-review › Journal article – Annual report year: 2016