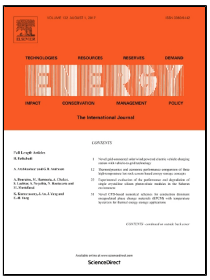
Accepted Manuscript



Multi-parameter Optimization of Double-Loop Fluidized Bed Solar Reactor for Thermochemical Fuel Production

Marco Milanese, Gianpiero Colangelo, Domenico Laforgia, Arturo de Risi

PII:	S0360-5442(17)31082-4
DOI:	10.1016/j.energy.2017.06.088
Reference:	EGY 11096
To appear in:	*Energy*
Received Date:	23 February 2017
Revised Date:	22 May 2017
Accepted Date:	15 June 2017

Please cite this article as: Marco Milanese, Gianpiero Colangelo, Domenico Laforgia, Arturo de Risi, Multi-parameter Optimization of Double-Loop Fluidized Bed Solar Reactor for Thermochemical Fuel Production, *Energy* (2017), doi: 10.1016/j.energy.2017.06.088

Multi-parameter Optimization of Double-Loop Fluidized Bed Solar Reactor for Thermochemical Fuel Production

Marco Milanese[a], Gianpiero Colangelo, Domenico Laforgia, Arturo de Risi

Department of Engineering for Innovation, University of Salento, SP per Monteroni, Lecce (Italy)

[a]marco.milanese@unisalento.it, +39 0832297760

Abstract

In this paper, the design of a double-loop fluidized bed solar reactor, involving CeO_2 nanoparticles and two gas streams of N_2 and CO_2, for efficient thermochemical fuel production, has been optimized in a six-dimensional parameter space by means of a multi-parameter optimization algorithm. The system under investigation is capable to develop a thermochemical two-step cycle, producing CO by means of the overall reaction $CO_2 \rightarrow CO + {}^1/_2O_2$. The use of nanoparticles as catalyst allows maximizing the performance of the reactor; actually, nanoparticles increase surface area of reaction, with respect to common catalysts and, at the same time, allow realizing the reactor as double-loop fluidized bed, which can operate without alternating flows of CO_2 and inert sweep gas. A genetic algorithm coupled with a quasi-random Sobol design population has been used, to find the optimal configuration of the double-loop fluidized bed solar reactor.

The results highlighted the very important role of several factors, as radius of fluidized beds, mean residence time of reactor, mass of nanoparticles within reactor, solar concentration ratio, etc., on the performance of the system under investigation and allowed to find the best configuration of the system, reaching the mean global efficiency over a period of time of 1 year equal to 29.96%, with a maximum of 59.46%.

Keywords: fluidized bed, solar reactor, syngas, nanoparticles, optimization.

Nomenclature

C	heat capacity [J/K];
Cp	specific heat capacity [J/(kg·K)];
E	energy [J];
h	heat transfer coefficient [W/m^{2}K];
H	height [m];