Project title **and acronym (if any)**	Investigation of Hydrodynamic Characteristics of Spouted Bed Nuclear Fuel Coaters
Project web site (if any)	http://www.multiphase.hacettepe.edu.tr/
Funding organization(s)	TUBITAK (The Scientific and Technological Research Council of Turkey)
Project no	108M453
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Project team	Salih Sarı, Pınar Çangal, Üner Çolak, Senem Şentürk Lüle, Görkem Külah, Murat Köksal
Budget	188 400 TL
Start-finish date	2009-2011

Project summary

One of the main applications of the conical spouted beds, which are widely used in industrial applications, is the TRISO particle coating with chemical vapor deposition (CVD) technique. TRISO particles are planned to be used in next generation high temperature gas cooled reactors (HTGR) as nuclear fuel elements. Currently, TRISO particles are produced in laboratory scale, small spouted bed coaters for prototype reactors. Once the full scale reactors are in operation, there will be a huge need for large scale CVD spouted bed coaters. In order to design and scale up large scale spouted bed coaters, the hydrodynamic (gas-solid flow and mixing patterns) characteristics of these type of contactors must be known. In the literature, available hydrodynamics studies on conical spouted beds have been mostly carried out with light particles (ρ > 2500 kg/m^3). However, nuclear fuel CVD coaters operate with uranium dioxide particles whose density decreases from 10000 kg/m^3 to 2500 kg/m^3 during coating. Information on the hydrodynamics of conical spouted beds with high density particles is scarce in the literature. The main objective of this study is to determine fundamental hydrodynamic characteristics of the conical spouted beds operated with high density particles. Within this scope, three different spouted beds were designed and manufactured with cone angles of 30˚, 45° and 60°and experiments were performed. In these experiments, zirconia (ZrO_2) particles with particles diameters of 0.5 mm and 1 mm and particle density of 6050 kg/m^3 were used. Using various types of measurement systems and techniques, minimum spouting velocities, bed pressure drops, gas and particle velocities, particle concentrations, gas mixing characteristics were determined for different operating conditions. Based on the experimental results, empirical correlations for predicting bed pressure drop and minimum spouting velocity were proposed.

Scientific, technological, economic and social gains obtained or expected by the project

The information obtained in this study and developed correlations can be used for the design of spouted bed nuclear fuel coaters.

Publications derived from the project

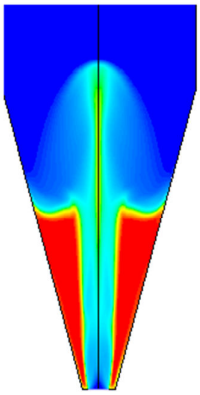
1. Kulah, G., Sari, S., Koksal, M., “Particle Velocity, Solids Hold-Up and Flux Distributions in Conical Spouted Beds Operating with Heavy Particles", **Industrial & Engineering Chemistry Research**, v.55, p. 3131-3138, 2016.

2. Senturk-Lule, S., Colak, U., Koksal, M., Kulah, G., "CFD Simulations of Hydrodynamics of Conical Spouted Bed Nuclear Fuel Coaters", **Chemical Vapor Deposition**, v.21, p. 122-132, 2015. (ilgili derginin kapağında yer aldı).

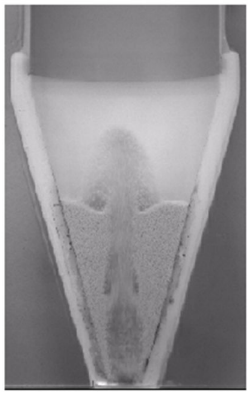
3. Mostoufi, N., Kulah, G., Koksal, M., "Flow Structure Characterization in Conical Spouted Beds Using Pressure Fluctuation Signals", **Powder Technology**, v.269, p. 392-400, 2015.

4. Sari, S., Kulah, G., and Koksal, M., “Characterization of Gas-Solid Flow in Conical Spouted Beds Operating with Heavy Particles”, **Experimental Thermal and Fluid Science**, v. 40, p. 132-139, 2012.

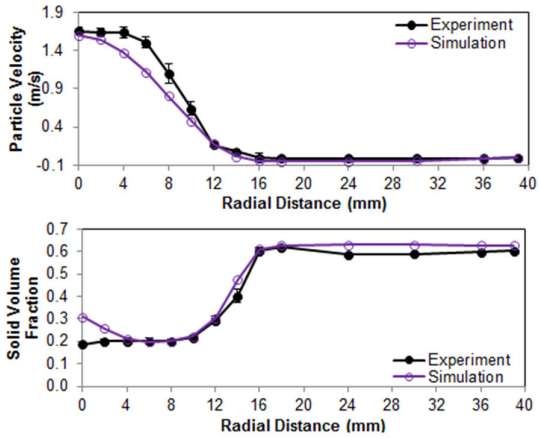
Figures and images related to the project



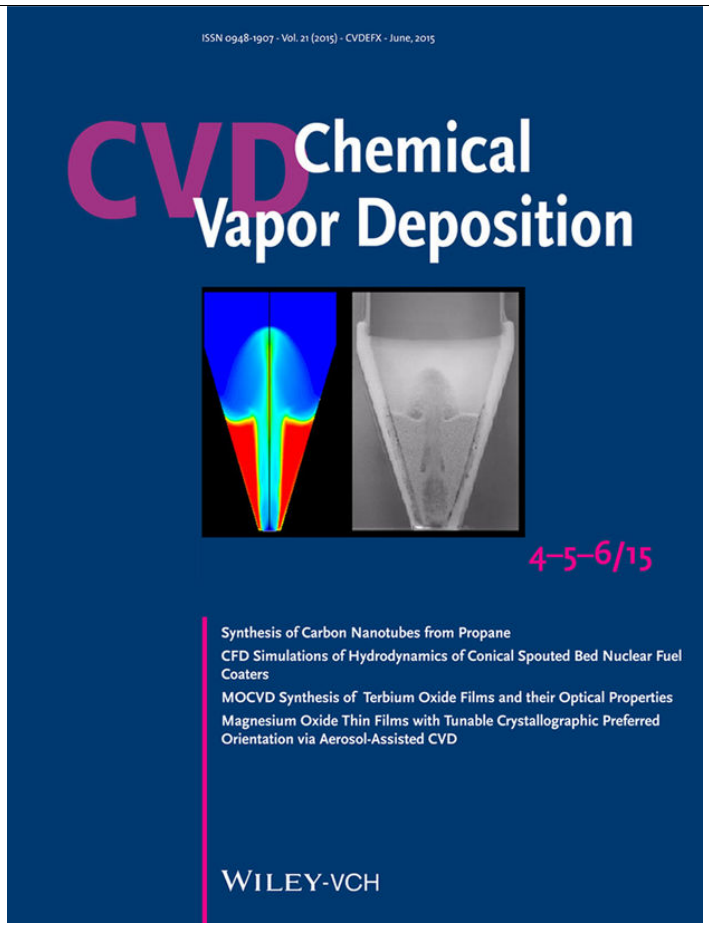
Simulation



Experiment



Comparison of the measured particle velocity and solids volume fraction with the results of the computational fluid dynamics (CFD) model in a conical spouted bed with high density particles. The image on the right hand side shows the experimental distribution of the solids volume fraction (obtained by a high speed camera) and the left hand side image shows the distribution obtained from the CFD model.



Cover page of the Chemical Vapor Deposition journal (Senturk-Lule, S., Colak, U., Koksal, M., Kulah, G., "**CFD Simulations of Hydrodynamics of Conical Spouted Bed Nuclear Fuel Coaters**", Chemical Vapor Deposition, v.21, p. 122-132, 2015).