Chapter 3
Fluid Dynamic and Mixing Characteristics of Biomass Particles in Fluidized Beds

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ABSTRACT

The study of fluid dynamic and mixing characteristics of biomass particles in fluidized beds is fundamental for comprehension of thermal conversion processes. In this chapter a review of literature showed a large lacks of technical information about the quality of fluidization and representative models concerning binary mixtures (biomass and inert). A case study was presented involving Eucalyptus grandis wood and tucumã endocarp in order to obtain fluid dynamic parameters such as the characteristic fluidization, velocity and porosity, and the bed expansion. These parameters were more significant for mixtures with smaller diameter and mass fraction ratios, and sphericity ratio, due to the facility of beds to fluidize. A map was presented to identify the limits of effective mixtures considering four classes as a function of the complete fluidization Reynolds’ and Archimedes’ numbers. Empirical correlations have been proposed and showed a good agreement with the experimental work.

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INTRODUCTION

The social requirement for sustainability has conducted researches to study the use of renewable energy sources in replacement of fossil fuels (non-renewable and highly polluting), widely applied in recent centuries. Among the alternatives available, biomass is the one to be considered. In Brazil, among the numerous sources, agricultural and industrial residues play an important role in the energy matrix (Brazilian Energy Balance, 2014).

Renewable fuels can be obtained through different equipments, and among them fluidized beds are highlighted. The development of these kinds of technologies over the years has allowed achieving higher efficiency levels reducing emissions and increasing fuel flexibility, which are keys to the current global market and environmental conditions (Peña, 2011). The products obtained from these technologies are: solid fuels (biochar) produced by pyrolysis, gases by gasification, and liquid after the synthesis of these gases. The fluidized bed design and the success of the scale-up applying biomass depend strictly of the best operating conditions and the fluid dynamic behavior of particles in the bed.

This chapter will present an overview from literature about fluid dynamic and mixing of biomasses associated to experimental studies, focusing in basic design parameters such as: characteristic fluidization velocities and porosities, and bed expansion in gas-fluidized beds. Besides that, a case study will exemplify the differences between biomasses (Eucalyptus grandis and tucumã endocarp) showing recommendations to succeed the best mixtures with inert material (sand), and also to propose empirical correlations of these parameters. This work can be useful for researchers of academy and industry to obtain better efficiency in their thermal conversion reactors improving the utilization of biomass as a renewable fuel.

BACKGROUND

Despite the efforts in developing technologies to convert biomass into energy employing fluidized beds, few authors have attempted to understand the fluidization mechanics of biomass or it mixture with an inert (Cui & Grace, 2007). Generally, it is assumed that the design and operation of equipment involving biomass can be based on the conventional knowledge of fluidization. The use of fluidized beds stands out with numerous advantages such as: high heat transfer, uniform and controllable temperatures, and efficient gas-solid contact. However, for it occur effectively, the ideal operating conditions and choice of materials must be performed carefully (Basu, 2010; Cui & Grace, 2007; Gómez, Mesa-Pérez, & Brossard-Perez, 2008).
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