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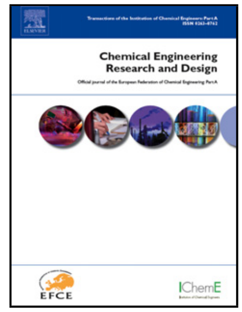

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Ultrasonic precipitation of manganese carbonate: reactor design and scale-up

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Abstract
This study discusses the reactor design and a possible scale-up strategy for ultrasonic precipitation of manganese carbonate. Preliminary experiments, performed in a 200 mL continuously stirred tank reactor (CSTR) equipped with an ultrasonic transducer or probe, identified the importance of generating a homogenously distributed ultrasonic field of about 40 kHz to improve the sphericity of the powder. In this lab-scale reactor, spherical particles with a tap density of more than 2.0 g.cm^{-3} were obtained under sonication, compared to only 1.3 g.cm^{-3} during silent conditions. Alternatively, a design with an ultrasonic unit in a recirculation loop resulted in a similar relative improvement compared to silent conditions. However, since the recirculation reactor did not reach a tap density of above 2.0 g.cm^{-3}, the scale-up of this configuration was discarded. In the end, a basic CSTR was scaled to 50 L by using a single radial oscillating probe, operating at 40 kHz and 1 kW. This semi-pilot scale reactor was able to produce particles with a tap density of about 90 % of the value attained at lab-scale although the power density was reduced by more than half.
Keywords: Ultrasonic precipitation, Particle engineering, Reactor design, Scale-up

Highlights

- Sphericity of $MnCO_3$ powder is strongly improved by a homogeneous ultrasound field;
- Parallel placement of ultrasound is a feasible reactor design, but optimization is required;
- Radial oscillating probes can efficiently be applied for large-scale processing;
- Successful design of a 50 L continuous stirred reactor for ultrasonic precipitation

1. Introduction

The potential of ultrasound in precipitation processes has been successfully demonstrated on lab-scale by many authors. In all cases, strong effects on both the particle size distribution (PSD) and morphology were observed.(Alavi and Morsali, 2010; Jeevanandam et al., 2001; Nishida, 2004; Shirsath et al., 2015; Sivabalan et al., 2007; Zhang et al., 2009) Firstly, ultrasound is able to reduce the PSD of the precipitates, also termed as grinding. (Alavi and Morsali, 2010; Cabanas-Polo et al., 2011; Kaully et al., 2003; Yang et al., 2007; Zhang et al., 2009) This *grinding effect* mainly originates from the mechanical effects of cavitation