Abstract

This paper focuses on the analysis of titanium oxide particle deagglomeration processes in industrial equipment. It covers theoretical model development, experimental research, and computational work. The study is divided into ten chapters. The first chapter includes purpose and scope. Second chapter describes the material, titanium oxide, its importance in industry, and the challenge of breaking up solid particles in industrial devices. The subsequent sections provide a characterization of commercially available titanium oxide powders, based on which the theoretical tensile strength of agglomerates is calculated. The paper includes descriptions of the rheological properties of suspensions and studies on the viscosity of liquid suspensions of titanium oxide powders. A method for testing the tensile strength of solid particle agglomerates using a rotational rheometer is proposed. Further, the paper discusses research on breaking solid particles in suspension using a mixer equipped with impellers that generate high shear stresses. Seven types of impellers were tested, including five novel designs, with their deagglomeration efficiency examined at various rotational speeds. The results for the three novel impellers that produced the best outcomes are presented, and their efficiency is compared with that of an industrial solution. The study also includes research on breaking titanium oxide particles using industrial rotor-stator systems and a bead mill. The research assessed the impact of rotor speeds, as well as, in the case of the mill, the size of the grinding media, the degree of chamber filling with beads, and the speed of the inner shaft rotation. The studies were conducted in both batch and continuous flow modes. In the following chapters, a computational fluid dynamics (CFD) analysis of industrial particle-breaking devices is described. Population balance techniques were then employed to predict the course of deagglomeration processes in mixers and bead mills. The final chapter summarizes the overall results and provides conclusions from the study.

Keywords: breakage, mill, rotor-stator, mixer, modelling