DE-AGGLOMERATION OF NANOPARTICLES IN AN IMPACTOR-ASSISTED FLUIDIZED BED

Jason R. Tavares, Department of Chemical Engineering, École Polytechnique de Montreal, Canada
jason.tavares@polymtl.ca
Hamed Nasri Lari, Jamal Chaouki, Department of Chemical Engineering, École Polytechnique de Montreal, Canada

High surface-to-volume ratio and high activity of nanoparticles cause interesting changes in material properties; however, these features often lead to the formation of undesired agglomerates. When agglomerated, nanoparticles lose their outstanding properties; hence, it is essential to break them up prior to use, and prevent the re-agglomeration.

There are several techniques to de-agglomerate nanoparticles, such as rapid expansion of supercritical suspensions (1) and low pressure single stage impactors (2). Utilizing fluidized beds, Pfeffer et al. applied a downwardly facing micro-jet in order to enhance the quality of nanoparticle fluidization (3). Bremer et al. (4) patented a method to de-agglomerate catalyst particles by applying a high velocity jet upwardly in the fluidized bed. Further efforts by Yi (5), using a vibrated fluidized bed, focused on particle mass concentration rather than de-agglomeration of nanoparticles. However, all these attempts were not able to result in long-lasting nano scale particle dispersions.

The main objective of this project is to break up the large fractal-shaped agglomerates to smaller clusters, preferably to individual nanoparticles, using an impactor-assisted fluidized bed. In our work, a fluidized bed is equipped with a pulsed-jet and an impaction plate. The force required to destroy the agglomerates is controlled by the gas jet velocity in the impaction zone. Calculating the impcation velocity determines the kinetic energy of particles upon impaction and makes it possible to measure the fragmentation degree of nanoparticles. This impactor-assisted bed also includes a surface functionalization post-treatment, based on photo-initiated chemical vapor deposition (6), to ensure particle stability.

REFERENCES

1. To, D., R. Dave, X. Yin, and S. Sundaresan, Deagglomeration of nanoparticle aggregates via rapid expansion of supercritical or high-pressure suspensions. AIChE J., 2009. 55(11): p. 2807-2826.
2. Seipenbusch, M., P. Toneva, W. Peukert, and A.P. Weber, Impact Fragmentation of Metal Nanoparticle Agglomerates. Part. Part. Syst. Char., 2007. 24(3): p. 193-200.
3. Pfeffer, R. and J.A.Q.J. Flesch, Fluidized Bed Systems And Methods Including Micro-Jet Flow. 2008, New Jersey Institute Of Technology Evonik Degussa Gmbh.
4. Bremer, N.J., L.R. Trott, and T.R. McDonel, Method for deagglomerating and re-exposing catalyst in a fluid bed reactor. 1992-06-23 The Standard Oil Company.
5. Nurkiewicz, J.Y.T.R., Nanoparticle aerosol generator, USPTO, Editor. 2014, West Virginia University: US.
6. Dorval Dion, C.A., W. Raphael, E. Tong, and J.R. Tavares, Photo-initiated chemical vapor deposition of thin films using syngas for the functionalization of surfaces at room temperature and near-atmospheric pressure. Surf. Coat. Technol., 2014. 244: p. 98-108.