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Effect of variable acoustic field on fluidization behaviour of micro particles

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ABSTRACT: *Suspensions of fine particles in either Newtonian or non-Newtonian fluids are often encountered in the physical, engineering and biological sciences. For example, the manufacture of particle-laden products such as reinforced composites, paints, paper, slurries, cements etc. involves the processing of particle suspensions. Fine particles become difficult to suspend due to interparticle attraction forces like ver der Waals force; capillary and cohesive forces etc. are responsible to convert the fine particles into aggregate. These aggregates restrict the particles to get suspend uniformly, hence external forces are essential to break these aggregates. External forces are magnetic field, electrical field, acoustic field, mechanical vibration etc. which are useful to break the aggregates and suspend the particle uniformly. This process is termed as homogeneous fluidization. It is common experience that, conventional fluidization is impossible if the interparticle attraction is large. Acoustic field is the best option to break the interparticle forces.*

I. INTRODUCTION

Recent interest in processing of fine particles raises the practical question of the fluidizability of non-fluent sol ids. For number of applications, particularly in ceramic processing, it is of ten de sired to obtain powder flowability without agglomerates. How ever, fluidization of very fine, cohesive powders (less than 75 mm) is dif fi cult to fluidize, since they have very poor flow character is tics. More over, gas channels and stagnant zones are formed in the bed resulting in restricted particle motion. Once the channels have been created, they tend to enlarge with further increase in gas velocity. In re cent years, the use of additional forces (i. e. mechanical vibration, stir ring elements, etc.) has been tested to improve the quality of fluidization of cohesive powders. How ever; much of attention has been directed to wards vibrated bed.

II. REVIEW OF LITERATURE

The work was started by Morse[1] to improve the quality of fluidization with the help of acoustic field. It was seen that, low-frequency, high-intensity sound above 110dB could improve the fluidization of fine particles[2] used sound intensity to speed up the fluidization for various materials ranging from 7µm to 97µm. A loudspeaker was located above and at the bottom of the bed. Fluidization of fine particle in presence of sound intensity was also studied in 2-D column.

Chirone[3] studied the effect of acoustic field on five cohesive solids, ranging from 0.3 to 11µm up to SPL of 150dB. Sound-assisted aeration gives rise to bubble free fluidization.

Afterward, Leu and Haung[4] presented a theoretical model of transition from Geldart group C to A powders. The interparticle forces and the group C/A boundary of lower density powders were estimated. The behavior of eight types of Geldart C particles was studied in the sound wave vibrated fluidized beds. Russo et al.[5] studied the influence of frequency by using nonfluent 0.5-45µm catalyst particle with a 145mm ID column. A loudspeaker generated acoustic field varying from 110 to 140dB and frequency from 30 to 1000Hz has been used with different L/D ratio. Levy et al.[6] studied the effect of acoustic field on very fine particles in the Geldart group C range. It was seen that, the homogeneous fluidization and bed expansion observed was occurred in presence of acoustic field due to external force on the bed particles. Guo et al.[7] investigated the fluidization behaviors of ultrafine particles in an acoustic fluidized bed with one type of micron particles and two types of nanoparticles (d_p = 500nm – 10.69µm). It was stated that, with the assistance of sound wave with low sound frequency and high sound pressure level, the micron and nanoparticles can be fluidized smoothly with fluidization behaviors similar to those of Geldart group A particles.

Also, Roy and Kytomaa[8,9] published the model on speed of sound in fine powder. Guo et al.[10] studied the fluidization behavior of three types of SiO_2 ultrafine particles (d_p = 5-500nm) in a fluidized bed with sound excitation. It has been shown that agglomerate size tends to reduce with an increase in sound pressure level. Recently, Langde et.al[11] worked on two different particles, 112 μm micro fumed silica and 180 μm glass bead powders, and reported that these two particle types gave good quality of fluidization in presence of acoustic field when compared with the performance without any sound field.

PROPOSED EXPERIMENTAL SETUP

The experimental set up is shown in fig. 1. It consists of cylindrical fluidization column and sound generation system. A porous distributor was located at the bottom of the column. Experiments will perform with air at atmospheric pressure and room temperature. The air flow rate will measured by using rotameter. A digital signal generator was used to obtain different wave of specified frequency. The signal was amplified by means of a power audio amplifier and sent to a speaker. The speaker was placed at the top of the column.

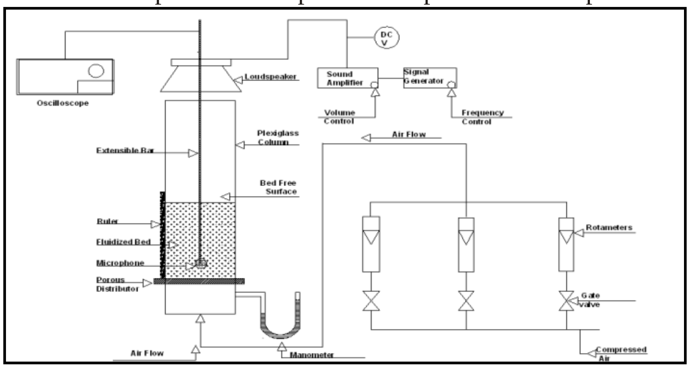

Fig.1 Experimental Setup

Aims and Objective:

To improve the flowability of fine particle.
To report the measurement of minimum fluidization velocity by varying sound pressure level
To study the effect of sound on binary mixture of particle

REFERENCES

Morse R.D.(1955), "Sonic energy in granular solid fluidization", Industrial & Engineering Chemistry, 47, 1170-1175.
Nowak, W., Hasatani, M., Derczynski, M. (1993) ,"Fluidization & heat transfer of Fine particles in an acoustic field." AIChE symp 89, pp. 137-149.
Chirone R., Russo P, Massimila L, and Russo S.(1994), "The influence of the frequency of acoustic waves on sound assisted fluidization of beds of fine particles", Powder Technology, 82, 53-57.
Leu, L.P., Huang, C.T. (1994) "Fluidization of cohesive powders in a sound wave vibrated fluidized bed." AIChE symp. Ser., 90, 301, pp. 124-141.
Russo, P., (1995), "The Influence of the Frequency of Acoustic Waves on Sound Assisted Fluidization of Beds of Fine Particles." Powder Technology, 82, pp. 219-230.
Levy, E.K., (1997), "Effect of an Acoustic Field on Bubbling in a Gas Fluidized Bed." Powder Technology, 90, pp. 53-57.
Guo, Q., (2006), "Influence of sound wave characteristics on fluidization behaviors of ultrafine particles." Chemical Engineering Journal, 119, 1, pp. 1-9.
R. Roy, J.F. Davison, V.G. Tuponogov (1990), "The velocity of sound in fluidized beds", Chem. Eng. Sci. 45 (11) 3233– 3245.
H.K. Kytomaa, Powder Technology, 82, 1995 115.
Q. Guo, Y. Li, M. Wang, W. Shen, C. Yang (2006)"Fluidization Characteristics of SiO2 Nanoparticles in an Acoustic Fluidized"
Langde A.M. , Tidke D.J., Sonolikar R.L, "Hydrodynamics study of group A/B particles in presence of an acoustic filed", International journal of Acoustic and Vibration, vol. 16, pp. 81-87 (2011a)
Leu, L.P., Li, J.T., Chen, C.M. (1997) "Fluidization of Group B Particles in an Acoustic Field. Powder Technology", 94, pp. 23-28.
Levy, E.K., Celest, B., (2006), "Combined Effects of Mechanical and Acoustic Vibrations on Fluidization of Cohesive Powder". Powder Technology, 163, 1-2, pp. 41-50.
Xu, C., Cheng, Y., Zhu, J. (2006), "Fluidization of fine particles in a sound field and identification of group c/a particles using acoustic waves. Powder Technology", 161, pp. 227-234.
Xu, C., Zhu, J. (2006), "Parametric study of fine particle fluidization under mechanical vibration. Powder Technology", 161, pp. 135-144.
Chao Zhu, Guangliang Liu, Qun Yu, Robert Pfeffer, Rajesh N. Dave, Caroline H. Nam, (2004) "Sound assisted fluidization of nanoparticle agglomerates". Powder Technology, 141, pp 119 – 123.
Luis F. Hakim, Julie L. Portman, Michelle D. Casper, Alan W. Weimer, (2005), "Aggregation Behavior of nanoparticles in fluidized beds", Powder Technology, vol 160, pp. 149-160