Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 1, Number 2; October, 2014 pp. 43-45

http://www.krishisanskriti.org/jbaer.html

DEM Simulation of Coal Particles for Effective Dispersion

Rahul S. Mehatre[1], Shailesh M. Dhomney[2], Devendra K. Sakhre[3], Rahul S. Mehatre[4]

[1,2]*M.Tech. Student, DBACER College, Nagpur*
[3]*CSIR-CIMFR Nagpur*
[4]*Corresponding author, M Tech- CAD CAM Automation, rahulmay@gmail.com*

Abstract: ***The concept of discrete & numerical discrete element method (DEM) was studied for the effect of particle having circular/noncircular shapes for granular flow through the hoppers in the air media. Coal is here used as a granular material considering circular/non-circular shape and size for the computerized analysis. For this high-end mechanical engineering software was used as CATIA for 3D Modelling, ANSYS ICEM CFD for Meshing & E-DEM for Modelling of particles and Simulation of the whole process to obtain the numerical result data and to find dispersed particle displacement. The study of the effect of particle shape, size, and density on the discharge flow rate of giving airflow.***

Keywords: CAD, CFD, DEM, Coal & Granular Material.

1. INTRODUCTION

Flow of granular materials through hopper is important in the field of Mining, Mineral processing and Parma industry. This also has a considerable scientific interest because they exhibit some phenomena which are specific to granular materials. The present day development in the field of CAD, CFD and EDEM provides the opportunity to the design Engineer for devising best possible equipment.

The Discrete Element Method (DEM) is very sophisticated tool for studying the granular flow and the behavior of the granular materials. Here the particle can be modelled as an assembly with considering the dynamic parameters like its positions, velocity, its orientation, etc.

Modelling in DEM allows us to consider the nature of granular material, and the fundamentals of the granular flow. Many of the researchers were made research on the flow of granular material; some of them have also used the Discrete Element Method to perform the analysis of granular materials, but still researchers and scientist are working on the study on the flow of granular materials.

To explore the effect by using regular shaped (circular particle) and irregularly shaped particle (peanut shape and plate shape) together of coal with different density were used in the simulation. The result of same is presented and discussed below.

2. DEM - DISCRETE ELEMENT METHOD

DEM - Discrete Element Method is a numerical method for computing the motion and effect of a large number of small particles. Simulation in E-DEM Software is transforming the business of designing and optimizing equipment for the handling and processing of bulk materials. In proper use DEM simulation can give key design information on bulk solid material flow behaviour that is very difficult to get using standard test methods or other methods of engineering simulation.EDEM is high-performance DEM simulation software–the only commercially available software that is capable of generating the powerful DEM simulations and analysis required to solve complex problems in the design, prototyping, and optimization of equipment that handles and processes bulk solid materials–across a wide range of industry sectors, which was introduced to industry nearly a decade ago, EDEM is powered by state-of-the-art Discrete Element modelling technology and uniquely provides engineers with the capability to quickly and accurately simulate and analyse the behaviour of their granular solids systems.

3. GRANULAR MATERIAL

Granular materials are as a large conglomerations (a number of different things, parts or items that are grouped together) of discrete macroscopic particles. As explained in the article of "The Physics of Granular Material" by Jaeger & Nagel. This also tells, that granular material behaves different from the other familiar forms of matter-solids, liquids or gases-and might therefore be considered an additional state of matter in its own right.

4. MODELING OF GRANULAR MATERIALS

Using Coal as a granular material and aiming to track the trajectories and study the behavior of coal with air media. The modelling of particles is possible in EDEM but for this we need to provide some physical properties of respective material, this was taken from the Govt. Coal laboratory (CIMFR) by studding more about Coal we found that coal mostly has an irregular shape and size, in which it founds nearly as spherical shape, peanut type shape and plate type shape, so we made modelling of a coal particle as same (see figure 1).

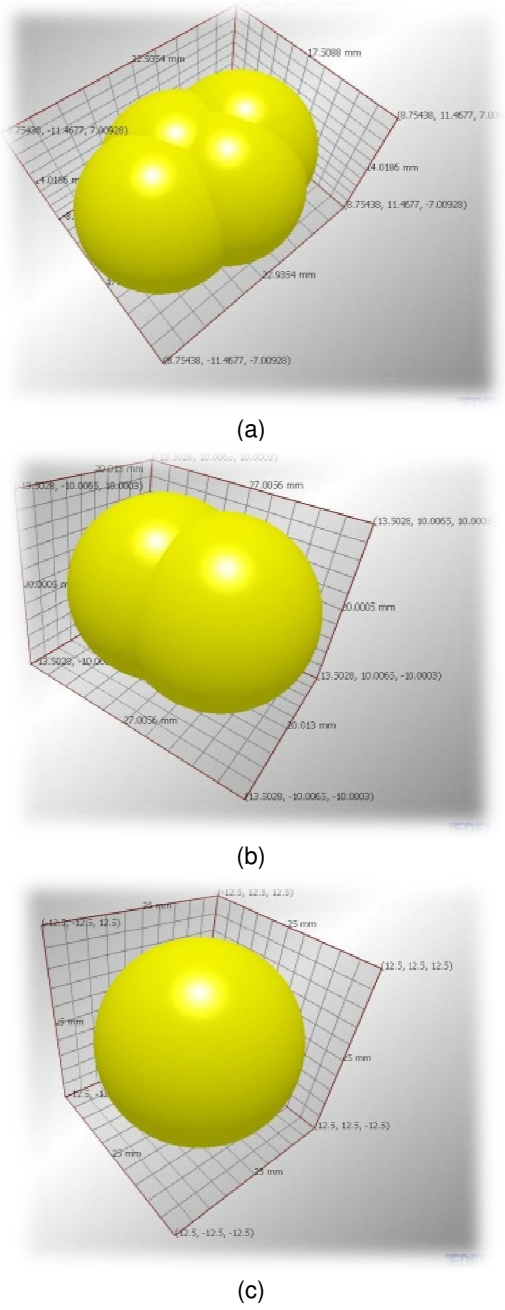


Fig. 1. Shape of Coal Particle generated in EDEM (a) plate, (b) peanut and (c) Spherical

5. CAD & CFD WORK

Considering rectangular hollow box as working chamber and 3d modelling of same is made in the CATIA V5 R21, this chamber also has a hopper on its upper side, and opening and exit for air flow in its left and right side as, shown in figure 2. The same 3d modelling is also possible in EDEM itself, but as this is made for simulation and analysis work it makes more difficult to use this for 3d modelling.

Airfield also needed to create in CFD-Fluent, which is shown in small blue vectors in 3d model of the chamber.

6. CFD-DEM SIMULATION

The coupling of CFD field is needed to do with EDEM, for which parameters needed to use like as the mass flow rate of the granular materials, time step and unit cell size, etc. So one can able to vary the mass flow rate of granular material, but to make change in air velocity its needed to create another CFD field for each time.

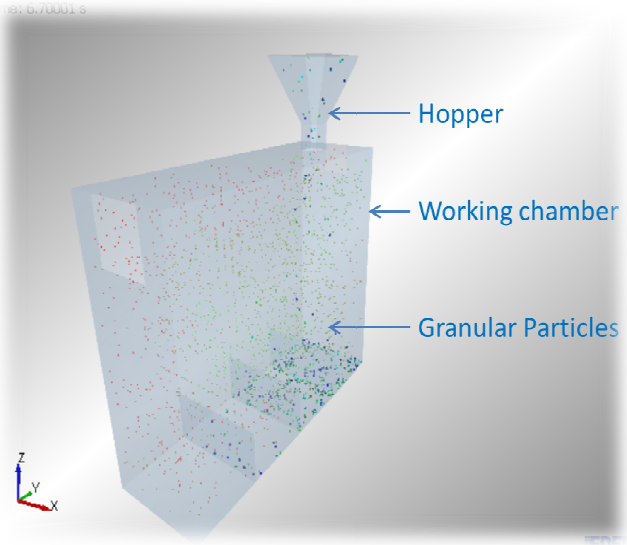


Fig. 2. In Simulation

7. RESULT AND DISCUSSIONS

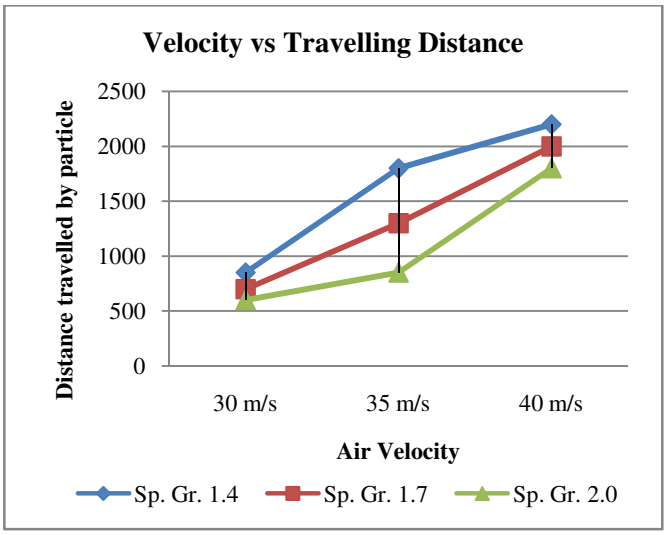
After doing much experimentation with CFD-DEM simulations, important of them are presented here for discussion

8. FOR AIR VELOCITY

To fix the air velocity, we made experimentation on EDEM using similar sized & shaped coal particles but of different sp. gravity was tested at three different air velocities.

Table 1. Velocity Vs travelling distance

Sr. No.	Coal (spherical shaped)	Air Velocity		
		30 m/s	35 m/s	40 m/s
1	Sp. Gr. 1.4	850 mm	1800 mm	2200 mm
2	Sp. Gr. 1.7	700 mm	1300 mm	2000 mm
3	Sp. Gr. 2.0	600 mm	850 mm	1800 mm



Graph 1. Velocity Vs travelling distance

The above graph clears that in 35 m/s velocities, travelled distance for different sp. gravity coal is resulting with more distance in between than the other, so for better understanding fixing the velocity for further experimentations.

Table 2. Result of different shaped coal on 35 m/s air field

Sp. Gr.	Coal Shape	The distance travelled by Particles				
		0.7 m	1m	1.3 m	1.6 m	1.9 m
1.4	Spherical shape	0	12%	21%	29%	38%
	Peanut type shape	6%	15%	20%	26%	33%
	Plate type Shape	3%	14%	21%	27%	35%
1.7	Spherical shape	4%	17%	26%	20%	33%
	Peanut type shape	7%	21%	23%	21%	28%
	Plate type Shape	5%	20%	24%	19%	32%
2.0	Spherical shape	9%	42%	30%	13%	5%
	Peanut type shape	8%	40%	32%	18%	2%
	Plate type Shape	5%	38%	32%	15%	9%

Dispersion pattern of coal particles

Air velocity of 35 m/s was used to understand the dispersion pattern of different shaped and specific gravity of coal particles. Spherical, peanut and plate shaped coal particles with specific Gravity of 1.4, 1.7 and 2.0 was used.

The Table No. 2 shows the weight % of coal particles separated at different distances from the air feed end at 35 m/s air velocity. The result shows that higher density particle travels at less distance and lower density particles travels more distance in the working chamber.

9. ACKNOWLEDGEMENTS

This work was supported by Central Mining & Fuel research Institute, Nagpur under the Council of Science & industrial Research, India.

10. CONCLUSION

Segregation of different density particles by air medium can be effectively utilized for separation of various densities particles in Agri. and Mineral industries. To study the behavior of segregation of particles at different input parameters EDEM software along with 3D CAD, FLUENT can be effectively used.

REFERENCES

[1] H.P. Zhu & Z.Y.Zhou, Discrete particle simulation of particulate systems: A review of major applications and findings, journal of chemical engineering science 63(2008),

[2] Robertas Balvicius & Rimantas Kacianauskas, Modelling of filling and discharge of granular materials in hoppers by discrete element method: optimization of some flow parameters, from 6th world congress of structural and multidisciplinary optimization 2005

[3] P.W.Cleary & M.L.Sawley, DEM Modelling of industrial granular flows: 3D case studiesand the effect of particle shape on hopper discharge, Applied Mathematical Modelling 26 (2002) 89-111.

[4] H.M.Jaeger & S.R.Nagel, The Physics of Granular Materials, an article in Physics Today, April 1996 of American society of physics.

[5] R.L. Michalowski, Flow of granular Material through a plane Hopper, powder technology, 39 (1984) 29-40.