PhD Public Defence

Title:	On the Adhesive Behaviour of Micron-sized Particles in Turbulent Flow - A numerical study coupling the discrete element method and large eddy simulations
Location:	Pontoppidanstræde 105, room 3.115
Time:	Monday 27 November 2017 at 13.00
PhD defendant:	Jakob Hærvig
Supervisor:	Associate Professor Kim Sørensen
Moderator:	Professor Lasse Rosendahl
Opponents:	Professor Søren Knudsen Kær, Dept. of Energy Technology, Aalborg University (Chairman) Professor Martin Sommerfeld, Otto-von-Guericke University Magdeburg, Germany Professor Jeffrey S. Marshall, University of Vermont, USA

All are welcome. The defence will be in English.

**After the defence there will be an informal reception
in Pontoppidanstræde 111 (coffee room).**

DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

Abstract:

Small particles are commonly observed to stick to one another (typically denoted agglomerate) due to inter-particle attractive forces. When particles agglomerate their interaction with the surroundings is changed significantly. Particles with this behaviour are found in wide range of processes ranging from dust particles in space, that agglomerate to form early stages of planets, to soot particles emitted from various combustion processes on Earth that reduce the efficiency of various industrial processes by sticking to surfaces. Most particles influenced by inter-particle attractive forces have diameters ranging from $d_p = O(0.1\ \mu m)$ to $d_p = O(10\ \mu m)$. Due to their small size, experimental investigations are limited to single particles colliding with a surface under well-controlled conditions. When adhesive particles interact in a turbulent flow, tracking individual particles in time becomes close to impossible. Due to the difficulties with tracking adhesive particles experimentally, computational methods with varying level of complexity have been developed over the last decades. Recent development within computational methods, such as the Discrete Element Method (DEM), allow more aspects of the agglomeration process to be resolved directly based on the properties of the particles. Despite the increase in computational power in the recent years, simulating the interaction of thousands, millions or even billions particles remains limited by the computational power of modern computers.

In this study, focus is first on how to analytically derive a criterion describing how to effectively speed up DEM simulations by altering the physical properties of the particles. For this purpose, simulations involving two particles colliding under various conditions are carried out to ensure the adhesive behaviour remains unchanged after applying the criterion. In conjunction with the criterion proposed, a relation describing the computational speed up is proposed.

Secondly, focus is on applying the criterion to investigate how adhesive particles interact in a turbulent pipe flow by coupling Large Eddy Simulations (LES) of turbulent flow to the Discrete Element Method (DEM). Initially, simulations are done to verify the validity of the analytically-derived criterion. Next, simulations are done for a wide range of particle properties to get a better understanding of how particle properties affect the agglomeration and deposition process.