Summary

In the process of handling, storing and transshipping of bulk solid materials more and more attention is demanded to environmental aspects, especially on the subjects of dust- and noise pollution.

This extra demand for more attention results in research on possible solutions for minimizing dust loss during bulk handling operations and leads to the main research question: *"Can numerical methods like Computational Fluid Dynamics be used to analyze dust propagation at handling, storing and transshipping activities of bulk solid materials?"*

First, the basic working principles of Computational Fluid Dynamics software were researched: CFD uses the Navier-Stokes equations of conservation of mass, momentum and sometimes energy to calculate the flow field to be simulated. Besides this, the general capacity of CFD to simulate particle transportation in a gas flow was researched: on a particle-scale CFD makes use of Discrete Element Modeling to simulate particle trajectories and collisions. The most important choices and variables to be determined in order to provide a correct simulation are also provided.

Then, the field of aeolian sedimentology is researched: the forming processes of dunes where deemed highly similar to airflow past bulk solid material stockpiles. Basic types of the flow field are provided, as well as the different processes of particle entrainment, transportation and deposition. Also, the forces acting on individual particles are determined as well as factors like moisture or vegetation, influencing the threshold of entrainment. On a smaller scale, the most important characteristics of bulk solid material particles are treated as well as their influence on the bulk material.

In order to characterize the literature found in the field of dust propagation at bulk handling processes or similar fields, the bulk handling cycle of transportation, transshipment, transfer and storage was summarized. Then, four cases were determined which were thought to have the highest degree of dust propagation during the handling of bulk solid materials: belt conveying, pneumatic conveying, deposition of bulk solid materials and bulk storage in stockpiles.

Concluding, to answer the main research question, it can be stated that CFD can indeed be used to analyze dust propagation at handling, storing and transshipping activities of bulk solid materials, but that the level of research is not up to correctly simulating all phenomena involved with dust propagation. In some fields only qualitative statements concerning dust propagation

based on the simulated flow field can be provided, while in other cases techniques are able to simulate dust propagation at the scale of individual particulates. This conclusion results in a division of dust simulations using CFD into two main categories: the first is CFD-only, where quantitative and qualitative statements can be made about the flow field; using these flow field conclusions, only qualitative conclusions can be made about dust transport. The second part is the combination of CFD and DEM, in which case particles are actually included in the simulation and qualitative as well as quantitative conclusions can be drawn about the subject.

Another important conclusion is that, because of the limited availability of experimental data, a big portion of CFD simulations use the same experimental results to validate the simulations: this results in a disproportionate influence of certain experimental research on simulations, which might cause mistakes in experimental measurements to wrongfully be modeled and validated in CFD simulations.

An interesting recommendation is that it would probably be a good start to research if it is possible to use the CFD-DEM modeling techniques from the pneumatic conveying simulations on simulating bulk storage in stockpiles. It is also recommended to further investigate the influence of the different CFD and DEM model parameters, because none of the research found presents a complete image of the choices that have been made as well as a complete assessment of the influence of these choices on the modeled results.