



SMALL  MATTERS

Research & Development

**Bulk powder
behavior**

Sizing

Porosity

Composition

This summary is a compilation of the Delft Solids Solutions' research capabilities and services. On request, our expertise enables special projects going beyond these illustrated capabilities and services. Most of the investigations can be executed in accordance with International Standards (DIN / ASTM / EN-ISO)



Bulk Powder Behavior

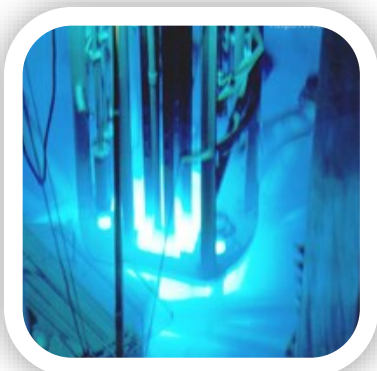
Reliable mass flow of bulk solids from silos, hoppers, and big-bags is essential. However, core/funnel flow, stagnant zones, arching, ratholing, uncontrolled flow and segregation are common problems. Handling e.g. conveying may cause wear of the particles, cause fine dust and can affect quality. Investigation and quantification of such properties of a powder or granular material can prevent or eliminate problems and is essential for quality control, material engineering or design of equipment.



- ◆ Flowability and Floodability according to Carr
- ◆ Shear stress according to Jenike, Schulze or Peschl in consolidation ranges up to 30 kPa
- ◆ Uniaxial compact strength to mimic big bag consolidation
- ◆ Particle crushing strength / hardness, particles from micrometers up to millimeters
 - ◇ repeated impact
 - ◇ crushing individual particles, granules or extrudates
- ◆ Bulk crushing strength of powder/particle beds
- ◆ Dustiness of bulk materials
 - ◇ Quantitative determination of inhalable, thoracic and respirable dustiness fractions
 - ◇ Total dust formation of feed, food, active pharmaceutical ingredients, etcetera
- ◆ Segregation tendency of bulk solids and powders by different segregation mechanisms
- ◆ Attrition and Abrasion; the propensity of particles and granules to produce fines in the course of transportation, handling, and use

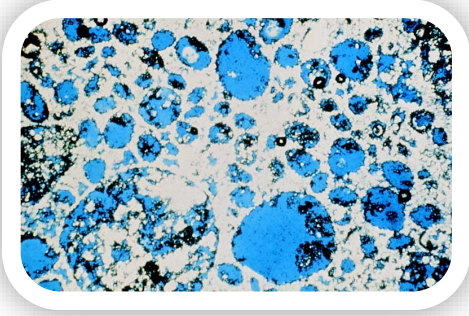
Composition

All matter consists of elements and for defining matter compositional and structural information is key. The elemental fraction or composition provides insight into effect, reactivity, history and quality while in case of impurities, elemental composition may identify its origin. A number of methodologies is available for investigation of the chemical composition and structure of materials.



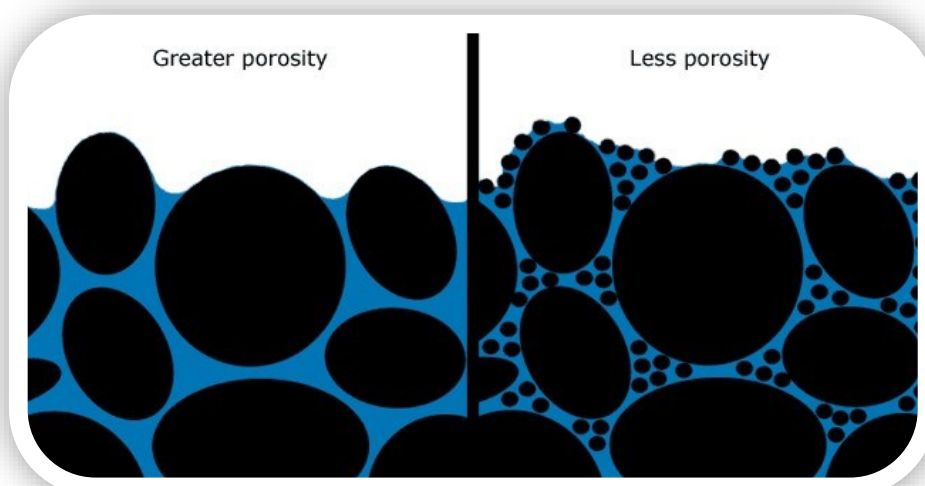
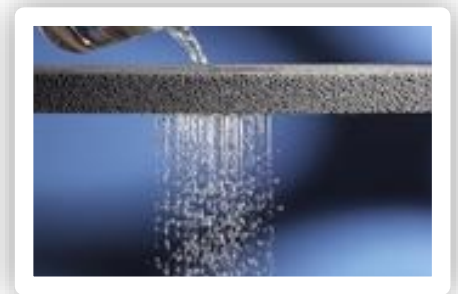
- ◆ Scanning electron microscopy with energy dispersive X-ray
- ◆ Neutron activation
- ◆ X-ray fluorescence
- ◆ Combustion analysis for organic matter
- ◆ X-ray diffraction for (crystal) structural information

Porosity



The porosity and surface area of materials are key in a variety of applications, e.g. in catalysis, adsorption and filtration processes, pharmacy, etc. Having more fundamental insight into the properties on the micro level will improve understanding of behavior on the meso and macro level.

- ◆ N₂ physical gas adsorption at 77 K to derive information on (BET) specific surface area, pore size distribution and pore volume
- ◆ Ar or N₂ Low-Pressure High-Resolution Physical Gas Adsorption at 77 K or 87 K for detailed assessment of micropore structure
- ◆ Kr Physical Gas Adsorption at 77 K for low-surface area investigations
- ◆ Adsorption of CO₂ and other e.g. hydrocarbon gases at different temperatures in the range from vacuum up to 10 bars, also kinetic studies are feasible
- ◆ H₂ or CO chemical gas adsorption for catalyst characterization
- ◆ Water or organic vapor adsorption investigations
- ◆ Temperature Programmed Adsorption and Desorption studies for acidity and basicity assessment
- ◆ Mercury intrusion porosimetry for porosity and density investigations in the pore size range of nanometers up to several 100's of micrometers
- ◆ Skeletal density by helium or nitrogen pycnometry and other bulk densities (aerated, tapped, envelope)
- ◆ Pore volume by oil absorption



Sizing



Particle size and shape information of powders is important to describe the effectiveness of physical and chemical processes and the quality of semi-finished products and final products. Modern techniques cover a size range from nanometers up to millimeters.

- ◆ Laser Diffraction or static light scattering for particle size analyses of dry powders or powders suspended in aqueous or organic liquids
- ◆ Droplet size distributions of sprays, nebulizers, inhalers, etcetera
- ◆ Optical imaging
- ◆ Nano particle assessment by photon correlation spectroscopy or dynamic light scattering
- ◆ Morphology (surface and size) by scanning electron microscopy (SEM) coupled to elemental analysis with Energy dispersive X-ray (EDX)
- ◆ Zeta potential
- ◆ Gravitational Sedimentation
- ◆ Electrical Sensing Zone, highest resolution for narrow size distributions. Also applicable for cleanliness investigations of liquids and particle concentrations of dispersions
- ◆ Sieve Analysis, dry or wet, mechanical and sonic
- ◆ Electron Microscopy, "Seeing is Believing"



About the DSS Method

Investigations are performed in close consultation with the client and - as far as possible - executed under conditions that closely match the targeted application of the product or actual problem.

This is feasible due to the broad array of instruments and specially designed and built set ups, accessories, and sample holders and access to a modern workshop enabling the design of additional accessories.

Reporting of investigations is done by means of a full analysis report that, besides the results in graphical and tabular form, are accompanied by a discussion of the results and the report also includes background information on the methodology and equipment used.

Quality of the experimental results is assured by working in accordance with GMP guidelines and by active participation in- and even organization of international round robins.

Our fully equipped laboratory also offers more standardized assessment of physico-chemical properties such as moisture content, pH, ash content, etc. Biosafety-cabinets, walk-in fume hoods, and glove-boxes working under nitrogen atmosphere are available in the laboratory in order to be able to work with a variety of (hazardous) materials under appropriate and safe conditions. Environmental chambers are available for stability testing and storage under controlled temperature and humidity. Delft Solids Solutions also organizes annual open courses as well as in-company courses in the field of particle technology.