IFPRI Report

Fine particle coating

Prof. Dr.-Ing. Andreas Bück, Institute of Particle Technology,
Friedrich-Alexander University Erlangen-Nürnberg, Erlangen, Germany

Abstract

This report provides a critical overview of process technologies for the coating of particles up to a size of 200 µm. Traditional as well as novel technologies are reviewed, assessing their potential in design of coating layers with specified characteristics, for example moisture and adhesion control. The interplay between coating mechanism, process conditions and resulting structure of coating layers is presented. Equipment for coating of fine particles is presented and the limits of (industrial) operation are discussed.

Introduction

Definition
Purposes and requirements
Theoretical concepts
Measurement techniques

In this introductory section, a working definition and general overview of coating and its purposes is given. Several important layer characteristics, like morphology/porosity and surface roughness, are introduced and links to product properties, like flowability (interparticle adhesion), and moisture diffusivity, are established. This section will also introduce *main theoretical concepts*, for example from heat and mass transfer, and electrostatic interaction (e.g. adhesion/van der Waals interaction), that are required for the presentation of the main coating mechanisms. Furthermore, *main measurement techniques* to access layer properties are introduced.

Coating mechanisms

Presentation of different coating mechanisms
Interplay of process conditions and layer properties
Approaches to process modelling

The presentation of the coating mechanisms will be divided into the following groups:

- Coating by mechanical means, e.g. dry coating
- Coating by physical and chemical interaction, e.g. physical and chemical vapour deposition
- Coating by thermal means/drying, e.g. spraying of solid containing liquids (suspensions, solutions)
- Coating by electrostatic interaction, e.g. electro-spray
- ...

For each group, the mechanisms are introduced, the interplay of process conditions on layer and coated particle properties is discussed, and process limits are presented, for example the transition from coating to agglomeration in thermal spray processes.

Additionally, a brief overview of the current *state of modelling* of the different mechanisms will be provided. Here, the focus will not only be on single particle modelling but also on multi-particle interaction. Some key ideas and results from literature are presented, for example from the field of *discrete element simulation* (DEM), *computational fluid dynamics* (CFD) and *population balance modelling* (PBE).

Coating equipment

Presentation of main equipment for coating of fine particles

Overview of process control in application

For each of the groups of coating mechanisms, equipment for its (industrial) realisation will be presented, highlighting challenges in operation and pointing to expectable deviations (with respect to modelling approaches) in product properties. Traditional equipment, for example mixers, and novel approaches, like atmospheric plasma-assisted fluidised beds, will be discussed. For the novel approaches, an assessment of potential of industrial application will be performed. Where available, a critical review of the *state of control of process* and equipment will be given.

Selected applications

Applications:

Additive Manufacturing

Pharmaceuticals

Food and feed

From each group of mechanisms, a few practical examples of successful coating of fine particles at industrial scale will be presented in detail. Examples range from functionalised powders for use in *additive manufacturing* to design and production of multi-layer coatings in *pharmaceuticals, and food and feed*. Information on achievable product properties will be provided as well as required improvement in design and operation of coating processes and equipment for fine particles.

References

The given list will be *annotated*, i.e. a few comments on the content and outcomes of each reference are given. In addition to cited works, (commented) *links to other sources* will be provided for further reference.

Abbreviations and nomenclature