

Material Properties Affecting Solids Blending & Blender Selection

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In the preceding article the mechanisms of solid blending and the types of blend structures were discussed. In continuation of the discussion on solids blending, this article identifies the material properties that affect blending of solids. Each of these properties is defined. The article emphasizes the importance of the material properties affecting solids blending and blender selection.

Properties of Solids Affecting Blending

Properties of materials being mixed is one of the most important factors affecting the blending operation. Each component in a mixture has distinct physical and chemical characteristics that contribute to the properties of the resultant blend.

The materials to be blended may comprise of several unit particles each of which may differ in properties such as density, particle size, shape, surface characteristics, agglomeration, cohesiveness etc. Since blending is a dynamic state of an assemblage of particles, the properties of the unit particles must be considered while discussing the dynamics of blending.

The differences in properties pose several challenges to process engineers and equipment designers for selecting the most suitable blender for their application.

The important material properties affecting blending are as follows:

- Angle of Repose
- Flowability
- Bulk Density
- Particle Size, Distribution
- Particle Shape
- Cohesiveness
- Adhesiveness
- Agglomeration
- Friability
- Abrasiveness
- Explosiveness
- Material Composition
- Surface Characteristics
- Moisture Content of Solids
- Density, Viscosity, Surface Tension of Liquids Added
- Temperature Limitations of Ingredients

Angle of Repose

The angle of repose of a bulk material is the angle formed between the horizontal and sloping surface of a piled material, which has been allowed to form naturally without any conditioning.

Flowability

Flowability is the ease with which a bulk material flows under the influence of gravity only. The 'Coefficient of Friction' of a powder is the tangent of the angle of repose and is the measure for its flowability. Flowability of bulk solids depends upon factors such as particle size and size distribution, particle shape, bulk density, cohesiveness, all of which affect blending.

Bulk Density

Bulk density is defined as the mass of a material that occupies a specific volume. It includes not only particle mass but also the air entrained in the void spaces between the particles. It is generally measured in kg/m^3 or lb/ft^3 .

Particle Size, Distribution

Particle size and size distribution in powders have a considerable impact on the flow properties of powders. As a result, the dynamics of blending is affected by the size of particles and their distribution in the bulk solids. Particle size is generally quantified in microns or as mesh size.

Particle Shape

Particle shape affects inter-particle powder friction and thereby the flow, blending properties of the powder.

Cohesiveness

Cohesiveness describes the tendency of a material to adhere to itself.

Adhesiveness

Adhesiveness is described as "external cohesiveness" which is the ability of material to adhere to other surfaces.

Agglomeration

Adherence of particles due to moisture, static charge or chemical or mechanical binding results in agglomeration.

Friability

Friability describes a bulk material where particles are easily crumbled or pulverized.

Abrasiveness

The abrasiveness of a material is determined by its hardness factor and the shape of its particles. The hardness of materials is quantified by Moh's hardness factor.

Explosiveness

In certain conditions, some bulk materials can form potentially explosive mixtures when combined with air.

Material Composition

Composition of unit particle is its quantitative and qualitative makeup. Individual units of pure substances have their unique molecular composition and arrangement that dictates their behavior and distinguishes them from other substances. The chemical composition is important because chemical reactivity shall be a major factor in choice of a particular substance for the application.

Surface Characteristics

Surface characteristics include surface area and electrostatic charge on the particle surface. Smaller particles have a larger surface area which lead to formation of weak polarizing electrical forces termed as 'Van Der Waals'

forces. When electrostatic charge is generated due to friction between two surfaces, the electric charge generated is referred to as 'Triboelectric' charge.

Moisture of Liquid Content of Solids

Increased surface exposure of fine particles to the atmosphere may result in moisture adsorption, absorption. Materials that naturally contain bound moisture or tend to adsorb, absorb moisture are termed as hygroscopic.

Density, Viscosity, Surface Tension of Liquids Added

Some blending operations require addition of liquids into the solids for a specific purpose. In such cases, it is essential to know the properties of the liquids to be added during blending and its purpose.

Temperature Limitations of Ingredients

An unwanted rise in the temperature of materials during the blending operation beyond product limits can lead to product degradation, melting or even be a source for ignition.

The properties discussed above are closely interrelated. Though the effects of each property must be considered individually, their combined effect as a set of group of co-related variables must be accounted. The following articles in this series shall discuss the effect of each of these properties in detail.

It is extremely important for process engineers to gather maximum information on the properties materials to be blended. This information should be furnished to blender manufacturers at the time of enquiry to ensure proper selection and design of the blender.

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