1

Mixing

Mixing may be defined as a unit operation that aims to treat two or more components, initially in an unmixed or partially mixed state, so that each unit (particle, molecule etc.) of the components lies as nearly as possible in contact with a unit of each of the other components.

TYPES OF MIXTURES

Mixtures may be categorized into three types.

Positive mixtures: Positive mixtures are formed from materials such as gases or miscible liquids which mix ***spontaneously*** **and** ***irreversibly*** by diffusion, and tend to approach a perfect mix. There is no input of energy required with positive mixtures if the time available for mixing is unlimited, although it will shorten the time required to obtain the desired degree of mixing. In general, materials that mix by positive mixing present no problems during product manufacture.

Negative mixtures: With negative mixtures the components will tend to separate out. If this occurs quickly, then energy must be continuously provided to keep the components adequately dispersed, e.g., with a suspension formulation, such as calamine lotion, where there is a dispersion of solids in a liquid of low viscosity. With other negative mixtures the components tend to separate very slowly, e.g., emulsions, creams and viscous suspensions. Negative mixtures are generally more difficult to form and maintain and require a higher degree of mixing efficiency than do positive mixtures.

Neutral mixtures: Neutral mixtures are said to be static in behavior, i.e., the components have no tendency to mix spontaneously or segregate spontaneously once work has been input to mix them. Examples of this type of mixture include mixed powders, pastes and ointments. It should be noted that the type of mixture might change during processing. For example, if the viscosity increases the mixture may change from a negative to a neutral mixture. Similarly, if the particle size, degree of wetting or liquid surface tension changes the mixture type may also change.

Factors affecting solid-solid mixing

(a) Material density
(b) Particle size and distribution
(c) Wettability
(d) Stickiness/Moisture content

(e) Particle shape/roughness
(f) Selection of mixer

APPLICATIONS

To ensure the uniformity of dose.

Mechanisms of Mixing

Mixing involves the following steps:

- Convective movement of relatively large portions of the bed (Macromixing)
- Shear failure, which reduces the scale of segregation
- Diffusive movement of individual particles (Micromixing).

Evaluation of powder mixture: Mixing process is critically affected by a multitude of parameters like mixing time, mechanism of mixing, type of mixer and batch size. Various methods have been developed to quantify the quality of mixture.

Mixing Index

There is always some variation in the composition of the samples drawn from a random mixture and the standard deviation in the composition of large number of such samples can be determined, provided an accurate assay method is available. A random mix gives samples with low standard deviation as compared to mixture of the same components that have not reached the random state. This phenomenon is used to define mixing index, which is expressed as,

$$M = \frac{S_r}{S_{act}}$$

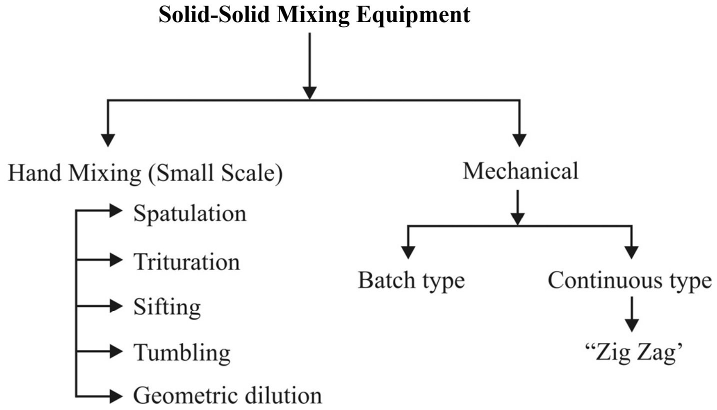
where, S_r is the Standard deviation of samples drawn from a fully random mix

S_{act} is actual Standard deviation determined on the partially mixed system.

SCALE OF SCRUTINY

Danckwert established the concept of scale of scrutiny which describes the minimum size of the regions of segregation in a particular mixture which would cause it to be regarded as insufficiently mixed. A poor mixture will have large scale of segregation and high intensity of segregation and vice versa. As the scale and intensity of the mixture is reduced the mixture passes from a stage of being unsatisfactory to satisfactory mixture.

Equipments: The detailed classification of the equipments used in soli-solid mixing is given below.



BATCH TYPE (LARGE SCALE)

(A) Batch types

I. Rotation of entire mixer shell or body with no agitator or mixing blade.

(a) Barrel
(b) Cube
(c) V. shaped
(d) Double cone
(e) Slant double cone

II. Rotation of the entire mixer shell or body with a rotating high shear agitator blade.

(a) V. shaped
(b) Double cone

III. Stationary shell or body with a rotating mixing blade.

(a) Ribbon
(b) Sigma blade
(c) Planetary
(d) Conical screw

IV. High speed granulations (stationary shell or body with a rotating mixing blade and high speed agitator blade)
   (a) Barrel
   (b) Bowl

V. Air mixer (stationary shell or body, moving air as agitator)
   (a) Fluid bed granulator
   (b) Fluid bed dryer

(B) Continuous types

I. Barrel
II. Zigzag