What is segregation?

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Outline of the presentation

- What is segregation
- Types of segregation
- Do’s and don’ts with respect to segregation
....so what is segregation

• Segregation results when particles separate due to differences in their size, shape, or density. Bulk solids can separate by different segregation mechanisms.

• The key to avoiding segregation is to determine the segregation behavior of a material.

• One needs to understand how products will transfer through your process in bins, hoppers, chutes, or conveyors.

• Knowing this behavior will allow equipment designers to either prevent particle segregation or recombine the separated material to maintain product quality.
The big five; The five major segregation mechanisms

The major causes of segregation are by:
• Sifting
• Angle of repose
• Fines fluidisation
• Air currents and attrainment
• Chute trajectories
Sifting segregation

- Sifting segregation occurs when there is a significant variation of particle diameters in a mix.
- Interparticle motion causes the finer particles to sift through the coarser ones.
- Side-to-side mechanism of segregation where the fine particles concentrate under the point of impact in a pile, while the coarse particles roll off the pile and locate at the periphery.
Sifting segregation in a stockpile
...possible solution
Angle of repose

- Differences in the angles of repose among different particles in a mix may give rise to segregation.

- Particles with a greater angle of repose will when deposited on the top of a pile will form a steep pile under the deposing point.

- Particles with the lower angle of repose will roll away from that point.
Angle of repose segregation
Fluidisation segregation

In this mechanism, the lighter or fluffier particles form a 'fluidized' layer. Only coarser particles can penetrate the fluidized fines and the finer particles remain in the top layer.
Figure 1: Fluidization segregation mechanism illustrated for bin discharge into a receiving container.
Air currents and entrainment

- **Air currents** caused during filling may carry fine material to regions where the air currents **decrease** sufficiently to **deposit** the fine material.
- This air entrainment segregation can produce a **radial pattern** or a side to side pattern depending on the **Position** of the inlet, outlet and the geometry of the vessel are important. Generally, fines accumulate near process **vessel walls** with this segregation.
Hopper fed alumina centrally
four air extraction points in top plate

19 compartments are placed in the silo bottom
12 in the outer circle
1 central compartment
6 compartments between centre and outer ring

Circulating air currents in the silo
CLEVER HOPPER FILLING DESIGN

Improper and proper multiple-outlet designs for center-filled bins (plan views)

a. Nonsymmetrical outlets (segregated fines flow through center outlet)
b. Symmetrical outlets (mixture flows through all outlets without segregating)
Chute trajectory segregation

-The difference of friction coefficients of different particles in a mix results in different discharge trajectories as the mix slides down a chute.

-Particles with high friction coefficients show lower discharge angles to the end close to the chute,

-the trajectory of particles with low friction coefficients deviate further away from the chute.
Figure 12—Schematic sketch of feed size segregation
TRAJECTORY ON IMPROPERLY DESIGNED CHUTE

Incoming stream with horizontal velocity component

Load not centered on belt

Trajectory in chute

Sloped chute with circular cross-section

Science - Engineering - Design
Reduction of Segregation

Segregation occurs primarily as a result of size difference
- Difficulty of mixing two components can be reduced by making the size of the components as similar as possible and by reducing the absolute size of both components
- Segregation is generally not a serious problem when all particles are less than 30 mm (for particle densities in the range 2000 – 3000 kg/m³)
- In fine powders, interparticle forces generated by electrostatic charging, van der Waals forces and forces due to moisture are large compared with gravitational and inertial forces
- Fine particles may stick together preventing segregation as particles are not free to move relative to one another
- The mobility of particles in free-flowing powders can be reduced by addition of small quantities of liquid (e.g. oil)
- The reduction in mobility reduces segregation and permits better mixing
- Agglomeration reduces segregation
When segregation occurs, intensive or extensive mixing will not help.

Any segregating material will segregate when mixed or moved around

…..sometimes we just have to deal with segregation as a given fact

…think about clever solutions
Impossible to mix
….reduce mobility
TRANSPORT SEGREGATION.

Many segregation mechanisms combined
USE OF SEGREGATION IN MINING
Thanks for your attention