TECHNOLOGY BRIEF:

This bulletin discusses use of 3D Mixer in Powder Metallurgy, which has superior benefits than conventional blenders.

World's top PM companies have started migrating from conventional mixers to using 3D Mixers at Laboratory as well as production scale.

Here, we are trying to show benefits and features of 3D Mixing for PM challanging needs.

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Alphie 3D Shaker Mixer for High Quality Blends in Powder Metallurgy - Paradigm Shift

What is Powder Metallurgy?

Powder metallurgy is a process - that produces complex shapes with a range of properties. The predominant market for Powder Metallurgy parts is the automotive sector, Aero – Engine and land based gas turbine systems, health care, oil & Gas industry etc. It is faster than forging or casting and permits the use of more performance-enhancing alloys than other prevailing techniques.

Powder used in the process has main ingredient as iron, which forms 96% to 97% of final mixture. Other metals used are copper / Nickel (about 2%), which strengthens the iron, graphite (0.8% to 0.9%), to harden the blend, and a lubricant (0.75%) such as stearates of zinc and aluminium, in minute amounts to reduce friction between particles and at the die wall during compaction. Some blends use de flocculants, which inhibit agglomeration of powders for improved flow characteristics during successive processing.

Why Mixing is so important?

The mixing, or blending, of powder is carried out for mainly two reasons:

1.To introduce alloying element additions in a homogeneous form - Die pressing feedstocks generally consist of elemental mixes in order to maintain as high a level of compressibility as possible.

2.To incorporate a pressing lubricant - Popular lubricants are stearic acid, stearin, metallic stearates or other organic compound of a waxy nature. The purposes of adding the lubricant are to reduce friction (and therefore even out density variations) during compaction, to reduce ejection forces and to minimise the tendency for ejection cracking in the compact.

How the mixing blend is tested?

The following parameters are monitored and controlled for ensuring good blend:

- Apparent Density (AD) – It is a standardised method of characterising the volume occupied by a given mass of metal powder when poured freely into a calibrated container. Apparent density is influenced by the powder's particle shape, size, and size distribution, among other properties.
- Flowability - It is the characteristic of a powder that permits it to flow readily and conform to the mold cavity. It can be described as the rate of flow through a fixed orifice.

- Compressibility - It is the ratio of the volume of intial powder to the volume of the compressed piece.

What is the current Mixing process and what are the problems of it?

Conventionally, homogeneous mix is produced from a double-cone or Y type geometry.

These conventional blenders are typically rotating on one axis and so producing centrifugal force. This generates local particle heating, particle segregation and contributes to more time to reach homogeneity. Due to motion only in axial periphery, the particles are colliding with each other giving variation in Apparent Density in batch to batch production.

Based on feedback given to Hexagon team at India's one of the biggest powder metallurgy part manufacturing company, we learnt that repetitive mixing cycles were taken to reach the required AD and Flow requirements. This lead to non consistent batch mixing results bringing to variation in final part properties.

What is 3D Shaker Mixer?

It is a mixer blender moving in 3 dimensions rotating on 2 axis, based on Kinematic Inversion mechanism. Unlike to conventional blenders like V or Double cone or barrel type blenders, which rotates only on single axis, 3D mixers rotate in all 3 planes. It is called shaker mixer because it makes 2 rotational and 2 linear motion in every cycle of revolution.

Why 3D Shaker Mixer are considered better than conventional one?

Shaker blenders are suitable for thorough blending of powdery material like dense powders, fragile solids, and abrasive materials. They are commonly used for making precise blends when trace components are present (<1%), or when ingredients are vastly dissimilar in size and density.

There is No rotating blade or agitator inside the mixer drum – and so they are called zero shear force mixers. There is no particle shearing or breaking as there is no centrifugal force. This is not Rotation, its Inversion!

How 3D Shaker Mixer is better for Powder Metallurgy application?

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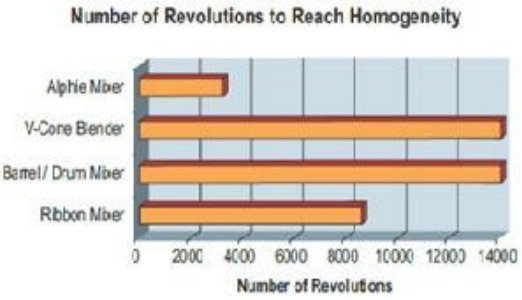
The biggest reason is ensured homogeneity. Where it needs couple of more cycle runs with longer period in conventional Double cone Blender, it is achieved much faster and consistently in 3D Mixer. Powder metallurgy mixed blend needs uniform mixing as primary requirement keeping time and cost factor as secondary. See this chart:



What Design options are offered in 3D Mixer?

3D Mixers are offered in two design variants:

1) Removable Drum – where the powder to be blended is filled in removable sealed drum and is inserted in mixer and removed after mixing. Hexagon offers specially designed conical bottom opening bins. Removable drum design offers advantage of non exposed and non contact type mixing of powder with machine and surrounding environment. However, it needs drum handling hoist or other loading system.

2) Fixed Drum – where the rotating drum is of double cone construction and is held vertical for powder loading and unloading. Much aliked to DCB, powder is filled from top side and is collected from bottom once mixing is done. In fixed drum, the conventional powder feeding and discharge system can be continued without much changes.

Each of the designs come with safety feature - interlock with guard, sampling device, PLC based time and speed control, pneumatically operated butterfly valve etc.

What other customisation / options are offered by Hexagon?

We can offer the blender with CE and ATEX approval also, shall the client needs. We can also offer Thro-wall design construction, where the mixing drum and drive unit are kept in different rooms with a wall partition. This ensures, that mixing explosion risk and electrical spark situations are never exposed to each other.

Conclusion- Results were analysed for various trials taken in Alphie 3D mixer at the same company. We found that - not only mixing occurred in much lesser time, it also improved AD consistency. For multiple batches, AD and flow results were achieved in closer range helping them to minimise batch to batch property variation.

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