SCHATZ GEOMETRY SHAKER MIXER MECHANISM – A Review

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ABSTRACT

Extremely challenging mixing tasks include combining fluids with heavy density metal powder or other fluids with jelly. The traditional approach involves using a unidirectional stirring machine to combine the fluid with the metal powder. The traditional mixer's shortcomings are explored in this article. A homogenous mixing of powdered substances with various specific weights and particle sizes is achieved using the Schatz geometry shaker-mixer, which is also covered in this work. Each component is blended in its own sealed container. The Schatz geometric theory dictates a three-dimensional motion for the mixing container, including rotation, translation, and inversion. In a short amount of time, the results meet all standards.

Keywords: Traditional mixer, Schatz linking mechanism, restrictions, uses.

INTRODUCTION

Powder mixing is a typical process in every sector. Particles of varying sizes may migrate downwards and upwards when the powder is agitated, particularly if the bulk densities of the particles are variable. As a result of variations in particle size, density, shape, and durability, segregation also occurs. [1] Industry mixing is summarized in this document. Traditional mixers and their shortcomings in comparison to the Schatz linkage shaker mixer are detailed in Section 2. The Schatz linkage shaker mixer is briefly described in Section 3, with sections outlining its construction, operation, benefits, and applications. Section 4 concludes the article.

CONVENTIONAL MIXER

The traditional approach involves using a unidirectional stirring machine to combine the fluid with the metal powder. Because centrifugal force causes the stirrer of traditional machines to spin in just one direction, it produces a certain flow pattern in the fluids, which causes the particles to adhere to the container wall and, in the end, produces a mixture of inferior quality. When compared to materials with lower densities, those with higher densities tend to settle down. [2]

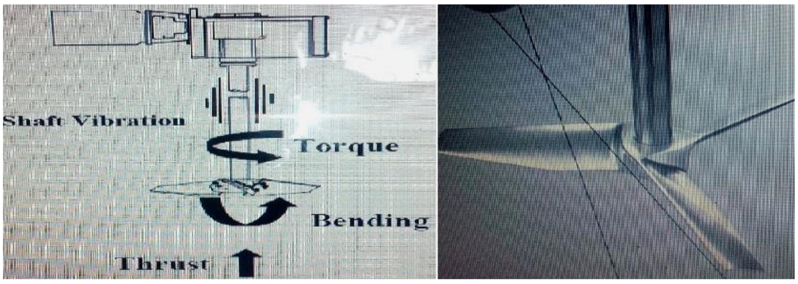

Fig.1 Traditional Blender

The typical mixer's blade profile is shown in the figure. Another major problem is the machine's high maintenance requirements, noise caused by vibrations, thrust, and bending forces. A 3D-motion mixer with a Schatz linkage system can quickly and evenly mix powders with varying specific weights and particle sizes. [2]

Fig.2 Schatz Shaker Mixer Geometry

Similar parts are referred to as "like" in this description. Paul Schatz invented the inversion linkage, commercially known as Turbula, in 1942. It is used extensively in spatial mixing machines.

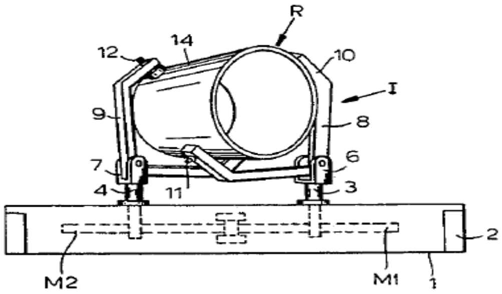

Fig. 3 Schatz linkage, where the receptive link is located in the middle

Fig. 3 depicts a base 1 with appropriately journaled shafts 3 and 4 that extend vertically from base 1, as shown in base 1's enclosure 2. The M1 and M2 reference numbers typically denote the base 1 drive system. Shafts 3 and 4 transfer torque to clevises 6 and 7, which in turn transfer torque to yokes 8 and 9. Yokes 8 and 9 are connected to the receptacle denoted by reference R. All this time we've been talking about a closed and restricted invertible kinematic linkage, with the receptive center link 14 acting as receptacle R and being hinged at ends 14a and 14b via connections 10–13 to the receptive one of two yoke-shaped links 8 and 9, which encircle the receptive center link 14, respectively. The two sets of hinges (10, 11) and (12, 13) have central axes that extend in different planes, so they form a right angle. At their midpoints, the two yokes (8 and 9) are hinged to the clevises (6 and 7), which have axes that extend in different planes but are right angles to the central axes of the adjacent horseshoe-shaped yokes (8 and 9). The clevises (5 and 6), which are extensions of the two parallel shafts (3 and 4), are rotatably mounted in the base 1. The lifting of the center link 14 occurs during just two phases, denoted by segments of arc, in every 360˚ rotation of a corresponding shaft (3 and 4). As the inversion linkage mechanism is lifted from its halfway position, the right-hand end 14a of the center link 14 is raised from its perpendicular position, and the yokes 8 and 9 are positioned with respect to the vertically disposed shafts (3 and 4) in a lifting in specification manner.

Figure 3 shows the halfway point, when the yokes 8 and 9 are now parallel to each other. Similar motions occur when shafts 3 and 4 are positioned horizontally. The center link 14 undergoes two lifting phases at its end (14a) and two at its other end (14b) during each full cycle of motion. That is, for every 360˚ rotation of the drive shaft (3 and 4), both ends are lifted twice. The centers of the yokes 8 and 9, which are joined at the pivot axes of the clevises 6 and 7, are positioned at a right angle to each other. For every full rotation of the center link 14, four lifting phases are required.

Advantages of Schatz geometry shaker mixer

- To supply a device that is easy to use and build.
- Machines with more power should use this connection.
- Comparatively, this connection is less expensive than alternative tools.
- Less energy needed for more effective mixing.
- Mixing the product in its sealed container allows it to reach the targeted mixing speed and quality.

Applications of Schatz geometry shaker mixer

- The chemical business
- The market for pharmaceuticals
- The painting trade
- Industry involved in processing food
- Metal and plastics manufacturing
- Combining powders of different densities
- Blending considerably smaller amounts of granules into more substantial ones

SCHATZ LINKAGE MECHANISM FOR 3D-MOTION MIXER

There are a number of mixing difficulties that the Schatz mechanism has effectively solved. When it comes to blending powders, the turbula mixer is the gold standard. His work primarily focused on "To Design and Fabrication of 3D motion mixer," which drew the attention of professors R. B. Chadge and P. S. Kulat [4]. Multiple industries rely on industrial mixers and blenders to combine various materials. These include the food, chemical, pharmaceutical, plastic, and mineral sectors. One of the biggest challenges of mixing powders is determining their concentration both before and after mixing (Kaye 1997). Considering the small standard deviation values observed in all samples (ranging from 0.05 to 0.1), reproducibility has been attained, which is the most crucial thing. Research into the Kenics static mixing device type has yielded the best powdered material type. Static mixers can improve the quality of mixtures in processes like backfilling material during packaging and can replace common device types. Powders often separate when kept in storage. In this study, Yong KweonSuhand and Sangmo Kang [5] examine a review of microfluid mixing. They go over the many types of mixers and how they work in various scenarios. The designs will be categorized according to the driving forces utilized to regulate the flow of fluids during mixing, which can be mechanical, electrical, or magnetic. The article will also discuss the pros and cons of each design. In conclusion, they will outline the planned advancements in mixer design and associated matters for the purpose of improving mixing performance in the future.

A fast hydrodynamic focusing microfluidic mixer was designed by conducting experiments on 2D and 3D modeling and optimization by Benjamin Ivorra, Juana L. Redondo, Juan G. Santiago, Pilar M. Ortigosa, and Angel M. Ramos [6]. By running a sensitivity analysis on the parameters, they ensure that the optimized outcome is resilient. Compared to earlier mixers, their design is around an order of magnitude faster, with an estimated mixing time of 0.10 µs. The characterization of mixing in a basic paddle mixer using velocity fields derived empirically has been done by Douglas Bohl, Naratip Santitissadeekorn, Akshey Mehta, and Erik Boll [7]. For various impeller positions inside the cylinder, three Reynolds numbers (0.02, 8,108) were examined. The results showed that increasing the distance between the blade and the cylinder wall improved mixing in the area defined by the blade's motion. Both the position of the blades and the flow Reynolds number were determined to have no effect on the overall mixing average inside the tank. The authors Jiten Patel and G.K. Ananthasuresh [8] have reviewed a theory of kinematics for planar links that are radially foldable. In this study, a kinematic theory for planar, radially foldable closed-loop linkages is established by utilizing the algebraic locus of the coupler curve of a PRRP planar connection. Using this theory, we may deduce the previously developed building blocks for planar foldable structures, which are comprised of just two interconnected angular parts. The design equations obtained here simplify and systematize the notion of even the most complicated planar radially foldable links. The use of the design equations and the creation of prototypes are demonstrated by presenting representative instances. Also mentioned are the theory's present limits as well as some potential future extensions. The synthesis and characterization of sub-micron sized copper-ruthenium-tantalum composites for interconnection an application has been explored by R. Sule, P.A. Olubambi, B.T. Abe, and O.T. Johnson [9]. The high temperature high pressure approach was used to synthesis copper composites reinforced with ruthenium and tantalum, which are appropriate for electronic interconnection applications and have a size smaller than a micron. A Turbula mixer was used to mix high purity sub-micron starting powders with different compositions. The mixture was then compressed for 30 minutes at 850˚C and 30 MPa pressure. The electrical conductivity, hardness, microstructure, density, and phase composition of the produced materials were studied. Adding tantalum during sintering inhibited the development of copper grains. Adding reinforcing elements to copper-based composites did not significantly increase their electrical resistivity. A study on three-dimensional flow instability over a backward-facing step was conducted by Dwight Barkley, M. Gabriela, M. Gomes, and Ronald D. Henderson [10]. The findings are presented from a computational stability study of flow over a backward-facing step in three dimensions, operating at Reynolds numbers ranging from 450 to 1050 and with an expansion ratio of 2. According to the results, at a crucial Reynolds number of 748, the steady two-dimensional flow experiences its first absolute linear instability, which manifests as a steady three-dimensional bifurcation. A flat roll structure with a span wise wavelength of 6.9 step heights characterizes the critical Eigenmode, which is localized to the major separation bubble. Additionally, up to a Reynolds number of 1500, the system is demonstrated to be completely stable in the face of two-dimensional perturbations.

The topic of structural mechanism design was covered in Yan Chen's dissertation [11]. He investigates the feasibility of building huge structural mechanisms systematically from revolute joints and existing spatial over restricted links. The Bennett connection, a famous spatial 4R linkage, is the basis for the structural mechanisms (networks) discussed in the first section of the dissertation. The foundational element has been this unique connection. An optimal arrangement of the buildings has been found that permits an endless expansion of the network by the repetition of its constituent parts. This led to the discovery of a class of structural mechanisms known as single-layer structural mechanisms. The majority of the time, these structures expand into cylindrical surface profiles. Furthermore, the mathematical derivation states that the hitherto unsolved problem of combining two comparable Bennett links into a mobile structure has also been resolved. There has also been research into the possibility of other Bennett linkage types. It has been deduced that the alternative shapes must meet the conditions of compact folding and maximal expansion. Thanks to everyone's hard effort, the most efficient deployable element based on the Bennett linkage has been created. Researchers P.S. Jadhav and Prof. B.R. Jadhav have used the three-dimensional Turbula mixer to mix composite solids [12]. Because of their cohesive nature, powders often agglomerate on their own when left in a humid environment or stored at high temperatures. The migration of smaller particles downwards and larger particles upwards can occur when powders with varying bulk densities are agitated. Particles in a ball milling operation will typically vary in size, density, shape, and durability, which can lead to segregation, another big issue. For this kind of blending, static mixers (of the Kenics variety) just won't cut it. The requirement for an apparatus that can rotate, tumble, and shake materials within a container with a closed and constrained invertible kinematic link-work, wherein one link acts as a container, and wherein thrusting power, instead of rotating power, is used to motivate the link-work, becomes apparent. He invented the "Electric drive for the mixing machine" [13], according to Reinhold C. International patents. Two electric motors, numbered 11 and 12, connected in series and supplied with a constant current through a common regulator make up the driving system of the inversion-kinematic Paul Schatz-type mixing machine, as described in the invention.

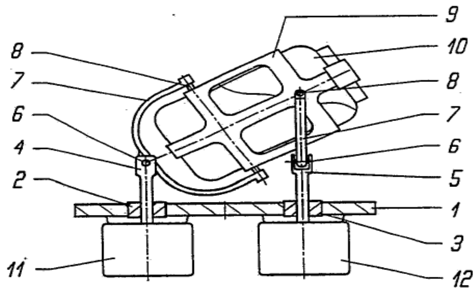

Fig.4 Motor powering the mixing apparatus

Spindle torque (4, 5 NM) is controlled by an adjuster that sets the current. Shafts (4, 5) rotate differently due to the machine's construction, and the mean revolution speed is determined by the voltage drop across the motors. In the mixing machine, two parallel shafts (4, 5) can revolve on a support (1) that has two bearings (2, 3). Two forks(7) are mounted on swivel bearings(6) at the top of the shaft (4, 5). The forks (7) are at right angles to both each other and the corresponding swivel axes (6), and axis bolts (8) that allow the machine to rotate pass through them. A cage (9) that receives a mixing container (10) is fastened to the two axis bolts (8) that allow for rotation. A variety of driving systems were discussed by Neil Sclater and Nicholas P. Chironis [14]. The Schatz mechanism is driven by one of them. The authors Richard S. Hartenberg and Jacques Denavit [15] provide a concise overview of the Schatz inversion connection, its mechanism, and a diagram showing its velocities and accelerations. The publication with the citation [16] by PadmanabhanS., Chandrashekharan M., and Srinivasna Raman V. details the design of the worm and worm wheel gear drive that powers the Schatz mechanism. This study presents the development of Ant colony optimization as a solution to issues with worm gear drives. The Zn-type hourglass worm wheel produced by hob cutters and the Zn-type hourglass worm produced by straight-edged blade cutters were both examined in this study by KuanYu Chen and Chung Biau Tsay [17]. Designers and manufacturers can benefit from analyzing these gear drives in order to create and choose the right settings. The definition of triangulation and the various mixing techniques are provided by Todd D. Jick [18]. We also determined the best machine by discussing the quality of the combination it produces. Various input systems of the Schatz mechanism, such as electrical motors, pneumatic cylinders, and piston-cylinders, were covered by Reinhold Caspar [19].

CONCLUSION

The combination of the Schatz mechanism and a 3D motion mixer results in a homogeneous mixer of high quality. Using a literature review as a foundation, this paper discusses the shortcomings of traditional mixers and the merits and uses of Schatz geometry shaker mixers. The Schatz geometry shaker mixer is a great tool for combining varying amounts of extremely fine powders, according to this survey.

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