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A Review on the Technology of Size Reduction Equipment

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Abstract: *Size reduction, also known as comminution, diminution, or pulverization, is the act of breaking down big solid units into small, coarse, or fine particles. There are numerous kinds of size reduction equipment that are frequently used in different contexts after being empirically created to handle particular materials. Since nearly all size reduction strategies involve developing new surface area, which necessitates adding energy proportional to the bonds holding the feed particles together, hardness is likely the most significant property determining size reduction. in addition to the milling process's usual changes. The benefits and drawbacks, mechanisms, theories, methods, developments, and therapeutic uses of size reduction technologies are highlighted in this systematic review*

Keywords: milling solid particles, absorption, impact, attrition, size reduction

I. INTRODUCTION

The ability of powder to be processed, including its mixing, flow, and compaction qualities, is greatly influenced by its particle size. In order to improve surface area and flow property, particle size reduction is important. Because they take longer to dissolve, larger particles have problems with solubility. Particles are insoluble in all media under specific circumstances. Particles in certain situations must dissolve in a suspension with the same particle size as the dissolving particles. Particle size is important for absorption because it increases the surface area of the particle and increases absorption when the particle size decreases. Size reduction is the process of reducing bigger solid unit masses into smaller or finer particles using a variety of tools, such as a jaw crusher, gyratory crusher, roll crusher, hammer mill, and ball mill. Here, the attrition and impact principles are mostly applied. The two main techniques used to accomplish size reduction are precipitation and mechanical. Size reduction is often referred to as comminution, diminution, or pulverization. In the precipitation process, a suitable solvent is used for dissolution, and in the mechanical process, grinding machines are used to submit the material to mechanical forces. The former is mostly utilized in the manufacturing of bulk medications, inorganic raw materials, and compounds such as calcium or magnesium carbonate. Numerous factors influence size decrease. Physical characteristics such as moisture content, hardness, stickiness, toughness, slipperiness, and abrasiveness are among them. Size reduction is also influenced by other material characteristics, such as the product's bulk and coarse densities, flow, shape, and size.

Increasing the particles' surface area is the primary goal of size reduction. Additional benefits of size reduction include improved and consistent mixing of powders because of the particles' limited size range, quick absorption, lower sedimentation rate, better physical appearance, and more stability in the case of emulsion particles. [1]

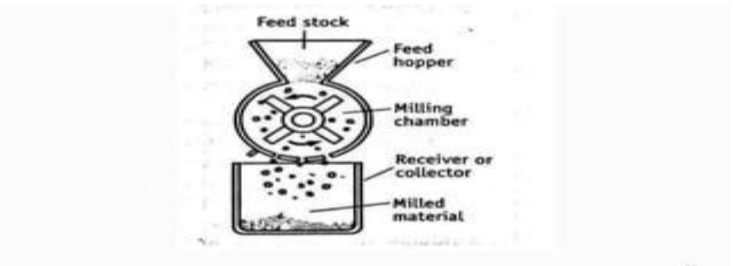

Fig : General part of size reduction

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OBJECTIVE OF SIZE REDUCTION

Communication or size reduction is typically done in the materials processing sector to:

- Increase the surface area because the area of contact with a second phase directly correlates with the pace of reaction in the majority of reactions involving solid particles.
- Divide a material into tiny particles so that the valuable component can be separated from the other two.
- Make intimate mingling a reality.
- To readily dispose of solid garbage
- To more closely combine solid particles [2]

MECHANISM OF SIZE REDUCTION

IMPACT

Impact happens when a material is held still and struck by a fast-moving object or when a material is kept moving quickly and collides with a stationary object.
Eg: Hammermill.

ATTRITION

It entails a collision between two high-kinetic-energy particles or a high-velocity particle and a stationary phase.
Eg : Roller mill Fluid energy mill

SHEAR

created when a particle traveling tangentially is squeezed between the edges of two hard surfaces.
Eg : Scissors

COMPRESSION

Through the use of pressure, the material is crushed in this mechanism to reduce its size.
Eg : Sharp knife.
Here the various mechanisms which are used in the size reduction are figured out in figure. [3]

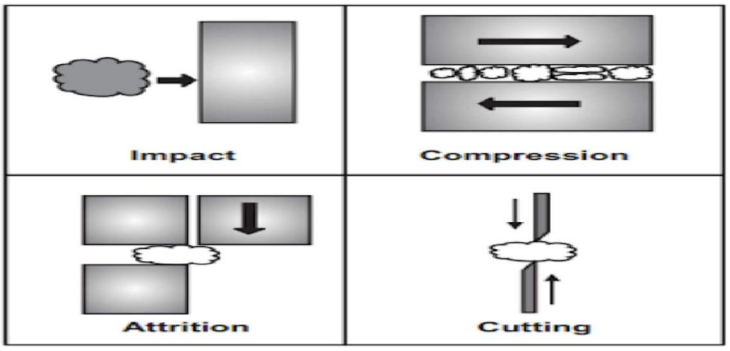

Fig : Various mechanisms of size reduction

ADVANTAGES

- The uniform flow
- Efficiency in drying
- Uniformity of substance
- Increase the viscosity or surface area.
- Increased absorption rate; the smaller the particle, the higher the absorption.
- The rate of solution has improved. [4]

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DISADVANTAGES

- Drug degradation
- Contamination
- Static charge may cause small particles to aggregate when their size decreases, which could lower the dissolving rate.
- Possibility of the active pharmaceutical ingredients changing their polymorphic form [5]

APPLICATION

- By enhancing the surface area of medications, size reduction aids in the quick development of solutions for chemical substances.
- pharmaceuticals and animal glands (liver and pancreas) is made easier by the solvent's easy penetration of the tissue, which increases the surface area and speeds up the extraction of the active ingredients.
- Reducing the particle size of several medications increases their therapeutic efficiency; for example, the dosage of griseofulvin is cut in half. [6]

METHOD

Grinding, compression, and impact pressures are the processes involved in size reduction, which is a unit operation process. Attrition, impact, and compression forces are the different force types at play.

The material is subjected to appropriate stress during size reduction, and the internal strains that arise cause the material to deform or shatter. The degree of deformation is influenced by various factors such as the hardness, structure, heat generation, and cracking tendency of the material. Additionally, it takes more energy for tougher materials to fracture. The kind of impact needed for size reduction depends on the nature of the materials. Shearing forces, for instance, are required for softer materials, while for fibrous materials, a combination of shearing forces and impact is required. [7]

Some of the common mechanical size reduction methods are listed as follows:

Equipment for cutting: widely used in the food business to cut meat or vegetable items. A typical example would be a bowl cutter.

Equipment for milling: They consist of both crushers and grinders. Shear and impact forces are employed by grinders to reduce size. Pulverizers, roller mills, and pulverizers are a few examples. Because sugar cane is subjected to compression forces, crushers are frequently used in the sugar cane business.

Equipment for homogenization: The process of homogenization involves dispersing the particles by combining two immiscible liquids into an emulsion. The liquid is pushed through a small nozzle during this process, which causes the liquid's particles to be subjected to compressive, shear, impact, and turbulence forces. [8]

LAWS GOVERNING SIZE REDUCTION:

KICK'S LAW:

Kicks law states that the energy required to reduce the size of particles is directly proportional to the ratio of the initial size to the final size of the material.[9]

RITTINGER'S LAW:

Rittinger’s law states that the energy required for size reduction is proportional to the change in surface area of the pieces.

BOND'S LAW:

Bond’s law states that the work required to form particles of size Dp from very large feed is proportional to the square root of the surface to volume ratio of the product. [10]

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EQUIPMENT IN SIZE REDUCTION

Many type of size reduction equipment are

- ❖ Crushers
- ❖ Grinders
- ❖ Ultra-fine grinders
- ❖ Cutting machine

CRUSHER'S

The initial stage of mineral processing is crushing, which is accomplished by slow-moving equipment used to coarsely reduce massive amounts of material. They can shatter big chunks of hard material and work by compressing. The range of particle sizes is 150 mm to 250 mm. It is mostly used to break up large solid particles into smaller lumps. Crusher are classified according to the stage of crushing, they are [11]

- Primary
- Secondary

TYPES OF CRUSHERS

- Jaw crusher
- Gyratory crusher
- Roll crusher

JAW CRUSHER

Stone is allowed to flow into the area between two jars, one of which is stationary and the other movable, in order for the jaw crusher to compress the feed between the stationary jaw and the flexible jaw. Compression is the mechanism that causes the gap between the jaws to decrease as the stone descends due to gravity and the movement of the moveable jaw, until the stone eventually passes through the lower hole. Manganese steel or another material that can tolerate abrasion is typically used to make jaw crushers. In order to concentrate pressure on springs and frames with relatively tiny areas, the faces of the crushing jaws are typically damaged.The pitman in this machine oscillates vertically due to an eccentric; toggles transmit this vertical movement to the movable jaw horizontally. If the speed of operation is too high, a lot of fines will be created because the material cannot leave quickly and is crushed repeatedly. Because the crushing action is intermittent, the machine's loading is uneven, which causes the [12]
crusher to work with a heavy flywheel. Between two jars, the material to be crushed is entered. During the backward motion, the material falls into a tiny space below and is crushed at the jaws. Between 250 and 400 times each minute, the jaw typically opens and closes. The diagrammatic representation of the jaw crusher is shown in figure..

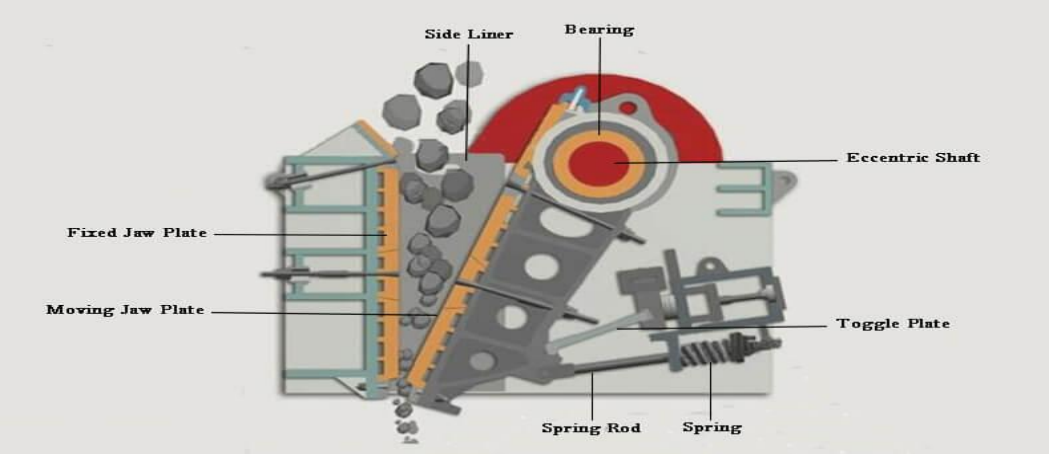

Fig : Jaw crusher

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Jaw crushers have the following benefits: a simple structure, low cost, easy maintenance, dependable operation, small machine body, easy device; however, their high viscosity also makes them difficult to join. Their disadvantages include lower productivity, lower power consumption, larger vibrations, small crushing ratio, uneven particle size, and a wide range of applications, such as mining, quarrying, demolition, and construction. [13]

GYRATORY CRUSHER

Gyratory crushers are utilized for both primary and secondary crushing of hard, rough, abrasive rock because they offer continuous crushing action. Secondary crushers are gyratory standard cone crushers. Gyratory crushers, which operate on the compression principle, can produce vast amounts of evenly fine crushed unbounded water. The crushing head is positioned on a hefty shaft in the shape of a truncated cone and [14]

rotates inside a funnel-shaped casing that is open at the top.The shaft's lower end is driven by an eccentric to form a circle, while the higher end is supported by a flexible bearing. The entire cone is subject to the crushing action. The crushing head's bottom typically moves toward and then away from the fixed wall while the material to be crushed is charged from the top. The crushing head's typical speed ranges from 125 to 425 gyrations per minute. The diagrammatic representation of the gyratory crusher is shown in figure.[15]

Fig. : Gyratory Crusher.

It features reduced vibration, a more stable operating condition, and a lighter equipment basis. The basis weight of a jaw crusher machine is five to ten times the weight of the machine itself, while the basis weight of a gyratory crusher is typically two to three times the weight of the main part. Gyratory crushers produce significantly fewer sheet products than jaw crushers.Its drawbacks include the fact that the gyratory crusher's body is larger than that of the jaw crusher, which is typically two to three times higher; this results in a higher cost and weight; additionally, the mine mouth size is seven to two times larger than that of the jaw crusher, which results in a higher equipment investment; and finally, it is not appropriate for crushing wet and sticky ore.

ROLL CRUSHER

Additional stone size reductions are produced using roll crushers. One or more strong steel rollers, each positioned on a separate horizontal shaft, are attached to a heavy cast frame to form a roll crusher.About 15% of the total amount going through the crusher will be greater than the setting, which is the theoretical maximum reduction ratio of 4:1, for any particular jaw or roll crusher setting. The revolving motion of the rolls draws the particle into the space between them, and the friction angle that forms between the rolls and the particle is known as the nip angle.The particle is forced between the two rolls' revolving surfaces into the progressively smaller gap area, and the fractures result from the combined forces of the rotating rolls. [16]

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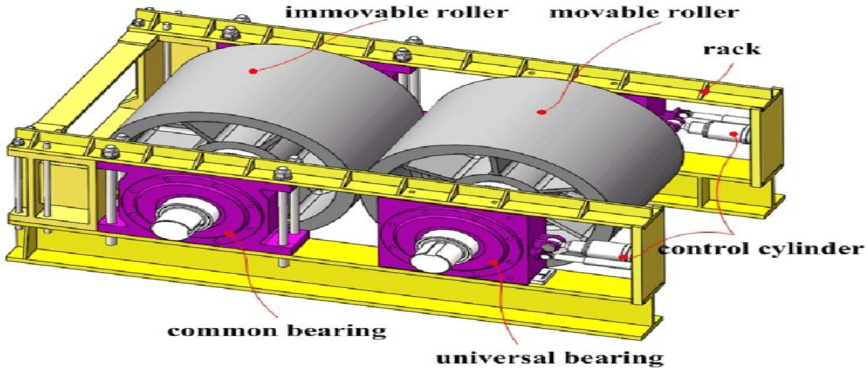

Fig : Roll Crusher

Roll crushers have two main benefits: they make very little dust or lines and provide a very fine product size distribution. Roll crushers are employed in smaller-scale production mining of more abrasive metal ores, including gold, and in the crushing of minerals where the ores are not too abrasive.It is most likely the biggest consumer of roll crushers; at the moment, coal plants employ single- or double-roll roll crushers as their main crushers to reduce the amount of ROM coal. Because of its straightforward design, a dependable toothed roll crusher has a limited output capacity that necessitates constant and consistent feeding. Additionally, the roller surface's easy wear widens the space between the two rollers, resulting in uneven product size that need frequent repairs. For producing sand from flat material, the roller crusher's actual crushing impact is not optimal.This is because the raw material "leaks" through the numerous spaces between the double roll crusher's two rollers, lessening the crushing action. [17]

GRINDERS

Any power tool or machine tool that can grind particles between 74 to 350 micrometers is called a grinder. Grinding is the process of pulverizing or powdering rock by applying the mechanical forces of attrition, shearing, compression, and impaction.

TYPES OF GRINDERS

- Hammer mills
- Rolling compression mills
- Ball mills

HAMMER MILLS

A high-speed rotor housed in a cylindrical case is coupled to a quickly moving hammer to form a hammermill. It operates on the basis of impact between the hammer and the particle that needs to be shrunk in size. Materials are added to a hammer mill, which reduces their size. The particles then go through a bottom screen and are gathered at the receiver. The rotor speed and screen feed rate size are the two main factors influencing the size reduction.14 The speed of a hammer mill is between 2500 and 5000 rpm. [18]

It is primarily used in the pharmaceutical industry to mill pharmaceutical materials, sugar, and herbal medicines as well as to process wet or dry granulation and disseminate powder mixtures. Without requiring a closed-circuit crushing machine, it generates a predetermined top size. Because of self-classification, it generates a comparatively large number of size distributions with the fewest possible penalty. Whether used for primary, secondary, or tertiary grinding, it offers a high reduction ratio and a large capacity with comparatively low energy consumption. Failure to manage the feed rate could cause damage by choking the mill. Inadequate garbling causes extraneous elements, such as metals or stones, to infiltrate the substance.crush possible that the screen will become clogged. [19]

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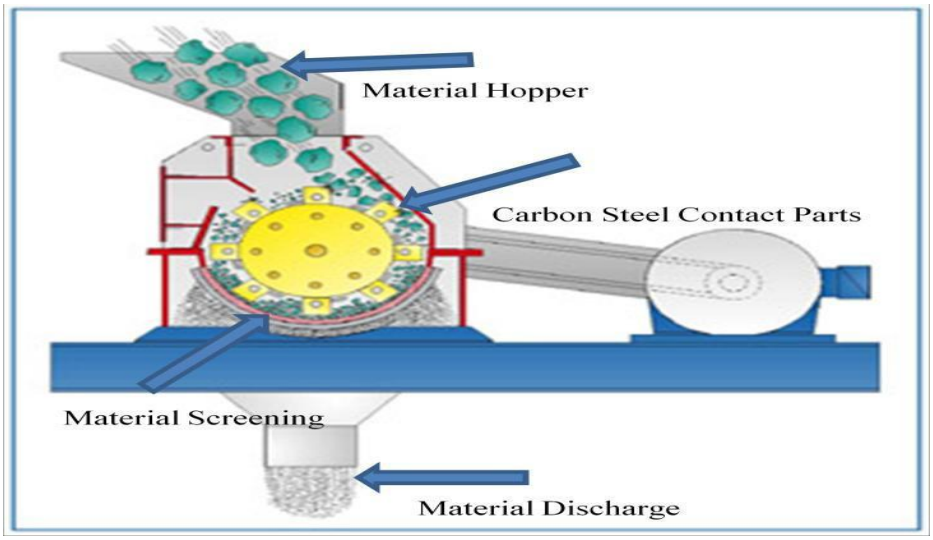

Fig : Hammer Mill

ROLLING COMPRESSION MILL

A roller mill is a type of compression mill that crushes or grinds a variety of materials using a single, double, or triple cylindrical heavy wheel that rotates about its long axis either in opposition to flat plates or in pairs. Typical temperature, speed, and interstr and time and the ranges of strain rate and actual strain at every stage. The stock runs at varying speeds at each stage of the rolling mill because the cross-sectional area gradually decreases with each set of rolls. Stress and attrition are applied to compress the material.16 Rotating heavy wheels apply stress, and two cylindrical stone/metal rollers with a diameter varying from a few millimeters to a meter are positioned horizontally. One roller is driven by a motor, while the other spins freely on a longitudinal axis. The strip is being pulled into the rollers without any pushing or tugging due to the friction between the rollers and the strip. Without affecting the workpiece's width, rolling causes the material's length to increase and its thickness to decrease. [20]

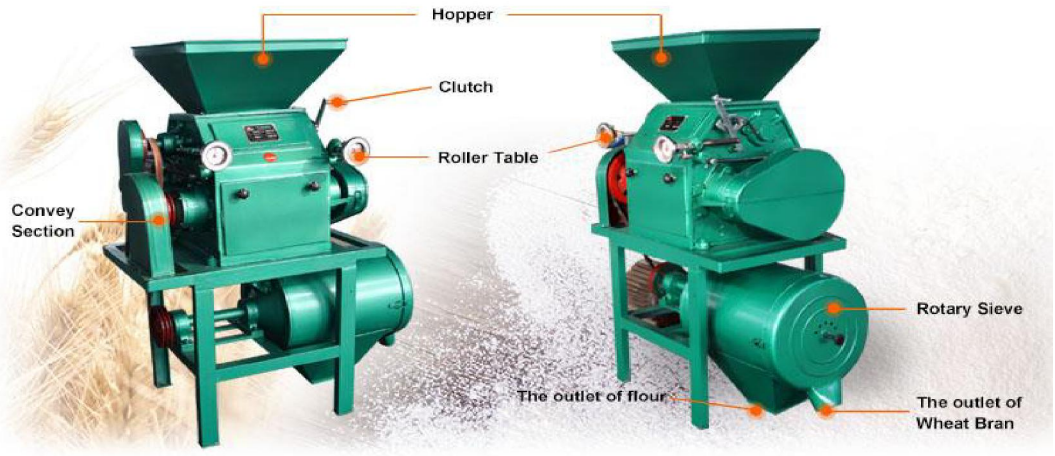

Fig : Rolling Compression Mill

The benefits of a rolling mill include the ability to achieve uniform component dimensions by rolling. In this respect, it makes use of the same tool; different components are produced using the same rollers. The components in the rolling process can have close tolerance. The rolling process involves high-speed production, and one of its drawbacks is the high cost of the equipment. Only large-scale production can use it, thus secondary processes like finishing are required.

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In the pharmaceutical business, rolling mills are primarily used for the production of rods and large-length cross sections. Additionally, the automotive industry uses it to manufacture a variety of parts. [21]

BALL MILL

In the fields of mineral dressing, paints, pyrotechnics, ceramics, and selective laser etching, a ball mill is a type of grinder used to ground or blend materials.18This kind of grinder uses balls of various sizes to grind and combine bulk materials into QDs or nanosize. Balls in the cylinder make up 30–50% of the mill's capacity. The ball's size is determined by the mill's diameter and feed quantity, while its weight remains constant. The basic idea is that as the ball falls from close to the top of a revolving hollow cylindrical shell, impact and attrition size reduction occur. [22]

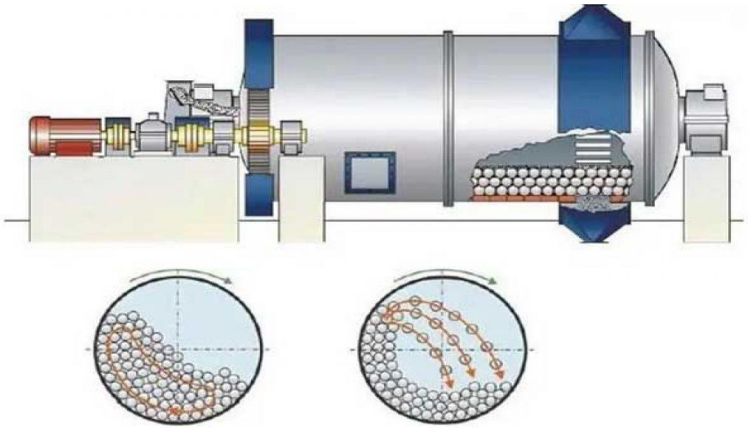

Fig : Ball Mill

It is appropriate for both batch and continuous operation, suitable for both open and closed circuit grinding, and applicable for materials with varying degrees of hardness. Its installation costs, power requirements, and grinding medium are all minimal.20 Large size, loud noise, powerful vibration, needing a firm base, low efficiency, and increased friction loss. Ball mills are primarily used to create fine powder that may be used to grind a wide range of materials.

ULTRAFINE GRINDING MILL

Ultra-fine grinding is a new form of mining equipment used to make micro powder, fine powder, etc., and it uses less energy than traditional milling techniques in the sub 100μm range. An ultra-fine grinding mill schematic diagram is depicted in the picture. Micron-level powder produced by an ultra-fine grinder employed in the creation of medicinal resources can break down the tissue cell wall's structure and yield the necessary material properties.

Compressed air is used to chill, filter, and dry the medical ultra-micro grinder. The nozzle is injected into the crushing cavity, creating a supersonic airflow. The pressure differential causes the substance to become fluidized. At the junction of several nozzles is the accelerated material. In order to accomplish ultra-fine particle grinding that may be utilized to create a variety of micron-level powders, converge, create intense impact, collision, friction, and shear. Medical ultra-fine grinders are used for a variety of purposes, including ultra-fine pulverization, wall-breaking processing, improving drug solubility, cleverly confusing and evacuating compound pharmaceuticals, making film ointment, and more. [23]

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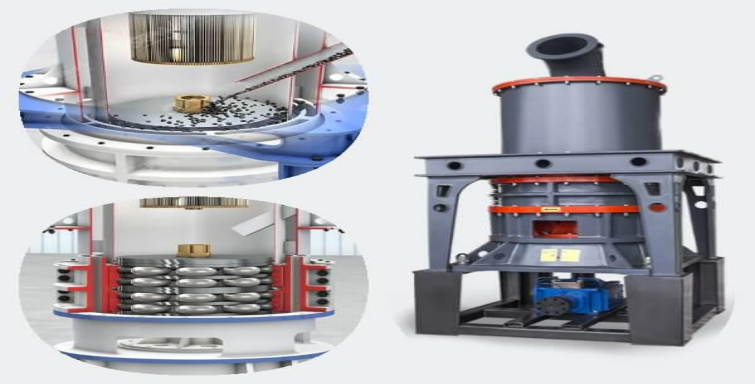

Fig : Ultrafine Grinding Mill

CUTTING MACHINE

Cutting machines operate on the cutting principle and can be operated with single-point or multipoint tools. The range of particle sizes is 2 mm to 10 mm. Using sharp knives, the feed materials are successively cut or sheared in the cutter mill to reduce their size. These mills are frequently used in laboratories to reduce the initial size of soft, medium-hard, fibrous, and stiff materials. Because cutting mills can contaminate finely reduced samples with metals from the blades and screens, they should be utilized carefully. These mills can be used to reduce dried bones, cereals, and other materials.

A horizontal rotor with several blades attached acts against a number of stationary knives fixed to the mill casing in a cutter mill.The cutter mill's schematic representation is displayed in figure.

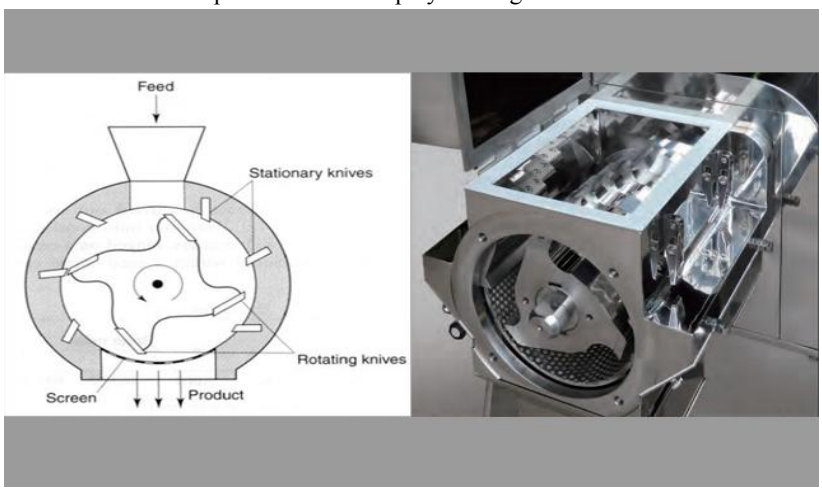

Fig : Cutting Machine

The optimum choice for size reduction when impaction, attrition, or compaction type milling is ineffective, particularly for tough, fibrous, or resilient materials, is a cutter mill. It is simple to set up, run, and maintain. The primary drawbacks are that the machines can be quite costly and that operating the cutting mill in the pharmaceutical business requires some Abstract general training for the workforce.[24]

II. CONCLUSION

The process of reducing big solid particles or unit masses into smaller particles, either fine or coarse, is known as size reduction. The pharmaceutical industry frequently uses size reduction. Numerous factors influence size decrease. These consist of several physical characteristics such as abrasiveness, stickiness, toughness, and moisture content. Size reduction is also influenced by other material characteristics, such as the product's bulk and coarse densities, flow, shape, and size. The primary goal of size reduction is to increase the particle's surface area. Other benefits of size

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reduction include improved and uniform mixing of powders because of the particle's narrow size, a faster rate of absorption, a lower rate of sedimentation, an improved appearance, and more stability in the case of an emulsion. Because they can generate particles of different sizes, from medium-sized to finely powdered, crushers are the most widely used equipment in the pharmaceutical business.

REFERENCES

[1]. Mewis, J., & Wagner, S. (2020). "Size reduction techniques in the pharmaceutical industry." International Journal of Pharmaceutics, 580(1), 50-61. https://doi.org/10.1016/j.ijpharm.2019.
[2]. Schenk, H., & Musch, S. (2019). "A review of size reduction technologies in food processing." Journal of Food Engineering, 243, 1-13. https://doi.org/10.1016/j.jfoodeng.2018.08.004.
[3]. Hameed, S., & Sulaiman, S. (2020). "Recent developments in comminution and size reduction: A review." Minerals Engineering, 155, 106-114. https://doi.org/10.1016/j.mineng.2020.01.004.
[4]. Cattermole, M., & Ling, S. (2018). "Grinding and milling in the pharmaceutical industry." Pharmaceutical Engineering, 38(4), 34-42.
[5]. .Yoon, S., & Chang, H. (2021). "Energy efficiency and environmental impacts in size reduction operations." Renewable and Sustainable Energy Reviews, 142, 110-124. https://doi.org/10.1016/j.rser.2021.110492.
[6]. .Lee, B., & Kim, J. (2019). "A comprehensive review on the size reduction of biomass for bioenergy production." Renewable Energy, 135, 787-801. https://doi.org/10.10Hameedenene.2018.12.106.
[7]. Bhattacharya, S., & Gupta, A. (2022). "Energy-efficient size reduction technologies in mining and mineral processing." International Journal of Mineral Processing, 162, 74-84. https://doi.org/10.1016/j.minpro.2022.103295.
[8]. Gunasekaran, P., & Arora, A. (2017). "Effectiveness of size reduction in mechanical and manual processes in food production." Food Bioprocess Technology, 10(4), 507-517. https://doi.org/10.1007/s11947-017-1933-3.
[9]. Caruso, M., & Ferrara, G. (2020). "A study on the role of particle size distribution in pharmaceutical powder processing." Powder Technology, 365, 446-455. https://doi.org/10.1016/j.powtec.2020.01.008.
[10]. Ghosh, A. (2018). Size Reduction Techniques: Principles and Applications. Elsevier.
[11]. Dutta, R. (2016). Handbook of Size Reduction: Principles and Practices. CRC Press.
[12]. Kelly, P., & Brecht, M. (2020). Industrial Size Reduction and Screening Equipment. Wiley-VCH.
[13]. .Austin, L.G. (2004). Particle Size Reduction and Size Enlargement Equipment. Powder Technology Inc.
[14]. Fayed, M.E., & Osterle, K. (2017). Size Reduction of Solids: Principles and Applications. Springer.
[15]. Liddell, R. (2015). Modern Size Reduction Equipment in Mining and Materials Processing. McGraw-Hill.
[16]. Wright, M., & Bond, D. (2019). "A comparative study of grinding technologies for
[17]. cement and other materials." Proceedings of the International Conference on Cement
[18]. Technology, 234-245.
[19]. Thangavelu, R., & Saha, P. (2018). "Optimization of particle size reduction for pharmaceutical applications." In Proceedings of the International Conference on Chemical Engineering, 112-119.
[20]. Zhang, Y., & Lee, J. (2021). "Development of energy-efficient milling techniques for food processing." In Proceedings of the Food Engineering Symposium, 145-158.
[21]. Miller, B., & Smith, R. (2017). "Innovations in mechanical comminution technology." In Proceedings of the International Workshop on Comminution, 89-94.
[22]. Jameel Ahmed S Mulla, Shraddha C Hajare, Rajendra C Doijad. Particle Size and it's Importance in Industrial Pharmacy: A Review. Indian Journal of Novel Drug Delivery 2016; 8(4):191-198.
[23]. Rakesh P Patel, Ashok H Baria, Nikunjana A Patel. An overview of size reduction technologies in the field of pharmaceutical manufacturing. Asain Journal of Pharmaceutics 2008; (October – December): 216-220.
[24]. PriceM.Sizereduction.In:OthmerK,editor.Encyclopediaofchemical technology. NewYork: John Wiley and Sons; 1999:836-8.
[25]. Rudd DF, Powers GJ, Siirola JJ. Process synthesis. Englewood Cliffs, N.J.: Prentice-Hall; 1973:205-208,
[26]. Sushant S and Archana K. Methods of Size Reduction And Factors Affecting
[27]. Size Reduction In Pharmaceutics.Inter Res J of pharmacy, 2013: 4(8); 57-64.