A Project Report

On

"EFFICIENCY STUDY OF A LABORATORY BALL MILL"

Submitted in partial fulfillment of the requirement for Diploma in "Food Processing Technology" Submitted by Prabhat Boro (Dip/10/FPT/19) & Danswrang Basumatary (Dip/09/FPT/03)

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CERTIFICATE

This is to certify that the project Work entitled "EFFICIENCY STUDY 0F A LABORATORY BALL MILL" a bonafide work which has been done by PRABHAT BORO and DANSWRANG BASUMATARY, under my guidance and supervision.

This project is submitted to the Central Institute of Technology, Kokrajhar in partial fulfillment of the subject FPT: 601: Project for the requirement of Diploma in FPT as per the rules of the C.I.T., Kokrajhar.

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ABSTRACT

Ball mills are one of the many mixing vessels used in a mineral processing industry. During grinding, the mill's efficiency depends on particle presentation to the grinding media and the adequate utilization of the applied forces to effect breakage of particles (ore). Utilization of applied forces is affected by how well particles and grinding media are mixed. The study of charge mixing is important as it affects the mill's production rate and accelerates media wear, thus relevant to the cost reduction for the milling process.

Ball milling has been used to produce fine particles from coarse feed for an extended period. However, in the traditional ball mill, the energy exchange between the tumbling balls themselves and the feedstock tends to be chaotic in some circumstances. If the trajectory of the ball can be controlled at will, then, a far more selective comminution process can be devised, which offers considerable advantages in reducing grinding costs by conserving momentum for feed stock fracture rather than grinding time and ball consumption. In commercially available ball mills, the movement of the balls is chaotic, driven by the accidental collision between the balls themselves or with the walls of the chamber.

as a media, including ceramic balls, flint pebbles and stainless steel balls. An internal cascading effect reduces the material to a fine powder. Industrial ball mill can operate continuously, fed at one end and discharged at the other end. Large to medium sized ball mills are mechanically rotated on their axis, but small ones normally consist of a cylindrical capped container that sits on two drive shafts. Ball mills are also used in pyrotechnics and the manufacture of black powder, but cannot be used in the preparation of some pyrotechnics mixture such as flash powder because of their sensitivity to impact. High quality ball mills are potentially expensive and can grind mixture particles to as small as 5nm, enormously increasing surface area and reaction rates. The grinding works on the principle of critical speed. The critical speed can understood as that speed after which the steel balls start rotating along the direction of the cylindrical device; thus causing no further grinding. Ball mills are used extensively in the mechanical alloying process in which they are not only used for grinding but for cold welding as well, with the purpose of producing alloys from powders. The ball mill is a key piece of equipment for grinding crushed materials, and it is widely used in production lines for powder such as cement , silicates, refractory materials, fertilizers, glass ceramic, etc. as well as for one dressing of both ferrous metals. The ball mill can grind various ores and other materials either wet or dry. There are two kinds of ball mill, grate type and overall type due to different ways of discharging materials. There are many types of grinding media suitable for use in ball mill, each material having its own specific properties and advantages.

Key properties of grinding media are size, density, hardness, and composition.

Size: The smallest media particles, the smaller the particle size of the final product. At the same time, the grinding media particles should be substantially larger than the largest pieces of material to be ground.

Density: The media should be denser than the material being ground. It becomes a problem if the grinding media floats on top of the material to be ground.

Hardness: The grinding media needs to be durable enough to the grind materials, but where possible should not be so tough that it also wears down the tumbler at a fast pace.

Composition: Various grinding applications have special requirements. Some of these requirements are based on the fact that the some of the grinding media will be in the finished product.

1.3. APPLICATION:

The ball mill is key equipment for regrinding. It is widely used for the cement, the silicate product, new type building material, fire-proof material, chemical fertilizer, black and nonferrous metal, glass, ceramics and etc. Our ball mill can grind ore or other materials that can be grinded either by wet process or by dry process.

1.4. WORKING PRINCIPLE:

This ball mill is horizontal type and tubular running device, has two warehouses. This machine is grid type and its outside runs along gear. The material enters spirally and evenly the first warehouse of the milling machine along the input material hollow axis by input material device. In this warehouse, there is a ladder scale board or ripple scaleboard, and different specification steel balls are installed on the scaleboard, when the barrel body rotates and then produces centrifugal force, at this time, the steel ball is carried to some height and falls to make the material grinding and striking. After grinded coarsely in the first warehouse, the material then enters into the second warehouse for regrinding with the steel ball and scaleboard. In the end, the powder is discharged by output material board and the end products are completed.

1.5. FEATURES AND BENEFITS

This machine is made up of feeding part, art, Ball mill is an efficient tool for grinding many to discharging part, gyre part, transmission p (decelerator, small transmission gear, and generator electrical control) and so on. The hollow axis adopts the cast steel and the lining can replace the rotating big gear processes in the way of casting rolling gear.

The barrel body is wearable and bears wearable scale board. This machine run steadily *and works reliably materials into fine powder.*

The Ball Mill is used grind many kinds of mine and other materials, or to select the mine. It is widely used in building material, chemical industry, etc. There are two ways of grinding: the dry process and the wet process. It can be divided into tabular type and flowing type according to different forms of discharging material.

1.6. OPERATION AND MAINTENANCE

1. Before the ball mills start, check whether every part of ball mills normal, whether the connecting bolts loose, whether the lubrication of lubrication points normal, whether the driving device reliable, whether protective equipment intact, whether connection of motor carbon ne.

2. Check whether there is barrier surrounding the ball mills. Forbid persons standing near ball mills when it is starting.

3. Press start button to start the motor and notice the change of electric current. The ball mills' continuous starting don't surpass two times and the rest starting and the second starting should separate for more than 5 minutes. If it must be thirdly started, it should be check by electrician and filter before it is started.

5. Feed water, feed ore and add steel ball to the ball mill must follow the operate routine. Overload and preparation are both bad for the ball mill.

4. The ball mill doesn't start with other equipment at the same time avoiding the high current.

6. When the ball mill is running, it should be checked whether the barrel body leak, where the feeding water or ore is normal, where the electric current and voltage is normal. If there is some problem should be handled quickly.

7. When the ball mill is running, it should be checked whether the bearing or the oil ring is lubricated and whether the temperature of bearing is normal.

1.7. ROLL OF BALL MILL

A typical type of fine grinder is the ball mill. A slightly inclined or horizontal rotating cylinder is partially filled with balls, usually stone or metal, which grinds material to the necessary fineness by friction and impact with the tumbling balls. Ball mills normally operate with an approximate ball charge of 30%. Ball mills are characterized by their smaller (comparatively) diameter and longer length, and often have a length 1.5 to 2.5 times the diameter. The feed is at one end of the cylinder and the discharge is at the other. Ball mills are commonly used in the manufacture of Portland cement and finer grinding stages of mineral processing. Industrial ball mills can be as large as 8.5 m (28 ft.) in diameter with a 22 MW motor, drawing approximately 0.0011% of the total world's power. However, small versions of ball mills can be found in laboratories where they are used for grinding sample material for quality assurance.

Ball mill is suitable to grind various mineral and other materials, which is widely used in various industries such as beneficiation, construction materials, chemical industry, etc. It has two ore grinding ways: dry way and wet way. According to discharge type of finished powder, it can be divided into two kinds: grid type and overflow type. Ball mill is widely used to process cement, silicate product, new building product, new building materials, fireproof materials, fertilizer, ferrous and non-ferrous metal ore beneficiation, glass, ceramics, etc.

1.8. OBJECTIVES OF BALL MILL

1. To study the grinding efficiency of Ball Mill.
2. To get a fine powder of any materials to be grind.
3. To get a desired grinding product.

CHAPTER-2

2.1. REVIEW OF LITERATURE

The present laboratory Ball Mill is designed to crush particles to very fine particles (powder). It can handle variety of material. The compact and rugged construction can handle general laboratory requirement. The shell is fabricated from thick steel and balls are of steel. An opening and tightening arrangement is provided in the center of the shell to feed and to take off the material.

2.2. PRINCIPLE OF MILLING

The phenomenon of Milling is typified in dry and wet milling operations that use colliding milling media such as rotating mills or attritor mills. The number of particles caught between two colliding bah is variable ranging from one particle to several thousand particles. It is dependent on the particle size and the density of the balls used in the milling operation. Also, there are other factors affecting the trapped particles between the collided balls such as the bal1 diameter relative to the particle diameter. And the amount of powder particles used. There is also a binding action between the particles and the surfaces of the balls.

As the balls are deaccelerated during the impact, a radial displacement of powder particles occurs in the direction of least resistance to the particle flow. The first stage of compaction begins with a powder mass that is characterized by a relatively large space between particles compared to the particle size. The finished product is a mass of powder with comparatively small pores. This stage of compaction consists of the rearrangement and restocking of the particles.

During this stage the particles slide past one another producing some fines. Which partially fil1 the void spaces. The second stage of compaction involves the elastic and plastic deformation of particles. The third stage of compaction involves particle Fracture, which results in further deformation of the particles. The density of the powder bed reaches a maximum value at the zone.

2.3. MILLING PROCESS

The changes in powder particle morphology that occur during the milling of a material powder are produced by the following processes:

2.3.1. MICOFORGING

The initial and predominant process during milling is the compression shape forming of ductile material particles by impact from the milling medium, (grinding balls, rods) Individual particles or a cluster of particles are impacted repeatedly by the milling medium so that they deform with little or no net change in individual mass.

2.3.2. FRACTURES

After a period of milling, individual particles deform to the extent that cracks initiate, propagate, and ultimately fracture the particles. Cracks, defects, and inclusions in particles facilitate fracturing. Particles formed from irregular or spongy Particles contain fissures and cracks that facilitate compression fatigue failure. And fragmentation, compared to the smooth, relatively nonporous spheroid particles formed by atomization.

2.3.3. AGGLOMERATION

Agglomeration of particles may occur by welding, mechanical interlocking of spongy or rough surfaces, or autohesion. Autohesion is the molecular interaction of particles among themselves, characterized by van der Waals forces. Deagglomeration is a process that breaks up agglomerates formed by autohesion without further disintegration of the individual powder particles.

2.4. MECHANISM OF MILLING

The milling mechanism consists of an initial stage of micron forcing. In this stage the particles deform by fracture and cold welding.

As the particles become deformed, they enter a secondary stage caused by fatigue failure and fragmentation. Fragments generated may continue to the reduced in size by alternate micro forging and fracture. When fracture dominates, particles with flake-like shape continue to become smaller.

As these flakes become finer, the coupling forces tend to become greater and agglomerates become stronger. When the milling forces that deagglomerate the particles reach equilibrium with the coupling forces and a fixed agglomerate particle size results.

CHAPTER 3

3.1. MATERIALS

i. Raw Materials For feed: Limestone, Sandstone.
ii. Container.
iii. Weighing Balance.
iv. Grinding Balls (Wooden balls, Metallic balls or rubber balls).
v. Sieve shaker for analysis.
vi. Electricity supply: Single phase 220 V AC, 50 Hz, 5-15 Amp socket with Earth connection.
vii. Floor area required: 1.5m ×1m.

3.2. METHODS

A Ball Mill consists of a cylindrical shell slowly turning about a horizontal axis and filled with solid grinding medium (Metallic balls, Wooden balls or rubber balls). In a Ball Mill most of the size reduction is done by impact. The energy expanded in lifting the grinding units is utilized in reducing the size of the particles.

CRITICAL SPEED OF BALL MILL (n_c):

$$n_c = \frac{1}{2\pi} \times \sqrt{\frac{g}{R-r}}$$

Where n_c= Critical rotational speed

R= Radius of the ball.

3.3. INTRODUCTION TO BALL MILL

Generally the ball mills are known as the secondary size reduction equipment. The ball mill can be used on a greater variety of soft materials than any other type of machine. When the ball mill is rotated, the grinding elements (balls) are carried to the side of the shell nearly to the top, from where; they fall on the particles under gravity. In Ball Mill most of the size reduction is done by impact. The energy expanded in lifting the grinding units are utilizes in reducing the size of the particles.

3.4. PROCEDURE

i. Prepare a uniform sized feed of material to be crushed (5mm to 8mm approx.)
ii. Fill the shell with the balls provided.
iii. Ensure that all switches given on the panel are at off position.
iv. Now switch on the main power supply.
v. Switch on the MCB and then starter to run the machine.
vi. Calculate the power consume to run the machine at no loaded condition by determining the time for 10 or 20 pulses on the energy meter.
vii. Switch off the starter and then MCB.
viii. Fill the feed in the ball mill.
ix. Switch on the MCB and then starter to run the machine.
x. Calculate the power consume to run the machine at loaded condition by determining the time for 10 or 20 pulses on the energy meter.
xi. Run the machine for a specific time and calculate the size distribution of the product.
xii. Repeat the above steps for different time interval using fresh feed every time.

CHAPTER 4

4.1. RESULTS

BALL MILL							SHIEVE SHAKER		
Weight of feed(gm)	No of balls	Gear	Final wt (gm)	RPM	Time (min)		Shieve no	Shieve size	weight (gm)
							1	2mm	356
							2	1.1mm	4.3
							3	600microns	5
							4	425microns	6.9
500	30	1	425	364	15		5	300microns	8.7
							6	150microns	9
							7	80microns	9.4
							8	75microns	7.2
							9	45microns	6.1
							10	Less than 45	2.6
							1	2mm	327
							2	1.1mm	4.3
							3	600microns	6
							4	425microns	8.6
500	30	2	415	391	15		5	300microns	9.4
							6	150microns	10.1
							7	80microns	10.4
							8	75microns	8.6
							9	45microns	7.7
							10	Less than 45	4.3
							1	2mm	315
							2	1.1mm	5.9
							3	600microns	7.4
							4	425microns	9.7
500	30	3	391	415			5	300microns	10.5
							6	150microns	11.6
							7	80microns	11.4
							8	75microns	11.7
							9	45microns	7.9
							10	Less than 45	6.3

BALL MILL							SHIEVE SHAKER		
Weight of feed(gm)	No of balls	Gear	Final wt (gm)	RPM	Time (min)		Shieve no	Shieve size	weight (gm)
							1	2mm	327
							2	1.1mm	4.6
							3	600microns	3.1
							4	425microns	6
500	60	1	413	330	15		5	300microns	8.7
							6	150microns	8.9
							7	80microns	9.6
							8	75microns	8.3
							9	45microns	6.9
							10	Less than 45	4
							1	2mm	315
							2	1.1mm	5.4
							3	600microns	3.6
							4	425microns	6.4
500	60	2	378	397	15		5	300microns	9.2
							6	150microns	9.7
							7	80microns	10.2
							8	75microns	7.9
							9	45microns	8.3
							10	Less than 45	5.2
							1	2mm	294
							2	1.1mm	5.4
							3	600microns	5.7
							4	425microns	8
500	60	3	386	403			5	300microns	7.6
							6	150microns	9.2
							7	80microns	10
							8	75microns	9.4
							9	45microns	6.9
							10	Less than 45	4.4

BALL MILL							SHIEVE SHAKER		
Weight of feed(gm)	No of balls	Gear	Final wt (gm)	RPM	Time (min)		Shieve no	Shieve size	weight (gm)
							1	2mm	321
							2	1.1mm	3.2
							3	600microns	3.9
							4	425microns	3
500	90	1	392	304	15		5	300microns	4.2
							6	150microns	5.9
							7	80microns	5.5
							8	75microns	5.7
							9	45microns	5.3
							10	Less than 45	3.2
							1	2mm	300
							2	1.1mm	3.8
							3	600microns	4.3
							4	425microns	4.5
500	90	2	373	358	15		5	300microns	5.7
							6	150microns	5.4
							7	80microns	6.4
							8	75microns	6.1
							9	45microns	4
							10	Less than 45	3.1
							1	2mm	268
							2	1.1mm	5.6
							3	600microns	4.8
							4	425microns	6.4
500	90	3	349	381			5	300microns	7.3
							6	150microns	7.4
							7	80microns	7.7
							8	75microns	8
							9	45microns	7.6
							10	Less than 45	5.8

BALL MILL							SHIEVE SHAKER		
Weight of feed(gm)	No of balls	Gear	Final wt (gm)	RPM	Time (min)		Shieve no	Shieve size	weight (gm)
							1	2mm	291
							2	1.1mm	3.8
							3	600microns	3.1
							4	425microns	4.5
500	120	1	368	286	15		5	300microns	4.3
							6	150microns	4
							7	80microns	4.4
							8	75microns	5.6
							9	45microns	5.2
							10	Less than 45	4.1
							1	2mm	280
							2	1.1mm	4
							3	600microns	3.8
							4	425microns	4.3
500	120	2	331	333	15		5	300microns	4.7
							6	150microns	5
							7	80microns	5.4
							8	75microns	5.3
							9	45microns	4.6
							10	Less than 45	4
							1	2mm	240
							2	1.1mm	4.5
							3	600microns	4.3
							4	425microns	5.5
500	120	3	304	365			5	300microns	5.8
							6	150microns	6.4
							7	80microns	6.7
							8	75microns	7.1
							9	45microns	6.2
							10	Less than 45	5.9

BALL MILL						SHIEVE SHAKER		
Weight of feed(gm)	No of balls	Gear	Final wt (gm)	RPM	Time (min)	Shieve no	Shieve size	weight (gm)
						1	2mm	24
						2	1.1mm	5.6
						3	600microns	5.4
						4	425microns	5.9
500	150	1	281	244	15	5	300microns	6.3
						6	150microns	6
						7	80microns	6.5
						8	75microns	7
						9	45microns	6.9
						10	Less than 45	5.7
						1	2mm	152
						2	1.1mm	5
						3	600microns	5.4
						4	425microns	6.1
500	150	2	232	287	15	5	300microns	6.6
						6	150microns	6.9
						7	80microns	7.3
						8	75microns	7.5
						9	45microns	6.7
						10	Less than 45	5
						1	2mm	92
						2	1.1mm	5.2
						3	600microns	5.8
						4	425microns	6.4
500	150	3	182	300		5	300microns	5.9
						6	150microns	8.7
						7	80microns	9
						8	75microns	9.4
						9	45microns	7.7
						10	Less than 45	4.8

4.2. DISCUSSION

It is a ball milling process where a mixture placed in the ball mill is subjected to high-energy collision from the balls.

During the high-energy ball milling process, the particles are subjected to high energetic impact. Micro structurally, the mechanical alloying process can be divided into four stages: (a) initial stage, (b) intermediate stage, (c) final stage, and (d) completion stage.

(a) At the initial stage of ball milling, the particles are flattened by the compressive forces due to the collision of the balls.

(b) At the intermediate stage of the mechanical alloying process, significant changes occur in comparison with those in the initial stage.

(c) At the final stage of the mechanical alloying process, considerable refinement and reduction in particle size is evident. The microstructure of the particle also appears to be more homogenous in microscopic scale than those at the initial and intermediate stages.

(d) At the completion stage of the mechanical alloying process, the powder particles possess an extremely deformed metastable structure.

CHAPTER 5

5.1. SUMMARY AND CONCLUSSIONS

Thus we can conclude that different grinding efficiency can be obtained by using different operating conditions with respect to different types of feed to be grinded.

The operating conditions are the following.

1. Use of different gear.
2. Use of particular size feed.
3. Use of advanced qualities of ball mill.

CHAPTER 6

6.1. BIBLIOGRAPHY

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