UNIT 3 DIFFERENT TYPES OF MILLS

Structure

3.0 OBJECTIVES

After reading this unit you should be able to:

- understand the functioning and working principle of horizontal stone mills;
- understand the functioning and working principle of vertical stone mills;
- explain various arrangements of rolls in a roller mill; and
- describe the advantages of roller mills over stone mills.

3.1 INTRODUCTION

Until about hundred years ago, stone mills were the only mills used for milling of coarse grains like Wheat, Maize etc. In most of the mills today, these are replaced by Roller mills. However one can still find stone mills in India for grinding of whole wheat into atta, as well as also in a small Bansi (durum)sooji, rawa production mills.The stone mill is occasionally used today in mills only for certain break meal applications and for scouring work. You can also find these mills in spice and pulses mills for pre breaking applications.

Stone mills are two types and these are - Horizontal and Vertical stone mills.

3.2 HORIZONTAL STONE MILLS - CONSTRUCTION AND WORKING PRINCIPLE

A stone mill will consists of a pair of horizontal stones, the upper one being the rotating "runner" and the lower one is fixed to the body of the mill. The upper stone turns with a circumferential velocity of 8-9 m/sec.

The conical centre part of the upper stone provides for an easy feeding of the grains in the grinding zone. An agitator or a shaker shoe fitted at the inlet ensures continuous feeding of grain. The runner stone is driven from below by a conical gear or by a pulley from the drive motor.

For the removal of grinding dust as well as for cooling the grinding stones, the stone mill should have its own aspiration unit or connection to an external central aspiration system.

1. Inlet with agitator
2. Filter
3. Drive of the agitator
4. Sealing sleeve
5. Slip-ring
6. Knocking cam
7. Aspiration
8. Drive for filter knocking
9. Sweep
10. Bottom stone support
11. Mill stone
12. Hand wheel for disengaging the gear
13. Thrust bearing with trunnion
14. Journal bearing
15. Lifting spindle
16. Lifting lever
17. Outlet
18. Driver with mattock
19. Belt pulley
20. Tub (casing)
21. Spur pedestal
22. Transmission

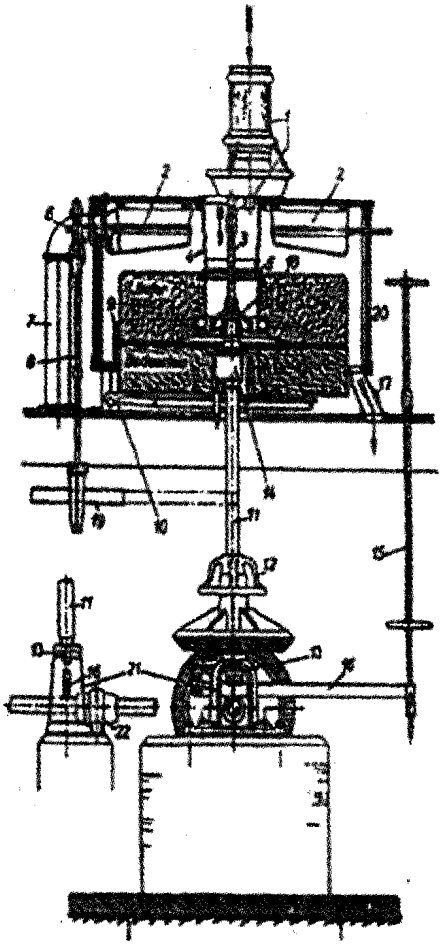
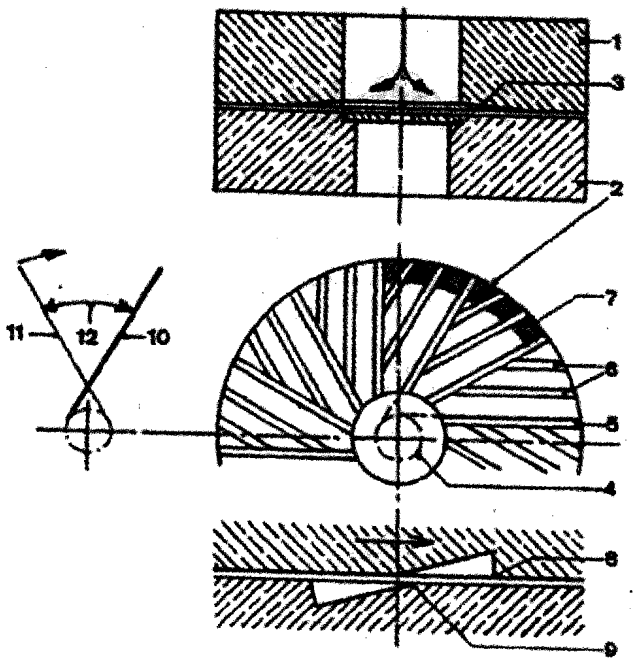


Fig. 1: Horizontal stone mill



1. Runner stone
2. Stationery stone
3. Cone (feed)
4. Basic circle
5. Main furrow
6. Side furrow
7. Milling beam
8. Back edge
9. Spring edge
10. Furrow position of the stationery stone
11. Furrow position of the runner stone
12. Crossing angle

Fig. 2: Milling stones

The main elements of the stone mill are the milling stones. The most common stones used for grinding are the so called French Burr (French Quartz) stones. For special applications stones made out of sand stone, Basalt, emery, granite are also used. Normal diameters of stones used various from 600 mm to 1500 mm

The grinding stones surface is provided with a series of furrows, such as

- Main furrows
- Side furrows
- Grinding furrows or shallow grooves

The purpose of these furrows in a grinding process is:

- To shear open the kernel
- To transport the product to the periphery with the help of centrifugal force
- To turn over the product during the grinding process
- To support the aspiration of grinding stones by forming air channels

Though over the years high degree of excellence has been achieved in the construction and operation of stone mills, the manual hand dressing of the stones is still critical for the performance of these mills.

The grinding in horizontal stone mills is considered to be very severe process. Normally whole wheat atta is produced using these mills

3.3 VERTICAL STONE MILLS – CONSTRUCTION AND WORKING PRINCIPLE

The application as well as the milling principle of the vertical stone mills is the same like the horizontal stone mill. In vertical stone mill as the name suggests, the stones are placed in vertical position.

The horizontal drive shafts are more convenient to drive at higher speeds and hence the size of the stone is very less. In general the stones diameter vary from 300 mm to 700 mm. This is the reason why the vertical stone mill is very compact compared to the horizontal stone mill. The Peripheral rotating speed of the stones varies from 10-12 m/sec.

The grinding stones are in general made out of natural stone or emery composition and some times grooved steel plates are also being used. The furrows on the stones are similar to horizontal stone mills.

The vertical stone mills produce less severe grinding action compared to horizontal stone mills. These are commonly used in pulses pre breaking and Small capacity durum sooji mills.

3.4 ROLLER MILLS – INTRODUCTION, CONSTRUCTION AND WORKING PRINCIPLE

Grinding by rollers instead of stones was started in Europe (Hungary) in the eighteenth century and the first flour mill was built using roller mills in England in 878.

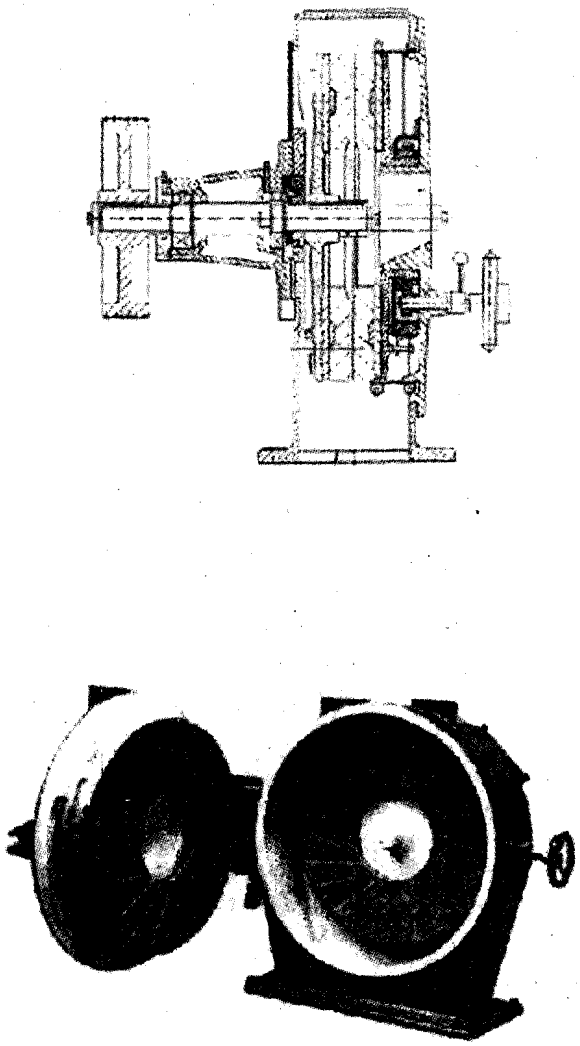


Fig. 3: Stone grinder with opened roof

The grinding zone or path in a roller mill is through a pair of rolls (usually porcelain in initial days). In spite of this grinding zone being shorter as well as it requires several repeated stages of grinding to achieve the same reduction, Roller mill became popular because of its grinding/milling efficiency.

Though the roller mill started with one pair of rolls in the earlier days, modern day roller mill will have two pairs of rolls as a standard design. Each pair of rolls formed as an independent unit and two such independent units are positioned back to back to form a modern day roller mill.

Modern day roller mill frames are made out of either mild steel or cast iron. And the main rolls are made of closed grain cast iron centrifugally cast, deeply chilled on the outside to give a very hard and durable outer surface retaining its soft core. These rolls are normally 250 mm diameter and run opposite to each other at differential speeds. The length of the rolls is usually 600 mm to 1500 mm.

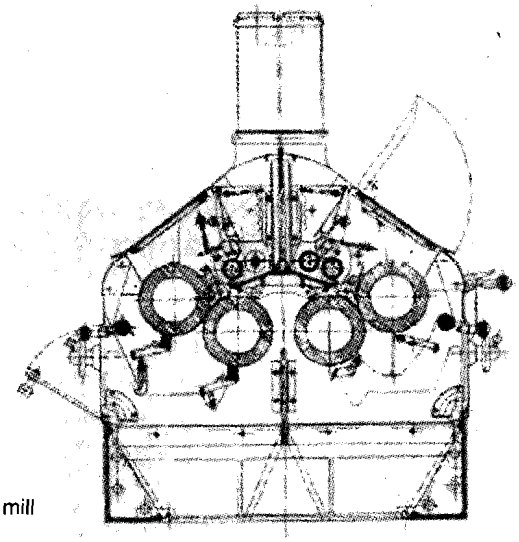
One of the main roll is driven by an electric motor using V belt or flat belt and this roll transmits the drive to the other roll using a set of gears or toothed belt.

Uniform feeding is very important throughout the length of the roll and a feed roll mechanism consisting of a pair of fluted feed rolls and a balanced feed gate is

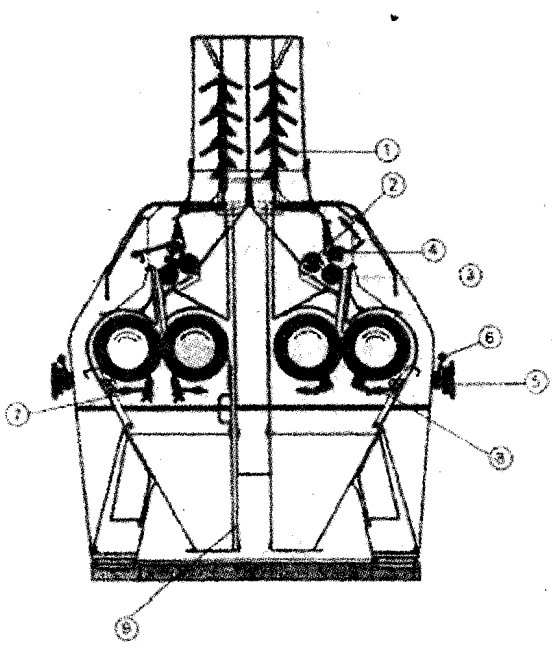
provided on top of the main rolls to ensure the distribution of product to the entire length of the roll. These feed rolls will be driven from the main roll

The main rolls are run on double row spherical roller bearings with grease lubrication. The gap between the rolls can be adjusted by moving the one roll precisely using hand wheels.

Roller mill generally used in break system will have flutes/grooves on its surface for breaking the grain to release endosperm from the bran layers. Where as the roller mill used in reduction system will have smooth surface for grinding the endosperm into flour. These rolls are provided with scrapers/brushes to clean the surface clean.



Cross-section of a diagonal four-roller mill



Cross-section of a roller mill "AIRTRONIC"

1. Impulse transmitter
2. Distribution screw
3. Front feed screw
4. Feed segment
5. Hand wheel for adjusting grinding gap
6. Locking gear
7. Knife scraper for smooth rolls
8. Brush scraper for corrugated rolls
9. Grinding gap aspiration

Left roll stand half:
Reduction passage with smooth rolls and corresponding feed.

Right roll stand half:
Breaking passage:
Corrugated rolls and corresponding feed

Fig. 4: Roller mills

3.5 VARIOUS ARRANGEMENTS OF ROLLS IN A ROLLER MILL

a) Horizontal roller mill

b) Vertical roller mill

c) Diagonal roller mill

Horizontal roller mill:

In this type of roller mills rolls are positioned horizontally.

The advantages of this roller mill over others are:

- Uniform feeding
- Better control over the roll adjustment

The disadvantages are

- Becomes bulky and occupies more space
- Access to roll scrapers/brushes is difficult

Vertical roller mill:

In this type of roller mills rolls are positioned vertically.

The advantages of this roller mill over others are

- Easy accessibility to the roll scrapers/brushes
- Occupies less floor space compared to horizontal roller mill

The disadvantages of this roller mill are

- Requires more head room
- Impossible to ensure that the stock uniformly enters the nip of the roll or grinding zone.

Diagonal roller mill:

In this type of roller mills rolls are positioned diagonally to each other.

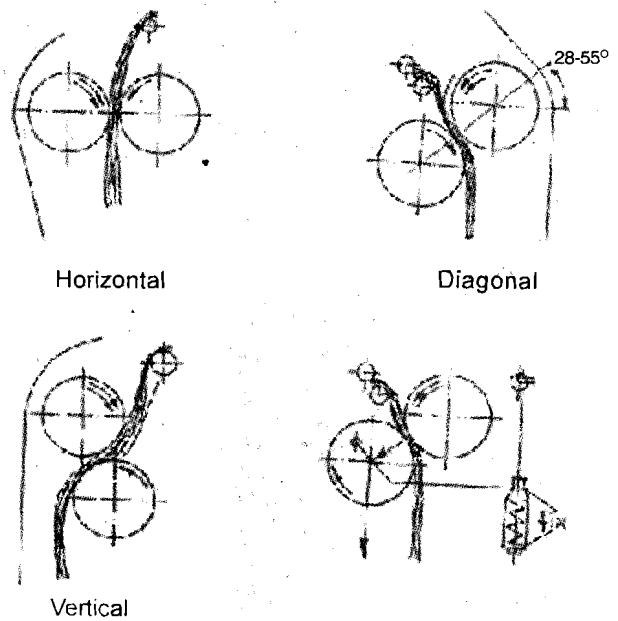


Fig. 5: Various Arrangements of Rolls

The advantages of this roller mill over others are

- Occupies less floor space than horizontal roller mill and less head room than vertical roller mill
- Easy accessibility to roll scrapers/brushes
- Uniform feeding to the grinding zone

Though there is no specific disadvantage with this type of roller mill, modern day mechanisms of roll gap setting is more suitable for horizontal roll arrangement.

3.6 ADVANTAGES OF ROLLER MILLS OVER STONE MILLS

- Smooth and continuous operation
- Better control over milling/grinding results
- Better yields of low ash flours/whiter flours
- Better separation of by-product (bran) from product
- Less power consumption for a given capacity
- Sophisticated and better safety controls
- No manual redressing only machine made flutes are used
- Better control over feeding, grinding and discharging
- Flexible in operation
- Less space requirement for a given capacity
- Less down time, easy maintenance and easy to operate.
- Bigger the capacity more the benefits
- Hygienic and safe products

Check Your Progress

Note: a) Use the spaces given below for your answers.
b) Check your answer with those given at the end of the unit.

1. Give the main differences between horizontal stone grinders and vertical stone grinders?

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2. Describe the various furrows on the grinding stones and their necessity

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3. Describe the main elements of the roller mill

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4. Give the main advantages of roller mills over stone mills

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3.7 LET US SUM UP

Today Roller mill has become very popular and important equipment in grain milling.

Lot of research is being done on this and lot of developments are still happening. Apart from standard 4 roll (2x2pair rolls) roller mill, which we have discussed, now eight roll roller mill has also been developed.

Roll tightening or creating the grinding pressure between the rolls used to be using mechanical springs in the earlier days. Then came hydraulic cylinders and at present pneumatic cylinders are being used.

The technological changes in a mill and the high automation levels of mills will be well supported by roller mill and not by stone mills

With the quality consciousness as well as the high market competition and high capacities are making roller mill more and more important.

Stone mills are sparingly used only for some special purposes. The capacity of the mill and the quality of the product to be produced decides the equipment.

3.8 KEY WORDS

Horizontal stone mills : Consists of a pair of horizontal stones upper one being the rotating or runner and lower one is fixed.

Vertical stone mills : Consists of a pair of stones mounted vertically on the machine and generally used for pulses and durum sooji mills

Diagonal roller mill : In this type of mill, the rolls are portioned diagonally to each other and it occupies less space.

Furrows : The grinding stones are provided with a series of furrows such as main furrows, side furrows or grinding furrows to shear open the kernel and to transport the kernel to the periphery with the help of centrifugal force.

Roller mills : The grinding zone or path for the material is through a pair of rolls made out of closed grain cast iron – centrifugally cast deeply chilled on outside

3.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISE

1.

Horizontal Stone Mills	Vertical Stone Mills
a. Pair of discs are arranged horizontally	a. Pair of disc are arranged vertically
b. Lower stone is fixed	b. No such arrangement exists
c. Mills produce severe grinding action	c. Discs produce severe grinding action

2. The grinding stones surface is provided with a series of furrows such as:
   - Main furrows
   - Side furrows
   - Grinding furrows or shallow grooves

   The purpose of these furrows in the grinding process is
   - to shear open the kernel/grain
   - to transport the kernel to the periphery with the help of centrifugal force
   - to turn over the product during the grinding process
   - to support the aspiration of grinding stones by forming air channel.
3. The main elements of a roller mill are:
   a. Grinding is performed by rolls instead of stones
   b. Grinding path in a roller mill is through a pair of rolls.
   c. Grinding/milling efficiency is high.
   d. Uniform feeding is possible throughout the length of roll.
   e. Gap between rolls is adjustable
4. Main advantages of roller mills over stone mills
   - Smooth and continuous operation
   - Better control over milling/grinding results
   - Better yields of low ash flours/whiter flours
   - Better separation of by-product (bran) from product
   - Less power consumption for a given capacity
   - Sophisticated and better safety controls
   - No manual redressing only machine made flutes are used
   - Better control over feeding, grinding and discharging
   - Flexible in operation
   - Less space requirement for a given capacity
   - Less down time, easy maintenance and easy to operate
   - Bigger the capacity more the benefits
   - Hygienic and safe products

3.10 SOME USEFUL REFERENCES

1. Arthur W. Rohner, Machine manual for millers, Buhler Brs., Oberuzwil, Switzerland.
2. The Practice of Flour Milling. Vol. I, 1979, Nabim, 21 Arlington St. London.