

**PROCESSING
TECHNOLOGY OF CEREALS
ASFE 2201**

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PADDY PROCESSING



SHELLING OF RETURN PADDY

- Paddy collected from the separator is called return paddy, for it has to be returned to the sheller.
- The return paddy grains are shorter (if in disc sheller) or thinner (if in rubber-roll sheller) than normal paddy.
- Hence, it is preferable to collect the return paddy in a top bin and shell it at the end with closer clearance between the discs or rolls.
- Alternately, the return paddy can be shelled in a separate, small sheller.
- This will increase the capacity of the dehusker. If return paddy is returned to the original sheller, it will simply go on circulating, thus lowering the capacity.

WHITENING / POLISHING

- The term whitening refers to the operation of removal of bran layers from husked rice kernels.
- The three major kinds of whitening machines used in modern rice processing industry are :-
 - Vertical abrasive whitening cone (European)
 - Horizontal abrasive whitening roll (Japan)
 - Horizontal metallic friction type roll (Japan)

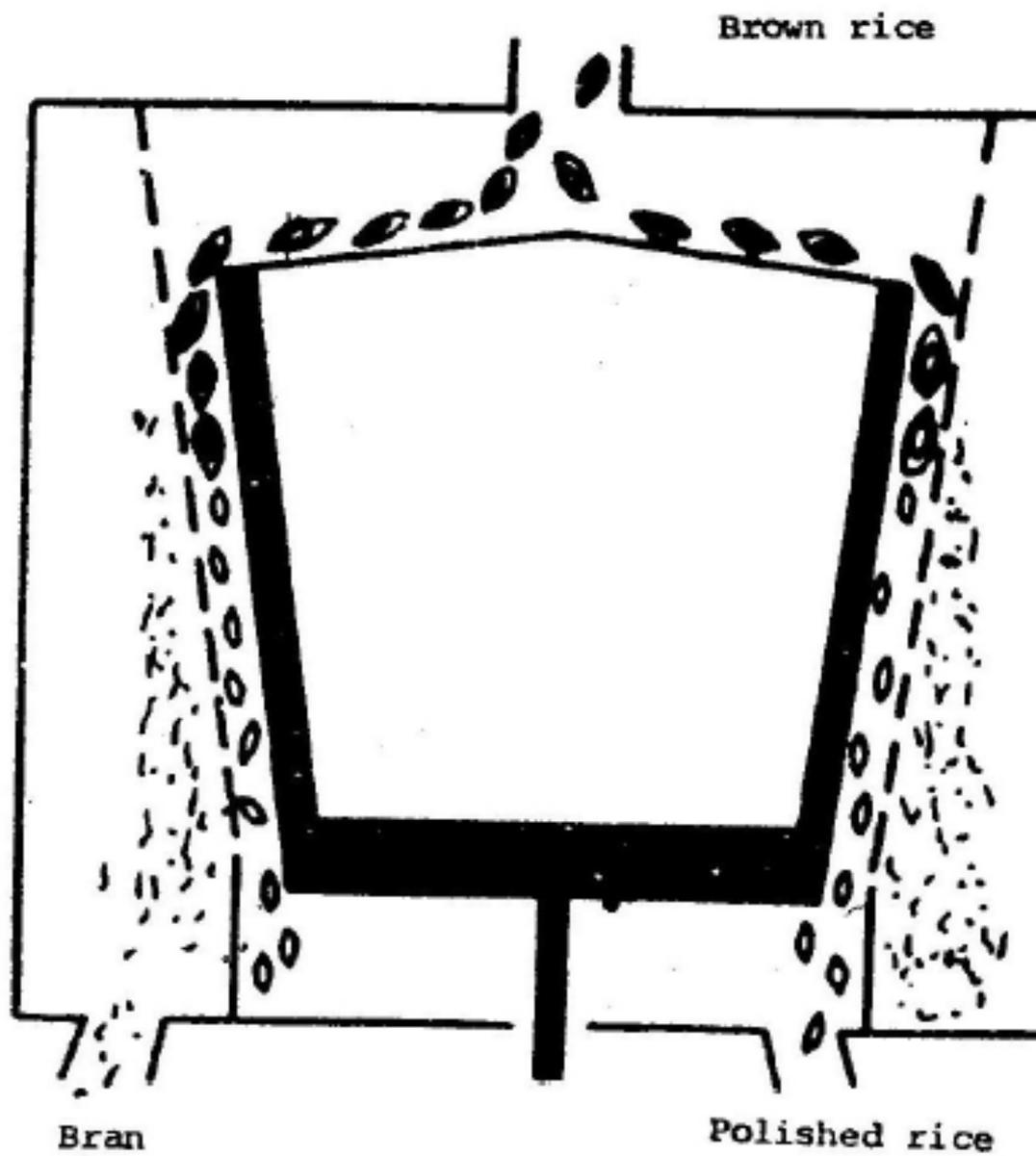
- To remove the bran layers, there are two different types of whitening machines: grinding type and friction type.
- As the surface of husked rice is smooth and slippery, the grinding type of machine is used at the initial stage to shave and grind the bran layer into smaller particles and impart roughness to the grain surface as well by the thrust and frictional force of a revolving abrasive roll.
- The friction type machine is employed subsequently to peel off the remaining bran layer easily by the friction between rice and rice by the high pressure created by rotating ribbed steel rolls.
- If the smooth husked rice kernels were directly whitened by the friction type machine only, it would require much higher pressure and power for whitening. The yields of broken would also be more.
- Grinding type uses more impact force rather than friction.

	Grinding type	Friction type
Peripheral speed	Over 600 m/min	Below 300 m/min
Pressure	Below 50 gm/cm ²	Over 200 gm/cm ²

System/Item	<i>Grinding type</i>		<i>Friction type</i>	
	Initial stage	Middle stage	Initial stage	Middle stage
Efficiency	high	low	low	high
Breakage	small	small	much	small
Whitening degree	high	high	low	low
Glossiness (shine)	low	low	high	high
Moisture absorption	fast	fast	slow	slow
Deformation	partially deformed	partially deformed	full	full
Embryo removal	easy	easy	easy	difficult

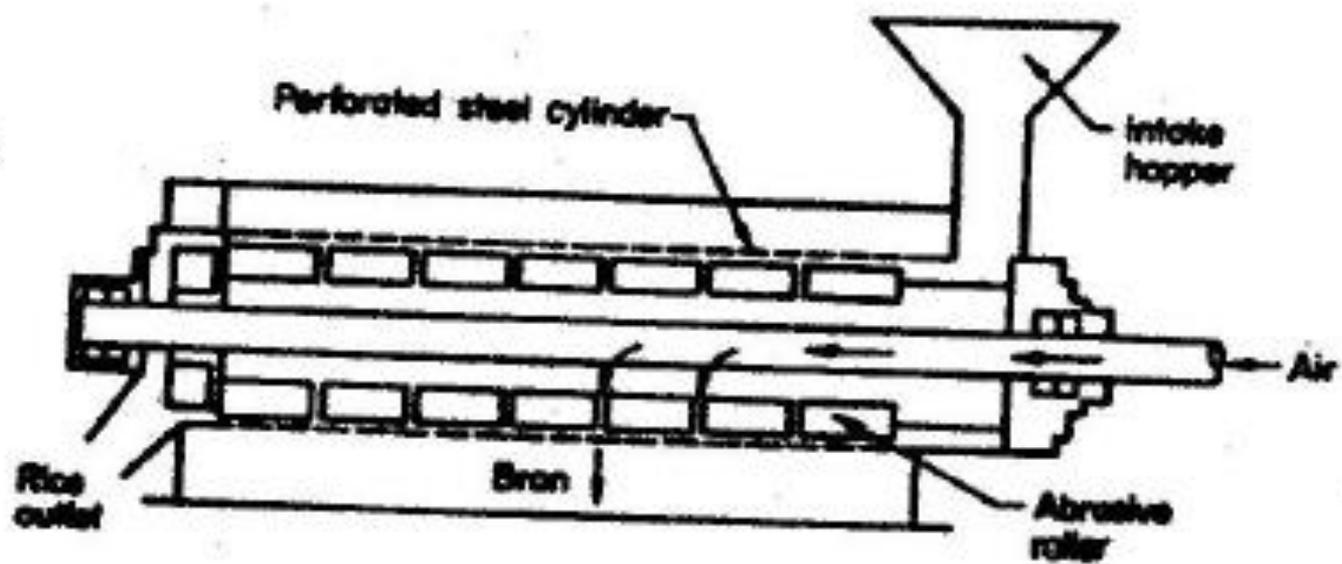
VERTICAL ABRASIVE WHITENING CONE (EUROPEAN)

- It consists of an inverted cast iron frusto-conical rotor , covered with emery, which rotates inside a wire screen.
- The clearance between the cone and screen can be adjusted by raising or lowering the cone.
- At regular intervals around the cone, the wire screen is divided into segments by vertical adjustable rubber brakes.
- The peripheral speed of the cone should be 13m/sec.
- The peripheral speed is higher at the upper part but the density and pressure at the lower part is higher. As a result, the grinding action is predominating at the upper part while frictional force is stronger at the lower part.



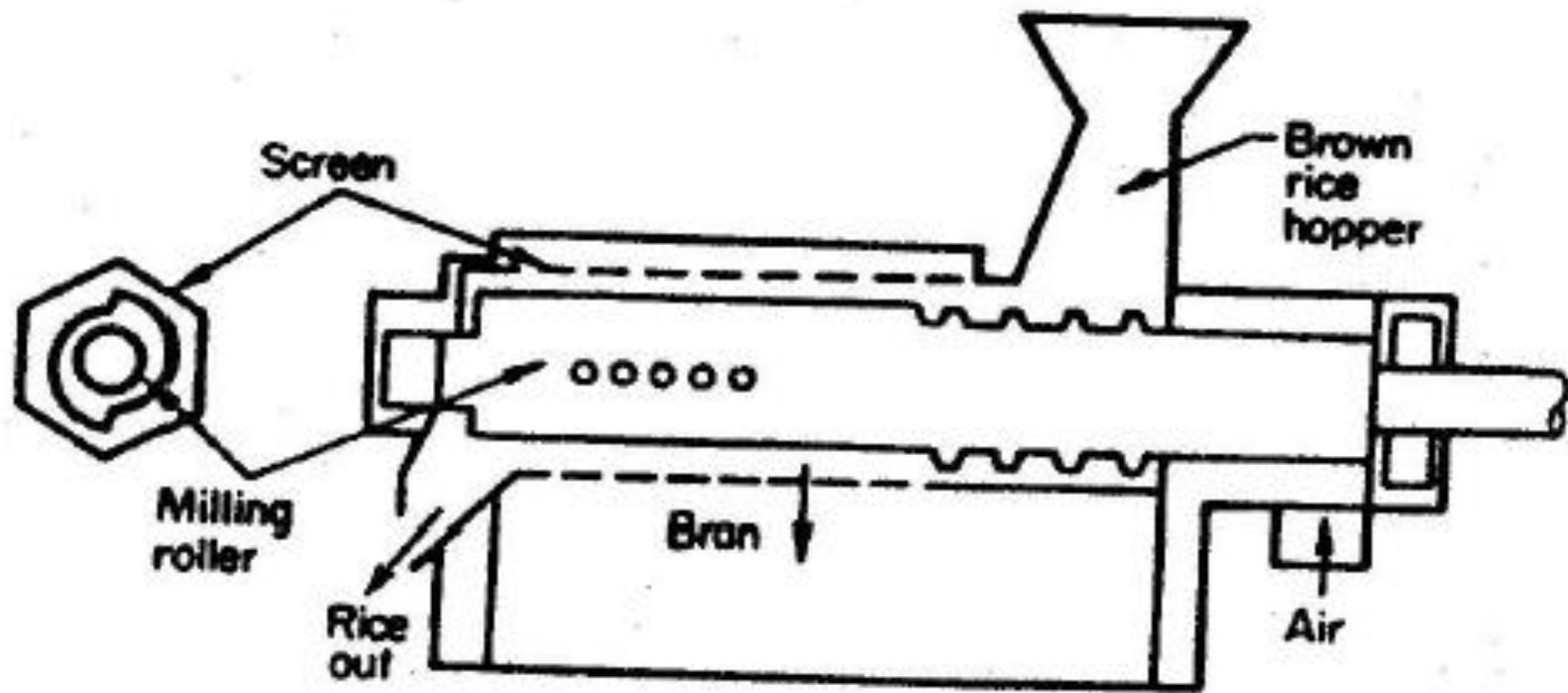
HORIZONTAL RICE WHITENING MACHINE (JAPAN)

- The machine consists of an abrasive cylindrical emery stone attached to a steel shaft rotating in a cylindrical, perforated metallic screen mounted horizontally.
- Brown rice enters at one end, and moves round and round the abrasive roll to the opposite discharge end.
- The pressure on the grain is controlled by hanging different weights on the discharge gate.
- As the grain passes through the space between the roll and the perforated screen, the bran layers are peeled off from the grain.
- The bran passes out through the perforated screen and polished rice is discharged through the outlet.
- The abrasive roll is made of carborundum.
- The peripheral speed should be more than 600 m/min.



FRICITION TYPE WHIENING MACHINE (JAPAN)

- The machine consists of cylindrical steel roller rotating inside a hexagonal perforated screen.
- The cylinder has a long slit along its length and a hollow shaft for passing air.
- The clearance between the screen and cylinder is adjustable by opening or closing the screen.
- The pressure on the rice is further controlled by hanging weights on the discharge gate.
- A strong stream of air is blown by a centrifugal blower through the hollow shaft and long slit of the cylinder.
- The air helps in separating the bran and removing the heat generated by the friction between rice and rice.
- The peripheral speed of steel roller is 300 m/min.

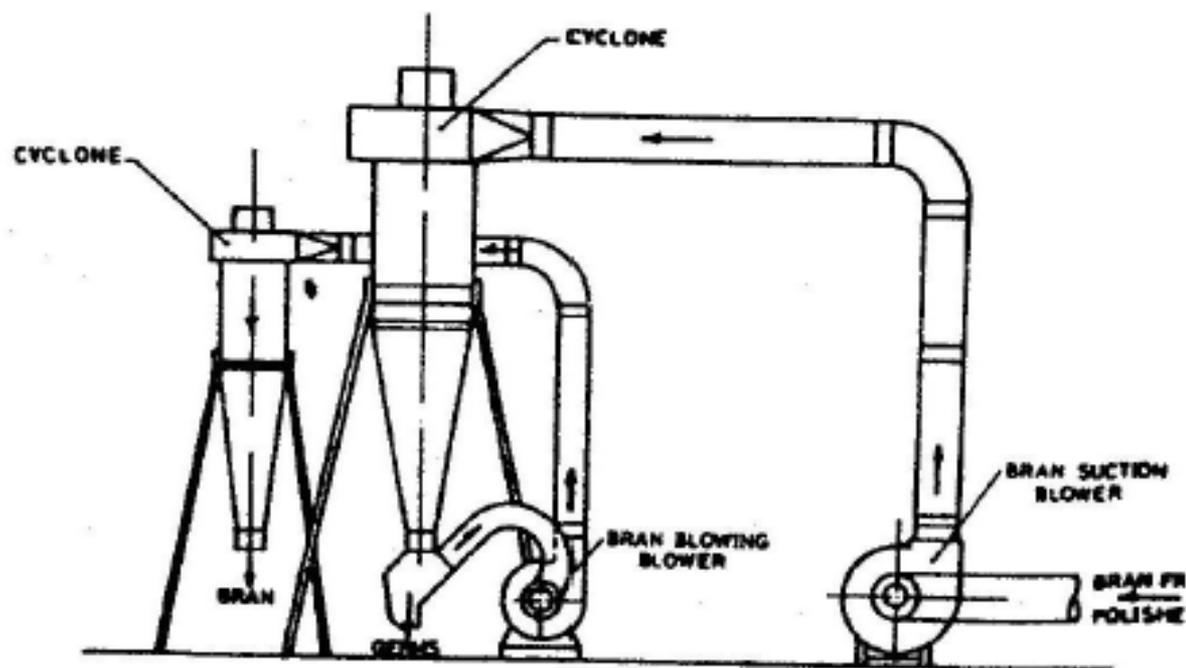


MIST POLISHER

Mist polisher. For producing premium or export quality rice, a mist polisher is employed to brush off remaining bran dust and to create a characteristic gloss on the milled rice. In mist polishers, a controlled amount of water mist is injected, resulting in highly polished grain. Mist polishing improves the storability of milled rice because of the complete removal of the bran.

The correct sequence for multi-step whitening is abrasive whitener (for first stage whitening) followed by friction-type whitener (for second stage whitening), followed by mist polishing.

Pneumatic bran separator: This equipment separates rice germs and broken from bran and also conveys the bran pneumatically (i.e by air). It consists of a powerful centrifugal fan which aspirates the bran from the polisher and delivers it to a cyclone. A blower and an auxiliary cyclone aspirates the bran from the outlet of the main cyclone. Thus fine bran is separated from coarse materials (germs and broken).

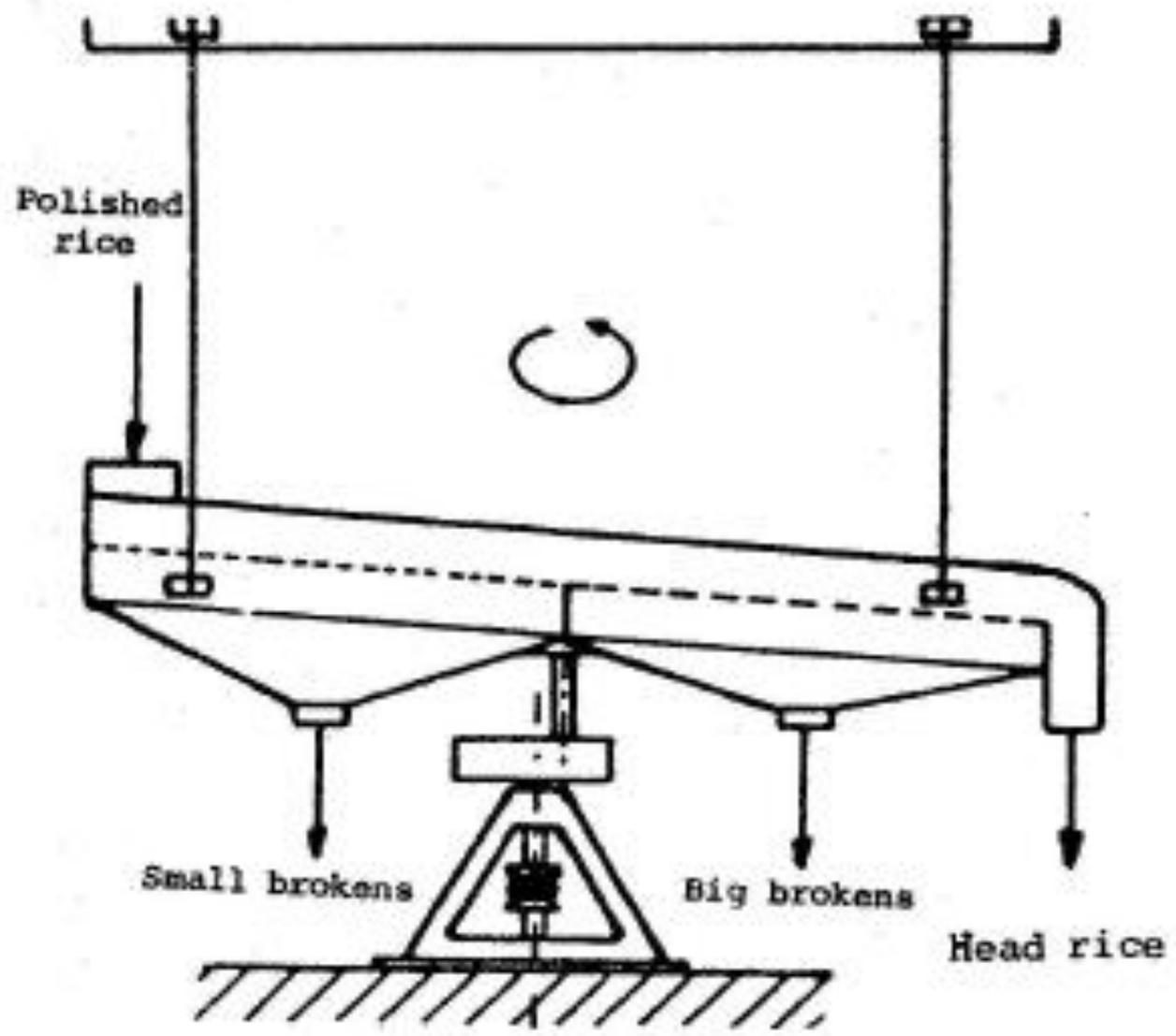


SIFTERS

- The last major step in rice milling is the removal of fine brokens, also reffered as brewers rice from the milled rice.
- Sifters remove small brokens, germs and bran still present in the milled rice after whitening and polishing.
- The equipments generally used for the purpose are:-
 - 1) Screen sifters
 - 2) Indented cylinders.

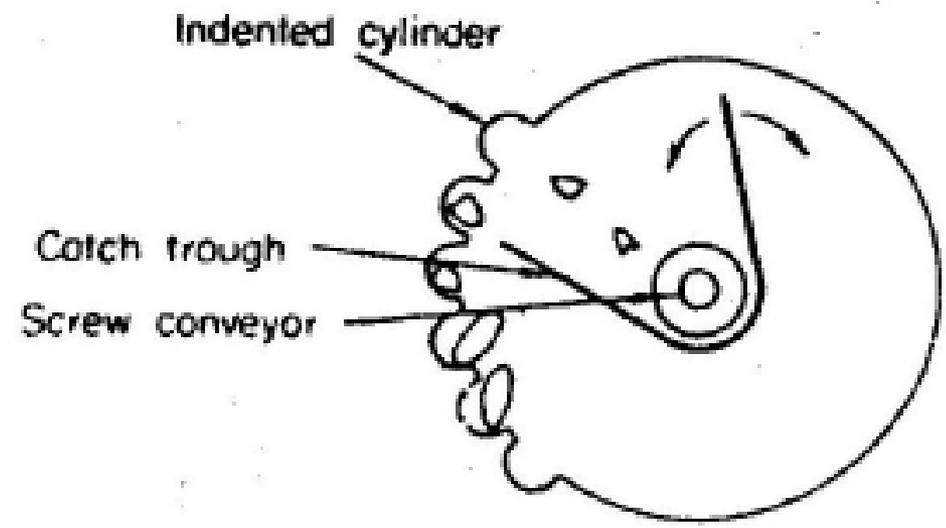
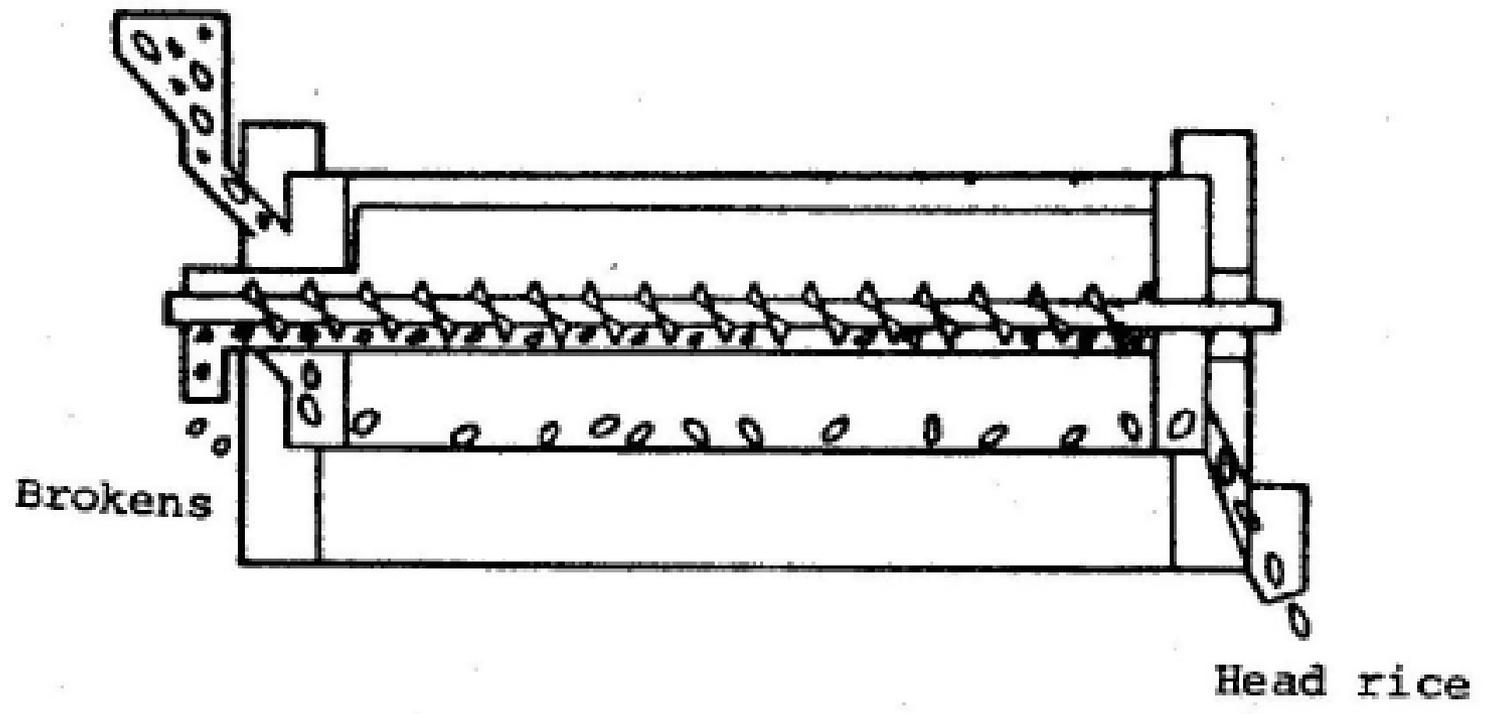
PLANSIFTER/SCREEN SIFTER

- It is a single or double-decked sieve which is given a swinging motion produced by an eccentric drive.
- It consists of two sheets of different perforations (first small and then large) to separate two grades of broken rice from the polished rice.
- The grain moves across the swinging sieve in a continuous spiral path.
- It cannot separate all broken grains from head rice.
- Big broken rice remain along with head rice, while small broken rice (less than half size) are removed.
- Sieves of the grader should be kept free from clogging for maximum removal of broken rice.



TRIEUR/INDENTED CYLINDERS/ LENGTH GRADERS

- This is slightly inclined rotating cylinder containing indentations, like small pockets, all along its inner body.
- The mixed (head and broken) rice is unloaded into the raised end of the cylinder.
- As the rice passes along the slowly rotating cylinder, the broken grains sit nicely in pockets and are therefore picked up by the rotating cylinder.
- But as the cylinder rotates upward, the sitting broken grains finally fall out at a high point and are caught by a collector trough fixed inside the cylinder and discharged separately.
- The unbroken grains, being too long, cannot sit in the pockets which are too small.
- Hence they move along undisturbed down the cylinder as it rotates. Whole and broken grains are thus separated into two streams.
- By adjusting the size of the indentations and the position of the trough, broken rice of different sizes can be separated.



Bagging. In most rice-growing countries, milled rice is marketed in bags, and therefore bagging stations is an integral part of the modern rice mill. The size of the bags depends on the requirements of the customer. In larger rice mills that cater to supermarkets, milled rice is packaged in plastic bags of 2, 5, 10 and 20kg, and packaging is fully mechanized. The basic bagging station consists of a bagging bin, a platform scale, and a bag closing-sewing machine.

Guidelines to Improve the Output of the Rice Mill

Provided that the quality of paddy received at the rice mill is good, the best quality milled rice will be attained from a mill if a number of guidelines are followed.

Optimum harvest time. Harvesting should be done immediately after attaining the maturity having the moisture content ranges between 19 and 23 per cent (wb).

Mill rice at the right moisture content: 14% MC. If moisture content (MC) is too low, high grain breakage will take place resulting in low head rice recovery. Broken grain has only half the market value of head rice.

Pre-clean paddy before husking. Use of paddy without impurities will ensure a cleaner and higher quality end product.

Use rubber roll technology for husking. Engleberg-type or “steel” hullers are no longer acceptable in the commercial rice milling sector, as they lead to low milling recovery and high grain breakage.

Separate all paddy from the brown rice before whitening. Paddy separation after husking will lead to better quality milled rice, and reduce overall wear and tear on the rice mill.

Consider two-stage whitening. Having at least two stages in the whitening process (and a separate polisher) will reduce overheating of the grain and will allow the operator to set individual machine settings for each step. This will ensure higher milling and head rice recovery.

Install a screen sifter to remove small brokens and chips from the polished rice. Rice with a large number of small brokens (or brewer’s rice) has a lower market value. The small brokens can be utilized to produce rice flour.

Monitor and replace spare parts regularly. Turning or replacing rubber rolls, refacing stones and worn screens regularly will keep milled rice quality high at all times.

Do not mix varieties prior to milling. Different varieties of paddy have different milling characteristics that require individual mill settings. Mixing varieties will generally lead to lower quality of milled rice.

Measurement of Quality of Paddy Grain

Crack detector. Using the Paddy Crack Detector, count the number of cracked grains in a 100 grain sample, then compute the % cracked grains using the equation:

$$\% \text{ Cracked grains} = \frac{\text{Number of cracked grains}}{100 \text{ grains}} \times 100 \quad \dots(8.1)$$

Grain dimensions. Using a caliper or photographic enlarger, collect 20 paddy samples at random from each replicate and measure the dimensions to obtain the average length and width of the paddy grains. To obtain the paddy shape, the following equation can be used,

$$\text{Length to width ratio (L/W)} = \frac{\text{Average paddy length, mm}}{\text{Average paddy width, mm}} \quad \dots (8.2)$$

Paddy can be classified based on International Organization for Standardization (ISO) for paddy.

Immature Grains. Select a 25 gm grain sample and select, segregate and weigh the immature grains in sample. Calculate the percentage immature grains in the sample using the formula,

$$\% \text{ Immature grains} = \frac{\text{Wt. of immature grains}}{\text{Total weight of samples}} \times 100 \quad \dots (8.3)$$

Dockage in paddy. Remove light foreign matter, stones, weed and seeds from a 100gm sample. Obtain the total weight then compute the dockage percentage as follows,

$$\% \text{ Dockage} = \frac{\text{Wt. of dockage}}{\text{Total wt. of sample}} \times 100 \quad \dots (8.4)$$

1000 Kernel weight. Determined by counting and weigh 1,000 grains (paddy).

Measurement of Quality of Milled Rice

Milling degree. Milling degree is computed based on the amount of bran removed from the brown rice. To obtain the weight of brown rice, dehull the paddy samples using the Laboratory Huller. Estimate the percent milling degree using the following equation,

$$\% \text{ Milling degree} = \frac{\text{Wt. of milled rice}}{\text{Wt. of brown rice}} \times 100 \quad \dots (8.5)$$

Milling recovery. Using the Abrasive Whitener, mill the dehulled samples. Compute milling recovery by dividing the weight of milled rice recovered by the weight of the paddy sample, as follows,

$$\% \text{ Milling recovery} = \frac{\text{Wt. of milled rice}}{\text{Wt. of sample used}} \times 100 \quad \dots (8.6)$$

Dockage in milled rice. Select, segregate and weigh the foreign matter. Record the number of unhulled grains collected from the sample. Determine the percentage of dockage of milled rice using the equation,

$$\% \text{ Dockage (mr)} = \frac{\text{Wt. of dockage}}{\text{Total wt. of milled rice}} \quad \dots (8.7)$$

Broken grain. Using the Grain Grader, separate the broken grain from the whole grains. Compute the percentage of the head rice and brokens using the following equations,

$$\% \text{ Head rice} = \frac{\text{Wt. of whole grains}}{\text{Wt. of paddy samples}} \times 100 \quad \dots (8.8)$$

$$\% \text{ Brokens} = \frac{\text{Wt. of broken grains}}{\text{Wt. of paddy samples}} \times 100 \quad \dots (8.9)$$

Chalkiness. A visual rating of the chalky proportion of the grain is used to measure chalkiness based on the Standard Evaluation System (SES scale) presented below:

SES scale	1	5	9
% area of chalkiness	< 10	10 – 20	> 20

Select, segregate and weigh the chalky grains (SES Scale 9). Determine the % chalky grain using the equation :

$$\% \text{ Chalky grain} = \frac{\text{Wt. of chalky grains}}{\text{Wt. of milled rice}} \times 100 \quad \dots (8.10)$$

Whiteness. Measure the grain whiteness using the Whiteness Meter. Separate and weigh yellow-fermented grains. Calculate the percentage of yellow/fermented grains using the formula:

$$\% \text{ Yellow grains} = \frac{\text{Wt. of yellow grains}}{\text{Total wt. of milled rice}} \times 100 \quad \dots (8.11)$$

Grain shape. Follow the procedure of determining grain shape of paddy. Based on the length to width ratio, the shape of the milled rice will be determined. L/W ratio is given by:

$$L/W = \frac{\text{Average length of rice, mm}}{\text{Average width of rice, mm}} \times 100 \quad \dots (8.12)$$

ASSIGNMENT

- Write the advantages and disadvantages of vertical abrasive whitening cone (European), Horizontal rice whitening machine (Japan), Friction type whitening machine (Japan).
- Write about the By-Product utilization in rice milling.