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भारतीय मानक मसौदा

मोटा अनाज (श्रीअन्न) के लिए पर्लर कम पॉलिशर — विशिष्टि एवं परीक्षण संहिता

Draft Indian Standard

PEARLER CUM POLISHER FOR MILLETS — SPECIFICATION AND TEST CODE

ICS 65.060

Agriculture and Food Processing Equipment Sectional Committee, FAD 20	Last date of comments: **4 May, 2024**

FOREWORD

(Adoption clause will be added later)

Millets are the important food grains made of layers of husk and bran. Presence of these layers is considered as protection to store the grain/seed for longer. However they result in longer cooking duration and indigestion. The outer husk layers of millets are removed by dehusking followed by polishing to remove the bran. Pearling is the operation, where the removal of husk and bran are done in single operation by the gradual removal of grain tissues (by abrasive or friction action) starting from the outer grain tissues/layers, bran (i.e., pericarp, testa, aleurone, and subaleurone layers), and germ). Equipment used in millet pearling and polishing are very crucial for ensuring the quality of processed millets. Therefore, a need was felt, to develop a standard to maintain the overall quality and promote the consumption of this valuable and nutritious grain, benefiting all the equipment manufacturers, millet millers and consumers.

A need was felt to develop a standard to ensure the quality of the process and the produce as well as for third party testing and certification purpose. This standard will also serve as guidance to the manufacturers of these equipment.

A series of Indian Standards are being developed on the equipment used in primary processing of millets. Apart from this standard, four other standards on millets processing equipment have been published which are as under:

IS 19039 : 2023 Cleaner cum grader for millets with pre-cleaner — Specification and test code
IS 19040 : 2023 Millet Dehusker — Centrifugal Type — Specification and test code
IS 19041 : 2023 Destoner for Millets — Specification and test code
IS 19042 : 2023 Symbols and flow diagram for primary processing of millets

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2: 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant

places retained in the rounded off value should be the same as that of the specified value in this standard.

1 SCOPE

This standard specifies material, performance, constructional and other requirements of millet pearler cum polisher and it also prescribes the test methods for performance evaluation of this equipment.

2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

IS No.	*Title*
IS 210: 2009	Grey iron castings — Specification (*fifth revision*)
IS 277: 2018	Galvanized steel strips and sheets (Plain And Corrugated) — Specification (*seventh revision*)
IS 399: 1963	Classification of commercial timbers and their zonal distribution (*first revision*)
IS 715: 2002	Coated Abrasives — Specifications *(fourth revision)*
IS 816: 1969	Code of practice for use of metal arc welding for general construction in mild steel *(first revision)*
IS 2062: 2011	Hot rolled medium and high tensile structural steel — Specification *(seventh revision)*
IS 2405 (Part 1): 2023	Industrial Sieves Specification Part 1 Wire Cloth Sieves *(second revision)*
IS 2405 (Part 2): 2023	Industrial Sieves Specification Part 2 Wire Sieves *(second revision)*
IS 4333 (Part 2): 2017/ ISO 712: 2009	Methods of analysis for food grains: Part 2 determination of moisture content *(second revision)*
IS 6911: 2017	Stainless Steel Plate, Sheet and Strip — Specification *(Second revision)*
IS 9555: 1999	Rice Polisher - Specification *(second revision)*
IS 10520: 1989	Agricultural Produce Milling Machinery - Emery Stones for Burr Flour Mills — Specification (First Revision)

3 TERMINOLOGY

For the purpose of this standard, the following definitions shall apply.

3.1 Abrasive type Polisher/Pearler — The polisher/pearler for millets using abrasive surfaces as mechanism.

3.2 Bran — The powdered material obtained from the outer most part of the millet, may be with or without the husk/hull.

3.3 Broken Millet — Millet kernels which are broken and whose size (length/diameter) is less than three-fourth of the original size.

3.4 Degree of Polish — The quantity of bran removed from millet during polishing, expressed in terms of percentage of dehusked/dehulled or unpolished millet.

3.5 Emery-Coated Polishing Unit — Emery of specific grit size bonded with magnesium oxide and magnesium chloride coated on the surface to provide necessary abrasion for polishing. The surface may be a cone, drum/roller, disc, *etc.*

3.6 Feed Rate — The quantity of millet fed into the polisher per unit time.

3.7 Feed Regulating Mechanism — The mechanism which regulates the feed rate to the polisher.

3.8 Friction Type Polisher/Pearler — The polisher/pearler for millets using friction as mechanism for removal of bran.

3.9 Head Yield — The percentage of polished/pearled millet excluding brokens, over the quantity polished/pearled.

3.10 Millet Polisher — A machine used for the removal of bran layer from the raw or parboiled millet after dehusking/dehulling.

3.11 Pearling — This is a mechanical operation of removal of husk/hull and bran layers in a single operation by abrasion/friction. Both husk/hull and bran will be obtained as a mixture.

3.12 Polish Regulating Mechanism — The arrangement for varying the retention time for the millets during pearling/polishing. This is to achieve various levels of degree of polish/pearling.

3.13 Polishing — Removal of bran layer from the dehusked/dehulled millet by the mechanical action of abrasion or friction. It is also known as whitening.

3.14 Rated Input Capacity — The feed rate at which the degree of polish/pearling and the brokens are within the specified limit.

3.15 Total Yield — The percentage of polished/pearled millet along with brokens, over the quantity polished/pearled.

3.16 Whole Millet — Millet grains of size (length/diameter) three-fourth and above of the whole undehusked/unpolished millet grain.

4 TYPES OF MILLETS AND EQUIPMENT

4.1 Millet Grains

Millets are the group of small grains and following are the crops classified under millets (see Table 1), which can be processed by this equipment. Though they look similar in shape and size, the thickness of husk/hull vary, demanding different types and parameters for polishing/pearling.

Table 1 Common Names and Botanical Names of Millet Crops
(*Clause* 4.1)

Sl No.	Common Name of Millets	Botanical Name
(1)	(2)	(3)
i)	Sorghum/Jowar/Great Millet	*Sorghum bicolor*
ii)	Pearl millet/Bajra	*Pennisetum glaucum*
iii)	Finger millet/Ragi	*Elusine corocana*
iv)	Kodo millet	*Paspalum scrobiculatum*
v)	Foxtail/Italian millet	*Setaria italic*
vi)	Little millet	*Panicum sumatrense*
vii)	Proso/Common millet	*Panicum miliaceum*
viii)	Barnyard millet	*Echinocloa colona*
ix)	Brown top millet	*Urochloa ramosa*

4.2 Pearler

Removal of both husk/hull and bran from the millets like, sorghum, bajra, finger millet, *etc.*is the process of pearling. The equipment used is known as pearler. The pearler normally uses the abrasion force to scratch and remove husk/hull and bran in layers. Pre-treatment like moistening the millet is followed for easy removal of bran with less breakage. Roller/drum type and disc type pearler are in vogue.

4.2.1 *Roller/Drum Type Pearler*

The abrasive surface is made into a roller or drum, either with or without tapper for a required length. This roller/drum will be placed inside a concave made of perforated sheet/sieve. The concave will be the pearling chamber with depth according to the size of the roller/drum and closed at the top. The feed hopper with feed regulator will be placed above the cover. The clearance between the concave and the roller/drum will not be less than the mean size (diameter/thickness) of the millet being pearled. Provision will exist to adjust the clearance. On the drum/roller shaft, feed screw may be provided at the feed end for uniform feeding of the millets for pearling. Outlet for the millet grains after pearling will be discharged through the outlet given on the side of the pearling chamber opposite to the feed hopper. This outlet will be of self-loaded type to regulate the retention time of the millets for pearling. The concave will hold the millets and on the bed of millets, the rotor/drum will rotate through a suitable power source and apply abrasive force for pearling. The husk/hull and bran will pass through the perforated concave and collected through an outlet.

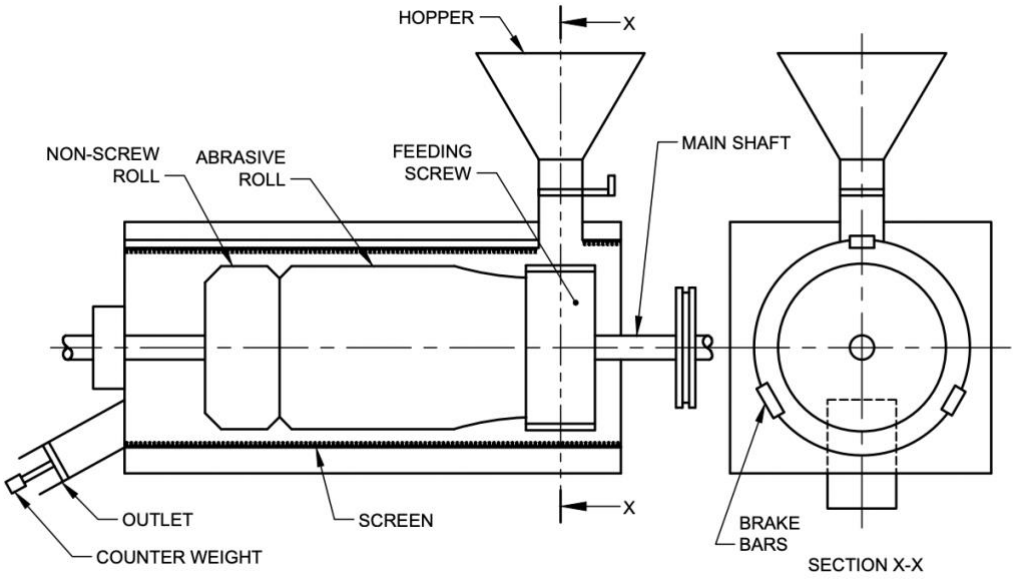

FIG. 1(A) SCHEMATIC DIAGRAM OF ABRASIVE HORIZONTAL POLISHER

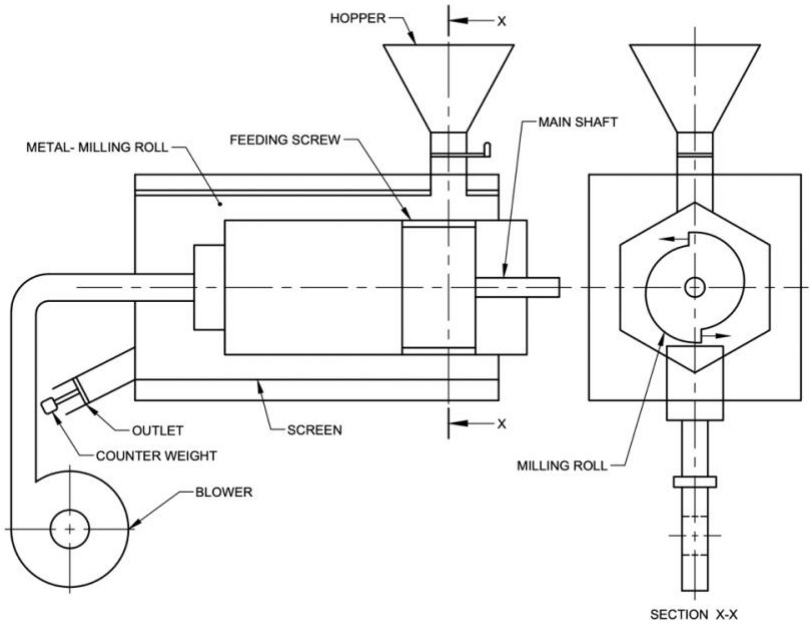

FIG. 1(B) SCHEMATIC DIAGRAM OF METALLIC POLISHER

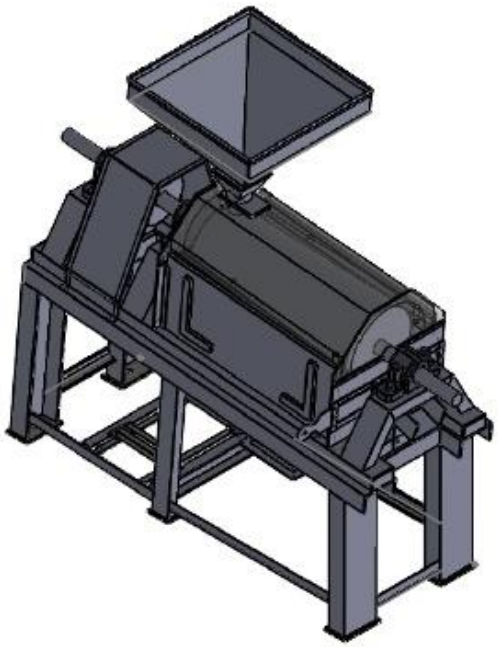

FIG. 1(C) STONE TYPE ABRASIVE POLISHER

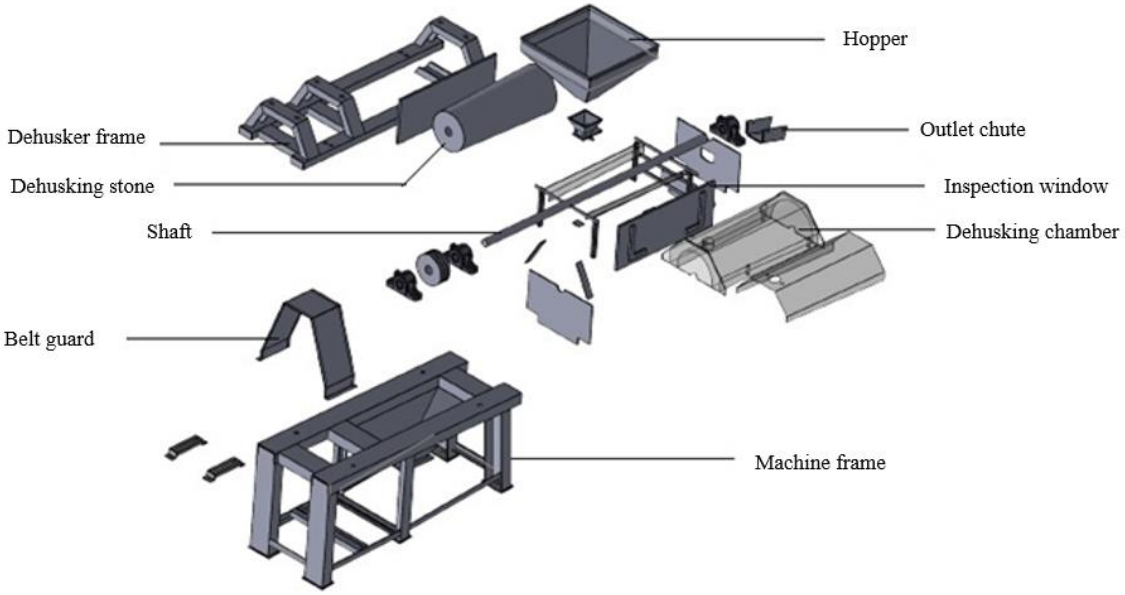

FIG. 1(D) SCHEMATIC DIAGRAM OF COMPONENTS OF STONE TYPE ABRASIVE POLISHER

4.2.2 *Disc Type Pearler*

This mechanism is like an under runner sheller with a pair of abrasive discs. The discs will be placed horizontally with either of the one will be made as stationary and other one rotating with a suitable drive. The millet grains to be pearled will be passed in the clearance between the discs. The clearance is adjusted according to the size (diameter/thickness) of the millet grains. Between the discs, the millet grains undergo compression, shear and abrasion, resulting in removal of husk/hull and bran layers. The hull and bran removed will be separated using sieve/aspirator. The pearled/polished millets will be received through the appropriate outlet.

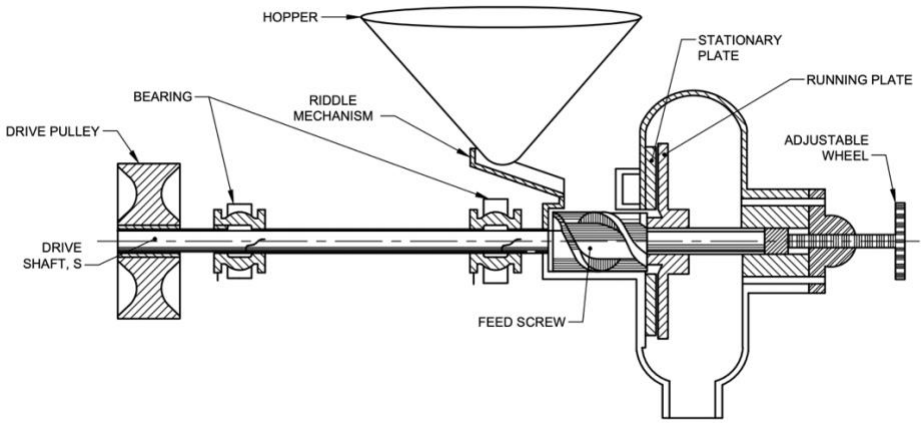

FIG. 2 DISC TYPE PEARLER

5 MATERIALS

5.1 The material of construction of various components of pearler cum polisher shall be as given in col 3 of Table 2 and the material shall conform to the relevant Indian Standards given in co1 4.

Table 2 Material of Construction
(*Clause* 5.1)

Sl. No.	Component	Material	Reference to IS
1.	Bearing housing/Plummer block	Cast iron	IS 210
2.	Blower casing	Mild steel	IS 2062
		Cast iron	IS 210
3.	Blower impeller (blade holder)	Cast iron	IS 210
4.	Bottom and top drum of Elevator	Cast iron	IS 210
5.	Bucket/cups	Mild steel/plastics	IS 2062
6.	Concave	Mild steel	IS 2062
		Galvanized sheet	IS 277
		Stainless steel (SS 204/SS 304)	IS 6911
7.	Discharge spout	Mild steel	IS 2062
		Galvanized sheet	IS 277
		Stainless steel (SS 204/SS 304)	IS 6911
8.	Elevator body/frame	Mild steel	IS 2062
		wood	IS 399
9.	Feed hopper	Mild steel	IS 2062
		Stainless steel (SS 204/SS 304)	IS 6911
10.	Frame	Mild steel	IS 2062
11.	Gears	High carbon steel	-

12.	Hand wheels/adjustment levers	Cast iron	IS 210
		Mild steel	IS 2062
		Stainless steel (SS 204/SS 304)	IS 6911
13.	Pulley	Cast iron	IS 210
		Mild steel	IS 2062
14.	Screens/sieves	Mild steel	IS 2062
		Stainless steel (SS 204/SS 304)	IS 6911
15.	Shafts	Mild steel	IS 2062
16	Emery disc/drum	Emery	IS 10520

6 CONSTRUCTIONAL REQUIREMENTS

6.1 Abrasive Surface — It shall be of emery of 3.60 minimum specific gravity with hardness on Moh's Scale of 8 [*see* IS 715] or silicon carbide of 3.12 minimum specific gravity with hardness on Moh's Scale of 9.5. The emery grit size and preparations of each grit shall be declared by the manufacturer. The emery coating shall be homogeneous and shall adhere firmly. Thickness of emery coating above the dovetail shall be minimum 12 mm for cone polishers and 25 mm for horizontal polishers and statically balanced. The thickness of emery coating or vitrified silicon carbide coating shall be uniform and shall be specified.

6.2 Concave — The concave will be made of non-corrosive material and perforations are punched as per the size of the millet grains. The size of the concave for various millets shall be declared by the manufacturer and provided as accessories. The perforation size should be such that it should permit the husk/hull and bran, and not permit millet grains to pass through it freely.

6.3 Feed Screw — A feed screw will be placed appropriately as an optional attachment, to feed the millets uniformly into the pearling/polishing chamber.

6.4 Frame — The main frame shall be made of suitable size using mild steel with channels/angle sections and shall be covered wherever required with mild steel sheet/galvanised sheet/stainless steel sheet of adequate thickness depending on the requirements and with provision to open the covers for any adjustments/maintenance.

6.5 Hopper — The hopper shall be made of metal sheet with minimum thickness of 1 mm. The hopper shall be provided with a feed regulating device.The hopper should be provided with side slope (30-35°) for easy flow of the grains. The feed hopper should be located at appropriate height from ground level for easy filling manually. Alternatively the unit may be provided with a bucket elevator for filling the hopper.

It is recommended that should be either permanently attached or firmly secured to prevent their removal without the aid of tools. The servicing and adjustments should be possible without complete removal of the guards.

6.6 Outlet for Grains, Kernels, Husk and, Bran — The outlet for the millet kernel after polishing or pearling will be placed at the suitable height from ground for easy collection/filling in gunny bags. Also will be provided with a regulating mechanism to adjust the retention time of the grains inside the polishing/pearling chamber. The husk/bran will flow along the slope provided in the respective outlet or to be collected by the aspirator, as an optional attachment and delivered.

6.7 Polishing or Pearling Chamber — The chamber shall house the drum or disc, or any other mechanism employed for pearling or polishing the millet grains. The chamber shall be made of minimum thickness of 1 mm. Provision shall be made for easy replacement/inspection of drum/discs. To regulate the degree of polish/pearling, appropriate mechanism will be provided.

6.8 Power Transmission — Suitable system for transmitting the power shall be provided. It may consist of V-belt and pulley, gears or sprocket and chain.

6.8.1 The guards shall be so designed as not to hinder in easy adjustment, servicing and operation of separator.

6.8.2 The guards shall have sufficient strength to support load of 600 N applied at any point over an area of 0.1 m^2 without permanent set.

6.8.3 Transmission guards shall be provided to prevent accidental contact of persons or parts of clothing being caught in the transmission system, unless the system is so constructed or placed as to be safe without guards.

6.9 Shafts — The shafts will be made of suitable material as per the required/calculated size and shall be supported with suitable bearings and housings on the stable part of machine.

6.10 Surface Finish — All the joints and surfaces will be made smooth and protected from weather conditions.

7 PERFORMANCE REQUIREMENTS

7.1 The pearler cum polisher after installation on level and hard surface, and running-in in accordance with **A-3.1** of IS 9555 shall be operated for half-an-hour at no-load. During the no-load run, the visual observations shall not indicate the following:

a) Presence of any marked vibration during operation;
b) Presence of any undue noise in the dehusker;
c) Frequent slippage of belts
d) Any marked unusual wear or slackness in any component, and
e) Any marked rise in bearing temperature.

7.2 When tested in accordance with the method given in **11.2.4**, the capacity per hour and rated capacity per kWh energy consumed shall be recorded. Various adjustments, clearances and speeds for the rated capacity shall be declared by the manufacturer.

7.3 The capacity of the pearler/polisher shall not be less than by 5% of the manufacturer's claim.

7.4 The dehusked millet shall not get any visible stain.

7.5 During and after the capacity test, the visual observation shall not indicate the following:

a) Observations given in **7.1 (a)** to **(e)**; and
b) Leakage of grain/kernel from the dehusker.

7.6 When tested in accordance with **4.1** of IS 9555, no breakdown and defects shall develop in any

component of the dehusker.

7.7 The pearling/polishing operation shall be capable of removing the outer layer (husk/bran) atleast from 50% of grains in case of raw millet and atleast from 60% of the grains in case of parboiled millet, in the first pass and in the subsequent passes the removal will be from 70 and 80%, respectively.

7.8 The maximum percent breakage shall be 20% in raw millet and 10% in parboiled millet in one pass.

7.9 The husk/bran aspiration unit shall remove minimum of 95% husk present. Not more than 5% of brokens/kernels/grains shall go along with husk/bran.

7.10 The degree of polishing (after dehusking/dehulling) shall not be more than 5%. Degree of pearling (without dehusking/dehulling) shall not be more than 20%.

7.11 The specific energy consumption for polishing/pearling shall not be more than 5 kWh/q.

8 OTHER REQUIREMENTS

8.1 Provision shall be made for lubrication of bearings and they shall be dust-proof.

8.2 A feed regulating system shall be provided

8.3 Various controls shall be easily accessible and capable of being locked in a chosen position.

8.4 In case of belt drive, provision shall be made for adjusting the belt tightness.

8.5 Transmission guards shall be provided to prevent accidental contact of persons on parts or clothing being caught in the transmission system, unless the system is so constructed or placed as to be safe without guards.

8.6 The guards shall be so designed as not to hinder in easy adjustment, servicing and operation of dehusker.

8.7 It is preferable that all guards shall be either permanently attached or firmly secured to prevent their removal without the aid of the tools. The servicing and adjustments should be possible without complete removal of the guards.

8.8 The pearler cum polisher shall be provided with the operator's manual.

9 WORKMANSHIP AND FINISH

9.1 The components of polisher/pearler shall be free from cracks, pits, holes and other visual defects which may be detrimental for their use.

9.2 The welding, if done, shall not be porous and shall be smooth (*see* IS 816).

9.3 A rust preventive coating shall be provided to the steel components.

10 MARKING AND PACKING

10.1 Marking

Each polisher shall be marked with the following particulars:

a) Manufacturer's name with recognized trade-mark, if any;
b) Batch or code number;
c) Power rating and capacity;
d) Type;
e) Model No.;
f) Year of manufacturing; and
g) Direction of rotating parts and rated speed.

10.1.1 A minimum cautionary notice worded as follows shall be-written in vernacular language legibly and prominently on the main body of the polisher/pearler:

a) Do not wear loose dress, bangles, watch, etc., while working in with polisher/pearler;
b) Do not work under the influence of intoxicants like liquor, opium, etc;
c) Children and aged persons should be discouraged from working in polisher/pearler;
d) Do not cross over moving belts;
e) Do not operate polisher/pearler without guards and safety devices;
f) Do not make adjustment when polisher/pearler is working; and
g) Do not put or take-off belt while pulley is running.

10.2 BIS Certification Marking — The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act, 2016* and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark.

10.3 Packing

10.3.1 The polisher shall be packed as agreed to between the purchaser and the supplier for safe handling in transit.

11 METHODS OF TEST

11.1 Test Material

Sufficient quantity of raw or parboiled millets of the same variety shall be taken. Moisture content of the rice in accordance with IS 4333 (Part 2) shall be between 12 and 14 percent (w.b.). Alternatively the test materials (millets) will be conditioned to the required level of moisture content as recommended by the manufacturer. The percentage of bold millet grains, brokens, immature, grains of other crops, foreign matter, *etc.* Present in the raw material shall be observed by taking five samples of 100 g each and the average shall be reported.

11.2 Type Tests

11.2.1 *General*

a) Checking of specifications (Annex A),
b) Checking of material of Construction *(Annex B)*, and
c) Visual observations and checking of provisions for adjustments (Annex C).

11.2.2 *Running-In and Preliminary Adjustments*

The polisher/pearler shall be installed on level and preferably on hard surface using foundation bolts and nuts/anti-vibration mounts. All the adjustments shall be made in accordance with the manufacturer's recommendation.

The polisher/pearler shall be attached with a suitable prime mover as recommended by the manufacturer, preferably with an electric motor and auto-voltage stabilizer. The energy meter or some form of transmission dynamometer shall be fitted. The power delivered to the polisher/pearler may be supplied in the following ways:

a) Direct coupling the prime mover with the main shaft of the polisher, and
b) Connecting the prime mover with the help of a flat or V-belt and pulleys with the main shaft of the polisher.

In case of (a), the power delivered to the polisher would be the power output of the prime mover; whereas in case of (b), the allowances for flat and V-belt drive losses may be taken at 6 and 3 percent, respectively.

11.2.3 *Test at No-Load*

11.2.3.1 After the running in is over, the polisher/pearler shall be run at no-load for 30 min at the specified speed. During and after no-load run, the visual observation of the polisher/pearler shall not show the following (Annex D):

a) Presence of any marked vibration during the operation,
b) Presence of undue knocking or rattling sound,
c) Frequent slippage of belts,
d) Any marked unusual wear or slackness in any component, and
e) Any marked rise in bearing temperature.

11.2.3.2 Power consumption (Annex D) shall be recorded from the start and closing reading of energy meter.

11.2.3.3 Data shall be recorded in accordance with the pro forma given in Annex D.

11.2.4 *Test at Load*

11.2.4.1 Operation and collection of data after the stabilization of the operation, the pearler/polisher shall be operated at its rated speed for minimum of 30 min at a feed rate equal to rated input capacity specified by the manufacturer. The quantity of the raw material used during the test will be recorded. During the run period, the following samples and data shall be collected:

a) Three sets of samples at an interval of 10 min at the following outlets for one minute:

1) Polished/pearled millet kernel outlet, and
2) Husk/bran outlet.

b) The speed of the main shaft and the readings of the energy meter or dynamometer shall be recorded.

11.2.4.2 At the end of 30 min feeding, the polisher shall be run for some time so that practically no more material already fed comes out. At the end of the test, the material received at polished/pearled millet kernel outlet shall be collected and weighed. The mass of the sample collected at polished/pearled millet kernel outlet [*see* **11.2.4.1a**] shall be added.

11.2.4.3 The husk/bran received through its outlet during the polishing/pearling operation shall be collected and weighed. The mass of the husk/bran collected at its outlet [*see* **11.2.4.1a**] shall be added. The husk/bran collected after each pass of pearling/polishing will be sieved using a hand sieve of appropriate sieve perforation and both the whole and broken kernels will be weighed.

Depending on the number of passes the millets subjected to polishing/pearling, samples will be collected during each pass and the time taken for polishing/pearling also will be recoded along with energy meter reading.

The data will be recorded appropriately in Annex. E.

11.2.5 *Preparation and Analysis of Sample*

The three sets of samples obtained at feed, polished/pearled millet kernel outlet and husk/bran outlet during each pass shall be weighed separately and thoroughly mixed to form composite samples. Out of these composite samples, 100 g of sample shall be taken and analyzed for the following:

a*) Raw material (feed)* — To be analyzed for good grains and foreign matter.
b) *Polished/pearled millet kernel outlet* — To be analyzed for whole kernel, broken millet, foreign matter, and husk/bran.
c) *Husk/bran outlet* — To be analyzed for foreign matter, polished/pearled millet kernel (broken millet and whole millet kernel).

The data will be recorded appropriately in Annex. F.

11.2.6 *Determination of Capacity*

The capacity of polishing/pearling of the unit will be determined from the quantity of raw materials fed and the corresponding time taken as follows and recorded in Annex E. If the operation involves number of passes to achieve higher level of polishing/pearling, the time taken for each pass will also be considered.

Polishing/pearling capacity,

$$C = (Q \times 60)/(t_1+t_2+t_3+\ldots) \quad \text{kg/hour}$$

where,

C = capacity in kg/hour
Q = quantity of feed taken for testing, kg
$t_1+t_2+t_3 \ldots = t_t$, sum of duration of polishing/pearling through the number of passes, min.
1, 2, 3, = suffix denote the number of the pass.

11.2.7 *Determination of Degree of Polishing/Pearling*

The degree of polishing/pearling shall be calculated using the following formula and recorded in Annex E:

$$D_1 = [Q_1 - (q_1 + g_1)] \times 100/Q_1 \ \%$$

$$D_2 = [Q_2 - (q_2 + g_2)] \times 100/Q_2 \ \%$$

$$D_3 = [Q_3 - (q_3 + g_3)] \times 100/Q_3 \ \%$$

....
....
....

where,

D = degree of polishing/pearling, %; $D = D_1 + D_2 + D_3 + \ldots$
q = quantity of polished/pearled kernel, including brokens obtained after each pass, kg
g = quantity of polished/pearled kernel, including brokens obtained by sieving from husk/bran after each pass, kg
Q = quantity of feed taken for polishing/pearling, kg
1, 2, 3… = suffix denote the number of the pass.

11.2.8 *Determination of Percent Breakage*

The percent breakage during polishing/pearling shall be calculated by the following formula (Annex F):

Breakage in polishing/pearling,

$$B1 = (b_1 \times 100/s_1), \ \%$$

where,

B =percent breakage of millet kernels, %,
b = mass of broken millet grain/kernel separated from the sample taken from polished/pearled kernel outlet, g.
s = mass of sample (100 g) taken from polished/pearled kernel outlet, g.
1, 2, 3… = suffix denote the number of the pass.

11.2.9 *Determination of Millet Kernel Lost Along Husk/Bran*

The millet kernel, both whole and brokens lost along the husk/bran is calculated as follows and recorded in Annex E:

Millet kernel lost along husk/bran,

$$L_1 = (g_1) \times 100/Q_1, \ \%$$

where,

L = millet kernel lost along husk/bran, %
g = quantity of polished/pearled kernel, including brokens obtained by sieving from husk/bran after each pass, kg
Q = quantity of feed taken for polishing/pearling, kg
1, 2, 3… = suffix denote the number of the pass.

11.2.10 *Power Consumption*

The power requirement during the test run shall be calculated/measured in accordance with the following methods and recorded in Annex E.

11.2.10.1. In case of prime mover fitted with an energy meter, from the initial and final readings taken during the test, the power consumption per hour giving due allowance to the type of drive shall be calculated and reported.

11.2.10.2. In case of prime mover fitted with the dynamometer, the reading taken shall indicate the torque required. The power consumption per hour, giving due allowance to the type of drive, shall be calculated by the following formula:

$$P = \frac{T \times S}{9549.30}$$

Where,

P = power, kW;
T = torque, Nm; and
S = speed, rev/min.

NOTE — For the purpose of certification, the power consumption at the declared feed rate shall only be calculated.

11.2.11 *Determination of The Specific Capacity and Specific Power Consumption —*

From the quantity of millet (Q kg) taken for the test and the total time (sum of all passes) taken (min.) for polishing/pearling this quantity, capacity is calculated and expressed as kg/h. The capacity in terms of the energy consumed shall be calculated by dividing the capacity by power consumed and shall be expressed in tonnes/kWh. The specific power consumption will be expressed as kWh/tonne. Record the data in Annex G.

11.2.12 *Long Run Test*

The dehusker shall be operated for a minimum duration of 20 hours at no load which could be covered by a continuous run of at least 5 hours. During and after the operation no break down or defects shall develop in the polisher/pearler. Record the major break-downs, defects developed and repairs made into the data sheet given in Annex I.

11.3. Summary Report

For the guidance of the user, compile a summary report on the proforma as given in Annex H and K.

ANNEX A
(*Clause* 11.2.1a)

SPECIFICATION SHEET

1 General

a) Name and address of manufacturer
b) Make
c) Model
d) Type and function
e) Serial number
f) Year of manufacture
g) Rated capacity (kg/hour)
h) Maximum capacity (kg/hour)

2 Power Unit

a) Type of recommended prime mover
b) Type of drive
c) Recommended power rating, kW

3 Main Drive

a) Type
b) Size of pulley on prime mover
c) Size of pulley on main shaft of polisher/pearler, mm
d) Size and number of belts
e) Type of belt tightening arrangement
f) Details of gear system, if used
g) Recommended speed of main shaft, rpm
h) Size of pulley (mm) and speed of blower/aspirator (rpm)
i) Provision for changing speed of main shaft

4 Feeding Arrangement

a) Type of feed mechanism
b) Storage capacity of feed hopper, kg
c) Type of drive for feed mechanism
d) Arrangement for controlling feed
e) Arrangement for uniform feeding of millet grains
f) Location of feed hopper from ground level, m
g) Provision of elevator

5 Polishing/Pearling Chamber

a) Diameter of the chamber, mm
b) Width of the chamber, mm
c) Height of the chamber, mm
d) Length of the chamber, mm

e) Type of polishing surface
f) Diameter of the drum/roller, mm
g) Length of drum/roller, mm
h) Diameter of the abrasion disc, mm
j) Thickness of the abrasion disc, mm
k) Method of mounting of roller/drum/disc on the shaft
m) Method of mounting of main shaft on the frame
n) Provision to control the outlet for the kernel after polishing/pearling to adjust the Retention time for the grains

6 Concave

a) Type of concave (full rotor/half cylinder)
b) Length of rotor, mm
c) Diameter of rotor, mm
d) Depth of concave, mm
e) Type of perforation
f) Size of perforation, mm
g) Method of fixing on the frame

7 Aspirator/blower

a) Type of blower/aspirator
b) Diameter of the impeller, mm
c) Width of the blower, mm
d) Type and number of bearings
e) Provision for adjusting airflow
f) Speed of impeller/blade, rpm
g) Provision of husk outlet

8 Overall Dimensions

a) Length, m
b) Width, m
c) Height, m
d) Ground clearance for discharge, mm
e) Total mass, kg

9 Tools, Accessories, Operation Manual and Spare Parts List Provided

NOTES:
1 The item which is not applicable in a particular dehusker should be crossed while filling.
2 If any other items are provided, their details should be given.

Test Engineer

ANNEX B

(*Clause* 11.2.1b)

DATA SHEET FOR MATERIAL OF CONSTRUCTION

Sl. No.	**Component**	**Material**
(1)	(2)	(3)
i)	Abrasive/Emery - disc/drum	
ii)	Bearing housing/Plummer block	
iii)	Belt guard	
iv)	Blower/aspirator	
v)	Blower/aspirator casing	
vi)	Blower/aspirator Impeller	
vii)	Blower/aspirator impeller (blade holder)	
viii)	Blower/aspirator shaft	
ix)	Bottom and top drum of Elevator	
x)	Bucket ups	
xi)	Concave	
xii)	Discharge spout for husk/bran	
xiii)	Discharge spout for miller kernels	
xiv)	Elevator body/frame	
xv)	Feed hopper	
xvi	Feed screw	
xvii)	Frame	
xviii)	Gears	
xix	Hand wheels/adjustment levers	
xxx	Inspection doors	
xxi)	Plummer block	
xxii)	Polished/pearled millet outlet	
xxiii)	Polishing/pearling chamber	
xxiv)	Pulleys	
xxv)	Screens/sieves	
Xxvi	Shafts	

Test Engineer

ANNEX C
(*Clause* 11.2.1c)

DATA SHEET FOR VISUAL OBSERVATIONS AND PROVISIONS FOR ADJUSTMENTS

1 Observations:

a) Provision for inspection window/cover
b) Provision for lubrication of moving parts
c) Adequacy of safety guards on moving parts
d) Provision for belt tightening
e) Provision for easy changing of components requiring frequent replacement
f) Provision for lifting and transport
g) Adequacy of protection of bearings from dust
h) Welding of seams
j) Tightness of fasteners
k) Provision for feed regulating and spreading system
m) Other observations

2 Provision for Adjustment of:

a) Feed rate
b) Speed of abrasive drum/disc
c) Clearance between abrasive drum/disc and concave
d) Speed of blower/aspirator impeller
e) Air displacement
f) Air pressure in pneumatic system, if any
g) Retention time for millet grains in the polishing/pearling chamber during operation.

Test Engineer

ANNEX D
(*Clause* 11.2.3.1)

DATA SHEET FOR TEST AT NO-LOAD

1 Details of Power Supply

2 Power Rating, Kw

3 Type of Drive

4 Air Flow from The Blower, M/Min.

5 Atmospheric Conditions:

a) Temperature, °C
b) Pressure, kPa
c) Relative humidity, %

6 Observations:

a) Presence of any marked vibration during operation
b) Presence of any undue noise in the dehusker
c) Any unusual heating of any component
d) Any slippage of belts
e) Vibration in blower running
f) Non smooth running of shafts in their respective bearings, and
g) Any marked unusual wear or slackness in any components

Test Engineer

ANNEX E
(*Clause* 11.2.4.1)

DATA SHEET FOR TEST AT LOAD

1 Details of Power Supply

2 Power Rating, Kw

3 Type of Drive

4 Type of Millet

5 Variety of Millet

6 Moisture Content of Millet, Percent (W.B)

7 Air Flow from The Blower, M/Min.

8 Atmospheric conditions:

a) Temperature, °C
b) Pressure, kPa
c) Relative humidity, %

9 Test Data*

Sl. No.	Date	Starting Time	Stopping Time	Duration Of Operation	Speed Of Main Shaft (Rev/ Min)	Feed Rate (Kg /H)	Energy Meter Reading In Relation To Time		No. And Quantity Of Samples			Polished/Pearled Millet Kernel Out Put, Kg
							Time (min)	Energy meter Reading (kWh)	No.	Quantity, g Pearled/polished kernel outlet	Husk/bran outlet	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(12)
Pass Number -1												
							0		i)			
							10		ii)			
							20		iii)			
							30		iv)			
Pass Number - 2												

	0	i)
	10	ii)
	20	iii)
	30	iv)
Pas Number – 3		
	0	i)
	10	ii)
	20	iii)
	30	iv)

10 Observations:

a) Presence of any marked vibration during operation
b) Presence of any undue noise in the dehusker
c) Smooth running of shafts in their respective bearings
d) Undue heating of any component
e) Vibration free running of blower/aspirator
f) Any marked rise in bearing temperature
g) Frequent slippage of belts
h) Rise in temperature in the polishing/pearling chamber
j) Any marked deformation, wear or breakdown
k) Frequent loosening of fasteners
m) Any other observations

Test Engineer

ANNEX F
(*Clause* 11.2.5)

DATA SHEET FOR ANALYSIS OF SAMPLES

SL No.	**Pass Number**	**Mass of different fractions, g**											**Remarks**
		Feed			**Polished/pearled kernel outlet**				**Husk/bran outlet**				
		Good grains (*gg*)	**Impurities (*i*)**	**Total (*F*)**	**Whole kernel (*w*)**	**Brokens (*b*)**	**Husk/ bran (*hg*)**	**Total (*s*)**	**Husk/ bran (*hb*)**	**Whole kernel (*wb*)**	**Brokens (*bb*)**	**Total (*h*)**	
(1)	(2)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(12)
Feed rate =		kg/h											
Total Feed rate =		kg/h											
Total Feed rate =		kg/h											
Total													

Test Engineer

ANNEX G

(*Clause* 11.2.6, 11.2.7, 11.2.9, 11.2.10 & 11.2.11)

CALCULATION SHEET FOR PERFORMANCES

Sl. No.	**Pass No.**	**Quantity fed, kg (*Q*)**	**Time taken, min. (*t*)**	**Total duration, min. (t_t)**	**quantity of polished/pearled kernel received, kg (*q*)**	**Quantity of husk/bran obtained, kg (*hb*)**	**Quantity of polished/pearled kernel obtained by sieving from husk/bran, kg (*g*)**	**Energy consumed, kWh (*E*)**	**Capacity, kg/h. (*C*) [(3)* 60/(5)]**	**Degree of polishing/pearling, % (*D*) [(3)-(6)-(8)] * 100/(3)**	**Millet kernel lost along husk/bran, % (*L*) (8)*100/(3)**	**specific capacity, tonnes/kWh (*S*) (3)*1000/(9)**	**Specific power consumption, kWh/tonne. (*P*) (9)/(3) * 1000**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)

Test Engineer

ANNEX H

(*Clause* 11.2.4)

DATA SHEET FOR EFFICIENCY, CAPACITY AND POWER REQUIREMENT

Sl. No.	**Details**	**Test No.**								
		1			2			3		
		Pass Number			Pass Number			Pass Number		
		1	2	3/total	1	2	3/total	1	2	3/total
1	Speed of abrasive roller/disc, rpm									
2	Capacity, kg/h									
3	Degree of polishing/pearling, %									
4	Percentage brokens during polishing/pearling									
5	Percentage of polished/pearled millet kernel in husk/bran.									
7	Power required, kW									
8	Specific capacity, tonnes/kWh									
9	Specific power, kWh/tonne									

Test Engineer

ANNEX J
(*Clause* 11.2.12)

DATA SHEET FOR LONG-RUN REST

1 Total Running Time, H

2 Continuous Running Time, H

3 Any Major Breakdown

4 Any Repairs Conducted

5 Any Other Observation

Test Engineer

ANNEX K
(*Clause* 11.3)

SUMMARY REPORT

1 Name of Testing Station

2 Name of Manufacturer

3 Model Number

4 Brief Description of The Polisher/Pearler

5 Type of Millet Used

6 Variety of Millet Used For Test

7 Nature of Millet (Raw/Parboiled)

8 Moisture Content of Millet, % (W.B.)

9 Adjustments:

a) Feed rate
b) Speed of abrasive drum/disc shaft
c) Flow rate from the polishing/pearling chamber to vary the retention time
d) Clearance between the concave and the abrasive drum/disc.

10 Power Requirements:

a) At no load, kW
b) At load on rated capacity, kW

Performances	No. of passes			
	1	2	3	Total

11 Capacity (Pass-Wise), Kg/H

12 Degree of Polishing/Pearling (Pass-Wise), %

13 Percentage of Brokens (Pass-Wise)

14 Percentage of Millet Grain/Kernel in Husk/Bran Outlet (Pass-Wise)

15 Specific Capacity (Pass-Wise), Tonnes/Kwh

16 Specific Power (Pass-Wise), Kwh/Tonne

Observations:

17 Any Marked Observation Affecting Performance

18 Any Major Breakdowns during Test

19 Other Observations, If Any

Test Engineer