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बायोमास हैमर मिल — विशिष्टि और परीक्षण संहिता

Draft Indian Standard

BIOMASS HAMMER MILL — SPECIFICATION AND TEST CODE

ICS 65.060

Agriculture and Food Processing Equipment Sectional Committee, FAD 20	Last date of comments**: 24 October 2025**

FOREWORD

(*Adoption Clause will be added later*)

Climate change and global warming are serious problems that the world has been facing for a long time. One of the major reasons for these problems is the use of fossil fuels like coal, oil, and gas. Significant amount of the electricity is still produced by burning coal in thermal power plants. To reduce the use of coal and protect the environment, the Government of India is promoting the use of clean and renewable sources of energy like solar and wind power.

The Ministry of Power, Government of India has set up a mission known as 'Sustainable Agrarian Mission on use of Agro Residue in Thermal Power Plants' (SAMARTH) to promote the use of crop residues such as rice straw, wheat straw, mustard straw, and other agricultural waste (after conversion into pellets) along with coal for power production.

Biomass co-firing helps in two ways – it reduces the amount of coal used and also provides a solution to the problem of burning crop residue in open fields, which causes air pollution. Farmers can now earn money by selling their crop waste instead of burning it.

The pellets used in power plants should be of good quality to ensure smooth operation and efficient burning. Hammering is a very important unit operation in the pellet production, therefore, it becomes very crucial to ensure that the selected hammer is preforming well in terms of both the capacity & effectiveness of the operation.

A need was felt to develop this standard to assist manufacturers in selecting appropriate materials of construction, incorporating safety features, and ensuring that the biomass hammer mill meets minimum performance criteria.

A series of Indian Standards are being developed for various equipment used in the production of biomass pellets. Apart from this standard, four other standards under development are as under:

a) FAD20(27725)WC Plant layout & optimal process for production of biomass pellets – guidelines
b) FAD 20(27726)WC Biomass Shredder – Specification and Test Code

c) FAD 20(27728)WC Biomass Pelletiser – Ring Die Type – Specifications and Test Code
d) FAD 20(27729)WC Biomass Pelletiser – Crank, Piston, and Cylinder Type – Specifications and Test Code

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 biomass hammer mill. It also prescribes the test methods for evaluating the performance of the biomass hammer mill.

2 REFERENES

The following standards given in Annex A contain provisions which through reference in this text, constitute provision 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 the standards indicated.

3 TERMINOLOGY

In addition to the definitions given in Doc. No. FAD20 (27725) WC, the following definitions shall be used for the purpose of this standard:

3.1 Biomass Hammer Mill — An equipment used to crush and granulate the various raw materials into smaller particles, preparing them for further processing, such as pelletizing or briquetting. It is commonly used in biomass pellet plants, briquette plants, and feed mills, where the biomass material needs to be reduced in size before it is efficiently processed into a finished product.

3.2 Desired Particle — Particle having its highest dimension less than 3.15 mm.

3.3 Feed Mechanism — The mechanism meant for uniform feeding of the shredded or non-shredded biomass into the hammer mill and for regulating the feed rate.

4 TYPES

4.1 Hammer mills can be classified based on two primary criteria, namely the direction of rotation ; and power consumption. This classification helps in selecting the appropriate type of hammer mill for the size reduction of any specific biomasses or any specific group thereof.

4.1.1 *Classification Based on Direction of Rotation*

4.1.1.1 *Reversible hammer mill*

In a reversible hammer mill, the hammer arms can be rotated in either direction i.e. clockwise or anticlockwise. It has increased operational flexibility as the direction of rotation can be changed to utilize both sides of the hammers, extending their lifespan. It has enhanced efficiency in processing materials since it can help in reducing blockages and maintaining consistent output.

4.1.1.2 *Non-reversible hammer mill*

In a non-reversible hammer mill, the direction of rotation is fixed and cannot be changed. Simplicity in design and operation often leads to lower manufacturing costs. It is suitable for specific applications where consistent particle size reduction is required without the need for reversible operation.

4.1.2 *Classification Based on Power Consumption*

4.1.2.1 *Light duty hammer mill*

Its power consumption is less than 200 kW and is generally used for grinding softer materials or smaller-scale operations. It is suitable for applications like feed milling or processing light biomass materials.

4.1.2.2 *Medium duty hammer mill*

Its power consumption ranges between 200 kW to 500 kW and is designed for more demanding applications that require higher output rates. It can handle a wider variety of materials, including tougher biomass types.

4.1.2.3 *Heavy duty hammer mill*

Its power consumption is above 500 kW and is used in industrial-scale operations where high throughput & durability are essential. It is suitable for processing very tough materials or large volumes of biomass.

5 MATERIAL REQUIREMENTS

The components of the hammer mill shall be made from material as specified in column 3 of Table 1 and the materials should conform to the relevant Indian Standards as per column 4.

Table 1 Material Specification for Various Components of Hammer Mill
(*Clause* 5)

Sl. No.	Component	Material	Relevant Indian Standard
(1)	(2)	(3)	(4)
1.	Airlock	Mild Steel	IS 2062
2.	Base frame	Mild steel	IS 2062
3.	Body Frame	Mild Steel	IS 2062
4.	Coupling	Casted MS	-
5.	Cyclone	Mild Steel	IS 2062
6.	Hammers	D2 Steel	-
		Alloy Steel (Abrex 500)	-
		Alloy Steel (Hardox 500)	-
		ISAR 450	IS 18809
		EN8	-
		EN9	-
7.	Hammer mounting pin/bar	Mild Steel	IS 2062
		EN8	-
8.	Induced Draft (ID) Fan	Mild Steel	IS 2062
9.	Pulley	CI	ASTM-A48
10.	Screen	Hot Rolled Carbon Steel	IS 1079
11.	Shaft	EN8	IS 2062:2011
12.	V-Belt	-	IS 2494 (Part 1)

6 PERFORMANCE REQUIREMENTS

6.1 The maximum dimension of pulverized biomass particle shall be less than 3.15 mm.

6.2 The biomass hammer mill shall withstand all the tests given in **10**.

6.3 The life cycle of hammer should be reported by the manufacturer for particular biomass which is to be used for purpose of testing. The variation in the rated capacity, efficiency, and specific energy consumption of the hammer mill shall be recorded during the long run test (*see* **10.6**) and shall not be more than 5% with respect to the values as declared by the manufacturer.

7 CONSTRUCTIONAL REQUIREMENTS

7.1 Casing or Housing

The casing or housing shall be designed in a way that it can enclose the grinding chamber, provide structural support and contain the material being processed. The thickness of the sheet used in manufacturing of housing shall not be less than 12 mm.

7.2 Hammers

A set of swinging hammers shall be attached to a hammer mill rotor. It may vary in shape (e.g., rectangular or round) and thickness to optimize the performance of hammer mill, however, the thickness of the hammer shall be not less than 5 mm.

7.3 Rotor Assembly

The rotor shall be capable of holding the hammers, it shall be properly balanced (statically & dynamically) to minimize vibrations during operation and ensure smooth operation. The rotor should perform satisfactorily when the speed is set as 1200 rpm to 2800 rpm for effective grinding.

7.4 Screening System

Screens with specific hole sizes shall be placed beneath the hammers to control the particle size of the output, however, the size of the holes can be adjusted based on the desired final particle size.

7.5 Feed Hopper

It may include a regulated feeding mechanism to ensure consistent and uniform flow. The feed hopper shall allow for easy loading of biomass materials into the mill. It should accommodate all types of biomasses.

7.6 Power transmission/Drive System

It shall consist of an electric motor of suitable power that can drive the rotor, either directly or through belts for better speed control.

8 OTHER REQUIREMENTS

8.1 Automatic temperature monitoring systems shall be in place at critical points, such as the discharge gate, to detect overheating and prevent fires or explosions.

8.2 Easily accessible emergency stop buttons should be installed to quickly halt operations in case of an emergency. A limit switch should be installed at the doors of the hammer mill to ensure that the machine does not run unless the door is properly closed.

8.3 The hammer blade materials such as alloy steel should have a hardness in between 49 HRC to 65 HRC, depending on the heat treatment processes used.

8.4 Air volume capacities can range from 3600 m^3/h to over 540000 m^3/h, accommodating various operational scales.

8.5 The noise level shall not be more than 86 dB when measured at a distance 7.5 m away from the source of noise.

9 WORKMANSHIP AND FINISH

9.1 The components of biomass hammer mill shall be free from cracks, pits, holes and other visual defects which may be detrimental for their use.

9.2 The welding shall not be porous and shall be smooth when inspected as per the methods given in IS 816.

9.3 Anti-corrosive coatings shall be provided to the steel components open to environment.

10 METHODS OF TEST

10.1 Selection and Specification of Biomass Hammer Mill

10.1.1 *Selection*

The machine shall be randomly selected by testing authority from the production line with the agreement of the manufacturer.

10.1.2 *Specification*

The manufacturer shall supply the details of the specifications of the biomass hammer mill consisting of the items listed in the specification sheet given in Annex B, as well as any further data required to carry out the tests. The manufacturer shall also supply all the relevant literature, such as operation and maintenance manual and parts catalogues, normally supplied along with the machine. The specification given by the manufacturer shall be checked and reported by the testing authority.

10.2 Pre-Test Observation

10.2.1 *Determination of Composition of Feed*

Different type of biomass can be used in biomass hammer mill to reduce the size. The type and quantity of the material used shall be declared and supplied by the manufacturer, respectively.

10.2.2 *Determination of Moisture*

The moisture content of feed material shall be determined by oven dry method in accordance with IS 17655 (Part 3).

10.2.3 *Running-in and Preliminary Adjustments*

10.2.3.1 The machine shall be installed at level and preferably on a hard surface. All the adjustments shall be made in accordance with the manufacturer's recommendations.

10.2.3.2 The machine shall be run-in for at least 30 minutes at no-load before commencing. The running-in shall be carried out in accordance with the manufacturer's recommendations.

10.3 *General*

10.3.1 *Checking of Specifications*

The specifications given by the manufacturer shall be checked and reported in the proforma given in Annex B.

10.3.2 *Checking of Material*

The material of construction of the various components of the machine shall be reported in the data sheet given in Annex C.

10.3.3 *Visual Observations and Checking of Provisions for Adjustments*

The observations and adjustments given in data sheet in Annex D shall be made and reported.

10.4 Test at no-load

10.4.1 *Determination of Power Consumption*

After the running-in is over, the machine shall be run at no-load for minimum of 10 minutes at the rated speed. The difference between the two consecutive energy meter readings shall be taken as the power consumption given in Annex E. .

10.4.2 *Visual Observation*

During and after no-load run, the visual observations given in Annex E shall be recorded.

10.5 Test at Load

10.5.1 *Feed Material*

Adequate quantity of chopped biomass material or mixture of two or more material of known quantity shall be taken. A choice of feed material taken depends on the manufacturer.

10.5.2 *Operation and Collection of Data*

After the stabilization of the operation, the machine shall be operated at the specified speed for 20 hours at the rated capacity specified by the manufacturer. The period shall be covered by a continuous run of at least 5 hours in a day. If the machine stops during the trial of less than 5 hours due to any reason including breakdown of machine, power cut, etc., such trial shall be initiated again for that day. With the help of an in-feed screw conveyor, the dried agricultural & forest waste in chopped/cipped form is conveyed into the hammer mill and final powdered product is collected from the outlet.

10.5.2.1 During the above run, the following data and samples shall be collected:

a) Three sets of samples each weighing 2 kg shall be taken from the outlet for each run for further analyses for moisture content, particle size, particle density and bulk density.

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

10.5.2.2 At the end of each feeding, the machine shall be run idle for some time, so that practically no more material already fed comes out. At the end of the test, the material dropped from the outlet shall be collected and weighed and shall be added to the mass of material collected during run test.

10.5.2.3 The test given **10.5.2** shall be repeated for half an hour with the feed rates 80, 90, 110, 120 percent of the rated capacity declared by the manufacturer by adjusting the inlet chute of the hopper.

10.5.3 The data shall be recorded in the data sheet as given in Annex F.

10.5.4 *Performance evaluation of machine*

From the observations made above, the following shall be calculated:

Size – Average size (higher dimension) of the feed and product shall be measured.

10.5.4.1 *Biomass loss*

$$Biomass\ Loss\ (kg) = M_i - M_o$$

10.5.4.2 *Rated capacity*

$$C = \frac{W_i}{T} \times \frac{M_o}{M_t}$$

Where,

C = Capacity of the machine, kg/h
W_i = Weight of material fed, kg
T = Time taken to form pellets from the input material, h
M_o = Mass of output biomass of desired size after grinding in the sample taken for analysis, kg

M_t = Mass of sample taken for analysis, kg

10.5.4.3 *Efficiency*

$$E = \frac{M_o}{M_i} \times 100\ \%$$

Where,

M_i = mass of input biomass, kg

M_o = mass of output biomass of desired particle size after grinding, kg

10.5.4.4 *Specific energy consumption*

$$Sp = \frac{[(P_{load} \times \eta_{load}) - (P_{no\ load} \times \eta_{no\ load})]}{Q}$$

Where,

Sp = Specific Energy Consumption, Wh/kg

P_{load} = Energy meter reading (average) at load, W

$P_{no\ load}$ = Energy meter reading (average) at no load, W

η_{load} = Efficiency of prime mover at load (0.90, if not specified)

$\eta_{no\ load}$ = Efficiency of prime mover at no load (0.50, if not specified)

Q = throughput of the machine, kg/h

NOTE — Reference for the efficiency of the prime mover at load and at no load has been taken from IS 14442.

10.5.4.5 *Determination of power consumption*

The difference between the two consecutive energy meter readings shall be taken as the power consumption. The data shall be recorded in the data sheet as given in Annex G.

10.6 Long Run Test (Endurance Test)

The biomass hammer mill shall be operated for at least 20 hours at load. The period should be covered by a continuous run of at least 5 hours. During and after the operation, no breakdown or defects shall develop in the machine. The major breakdown, defects developed, and repairs made, shall be recorded in the data sheet given in Annex H.

11 SUMMARY REPORT

For the guidance of the user, a summary report on the proforma as given in Annex J shall be compiled.

12 MARKING AND PACKING

12.1 Marking

Each biomass hammer mill shall be marked with following particulars:

a) Manufacturer's name, address and recognized trademark, if any
b) Batch or code umber
c) Power rating and capacity
d) Type
e) Model Number
f) Year of manufacturing
g) Efficiency
h) Direction of rotating parts
j) Rated capacity of pelletizer in kg/h
k) Specific energy consumption, kWh/kg.

12.2 A minimum cautionary notice shall be written in vernacular language legibly and prominently on the main parts of hammer mill:

a) Do not wear loose dress, bangles, watch, etc., while working
b) Do not work under the influence of intoxicants like liquor, opium, etc.
c) Children and aged person should be discouraged for working on pelletizer
d) Do not cross over moving belt
e) Do not operate hammer mill without guards and safety devices
f) Do not adjust when hammer mill is working; and
g) Do not put or take-off belt while pulley is running.
h) Wear protection (hair cap) for long haired person
j) Do not put hands in the hopper/grinding chamber to clear the clogging

12.3 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.

12.4 Packing

The biomass hammer mill or its components shall be packed as agreed to between the purchaser and the supplier for safe handling in transit and storage.

ANNEX A
(*Clause* 2)

IS No.	***Title***
IS 816:1969	Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)
IS 1079:2017	Hot rolled carbon steel sheet, plate and strip — Specification (*seventh revision*)
IS 2062:2011	Hot rolled medium and high tensile structural steel — Specification (*seventh revision*)
IS 2494 (Part 1):1994	V - Belts - Endless V - Belts for industrial purposes: Part 1 General purpose — Specification (*second revision*)
IS 14442:2024	Agricultural produce milling machinery - Burr mill - Specification and test code (*first revision*)
IS 17655 (Part 3):2025 ISO 18134-3 : 2023	Solid biofuels — Determination of moisture content Part 3 Moisture in general analysis sample (*first revision*)
IS 18809 : 2024	Wear and abrasion resistant steel sheet and plate — Specification
FAD20(27725)WC	Plant layout & optimal process for production of biomass pellets – guidelines

ANNEX B
(*Clauses* 10.1.2 & 10.3.1)
SPECIFICATION SHEET

B-1 General

a) Name and address of manufacturer
b) Make
c) Model
d) Type
e) Year of manufacturer
f) Rated capacity
g) Total mass of the machine

B-2 Power Unit

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

B-3 Main Drive

a) Type
b) Size and number of belts
c) Size of pulley on prime mover
d) Diameter of main/rotor shaft
e) Type of belt tightening arrangement

B-4 Feeding Arrangements

a) Type of feed mechanism
b) Storage capacity of feed hopper
c) Type of drive for feed mechanism

B-5 Crushing/Hammering unit

a) Type of hammer blade
b) Size and number of hammer blade, mm
c) Shape and size of screen, mm
d) Thickness of the screen, mm
e) Aperture size of the perforated screen
f) Other if any

B-6 Blower/cyclone/ induced draft fan

a) Type of the blower fan
b) Size of blower, m3/h
c) Size of fan/impeller diameter, mm
d) No. of blades
e) Pressure rating up to 150 mm of water column (1.47 kPa)
f) Type of surface treatment: Coated or Sand Blasted
g) Size of dust cyclone, mm
h) Ground clearance of the dust collector, mm

B-7 Overall Dimensions

a) Length, mm

b) Width, mm
c) Height, mm
d) Ground clearance, mm
e) Size of base frame

B-8 Performance Parameters for Particular Biomass,

a) Rated capacity, kg/h
b) Specific energy consumption, Wh/kg
c) Efficiency, %

B-9 Tools, Accessories, Operation Manual and Spare Parts List to be Provided

ANNEX C
(*Clause* 10.3.2)
DATA SHEET FOR MATERIAL OF CONSTRUCTION

Sl. No.	Name of Component	Material
(1)	(2)	(3)
1.	Airlock	
2.	Base frame	
3.	Body Frame	
4.	Coupling	
5.	Cyclone	
6.	Hammers	
7.	Hammer mounting pin/bar	
8.	Induced Draft (ID) Fan	
9.	Pulley	
10.	Screen	
11.	Shaft	
12.	V-Belt	

NOTE — Delete the component which is not applicable to a particular biomass hammer mill and add if any other component is provided

ANNEX D
(*Clause* 10.3.3)
DATA SHEET FOR VISUAL OBSERVATION AND PROVISIONS FOR ADJUSTMENTS

D-1 Observations

a) Adequacy of marking of inlets and outlets
b) Adequacy of protection of bearings from dust
c) Adequacy of safety arrangements, like cover, controls, etc. specially at moving parts and inlet
d) Provision for lubrication of moving parts
e) Provision of belt tightening, if required
f) Provision for easy changing of components requiring frequent replacement
g) Anti-corrosive coatings provided or not
h) Provision for inspection windows/covers
j) Tightness of bolts, nuts and other fasteners
k) Adequacy of safety guards on moving parts
m) Welding of seams
n) Provision of feed regulating and spreading system
p) Other observations

D-2 Provision for Adjustments

a) Feed rate
b) Speed of shaft
c) Sieves/screens

ANNEX E
(*Clause* 10.4.1 & 10.4.2)
DATA SHEET FOR TEST AT NO-LOAD

E-1 ENERGY CONSUMPTION

a) Source of power
b) Type of drive
c) Total time of run
d) Average energy consumption for one hour

E-2 OBSERVATIONS

a) Presence of any marked vibration during operation
b) Presence of undue knocking or rattling sound
c) Any slippage of belts
d) Smooth running of shafts in their respective bearings
e) Any marked unusual wear or slackness in any component
f) Any marked rise in bearing temperature
g) Unusual heating of any component
h) Other observation (if any)

ANNEX F
(*Clause* 10.5.3)
DATA SHEET FOR TEST AT LOAD

F-1 Details of power supply

F-2 Power rating, kW

F-3 Type of drive

F-4 Composition of feed, %

F-5 Moisture content of feed, %

F-6 Moisture content of powdered material, %

F-7 Size of feed & product, mm

F-8 Speed of shaft, rpm

F-9 Atmospheric conditions:

a) Temperature, ^{o}C
b) Relative humidity, %

F-10 Test Data

Sl. No.	**Date**	**Starting time**	**Stopping time**	**Duration of operation**	**Speed of shaft**	**Feed rate, kg/h**	**Energy meter reading in relation to time**	**No. of quantity of samples**	**Powdered material output, kg**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
								1. 2. 3. 4.	

F-11 Observations

a) Presence of any marked vibration during operation
b) Presence of any undue noise
c) Smooth running of shafts in their respective bearings
d) Undue heating of any component
e) Frequent slippage of belts
f) Any marked deformation, wear or breakdown
g) Any marked rise in bearing temperature
h) Unusual heating of any component
j) Frequent loosening of fasteners
k) Other observation (if any)

ANNEX G
(*Clause* 10.5.4.5)
DATA SHEET FOR EFFICIENCY, CAPACITY AND POWER REQUIREMENT

Sl. No.	Item	Test No.				
		1	2	3	4	Etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Feed rate, kg/h					
2.	Average size of powdered material, mm					
3.	Moisture content, %					
4.	Biomass Loss, kg					
5.	Efficiency, %					
6.	Bulk Density, kgm^{-3}					
7.	Gross calorific value, kcal/kg					
8.	Power requirement, kW					
9.	Rated capacity, kg/h					
10.	Specific energy consumption, kWh/kg					
11.	Specific capacity, kg/kWh					

NOTE — GCV need not to be measured in every test, if the feed stock is same.

ANNEX H
(*Clause* 10.6)
DATA SHEET FOR LONG-RUN REST

H-1 Total Running Time

H-2 Continuous Running Time

H-3 Any Major Breakdown

H-4 Any Repairs Conducted

H-5 Any Other Observations

ANNEX J
(*Clause* 11)
SUMMARY REPORT

J-1 Name of Testing Station

J-2 Name of Manufacturer

J-3 Model Number

J-4 Brief Description of the Equipment Used In Production of Non-Torrefied Pellets

J-5 Type of Material Used For Test

J-6 Moisture Content of Raw Material

J-7 Adjustments For:

a) Feed control
b) Screw conveyor speed

J-8 Power Requirements, kW:

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

J-9 Average Size of Powdered Material, mm

J-10 Biomass Loss, kg

J-11 Gross Calorific Value, kcal/kg

J-12 Efficiency, %

J-13 Rated Capacity

J-14 Any Marked Observation Affecting Performance.

J-15 Any Major Breakdowns During Test

J-16 Other Observations, If Any