PHILIPPINE NATIONAL STANDARD

PNS/PAES 264:2015
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ICS 65.060.01

Agricultural machinery – Rice husk fed heating system – Specifications

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National Foreword

The Philippine Agricultural Engineering Standards PAES 264:2015, Agricultural machinery – Rice husk fed heating system – Specifications was approved for adoption as Philippine National Standard by the Bureau of Philippine Standards upon the recommendation of the Agricultural Machinery Testing and Evaluation Center (AMTEC) and the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (PCAARRD-DOST).

Foreword

The formulation of this national standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Development of Standards for Rice Production and Postproduction Machinery" which was funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD) of the Department of Science and Technology (DOST).

This standard has been technically prepared in accordance with PAES 010-2 – Rules for the Structure and Drafting of International Standards.

The word "shall" is used to indicate mandatory requirements to conform to the standard.

The word "should" is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

In preparation of this standard, the following documents/publications were considered:

ASAE S248.3 MAR1976 (R2005) - Construction and Rating of Equipment for Drying Farm Crops

ANSI/ASABE S593 MAY2006 - Terminology and Definitions for Biomass Production, Harvesting and Collection, Storage, Processing, Conversion and Utilization

Johnson, G.I., Highley, E., and Champ, B.R. Grain Drying in Asia. Proceedings of an International Conference. Thailand, 1995

Mullinger, Peter and Jenkins, Barrie.2008.Industrial and Process Furnaces: Principles, Design and Operation. 1st Ed. Elsevier Ltd.

Primer on Philippine Grains Standardization Program of the National Food Authority.

Trinks, W., Mawhenney, M.H., Shannon, R.A., Reed, R.J., Garvey, J.R. 2004.Industrial furnaces.6th ed. John Wiley and Sons, Inc.

1 Scope

This standard specifies the manufacturing and performance requirements for rice husk fed furnace to be used as a heat source.

2 References

The following normative documents contain provisions, which through reference in this text constitute provisions of this National Standard:

PNS/PAES 101:2000 Agricultural Machinery – Technical Means for Ensuring Safety – General

PNS/PAES 102:2000 Agricultural Machinery – Operator's Manual – Content and Presentation

PNS/PAES 103:2000 Agricultural Machinery – Method of Sampling

PNS/PAES 138:2004 Agricultural Machinery – Guidelines on After Sales Service

PNS/PAES 201:2015 Agricultural Machinery – Heated-Air Mechanical Grain Dryer – Specifications

PNS/PAES 265:2015 Agricultural Machinery – Rice Husk Fed Heating System – Methods of Test

PNS/PAES 311:2001 Engineering Materials – Screws for Agricultural Machines – Specifications and Applications

PNS/PAES 313:2001 Engineering Materials – Bolts and Nuts for Agricultural Machines – Specifications and Applications

3 Definitions

For the purpose of this standard the following definitions shall apply:

3.1
ash
inorganic, non-combustible residue left after complete combustion of a material

3.2
ash arrester
component that reduces the fly-ash blown into the surroundings

3.3
ash discharging mechanism
component that removes the ash from the combustion chamber

3.4
biomass
organic materials used as renewable source of energy including but not limited to agricultural crops, feed and fiber crop residues, aquatic plants, forestry and wood residues, agricultural wastes, processing by-products and other non-fossil organic materials

3.5
blower
a power driven device used to supply appropriate volume of air to the chamber for efficient combustion

3.6
chimney
a refractory or metallic stack for moving waste gases from the heating system to the atmosphere

3.7
combustion chamber
compartment where the rice husk is being burned

3.8
direct-fired furnace
a type of furnace where the flue gas and other by-products of combustion goes into the dryer

3.9
flue gas
waste gases that have passed through the chimney and heat recovery equipment

3.10
grate
framework of metal bars or fire bricks used to hold rice husk in furnace for more efficient combustion

3.11
hearth
fire resistant surface located at the heating chamber of the furnace

3.12
heat exchanger
device used to transfer heat from one fluid stream to another without intermixing

3.13
indirect-fired furnace
a type of furnace that uses a heat exchanger to prevent flue gas and other by products of combustion to enter the drying chamber with the drying air

3.14
rice husk
rice hull
outermost rough covering of the paddy grain (palea and lemma) consisting of the empty glumes, floral glumes, and awn

3.15
rice husk fed heating system
interconnected components for intense heating using rice husk

3.16
workload
materials to be burned using rice husk fed furnace

4 Classification

Rice husk fed heating system shall be based classified according to:

4.1 Mode of Heat Transfer

4.1.1 Direct-fired furnace

Flue gas and other by-products of combustion goes into the dryer (Figure 1).

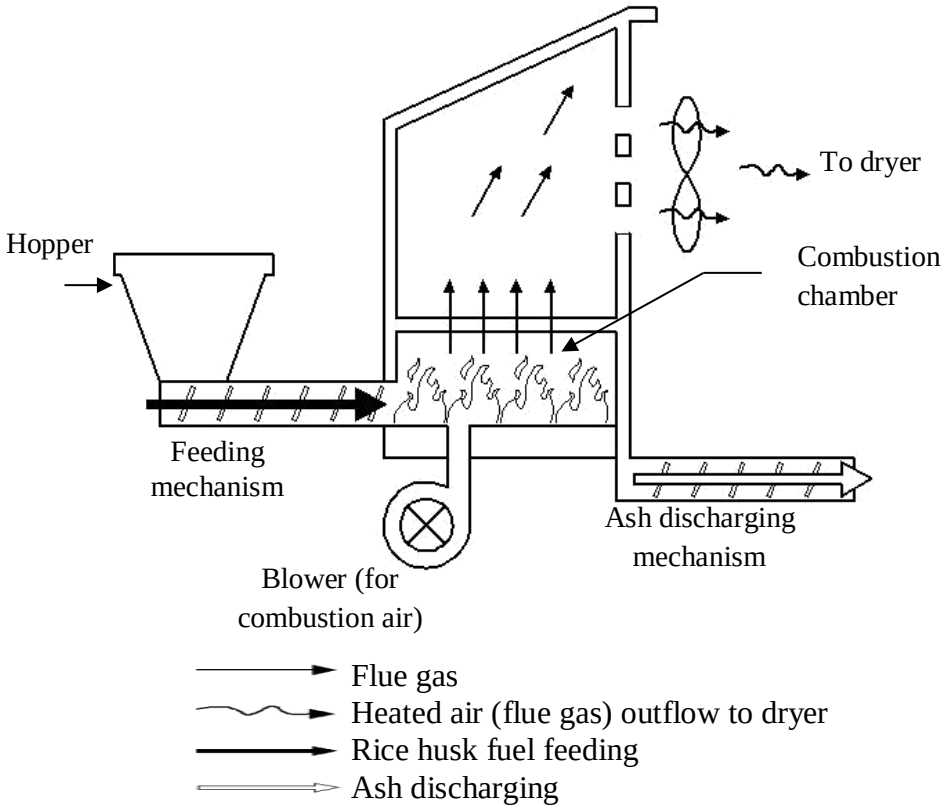

Figure 1 – Diagram of direct-fired furnace

4.1.1.1 Mode of Feeding

4.1.1.1.1 Cyclonic

Rice husks are fed on the combustion chamber in cyclonic manner using a blower. The fuel in this type of furnace is burned while in suspension (Figure 2).

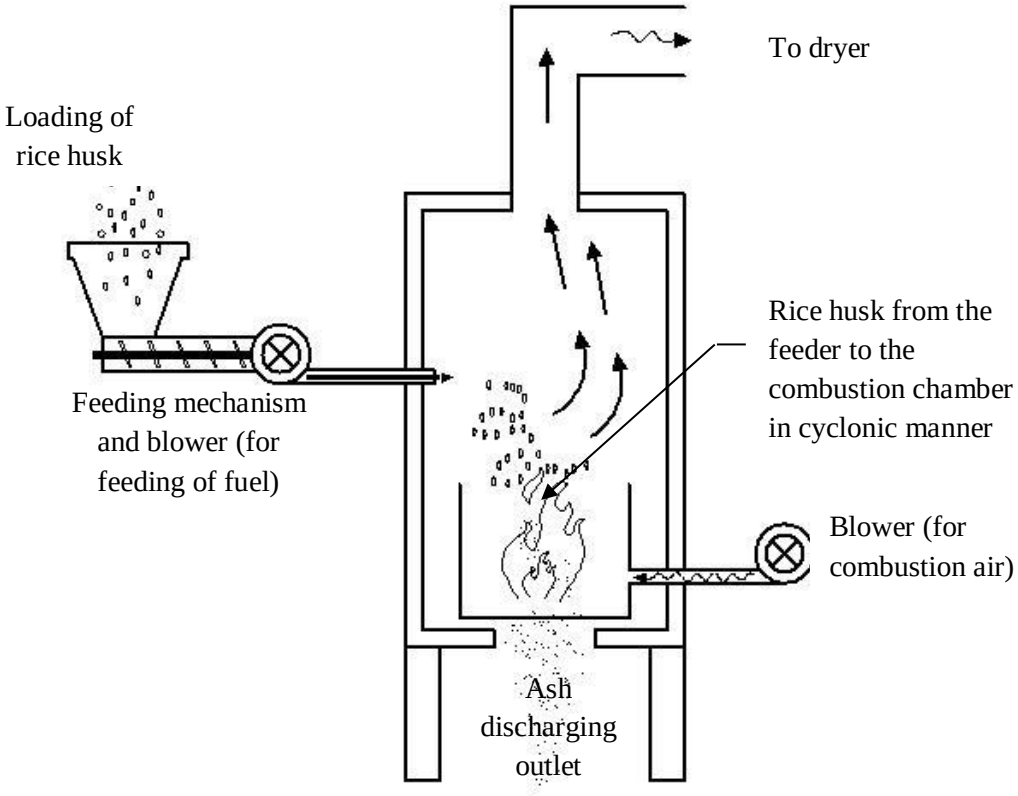

Figure 2 – Flow diagram inside cyclonic type furnace

4.1.1.1.2 Step-grate

The furnace with combustion chamber that have stair-liked arrangement of grate (Figure 3).

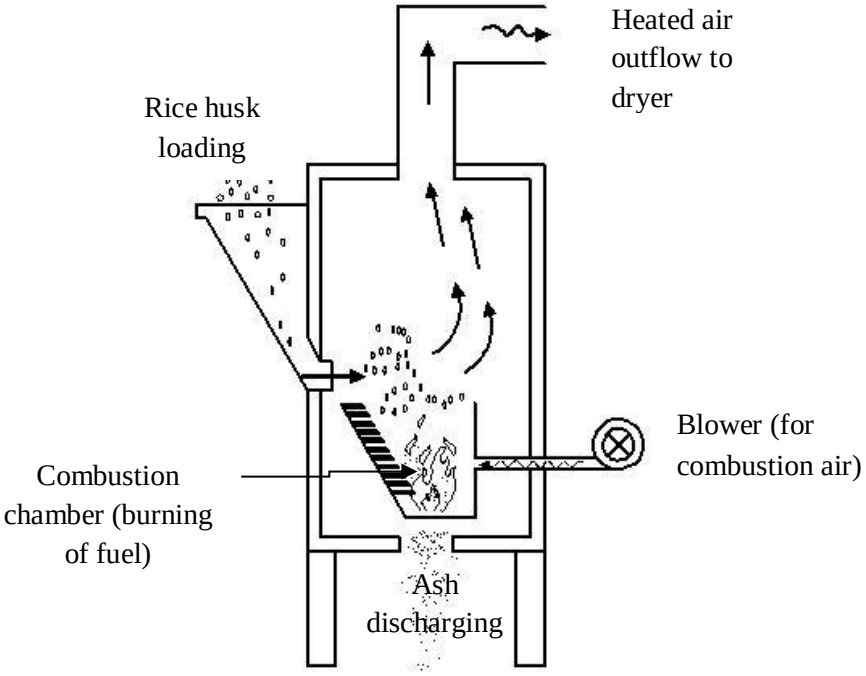

Figure 3 – Flow diagram inside step-grate furnace

4.1.1.1.3 Gravity

The furnace that uses gravitational force on feeding the fuel (Figure 4).

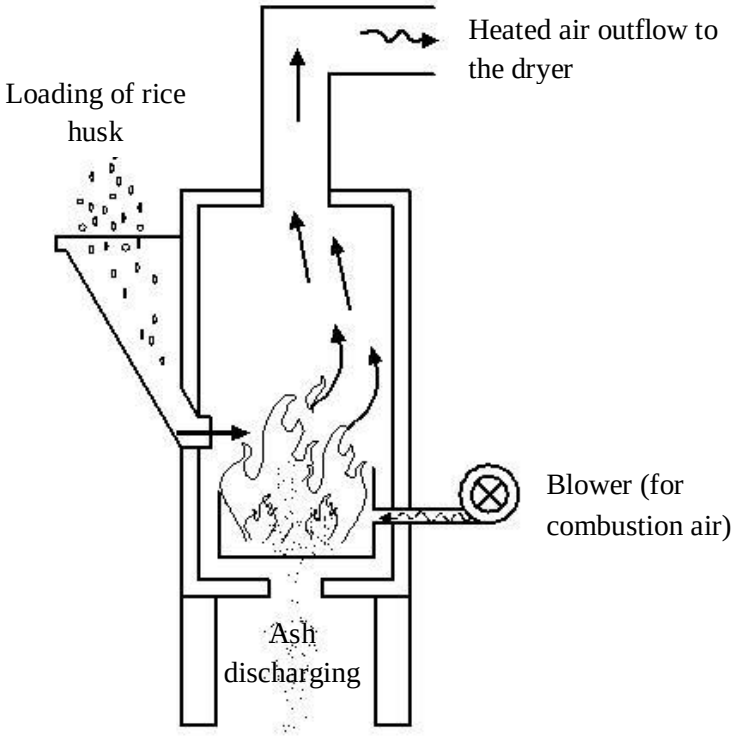

Figure 4 – Flow diagram inside the furnace using gravity in fuel feeding

4.1.2 Indirect-fired furnace

This type of furnace shall use a heat exchanger to prevent flue gas and other by products of combustion to enter the drying chamber with the drying air (Figure 5)

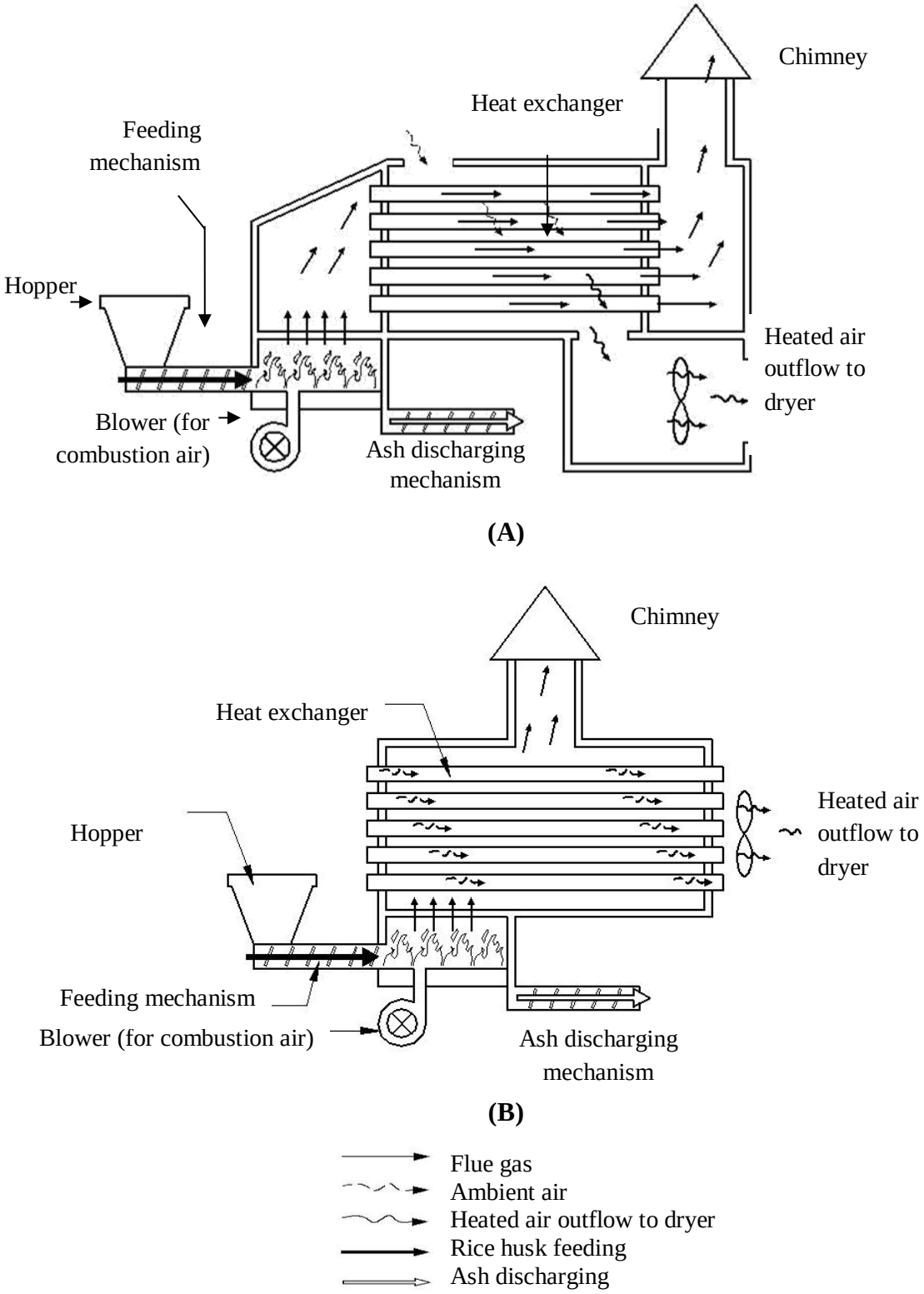

Figure 5 – Diagram of indirect-fired furnace (A-flue gas inside heat exchanger; B-flue gas outside heat exchanger)

4.1.2.1 Medium for Heat Transfer

4.1.2.1.1 Dry type furnace

Uses ambient air to be heated inside or outside the heat exchanger and be used as drying air (Figure 6)

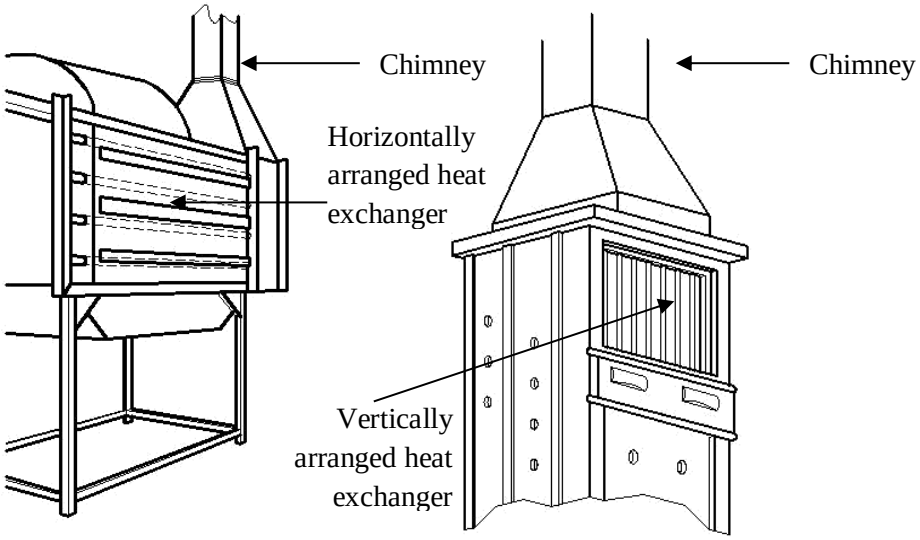

Figure 6 – Dry type furnace using (A) horizontal and (B) vertical heat exchanger

4.1.2.1.2 Wet type biomass furnace

Uses hot fluid as medium of heat transfer (Figure 7)

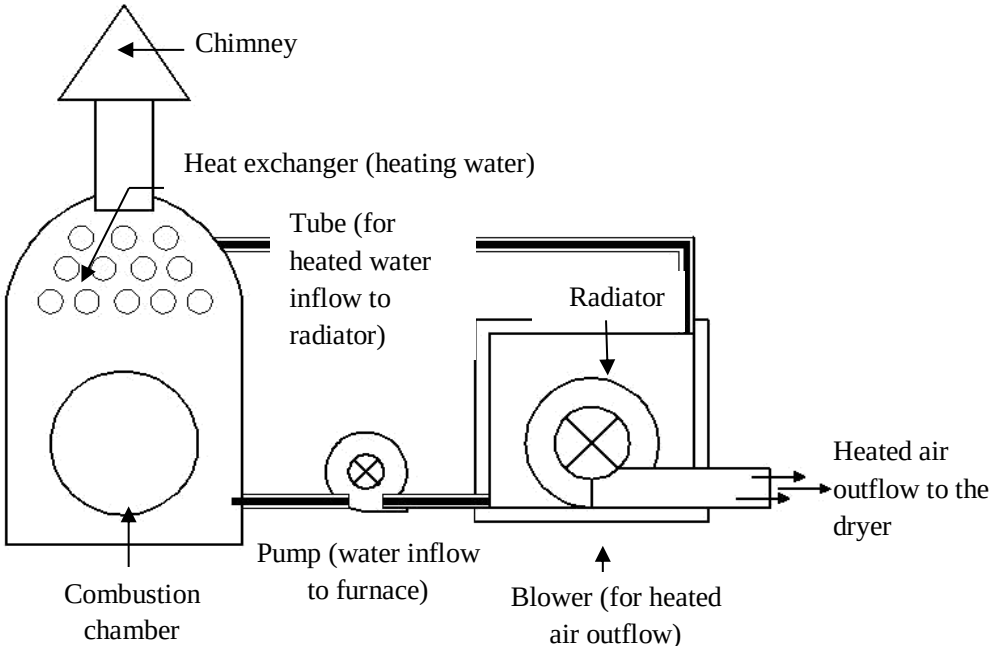

Figure 7 – Flow diagram of heated air inside wet-type biomass furnace

4.2 Insulating Materials

4.2.1 Brick lining

Heat resisting lining of the furnace using layer/s of fire bricks

4.2.2 Ceramic fiber lining

Heat resisting material used as a lining of the furnace using ceramic materials

4.2.3 Monolithic lining

Heat resisting lining of the furnace using aggregates and bonding agent(s)

4.2.3.1 Type of Lining

4.2.3.1.1 Castable refractory

Consist of course and fine grains with suitable bonding cement. These are poured in place using molds or pouring forms after mixing with water.

4.2.3.1.2 Refractory mortars

Finely ground refractory materials that, when tempered with water, become trowelable for bonding layered-up refractory shapes.

5 Manufacturing Requirements

5.1 The heating system shall have combustion chamber and walls with heat resistant lining, insulation, steel supporting structure and casing, hopper with feeding mechanism, ash discharge unit, ash arrester, heat exchanger and flue gas chimney (for indirect-fired).

5.2 Single layer heat resisting lining of the combustion chamber and walls shall be able to withstand the minimum operating temperature of 800 °C (1400 °F).

5.3 The furnace that is operating with higher temperature than 800°C (1400°F) shall have a multi-layer wall of hearth.

5.4 Multi-layered lining shall compose of two to three layers of refractory and an insulator.

5.5 The heat resisting lining of the combustion chamber and walls of the furnace shall be made of individual bricks, monolithic linings and/or ceramic fiber lining.

5.5.1 Brick lining shall be made of fire brick from fireclay and kaolin or silica brick.

5.5.1.1 The brick shall be staggered to avoid direct gas path from the hot gas side to the shell and shall be assembled using high temperature mortar based on high alumina cement.

5.5.1.2 Ceramic fiber board or insulating brick shall be used for multi-layered brick lining.

5.5.1.3 Expansion joints between the bricks shall be provided at regular intervals to prevent overstressing the brick during operation (Figure 8)

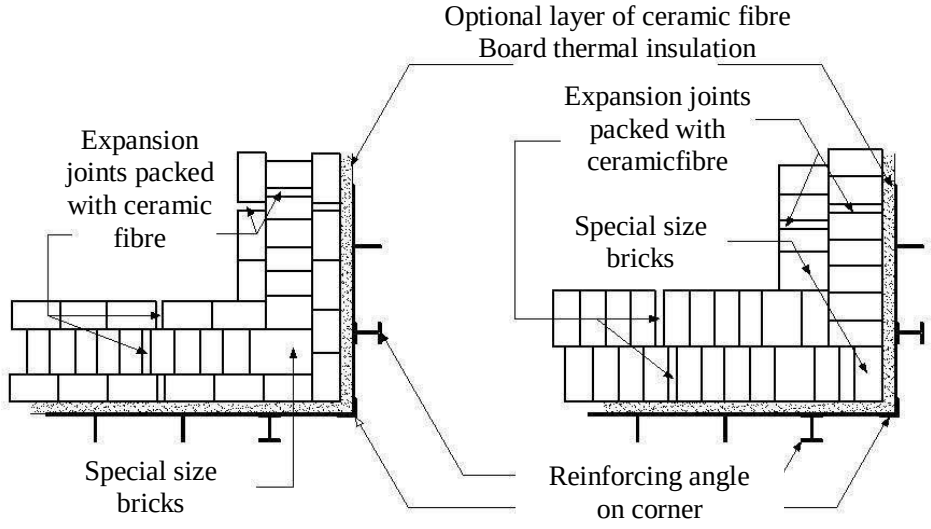

Figure 8 – Lining arrangement of the furnace using bricks. (Mullinger and Jenkins, 2008)

5.5.2 Monolithic lining shall be made of refractory materials graded to a range of sizes together with bonding agent attached to anchors (Figure 8)

5.5.2.1 Castable refractory shall be made of heat resisting aggregates and alumina cement that can be poured into forms.

5.5.2.2 It shall be made into a gas tight structure to avoid heat loss

5.6 Supporting structure and casing shall compose of steel shell or plate work and load bearing frame.

5.6.1 The supporting structure and casing shall be able to support the entire load of the furnace during operation.

5.6.2 It shall be painted with light color paint or aluminum paint.

5.7 Hopper should be made of metal sheet to minimize the friction between the rice husk and the surface of hopper. The angle of hopper shall conform to the angle of repose of the rice husk which is 35°-50°.

5.8 Hopper should have feeding section (e.g. screw feeder, rotary, etc.) to convey the fuel directly to the combustion chamber.

5.9 For indirect-fired furnace, fire tubes shall be used as heat exchanger.

5.10 The center to center distance of the heat exchanger tubes installed shall be more than 1.25 times the tubes outside diameter.

5.11 Total cross sectional area of heat exchanger used in furnace shall be equal to the cross sectional area of the duct connected to the plenum used in grain dryer.

5.12 Tube layout for heat exchanger should be triangular patterns for efficient heat transfer (Figure 9)

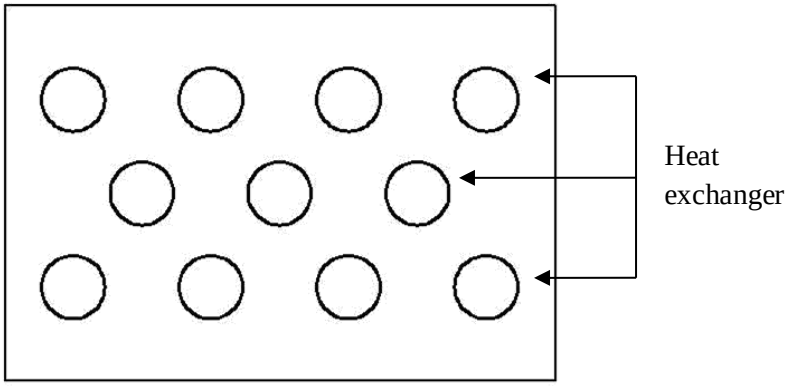

Figure 9 – Triangular arrangement of heat exchanger

5.13 Tubes of heat exchanger shall have provision for ease of replacement.

5.14 Grate for grate-type furnace shall be made of flat or square high temperature resistant ordinary flat bar.

5.15 Rice husk furnace with ash discharge mechanism (Figure 10).

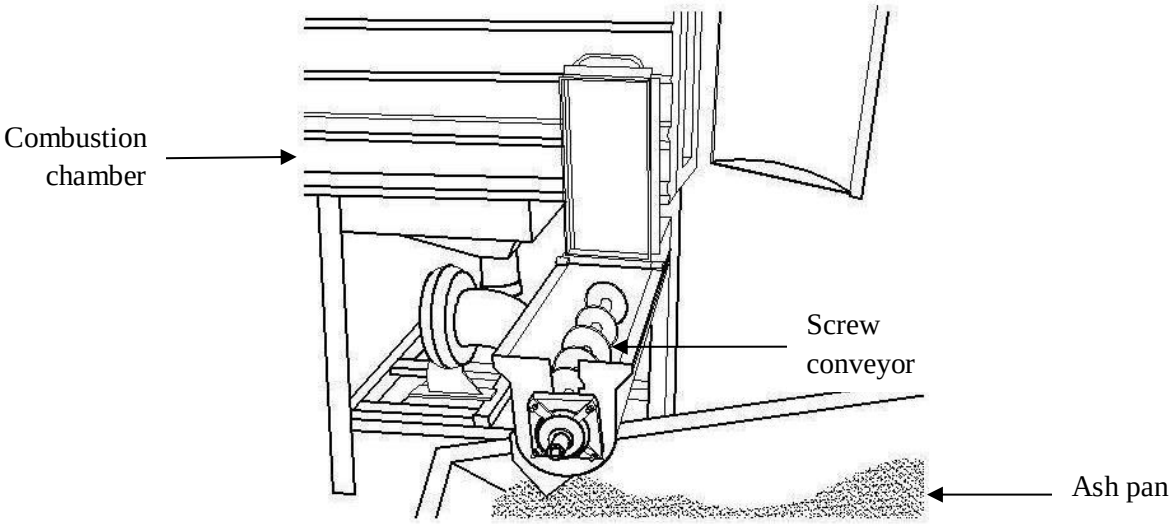

Figure 10 – Example of ash discharge mechanism (screw conveyor)

NOTE: In designing rice husk fed heating system, the following shall be considered: (1) Ash of rice husk is abrasive and acidic. (2) During operation ash temperature is high. (3) Ash content of rice husk is approximately 20%.

5.16 There should be provision for collecting and discharging the ash.

5.17 Indirect-fired furnace should have burning fly ash collector such as ash arrester, ash bin and/or scrubber system.

5.18 Direct and indirect-fired furnace shall have temperature control mechanism for monitoring.

NOTE: Temperature control mechanisms maybe louvers, air valves,

5.19 Bolts and screws to be used shall conform to the requirements of PNS/PAES 311:2001 – Engineering Materials – Screws for Agricultural Machines – Specifications and Applications and PNS/PAES 313:2001 – Engineering Materials – Bolts and Nuts for Agricultural Machines – Specifications and Applications.

6 Performance Requirements

6.1 Average fuel consumption per hour shall conform to manufacturer's specifications.

6.2 The furnace shall deliver the required heat for drying operation.

6.3 The furnace shall meet the maximum allowable operating temperature specified by the manufacturer without any damage to the furnace structure (ex. cracking and/orscaling).

6.4 Heating system efficiency of the furnace shall be at least 65% for direct-fired and 50% for indirect-fired. Refer to PNS/PAES 201:2015 – Heated Air Mechanical Grain Dryer.

6.5 Burning efficiency of the furnace shall be at least 95%.

6.6 Furnace efficiency shall be at least 65%.

6.7 The flue gas emitted by the furnace shall be within the maximum allowable level of pollutants as required by the Clean Air Act of the Philippines.

7 Safety, Workmanship and Finish

7.1 The unit shall be free from manufacturing defects that may be detrimental to its operation and may significantly affect its performance.

7.2 The unit shall be free from sharp edges and surfaces that may be unsafe. The warning notice shall be in accordance with PNS/PAES 101:2000 Agricultural Machinery – Technical Means of Ensuring Safety - General.

7.3 All surfaces shall be coated with a suitable paint material for surface protection and aesthetic purpose and durability.

7.4 All welded parts shall be water-tight (for boiler-type furnace) and smoothly polished and it shall pass visual inspection criteria (AWS D1.1:2000) for discontinuity of materials.

7.5 Welded joints shall not be less than 4 mm (1/8 inch) side fillet welded. Undercut shall not exceed 2 mm (1/16 inch) for any length of weld.

8 Warranty for Construction and Services

8.1 Warranty shall be provided for parts and services within one (1) year after the installation and acceptance by the user, except for normal wear and tear of consumable parts of the rice husk fed heating system. General requirements of the warranty shall be in accordance with PNS/PAES 138:2004 Agricultural Machinery – Guidelines on After Sales Service.

8.2 The construction shall be rigid and durable without breakdown of its major components for at least one year from the date of purchase of end-user.

9 Maintenance and Operation

9.1 Every unit shall be provided with basic tools, operation and parts manual containing full information on method of installation and operation. The manual which conforms to PNS/PAES 102:2000 Agricultural Machinery – Operator's Manual – Content and Presentation shall be provided.

9.2 Manufacturers/dealers shall provide operation and maintenance training, after-sales service, identify wearing parts and should provide spare parts.

10 Sampling

The unit shall be sampled for testing in accordance with PNS/PAES 103:2000 – Agricultural Machinery – Method of Sampling.

11 Test Methods

The sampled unit shall be tested in accordance with PNS/PAES 265:2015 –Agricultural Machinery – Rice Husk Fed Heating System – Methods of Test.

12 Markings and Labeling

Each unit shall be marked at a prominent place with the following information:

12.1 Registered trademark of the manufacturer

12.2 Brand

12.3 Model

12.4 Serial number

12.5 Rated fuel consumption, kg/h

12.6 Maximum allowable temperature of furnace, °C

12.7 Name and address of the manufacturer/ importer/distributor

12.8 Country of manufacture/ Made in the Philippines

12.9 The markings shall have a durable bond with the base surface material.

12.10 The markings shall be made of metal aluminum plate.

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3F Trade and Industry Building
361 Sen. Gil J. Puyat Avenue, Makati City 1200, Metro Manila, Philippines
T/ (632) 751.3125 / 751.3123 / 751.4735
F/ (632) 751.4706 / 751.4731
E-mail: bps@dti.gov.ph
www.dti.gov.ph

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