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**Solid biomass cookstoves —
Specifications**

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Requests for permission to reproduce this document should be addressed to

Rwanda Standards Board

P.O Box 7099 Kigali-Rwanda

Tel. +250 252 586103/582945

E-mail: info@rsb.gov.rw

Website: www.rsb.gov.rw

Contents

	Page
1	Scope 1
2	Normative references 1
3	Terms and definitions 1
4	Requirements 3
5	Emissions, performance and safety requirements 3
6	Fuel 4
7	Marking 4
	Annex A (Informative) General description of ceramic liner cookstove 5
	Annex B (Informative) Thermal shock/stress resistance 8
	Annex C (informative) Water Boiling Test Data Form 9
	Annex D (informative) Determination of thermal conductivity of ceramic liner 12
	Annex E (informative) Operating user guide 14
	Annex F (informative) Household solid biomass ceramic metal cladde d cookstoves dimensions 15

Foreword

Rwanda Standards are prepared by Technical Committees and approved by Rwanda Standards Board (RSB) Board of Directors in accordance with the procedures of RSB, in compliance with Annex 3 of the WTO/TBT agreement on the preparation, adoption and application of standards.

The main task of technical committees is to prepare national standards. Final Draft Rwanda Standards adopted by Technical committees are ratified by members of RSB Board of Directors for publication and gazettment as Rwanda Standards.

This standard replaces RS 165-1 Biomass stoves- Specifications - Part 1: Household charcoal cook stoves

DRS 290 was prepared by Technical Committee RSB/TC 23, *Mechanical engineering and metallurgy*.

In the preparation of this standard, reference was made to the following standards:

- 1) KS 1814-1:2005; *Biomass stoves — Performance requirements and test methods — Part 1: Household biomass stoves*
- 2) US 761:2007; *Energy efficiency stoves — Household biomass stoves — Performance requirements and test methods*
- 3) *Rwanda Improved Canamake (RIC) Stove Standard Document*

The assistance delivered from the above source is hereby acknowledged with thanks.

Committee membership

The following organizations were represented on the Technical Committee on Mechanical engineering and metallurgy (RSB/TC 023) in the preparation of this standard.

ABEM Engineering and Manufacturing
Chillington Rwanda
ENEDOM
Del Agua
Integrated Polytechnic Regional Centre - Kigali (IPRC)
Tumba College of Technology (TCT)
IB & C
Master Steel
Nikil and Consultant
Rwanda Agriculture Board (RAB)
Rwanda Environment Management Authority (REMA)
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INTRODUCTION

This Rwanda standard is intended for use to set performance requirements for cookstoves used primarily for cooking or water heating. Its purpose is to help producers and users to reduce the detrimental impact on environment and health of traditional cooking practices with the view to improve livelihood of citizens. The additional general description of ceramic liner cookstove is provided in Annex A as informative information to help local producers in manufacturing process.

This standard was developed to improve the quality of cookstoves on the market and was developed from best practices from existing cookstoves available on market which comply with minimum technical conditions as set by ISO and regional standards.

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Solid biomass cookstoves — Specifications

1 Scope

This Draft Rwanda Standard specifies the requirements and test methods for solid biomass cookstoves. The standard is applicable to cookstoves used primarily for domestic and small-scale institutional cooking or water heating excluding stoves used primarily for space heating.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO19867-1 (under development), *Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Standard Test Sequence for emissions and performance, safety, and durability*

ISO19867-2 (under development), *Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Contextual test sequences for emissions and performance*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions apply.

3.1 Cookstove

apparatus which is used to cook food and/or provide warmth and/or boil water through the conversion of biomass, typically through combustion

3.2

biomass

material of biological origin excluding embedded in geological formations and/or fossilized.

3.3

cooking vessel

pot or container fabricated of heat-resistant material in which food or water is heated and prepared

3.4

maximum cooking power

highest *cooking power* for which a *cookstove* is designed, in kW

3.5

minimum cooking power

lowest *cooking power* for which a *cookstove* is designed, in kW

3.6

organic carbon

carbonaceous material in which the carbon is chemically bonded to hydrogen and possibly also oxygen, nitrogen, sulphur or other elements

3.7

particulate matter

solids and liquids of a sufficiently small size to be suspended in air

3.8

PM₁₀

particulate matter such that the aerodynamic diameter of the particles is less than or equal to 10 μm

3.9

PM_{2.5}

fine *particulate matter* such that the aerodynamic diameter of the particles is less than or equal to 2.5 μm

3.10

combustion efficiency

proportion of latent heat in a fuel transferred as heat to a working fluid (water)

3.11

thermal efficiency

ratio of useful energy delivered to fuel energy used

3.12

Water Boiling Test

A test in which the performance of a stove is evaluated through the heating of a known quantity of water across a specified range of temperature following a defined protocol

3.13

black carbon (BC)

particulate carbonaceous material, typically the product of combustion that comprises primarily carbon

3.14

durability

ability of a cookstove to continue to be operated for an extended period safely and with minimal loss of performance under conditions typical of those found in the target community

3.15

safety

ability of a cookstove to be operated at an acceptable level of risk of harm

3.16

field testing

measurement of cookstove performance conducted in the target community under typical operating conditions

4 Requirements

4.1 General requirements

4.1.1 All component parts of solid biomass cook stoves shall be made of non corroding material or protected against corrosion by a suitable anticorrosion coating.

4.1.2 The solid biomass cook stoves shall use improved technologies to yield low emissions and high level of efficiency, durability and safety.

4.1.3 The solid biomass cook stoves shall be evaluated based on performance in the areas of fuel efficiency, emissions of fine particulate matter (PM 2.5) and carbon monoxide (CO), indoor emissions (particulate matter 2.5 and carbon monoxide), black carbon content, durability and safety and each area shall be ranked separately.

4.1.4 The cookstove shall be supplied with user guide in one of three official languages used in Rwanda

5 Emissions, performance and safety requirements

5.1 Emissions shall be measured for the qualitative and quantitative determination of pollutant-emitting sources to ensure that the pollution is within acceptable limits as given in table 1.

5.2 Cookstove performance (thermal efficiency and durability) and safety requirements shall be within the limits given in table 1

Note The standard ISO 19867 is still under development.

Table 1- Cookstoves performance

Type of stoves	Thermal efficiency (%)	PM _{2.5} (mg/MJd)	CO (g/MJD)	BC (mg/MJD)	Safety (score)	Durability (score)	Test protocol
Best	≥45	≤38	≤8	≤6	≥95	<10	ISO 19867-1 or ISO 19867-2
Better	≥35	≤137	≤11	≤21	≥88	<15	ISO 19867-1 or ISO 19867-2
Good	≥25	≤513	≤16	≤77	≥75	<20	ISO 19867-1 or ISO 19867-2

Note The test protocol done depending on the purpose (for general comparison, use ISO 19867-1 and for contextual sequence use ISO 19867-2)

5.3 Instruments used for measuring gaseous pollutant concentrations shall be calibrated at the beginning and end of each day of testing with certified calibration gases. Calibrations shall be documented.

5.4 All cookstoves shall be at least be classified in one of the three categories given in table 1.

5.5 After testing, the test report shall indicate the category of the tested cookstoves as given in table 1.

6 Fuel

The solid biomass fuel shall comply with the relevant national, regional or international standards.

7 Marking

All solid biomass cookstoves shall be indelibly and legibly marked with the following information in at least one of the three official languages used in Rwanda and shall be placed in a clear location on the cookstove:

- a) manufacturer's name or trade mark and address;
- b) name of product;
- c) production date;
- d) cooking thermal efficiency at maximum power;
- e) maximum cooking power;
- f) standard number;
- g) weight of the cookstove and
- h) maximum weight that the stove can withstand

The marking shall be done either by painting or by using tags

Annex A (Informative)

General description of ceramic liner cookstove

A.1 General requirements

A.1.1 The portable ceramic liner cookstoves shall consist of a fired ceramic liner cladded in a metal sheet surround using an acceptable insulation material, suitable pot rests, grate and stove stands.

A.1.2 The fixed ceramic liner cookstoves shall consist of a fired ceramic liner properly integrated in the mud hearth with acceptable insulation material, suitable pot rests, grate in adequate wood inlet and combustion chamber.

A.1.3 The improved cookstoves shall use improved technologies with environmental friendly materials to yield low emissions and high level of efficiency, durability and safety.

A.2 Material requirements for fixed and portable ceramic cookstoves

A.2.1 Cladding

The cladding materials used in the manufacture of household solid biomass ceramic metal cladded stoves shall be steel material sheet with a minimum thickness of 0.63 mm (Gauge 22).

A.2.2 Clay

Suitable clay shall withstand firing temperature of up to 1 000°C. Proportions of sand to clay shall be at least 3:7 (30% and 70%) in ratios respectively.

A.2.3 Clay testing

Tests shall include coiling and sedimentation.

A.2.4 Coiling test

The test shall be performed to determine the clay to sand ratio. It is done by taking a piece of clay and rolling to make a strip between two hands and then coiling.

A small lump is kneaded into a long strip that is drawn out into an arc or it makes a semi circle without breaking or cracking and therefore it is suitable.

A.2.5 Sedimentation test

Take a lump of clay and stir in water in 1:1 ratio. Put it in a transparent container and leave it to settle. Clay should settle on top and sand to the bottom. Sand goes to the bottom, then soil and water.

A.3 Ceramic liner

A.3.1 The ceramic liner shall be made from suitable pottery clay that has been fired as specified in 4.2.2

A.3.2 The ceramic liner shall be properly fired and shall not have a black core.

A.3.3 A properly fired liner produces a sharp high pitch tone sound when tapped with a finger or a stick while an under fired liner sound dull.

A.3.4 The ceramic liners shall not crack due to heating and cooling cycles developed due to thermal stress. A ceramic liner made with a clay mix which is thermal shock resistance shall be able to withstand 5 cycles when tested in accordance with the procedure specified in Annex B.

A.3.5 A ceramic liner shall have its thermal conductivity value not exceeding 2, 5 WK-1m-1 at 500°C when determined in accordance with the procedure specified in Annex D.

A.4 Pot rests

A.4.1 Pot rests for portable ceramic cookstoves shall be made from mild or twisted steel bars minimum diameter of 8 mm and shall be fixed at the top of the metal cladding during assembling.

A.4.2 Pot rests for fixed ceramic cookstoves shall be made from clay moulded and attached to the upper part of the ceramic liner.

A.4.3 Pot rests for complete ceramic stoves shall be of same material.

A.5 Insulation

The insulation between the cladding material and ceramic liner shall be made of various mixtures of material as described in Table 1.

Table 1 — Material composition of insulation

Material	Ratio (Volume)
Cement :sand: rice husks	1:½:4
Cement :sand: lime	1:1:2
Cement: lime: kaolin	1:1:2

Cement :sand :wood ash	1:½ :3
Cement: Vermiculite	1:3
Cement :Diatomite	1:3
Cement: Sand: ash	2:1:6
Note Any other insulation materials may be used provided that they meet the requirements of thermal conductivity tests (see Annex D)	

A.6 Assembling the complete stove

A.6.1 The cookstove shall be assembled in such way that it can withstand the weight of the pot while cooking.

A.6.2 All component parts of the portable cookstoves and improved cookstoves shall be made of non corroding material or protected against corrosion by a suitable anticorrosion coating.

A.6.3 The household solid biomass cookstove and its component parts shall be smooth and free from defects that adversely affect the appearance, performance and safety aspects during use such as cracks, sharp edges or burrs.

A.6.4 A grate shall be designed in such way that it can hold the burning solid biomass, evacuate ash and facilitate circulation of sufficient air through the burning solid biomass

A.6.5 The stove stands shall be designed in such way that it can maintain the stability of the entire cookstove while cooking and shall be non combustible material.

Annex B

(Informative)

Thermal shock/stress resistance

B.1 To test whether ceramic liners made from particular clay mix are thermal shock resistant, the liners shall be heated to temperature ranging 800 °C – 900 °C and then immersed in cold water at room temperature. These temperatures are attained in fireboxes when in use. This is repeated several times until the liner cracks. The heating can be done using a gas flame or an electric kiln.

B.2 As the test is extremely severe, a liner which can withstand 5 cycles shall be considered to be made from a clay mix that is thermal shock resistant

Annex C

(informative)

Water Boiling Test Data Form



Test number.....	Location.....
Data.....	Air temp.....
Stove.....	Stove condition.....
Tested.....	Remarks.....

Basic test data initial measurement	End of HPP	LPP
Amount of water .....kg		
Moisture cont. of charcoal .....kg		
Low heat value of charcoal.....kg		
Weight of charcoal.....kg	.....kg	.....kg
Weigh pot 1 (.....cm).....kg	.....kg	.....kg
Weigh pot 2 (.....cm).....kg	.....kg	.....kg
Water temp. Pot 1 .....°C	.....°C	.....°C
Water temp. Pot 2 .....°C	.....°C	.....°C
Time for Boiling point (pot 1) .....min		
Time for Boiling Point (pot 2).....min		

	HPP	LPP
Charcoal consumed	.....kg	.....kg
Charcoal remaining	.....kg	.....kg
Water vaporized pot 1	.....kg	.....kg
Water vaporized pot 2	.....kg	.....kg
Duration of test	.....min	.....min

Water temperature

High Power Phase

Low Power Phase

Min	pot 1(°C)	pot 2 (°C)	Min	pot 1(°C)	pot 2 (°C)
0		0
5		5
10		10
15		15
20		20
25		25
30		30
35		35
40		40
45		45
50		50
55		55
60		60

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Water boiling test

Test carried out by

Data calculation form

Comparison of different tests within one test series

Ambient conditions

Air temperature : °C

Air relative humidity : % It should be below 85%

Local boiling point : °C

Wind conditions:

Date

Stove type/model:.....

Diameter of pots:.....

Kg. of water:.....

Place:.....

Test Number						Average

Comments

.....

COF

Annex D (informative)

Determination of thermal conductivity of ceramic liner

For determination of thermal conductivity of ceramic liner, a specimen measuring 80 mm x 30 mm x 10 mm shall be cut from the ceramic liner whose thermal conductivity is to be determined.

The reference material measuring 80 mm x 30 mm x 10 mm shall be of hard fibre glass board, whose thermal conductivity is known.

D.1 Procedure

D.1.1 The Transient hot wire method of comparison shall be employed.

D.1.2 The hot wire is sandwiched between a plate-type experimental specimen and a reference specimen whose value of thermal conductivity is known.

D.1.3 The specimen to be tested is cut into a plate type experimental specimen just the same shape and size as the reference specimen of fibreglass board.

D.1.4 Both the specimen and reference material are pressed by loading to come into close contact with each other.

D.1.5 At the centre of the hot wire, a thermocouple is installed by means of spot welding.

D.1.6 Care should be taken so that the thermocouple wires have no gap between them because a gap at the junction will lead to the voltage due to the current of the hot wire to be added (or subtracted) to the electro

D.1.7 The thermocouple wires are fitted directly to thermocouple thermometer, which reads in °C. The specimens are placed inside a furnace so that the temperature at which the thermal conductivities are measured may be varied.

Table D.1 Calculations-Report of results-Thermal conductivity test-Data form

Oven temperature	Thermal conductivity $WK^{-1}m^{-1}$					Mean Value
	1	2	3	4	5	
200						
400						
600						
800						

1000						
------	--	--	--	--	--	--

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Annex E

(informative)

Operating user guide

Every biomass stove supplied shall contain operating user guide as illustrated in table E1 below for its safe and efficient use.

Table E 1– Operating user guide for solid biomass cook stoves

Dos	Don'ts
Load the stove with solid biomass that has already been broken down to convenient size	Do not break large pieces of solid biomass inside the stove
Make sure the air gate is open while lighting	Do not light the stove with paraffin or any petroleum oils, as this will damage the liner
Light using waste paper or twigs on one side of the solid biomass	Do not pour water in the stove to extinguish fire
Close the air gate for simmering of foods once they come to boil, this will help to save the fuel you are using	Don't shake the stove to add solid biomass when necessary
Remove ash by hand through the air gate	Don't remove ash by shaking the stove
Pass a piece of stick through the hot solid biomass to push ash into the ash box and add solid biomass	Don't pass a piece of plastic stick through the hot solid biomass to push ash into the ash box or add solid biomass
Use a piece of stick to push the remaining solid biomass out of the stove then pour water	Don't invert the stove to remove the remaining solid biomass
NOTE Cleaning the stove surface after use will make the stove to be more appealing for further use, but make sure that the stove should be getting cool if you are using you use wet fabrics to clean and don't leave the stove in the rain.	

Annex F

(informative)

Household solid biomass ceramic metal cladded cookstoves dimensions

Table F.1 —Household solid biomass ceramic metal cladded cookstoves dimensions in millimeters

Stove parts	Size			
	Designation	Small	Medium	Large
Bottom and top diameter of cladding	A	250-260	280-290	300
Overall height	h	200	220 ±10	230
Top inside diameter of liner	C	205	230	240
Base inside diameter of liner	D	150	165	175
Fire box depth	E	70	75	90
Ash box depth	F	60	90	90
Grate diameter	D	150	165	175
Grate thickness	t _g	20	20	20
Grate hole diameter	J	20	20	20
Inlet air door	K	80 x 120	100 x 130	100 x 130
Thickness of ceramic liner	L	20	20	20
Thickness for insulation	M	15	15	15

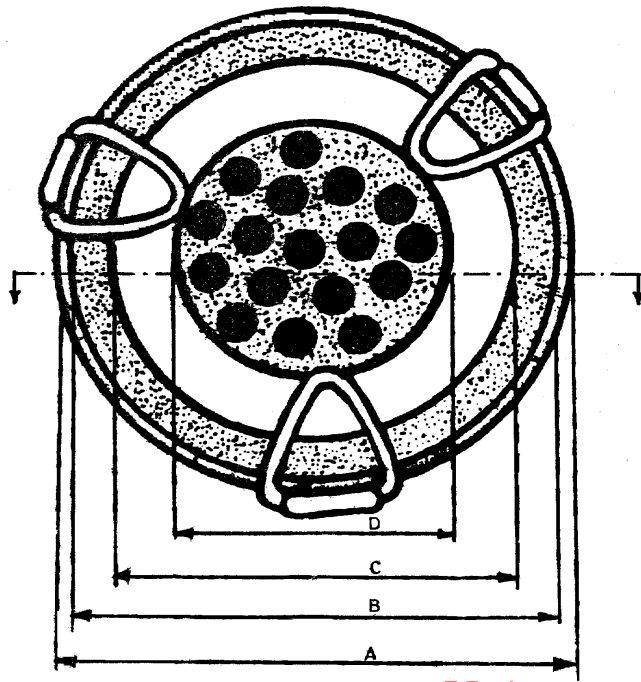


Figure E.1 - Top view of stove

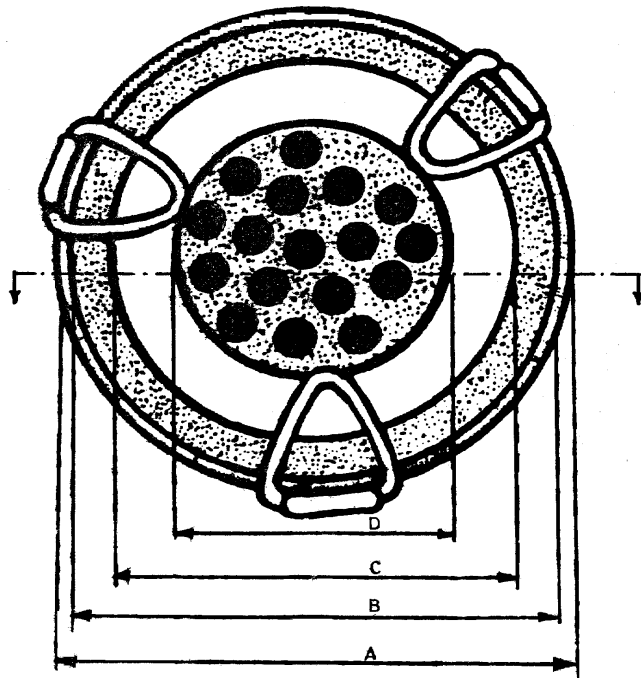


Figure E.1 - Top view of stove

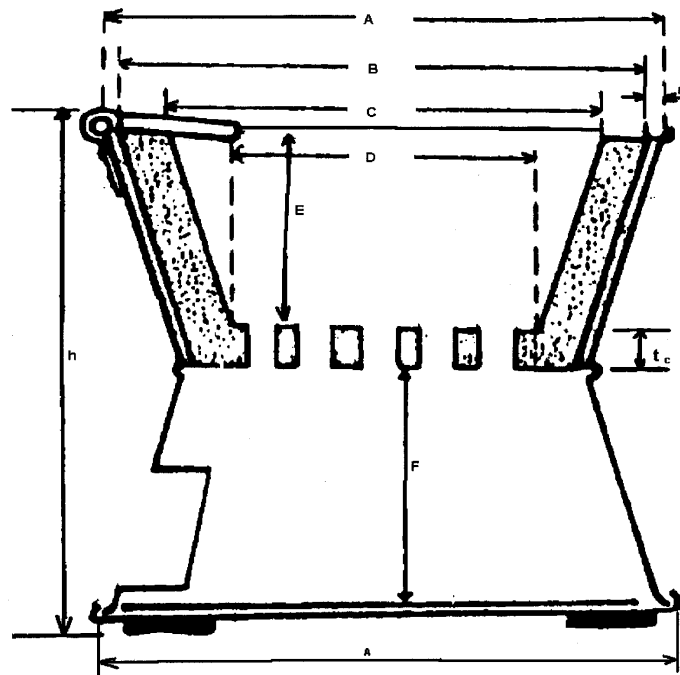


Figure E 2 Cross sectional view of the solid biomass stove (view x-x)

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