DRAFT TANZANIA STANDARD

Non-pressurized ethanol-fueled cooking appliances using liquid fuel — Specification

ISO International classification for Standards (ICS) 97.040.20

COOKING RANGES, WORKING TABLES, OVENS AND SIMILAR APPLIANCES

Foreword

This draft Tanzania Standard has been prepared under Clean Cooking Stoves and Clean Cooking Solutions (MEDC 12) Technical Committee, under supervision of Mechanical Engineering Standards Divisional committee.

Access to clean cooking fuels and stoves has been identified as an important area of international development. Millions of households in low- and middle-income countries rely on burning solid fuels to meet their basic energy needs. The resultant vicious cycle of poverty and ill-health can be broken by promoting clean cooking fuels and stoves expressly designed to burn these clean fuels as an alternative to polluting, inefficient stoves burning solid fuels.

Generally, there are three commonly employed ethanol stove technologies: pressurized liquid fuel stoves, non-pressurized liquid fuel stoves and non-pressurized gelfuel stoves, where ethanol has been gelled using calcium acetate and water (see SANS 448:2010, Ethanol gel for cooking.) This standard sets forth the requirements for non-pressurized liquid fuel ethanol stoves.

Ethanol liquid fuel has been identified as a practical and economical fuel option, promising significant environmental, health, economic and safety benefits when used in an appropriately designed appliance, and other countries in the region are showing interest in liquid-ethanol-fuel-based cooking, with several new appliances appearing in the market and commercial programs under way.

This standard is meant to facilitate the safe and proper uptake of liquid ethanol fuel and appliances for cooking in Tanzania.

During the development of this standard, reference was made to the following documents:

KS 2759:2018. Ethanol fuelled cooking appliances — Specification. Published by Kenya Bureau of Standards.

ISO 14895 Second edition 2016-06-01. Small craft — Liquid-fuelled galley stoves and heating appliances

SANS 666:2013. Edition 1.1. Ethanol-gel fuelled appliances.

SANS 1906:2012. Edition 3.1. Non-pressure paraffin stoves and heaters.

SANS 1243:2010. Edition 4. Pressurized paraffin-fuelled appliances.

ISO 19867-1:2018. Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 1: Standard test sequence for emissions and performance, safety and durability

ISO/TR 19867-3:2018. Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 3: Voluntary performance targets for cookstoves based on laboratory testing.

1 Scope

This Draft Tanzania Standard covers the requirements for ethanol fuelled appliances for cooking in households using a liquid fuel. It does not cover the requirements for heaters or lamps or for gelled-fuel appliances.

NOTE: The requirements for Denatured Ethanol for Use as Cooking and Appliance Fuel are provisionally covered in ASTM E3050–16: Standard Specification for Denatured Ethanol for Use as Cooking and Appliance Fuel. This standard is based on ASTM 4806 and is being updated to achieve a cleaner standard. Another ethanol fuel standard that may be referenced is ANP #19 2015 for Hydrous Ethanol Fuel (EHC).

Any rectified ethanol may serve as fuel provided it is (1) denatured with ≥10 ppm Bitrex (Denatonium benzoate), (2) colored with an non-fading, non-sunlight-reactive industrial dye, and (3) relatively free of carbon-heavy impurities, with particular reference to higher carbon C_4 – C_8 alcohols, which arise as distillation impurities. The desired threshold for these higher alcohol impurities is ≤600 ppm. The fuel may be further denatured with ≤20% methanol.

Indian Standard IS 323 (2009): Rectified spirit for industrial use, may be used as reference for this standard. Ethanol traded as Korean B Grade may satisfy this standard. Tanzanian standard FTZS 2530:2019, Ethanol for Industrial Use, was approved and published in the TBS Announcer Vol. XLVI, Jan – June 2019.

Methylated spirit 95%, Industrial Denatured Spirit (FTZS 2531:2019) may be used for stove fuel provided it conforms to the requirements listed above for use of rectified ethanol.

Water content in the ethanol fuel should be limited to ≤8%.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ASTM E3050-16, *Denatured ethanol for use as cooking and appliance fuel.*

ASTM D4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines

ANP RESOLUTION No. 19, 2015 Hydrous Ethanol Fuel (EHC)

IS 323 (2009): Rectified spirit for industrial use

FTZS 2531:2019: Industrial Denatured Spirit

FTZS 2530:2019: Ethanol for Industrial Use

Others as needed.

3 Terms and definitions

For the purpose of this standard, the following terms and definitions shall apply:

3.1
acceptable
Acceptable to the authority administering this standard, or to the parties concluding the purchase contract, as relevant.

3.2
appliance
Denatured alcohol (ethanol-liquid) fuelled device used for cooking and heating of food.

3.3
denatured alcohol
Ethanol liquid mixture meeting the minimum requirements of ASTM E3050-16 as updated, or meeting a rectified ethanol (FTZS 2530:2019, FTZS 2531:2019) standard where the ethanol has been denatured by any of several means and colored with a dye. Typical denaturing uses Denatonium benzoate at ≥10ppm and methyl alcohol (methanol) and a non-solar-reactive, non-fading industrial dye.

3.4
rolling boiling
Condition when boiling at which vigorous convection is attained.

3.5
rectified ethanol
Rectified spirit, rectified alcohol, a highly concentrated ethanol which has been purified by means of a process called rectification, an additional distillation step. Rectified ethanol is typically 95% alcohol by volume and is produced for industrial end uses.

3.6
Other terms as needed

3.7
Other terms as needed

Refer to ISO/TR 21276:2018 Vocabulary and add terms and definitions as needed.

4 Requirements

4.1 Materials

4.1.1 General

Material used in the construction of an appliance and its components shall be of such quality and thickness as to withstand (without cracking, warping, buckling, or other permanent damage) the operating conditions to which it will be subjected in normal service (see also 4.3.7 and 4.3.11).

4.1.2 Corrosion resistance

All metallic material shall be intrinsically corrosion-resistant, or shall be protected with an acceptable coating of such quality that, when the coated surface is tested in accordance with 6.11, there shall be no sign of pitting or penetration of the metal.

4.2 Construction

If not fully assembled, the appliance shall be assembled according to the manufacturer's instructions as supplied. Removable components shall fit in a positive, unique and rigid manner. No parts shall become detached if the appliance is knocked over. Permanently fitted components shall be rigid and fixed in a manner suitable for the duty they have to perform. If the design of the appliance is such that special tools are required for removable parts, such tools shall be supplied with the appliance.

4.3 Performance

4.3.1 Filling

The appliance shall be designed in such a way that it can be readily filled with minimum risk of spillage. Where necessary, the appliance shall be supplied with a tool/component that will facilitate the filling process (i.e. funnel for liquid ethanol fuel). It shall not be possible to refill the appliance while it is alight.

4.3.2 Ignition

When the appliance is fully assembled and filled with fuel, it shall be ready to light as per instructions supplied in accordance with 5.3.

4.3.3 Combustion performance

When tested in accordance with 6.3, the appliance shall heat 3 litres of water from 25 °C to 90 °C in less than 20 min and shall boil water within 30 min. (See also: Water Boiling Test, version 4.2.3. ISO 19867-1:2018. (Available at https://www.iso.org/standard/66519.html. Also available at: https://www.cleancookingalliance.org/binary-data/DOCUMENT/file/000/000/399-1.pdf.)

4.3.4 Power output

When tested in accordance with 6.4, the appliance shall produce a heat output of at least 1.4 kW at >45 % thermal efficiency.

4.3.5 Flame regulator

The appliance shall be fitted with a flame regulator, which shall be readily accessible and easily adjusted when the appliance is alight to obtain low, medium and high flame settings. The flame regulator must extinguish the stove when closed or turned to the off position.

4.3.6 Emissions

When tested in accordance with 6.5, the $CO:CO_2$ ratio shall not exceed a volumetric ratio of .03 to 1, or 3%.

4.3.7 Rigidity (ability to withstand heavy load)

When the appliance is tested in accordance with 6.6, no component shall become distorted or broken and each component shall maintain its position with its mating component in an operative manner.

4.3.8 Stability of the appliance

When tested in accordance with 6.7, the appliance shall not topple over.

4.3.9 Shutting off the appliance

When tested in accordance with 6.8, there shall be no flame visible when the flame regulator is returned to its “ON” position. The ON and OFF positions should be clearly marked

4.3.10 Surface temperature

When tested in accordance with 6.9, the surface temperature of any part of the appliance that may need to be touched during its operation shall not exceed 60 °C.

4.3.11 Durability

When tested in accordance with 6.10, the appliance and all its components shall be free of damage and distortion and all parts shall maintain their mating component in an operative manner.

4.4 Finish

All exposed surfaces of the appliance shall be easily cleanable; edges and corners shall be smooth. Corners, edges and control levers on appliances shall not entangle clothes and overturn the stove.

4.5 Additional requirements for appliance for safe operation

4.5.1 The burner of appliance shall be surrounded with a flame guard that will discourage;

a) accidental contact with the burner, and

b) any loose, heated components or accessories from becoming dislodged from the appliance.

4.5.2 If the appliance is intended to be portable, it shall be furnished with one or more carrying handles that are applied in a position that the user cannot burn his/her hand.

5 Packing, marking, instructions and warnings

5.1 Packing

Each appliance shall be packed to prevent damage to the appliance and its components and fittings during normal transportation and handling and there shall be no fuel in the fuel container.

5.2 Marking

Each appliance shall carry the following information legibly and indelibly marked in an easily identifiable position directly on the body or on an acceptable name plate or a heat-resistant sticker effectively attached to the body:

a) The name or trademark of the manufacturer and the country of origin;

b) The manufacturer's model name/number;

c) The manufacturer's batch number;

d) The words "USE DENATURED LIQUID ETHANOL FUEL ONLY"; and

e) On and off marking.

5.3 Instructions and warnings

The manufacturer of the appliance shall provide written instructions and warnings accompanying the appliance concerning its assembly, safe use, maintenance and operation. This shall be written at least in English and have sufficient pictograms to ensure comprehension. The manufacturer's instruction shall include the following:

a) Before lighting the appliance, ensure that all the components are undamaged and properly assembled in accordance with the illustrated design.

b) Do not place the appliance near flammable items.

c) Place the appliance on a reasonably level and stable surface. The level can be checked by placing a pan of water on the surface.

d) Use only the recommended denatured ethanol fuel. Do not use paraffin, petrol, or water in the appliance.

e) Store ethanol fuel out of reach of children.

f) Use the appliance in a well-ventilated area.

g) Do not refill the appliance when lit.

h) Do not carry or move a cooking appliance when lit.

i) Do not use the appliance near combustible materials.

j) Do not use a cooking appliance as a heating appliance.

k) Do not leave children alone when the appliance is lit.

l) Appearance of a persistent yellow flame indicates a malfunction.

NOTE 1 The manufacturer should include any other special instructions or warnings to ensure the safe and efficient operation of the appliance.

NOTE 2 The manufacturer should include instructions for the maintenance and servicing of the appliance to ensure optimum operation.

6 Inspection and methods of test

6.1 Test room conditions and preparation of the appliance

6.1.1 Test room conditions

The appliance shall be tested in a well ventilated test room that shall be free of draughts likely to affect the performance of the appliance. The room temperature shall be 20 °C ± 5 °C.

6.1.2 Preparation of the appliance

6.1.2.1 Both the appliance and the fuel shall be at room temperature at the start of the tests.

6.1.2.2 The appliance shall be placed on a reasonably level surface, and a pot shall be put on the cooking surface.

6.2 Inspection

6.2.1 Visually inspect each appliance for compliance with all the relevant requirements of clauses 4 and 5, compliance with which is not assessed by the tests given in 6.3 to 6.11 (inclusive).

6.2.2 Check and examine each appliance to ensure that all components are undamaged and are properly assembled and positioned according to the manufacturer's instructions.

6.3 Combustion performance test

For further guidance, see: The Water Boiling Test Version 4.2.3, now a part of ISO 19867-1:2018. (Available at: https://www.iso.org/standard/66519.html) and https://www.cleancookingalliance.org/binary-data/DOCUMENT/file/000/000/399-1.pdf.) A standard water boiling test may be conducted in place of the Combustion Performance Test.

6.3.1 Apparatus

6.3.1.1 Stove that is designed to operate on ethanol fuel

6.3.1.2 Aluminium pot, 225 mm ± 5 mm in diameter and 125 mm ± 5 mm in depth without lid.

6.3.1.3 Stopwatch.

6.3.1.4 Thermocouple that is able to measure temperature up to 100 °C.

6.3.2 Procedure

6.3.2.1 Ensure that the ambient air temperature of the laboratory is maintained at 20 °C ± 5 °C.

6.3.2.2 Introduce 3 L of water into the pot.

6.3.2.3 Fill the stove to its maximum extent with ethanol fuel.

6.3.2.4 Ignite the burner and adjust the flame to the highest level.

6.3.2.5 After ignition, place the pot on the cooking surface and immediately start the stopwatch.

6.3.2.6 Record the temperature rise of water every 5 min until it reaches 90 °C.

6.3.2.7 As soon as the water attains 90 °C, stop the stopwatch.

6.3.2.8 Continue heating water until roll boiling is achieved.

6.3.2.9 Record the total time taken to heat water from 25 °C to 90 °C.

6.3.2.10 Repeat the test 3 times and record results. Check for compliance with 4.3.3.

6.4 Determination of power output

6.4.1 Fill the appliance to the maximum level with fuel. Determine the mass of the fuel and appliance to ± 1 g. If the appliance is designed as a cooker, place a pot containing 2.5 L of water on the appliance.

6.4.2 Ignite the appliance and note the time.

6.4.3 Adjust the flame to the highest level.

6.4.4 Allow the appliance to burn for 30 min without refuelling while adjusting the flame, if needed, to its highest level.

6.4.5 After 30 min, extinguish the appliance and remove the pot.

6.4.6 Once more, determine the mass of the appliance to ± 1 g.

6.4.7 Calculate the power output in kW as follows:

where

P = [(Mcf –Mci) ×Hc] / (T*1000)

$$P = \frac{[(M_{cf} - M_{ci}) \times H_c]}{T \times 100}$$

P power (kW)

M_{ci} is the initial mass of fuel in the cookstove (grams)

M_{cf} is the final mass of fuel in the cookstove (grams)

H_c is the energy content of fuel (J/g)

T is the time of combustion phase (seconds)

NOTE 1 The net calorific value (NCV) of the fuel has to be determined.

NOTE 2 The net calorific value (NCV) of standard hydrous ethanol at 95.63% by mass (ethanol-water azeotrope), may be estimated at 24200 Kj/kg. Net Calorific Value (NCV) is also referred to as Lower Heating Value (LHV).

6.4.8 Check for compliance with 4.3.4.

6.5 Emissions test

See also: ISO 19867-1:2018. Clean cookstoves and clean cooking solutions — Harmonized laboratory test protocols — Part 1.

6.5.1 Apparatus

6.5.1.1 Aluminium pot, 225 mm ± 5 mm in diameter and 125 mm ± 5 mm in depth.

6.5.1.2 Collecting hood, as illustrated in figure 1 in the case of a stove.

6.5.1.3 Gas measuring instrument that can determine the quantity of carbon monoxide and carbon dioxide developed inside the collecting hood while the appliance is in operation.

6.5.2 Procedure

6.5.2.1 Fill and light the appliance and adjust the flame to the highest level.

6.5.2.2 For the stove, place the pot filled with water on the cooking surface and place the collecting hood over the stove such that the hood fits securely on the pot and the steam that develops is conveyed by means of the vents. Let the appliance run for 10 min before taking the samples.

6.5.2.3 Using a suitable measuring instrument, collect sufficient samples of gas and determine the CO:CO_2 ratio and check for compliance with 4.3.6.

6.6 Rigidity test

6.6.1 Apparatus

20 kg mass piece, of diameter 250 mm ± 3 mm.

6.6.2 Procedure

6.6.2.1 At the conclusion of the determination of the power output test (see 6.4) refill and light the appliances.

6.6.2.2 Place the mass piece on top of each cooking surface for a period of 8 h, refilling and relighting the appliance as necessary.

6.6.2.3 Carefully remove the mass piece and inspect the appliance and components for compliance with 4.3.7.

6.7 Stability test

6.7.1 Apparatus

Aluminium pot, 225 mm ± 5 mm in diameter and 125 mm ± 5 mm in depth filled with 3 L of water.

6.7.2 Procedure

6.7.2.1 When the appliance is full

Fill the appliance to its maximum extent with fuel. Tilt the appliance through an angle of 15°, maintain that position for 3 min, and check for compliance with 4.3.8. Repeat the test in three other directions, each 90° from the preceding one.

6.7.2.2 When the appliance is empty

Empty the appliance of all fuel. Place the pot on the appliance. Tilt the appliance through an angle of 10° and check for compliance with 4.3.8. Repeat the test in three other directions, each 90° from the preceding one.

6.8 Shutting off the appliance test

6.8.1 Apparatus

6.8.1.1 Aluminium pot, 225 mm ± 5 mm in diameter and 125 mm ± 5 mm in depth.

6.8.1.2 Stopwatch

6.8.2 Procedure

6.8.2.1 Fill the fuel tank to its maximum extent.

6.8.2.2 Light the burner(s) and adjust the flame to the highest level. Place the pot filled with 3 L of water on the cooking surface of the appliance. Let the appliance burn for 1 h.

6.8.2.3 Turn the flame regulator to the “OFF” position and simultaneously start a stopwatch.

6.8.2.4 Five **(**5) seconds later, turn the flame regulator to the “ON” position and check that the flame has been extinguished.

6.8.2.5 Check for compliance with 4.3.9.

6.9 Surface temperature

6.9.1 Apparatus

6.9.1.1 Aluminium pot, 225 mm ± 5 mm in diameter and 125 mm ± 5 mm in depth.

6.9.1.2 Thermocouple.

6.9.2 Procedure

6.9.2.1 Fill the appliance to its maximum extent.

6.9.2.2 Place a pot filled with 3 L of water on each cooking surface. Light the burner(s) and run the appliance for 1 h.

6.9.2.3 Using a thermocouple, measure the surface temperature of the flame regulator and any other parts that may need to be touched during normal operation.

6.9.2.4 Check for compliance with 4.3.10.

6.10 Durability test

Ignite the appliance and adjust the flame to its highest level. Allow the appliance to burn at this rate for 6 h, refilling and relighting the appliance as necessary. After this period, allow the appliance to cool to room temperature. Repeat this procedure 10 times. Leave the appliance to cool for 1 h, thereafter, inspect the appliance and its components for any damages.

Check for compliance with 4.3.11.

6.11 Corrosion resistance test for ethanol fueled stoves

6.11.1 Procedure

6.11.1.1 Inspect the stove and its fuel container for any surface imperfections or signs of scratches or wear. Record any observations.

6.11.1.2 Examine the fuel container for any signs of damage or corrosion. Check for compliance with 4.1.2.

6.11.1.3 Fill the stove fuel container with liquid ethanol fuel that complies with the published standard for fuel or which is recommended for the stove. See the manufacturer's instructions.

6.11.1.4 Place the appliance in a fume cupboard or fume hood operated at an air velocity sufficient to remove the products of combustion for 10 min.

6.11.1.5 Ignite the fuel and allow it to burn completely, then leave the appliance in the fume cupboard until the next test.

6.11.1.6 Repeat 6.11.1.1 to 6.11.1.5 (inclusive), above, every day for a total of 20 working days.

6.11.1.7 Inspect the appliance closely, note observations, and check for compliance with 4.1.2.

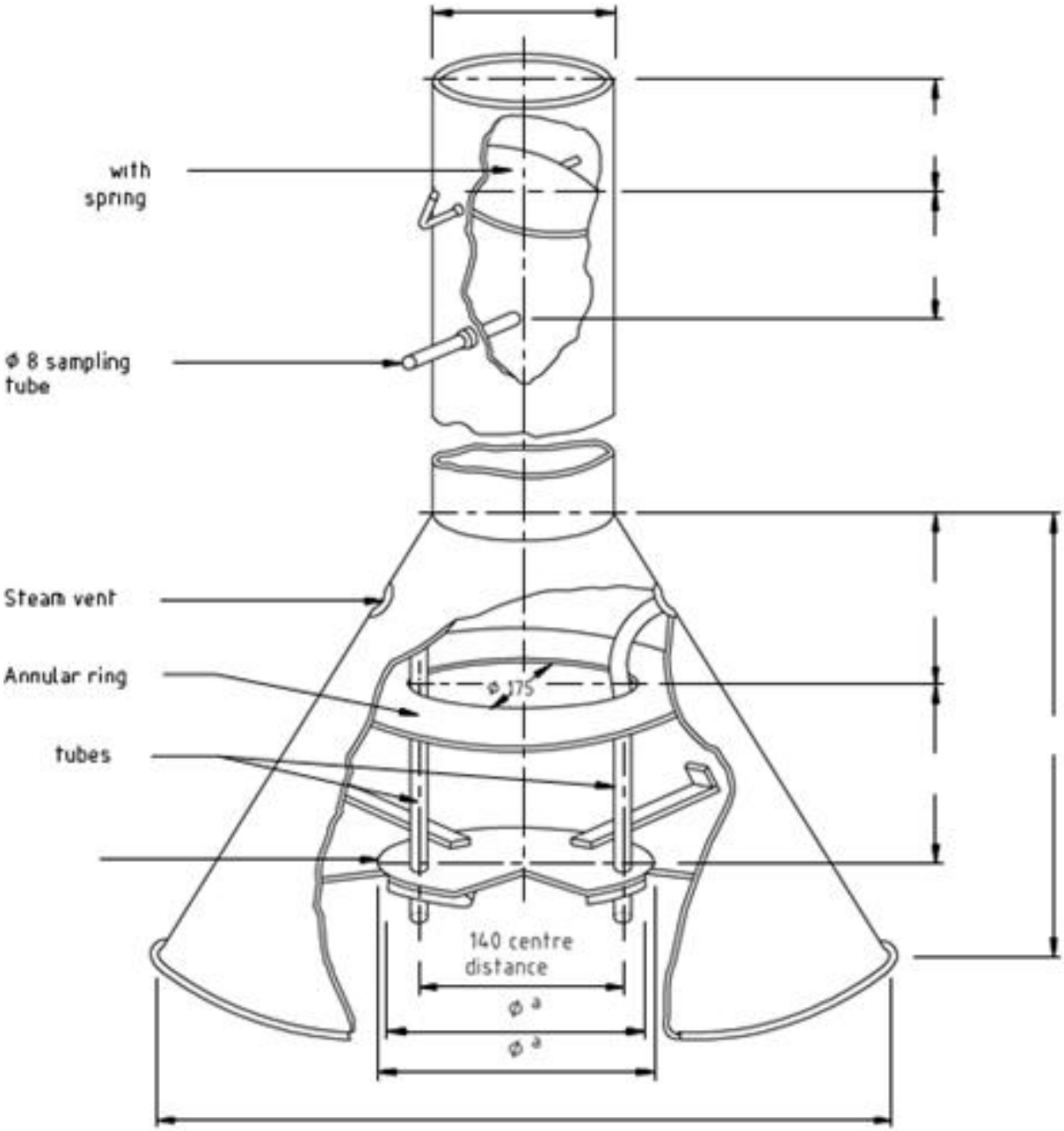

Figure 1 — Collecting hood for cooking stove