

Third edition

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**Rotational moulded polyethylene water
storage tanks — Specification**

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Reference number

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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.

DRS 128 was prepared by Technical Committee RSB/TC 48, *Plastic tanks, pipes, accessories and related products*.

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

- 1) IS 12701:1996, *Rotational moulded polyethylene water storage tanks*
- 2) ASTM D1998-21, *Standard Specification for Polyethylene Upright Storage Tanks*
- 3) SLS 1174:1998, *Polyethylene water storage tanks — Specification*
- 4) KS 1567:2005, *Rotational moulded polyethylene water storage tanks — Specification*

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

This third edition cancels and replaces the second edition (RS 128:2019), clause 4.1.2, which has been technically revised.

Committee membership

The following organizations were represented on the Technical Committee on *Plastic tanks, pipes, accessories and related products* (RSB/TC 48) in the preparation of this standard.

AQUASAN

Ecoplastics

Global community

PROWATER

ROTASSAIRWA

ROTO Ltd

Rwanda plastic industries

SOIMEX Plastic

TRIBUS SERVICES LTD

Rwanda Standards Board(RSB) – Secretariat

Public review Draft

Rotational moulded polyethylene water storage tanks — Specification

1 Scope

This Draft Rwanda Standard specifies requirements, sampling and test methods for rotational moulded polyethylene water storage tanks (closed and open top tank).

This standard does not cover mobile water tanks, horizontal cylindrical water tanks and underground tanks.

This standard is applicable to both open-topped and closed-topped water storage tanks subjected to the following two conditions:

- a) own hydrostatic head of water; and
- b) uniform flat base support.

The nominal service temperature is 1 °C to 50 °C.

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.

ISO 1209-2, *Rigid cellular plastics — Determination of flexural properties* — Part 2: Determination on flexural strength and apparent flexural modulus of elasticity

3 Terms and definitions

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

3.1

net capacity (actual)

net total volume of water contained between the lowest level of the overflow and lowest level of outlet (see Figures 1 and 2)

3.2

gross capacity (nominal)

total enclosed volume of the tank including any space, which may not be capable of being filled with water

3.3

mould parting

circumferential line visible only on the external surface of the tank corresponding to a parting joint of the mould required for rotational moulding (see Figures 1 and 2)

3.4

overall height

height of the finished empty tank at its highest point, including the top rim of the manhole and lid of the tank (see Figures 1 and 2)

3.5

effective height

height of the finished empty tank from its base to the point where overflow connection is provided for the purpose of limiting water storage capacity (see Figures 1 and 2)

3.6

overall diameter

maximum outer diameter of finished empty tank measured at its base (see Figures 1 and 2)

3.7

man-hole/hand-hole

hole of suitable internal diameter provided at the top of the tank for the purpose of inspection of internal surface and entry into the tank (see Figure 1)

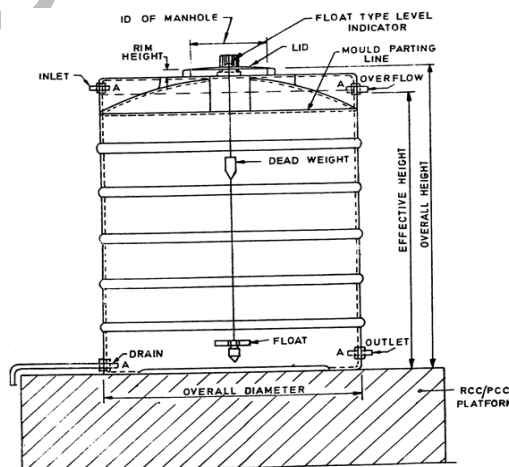


Figure 1— typical perspective view of closed top tank

RCC — Reinforced cement concrete

PCC — Pre-cast cement concrete

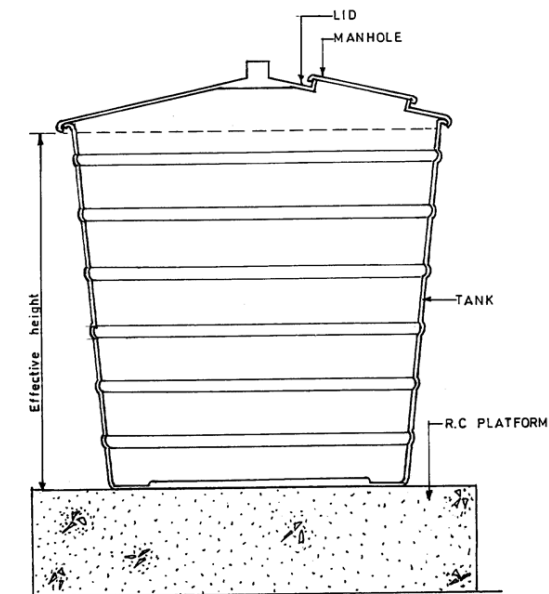


Figure 2— typical view of open top tank

3.8

internal diameter of man-hole/hand-hole

internal diameter of the rim of the manhole measured as the mean of two perpendicular diameters (see Figures 1 and 2)

3.9

rotational molding

three-stage commercial process consisting of loading the mold with powdered resin, fusing the resin by heating while rotating the mold about more than one axis, and cooling and removing the molded article

3.10

service factor, n

number less than 1.0 (which takes into consideration all the variables and degrees of safety involved in a polyethylene storage tank installation) which is multiplied by the hydrostatic design basis to give the design hoop stress

3.11

tensile stress

tensile load per unit area of minimum original cross section within the narrow parallel portion, carried by the test specimen at any moment. It is expressed in N/mm^2 (force per square millimetre)

3.12

elongation

increase in distance between references lines on the narrow parallel portion of the test specimen, due to a tensile load, and expressed as a percentage of the initial distance between the reference lines

3.13

yield point

first point on the load/extension curve at which an increase in extension occurs without an increase in load.

NOTE In cases where the yield point is not well defined by the load extension curve, it is frequently necessary to define an offset yield point. This is done by specifying a point on the load extension curve where the curve departs from linearity by a specified percentage elongation or extension (see Figure 10).

3.14

elastic modulus

ratio of stress to corresponding strain within the range of the greatest stress that the material is capable of sustaining without any deviation of proportionality of stress to strain.

4 Requirements

4.1 Materials

4.1.1 The material for construction of the tank and lid, which comes into contact with water, shall not impart any taste, colour or odour to water; they shall neither have any toxic effect nor contaminate water thereby making it unpotable.

4.1.2 Water tanks meant for outdoor use shall be manufactured from virgin polyethylene materials intended for the rotational molding process (resin). The addition of 5% to 10 % of the manufacturers own reworked material resulting from the manufacture of tanks only according to this standard is permissible. No other reworked or recycled waste material from any other source or filler shall be used in the manufacture of tanks

4.1.3 All polyethylene resin material shall contain a minimum of a U.V.-8 stabilizer as compounded by the resin manufacturer.

4.1.4 Each resin used in designing tanks covered by this specification shall have hydrostatic-hoop-stress data available.

4.2 Carbon black content

4.2.1 Carbon black pigment if added, to the moulding material for the outer layer or the exposed layer, shall be not less than 2.5 % \pm 0.5 % when tested in accordance with Annex A (melt compounding).

4.2.2 The carbon black or any other pigment added shall be uniformly dispersed in the material, when tested in accordance with Annex B.

4.3 Catalyst

The total amount of inorganic present in polyethylene shall not exceed 0.2 % (m/m) when tested by atomic absorption method and in accordance with Annex C. An alternative method of testing for the metals shall be by x-ray fluorescence, where the atomic absorption method may not be applicable or just non-operational.

4.4 Fillers and pigments

The plastic shall not contain any filler. Pigments may be added as desired by the customer, or as designated by polymer processing companies, but shall not exceed 0.5% dry blended, and 2% compounded in, of the total weight.

NOTE The excessive use of dry-blended pigments may result in an effect on physical properties, that is, impact strength.

4.5 Types

There shall be two types of tanks vis-à-vis:

- a) cylindrical vertical tanks (closed and open-end); and
- b) rectangular loft tanks (see Figure 3 a), and b)

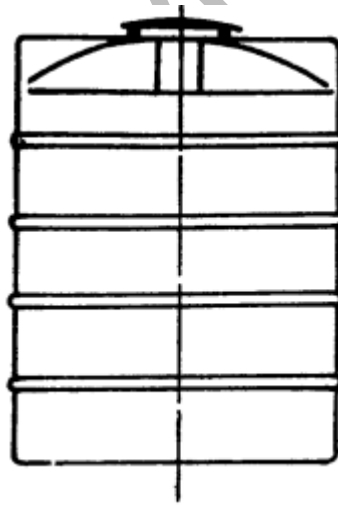


Figure 3a) — Cylindrical vertical with closed top

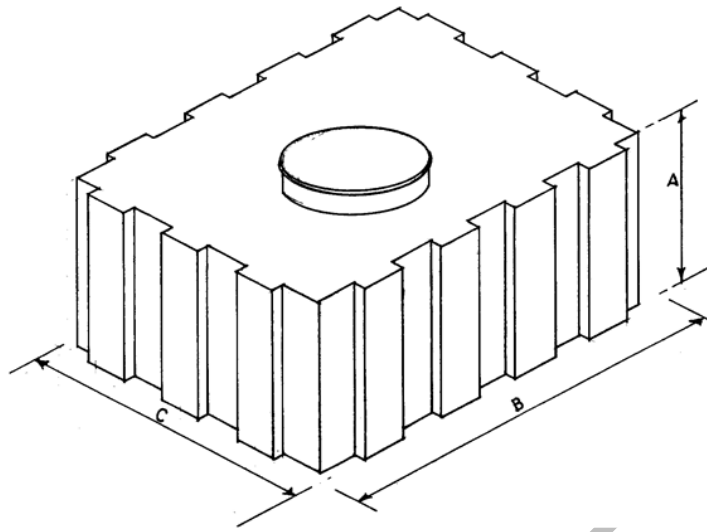


Figure 3 b) — Rectangular loft tank

4.6 Fittings

It shall be the prerogative of the manufacturer to provide as much information as is possible to the consumer regarding fittings.

NOTE Refer on Annex H for tank and fittings installations

4.7 Sizes

Tank sizes will vary in accordance with the customer's requirements.

4.8 Net capacity

When filled to the lowest level of overflow, and the volume attained measured, tanks shall discharge the capacity marked on it.

4.9 Design parameters

4.9.1 The design wall thickness shall be determined by appropriate engineering design methods, which may include finite element analysis, for the nominated service temperature.

4.9.2 The minimum required wall thickness (T) of a cylindrical straight walled shell (unsupported portion of a tank) at any fluid level shall be determined from the following equation:

$$T = P \times OD / (2 \delta)$$

$$P = 0.0098 \times SG \times H \text{ (MPa)}$$

$$\delta = HDB \times n$$

where

T wall thickness, mm;

P pressure, MPa;

SG specific gravity of fluid, g/cm³;

H fluid head, m;

OD outside diameter of tank, mm;

δ hydrostatic design stress, MPa;

n Service factor.

4.9.3 Hydrostatic pressure value is determined by the height (H) of the liquid container and the density (SG) of the liquid. The tank walls have to be made to resist this pressure at different levels of water storage. Basically, the taller the tank, the greater the pressure on lower tank walls

4.9.4 The hydrostatic design stress that is used to determine the minimum wall thickness at any fluid level must be based on hoop stress data for the resin. The hydrostatic design- basis must be reduced by a service factor to determine the actual hydrostatic design stress. The maximum service factor shall be 0.5 for wall thicknesses less than 9.5 mm. For thicknesses equal to or greater than 9.5 mm, the maximum service factor shall be 0.475.

4.9.5 The radius of the bottom knuckle of a flat-bottom tank shall not be less than 25.4 mm for tanks with a diameter less than 1.8 m and 38.1 mm for a diameter greater than 1.8 m. The minimum thickness of the radius shall not be less than the maximum thickness of the cylinder wall.

4.9.6 Tank hoop stresses shall be derated for service above 23°C.

4.9.7 The tolerance indicated in 4.10.3 applies to these dimensions.

4.10 Dimensions and tolerances

4.10.1 General

All dimensions will be taken with the tank in the vertical position, unfilled. Tank dimensions will represent the exterior measurements.

4.10.2 Outside diameter

The tolerance for the outside diameter, including out of roundness, shall be $\pm 3\%$.

4.10.3 Shell wall and head thickness

The tolerance for average thickness at each elevation shall be -10% of the design thickness on the low side and shall be unlimited on the high side. The tolerance for individual audit readings shall be limited to -20% of the design thickness. The total amount of surface area on the low side of the tolerance shall not exceed 10% of the total surface area.

4.10.4 Placement of fittings

4.10.4.1 The installations of fittings shall be done by the manufacturer

4.10.4.2 The tolerance for fitting placements shall be 12.7 mm in elevation and 2° radial at ambient temperature

5 Quality of finish

5.1 The internal and external surface of water storage tank shall be smooth, clean and free from other hidden internal defects, such as air bubbles, pits and metallic or other material inclusions.

5.2 The mould parting line near top rim of the tank shall be cut and finished to the required level. Defects like air bubbles and pits at the parting line and at the top of the manhole shall be repaired by hot air filler and rod welding method.

6 Testing

6.1 Resistance to deformation

6.1.1 When cylindrical vertical water storage tank is tested in accordance with method 1 described in Annex D, the difference between the circumferential measurements shall be not greater than 2% of the original measurements.

6.1.2 When rectangular loft tank is tested in accordance with method 2 described in Annex D, the difference between the longitudinal measurements shall be not greater than 3% of the original measurements.

6.2 Tensile strength

The tensile strength at yield shall be determined in accordance with Annex E, and shall be not less than 12 N/mm^2 .

6.3 Flexural strength

The flexural strength shall be determined in accordance with ISO 1209-2. The flexural modulus of the wall of the water tank shall be not less than 400 N/mm^2 . The manufacturer and/or importer of the raw polyethylene pellets shall be liable to supply those that can provide the above-described quality.

6.4 Hydrostatic pressure head

The tank shall be filled with water up to the nominal capacity. Thereafter it shall be fitted with a pump with a pressure gauge. The pump shall then be started and run till the nominal pressure level is attained and examined for leaks. There shall be no leakage observed. A hydrostatic water test will be conducted if ordered by the customer.

7 Sampling

7.1 Lot

7.1.1 All the water storage tanks of same raw material, same type, size and produced under relatively uniform conditions of manufacture shall constitute a lot.

7.1.2 Sample size shall be in accordance with Table 1.

7.1.3 These tanks shall be selected at random from the lot. In order to ensure randomness of selection, tables of random numbers shall be used.

7.1.4 Each selected tank, as per Table 1, shall be tested for the requirements in Table 2 below.

Table 1 — Scale of sampling and criteria for conformity for tanks

S/N	Lot size	Sample size	Acceptance number
i.	Up to 50	1	0 Failure
ii.	200	2	0 Failure
iii.	300	3	0 Failure
iv.	500	5	0 Failure
v.	501 and above	8	1 Failure

7.2 Routine test

The routine tests listed in Table 2 shall be carried out to ensure that satisfactory quality is maintained during a production run in accordance with test methods specified therein.

Table 2 — Routine test parameters

S/N	Requirements	Test method
i.	Resistance to deformation	Annex D
ii.	Hydrostatic pressure head	Clause 6.4
iii.	Carbon black content	Annex A
iv.	Carbon black dispersion	Annex B

8 Marking

8.1 All the plastic water storage tanks shall be marked with the following information:

- c) manufacturer's name and address;
- d) net capacity, in litres;
- e) lot number and batch number;
- f) country of origin;
- g) manufacturer date;
- h) material code; and
- i) recyclable

8.2 The marking shall be carried out either by painting, moulding or by sticking the identification marks on external surface of the water tank. The marking shall be permanent.

9 Transportation

9.1 Since there are variations in methods of transportation and handling, the manufacturer's instructions shall be followed in all cases.

9.2 A suitable means shall be provided, if required, at the open end of open-top tanks to keep the loaded tank rigid.

9.3 All fittings and flange faces shall be protected from damage by covering with suitable plywood, hardboard or plastic securely fastened. Tanks shall be positively vented at all times.

9.4 Pipe and tubing, fittings and miscellaneous small parts shall be packaged. Loose items which might scratch the interior surface shall not be placed inside the tank during transportation. Additional protection, such as battens, end wrapping, cross bracing, or other interior fastenings shall be used as required to assure such individual equipment pieces are not damaged in transit.

9.5 Upon arrival at the destination, the purchaser shall be responsible for inspection for damage in transit. If damage has occurred, a claim should be filed with the carrier by the purchaser. The supplier shall be notified if the damage is not first repaired by the fabricator prior to the tank being put into service. The purchaser accepts all future responsibility for the effects of the tank failure resulting from damage.

9.6 Fittings and accessories that interfere with tank transportation or could be broken during transportation are transported separately.

9.7 The supplier shall provide a brochure to the purchaser including information on installation instructions, cleaning procedures, disposal and proper caution and warning signs.

9.8 The brochure shall be in one of three official languages used in Rwanda.

10 Workmanship

10.1 The finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, crazing, cracking and delaminations that will impair the serviceability of the vessel.

10.2 All cut edges where openings are cut into the tanks shall be trimmed smooth.

Public review Draft

Annex A (normative)

Determination of carbon black content

A.1 Apparatus

- A.1.1** Combustion boat, made of porcelain or silica, having minimum dimensions of 15 mm length, 9 mm width and 8 mm height.
- A.1.2** Combustion tube, made of hard glass of approximately 30 mm diameter and 400 ± 50 mm length.
- A.1.3** Gas flow meter, for measuring and controlling the rate of flow of nitrogen within 1.7 ± 0.3 L/s.
- A.1.4** Thermometer, in the range of 250 °C to 550 °C.
- A.1.5** Furnace, to accommodate the combustion tube to give temperatures up to at least 500 °C.

A.2 Reagents

- A.2.1** Nitrogen, as technical grade.
- A.2.2** Trichloroethylene

A.3 Procedure

- A.3.1** Assemble the apparatus as shown in Figure 3. Both cold traps following the combustion tube shall contain trichloroethylene, but only the first need be cooled with solid carbon dioxide. Alternatively, the entire apparatus may be placed in a fume hood and the two traps following the combustion tube omitted. Fill the dry tube with anhydrous CaCl_2 or other suitable desiccant. Hold between loose plugs of glass wool.
- A.3.2** Heat a clean combustion boat to red heat in a Bunsen flame; then transfer the boat to the desiccant and allow it to cool over fresh desiccant. Hold between loose plugs of glass wool.
- A.3.3** Remove the boat from the desiccant and weigh it to the nearest 0.000 1 g. Immediately place 1.0 ± 0.1 g of the ethylene plastic under test in the boat and quickly weigh to the nearest 0.000 1 g.
- A.3.4** Heat the furnace to a constant temperature of 600 °C. Adjust the rate of nitrogen flow to $1.7 \text{ L/min} \pm 0.3 \text{ L/min}$. Open the inlet end of the 2.9-cm diameter tube, quickly place the combustion boat with the sample into the tube at the centre of the furnace, and adjust the thermocouple so that the weld is touching the boat. Insert copper plug, if this is used. Quickly close the furnace and allow heating to proceed for at least 15 min.
- A.3.5** Move the tube or furnace so that the boat is no longer in the heated zone of the furnace and allow 5 min for cooling, while maintaining the flow of nitrogen. Remove the copper plug, if present and the boat through the inlet end of the tube and allow it to cool for at least 30 min. Take care that the boat does not

become contaminated from any deposits on the walls of the tube. Then quickly reweigh the boat and its contents to the nearest 0.000 1 g.

A.3.6 Make all determinations in duplicate.

A.4 Calculation

Carbon black content, % by weight $W = \frac{W_s}{W_r} \times 100$

where

W_r the mass, in g, of the boat before heating in air;

W_s the mass, in g, of the boat after heating in air; and

W the mass, in g, of the material taken for the test.

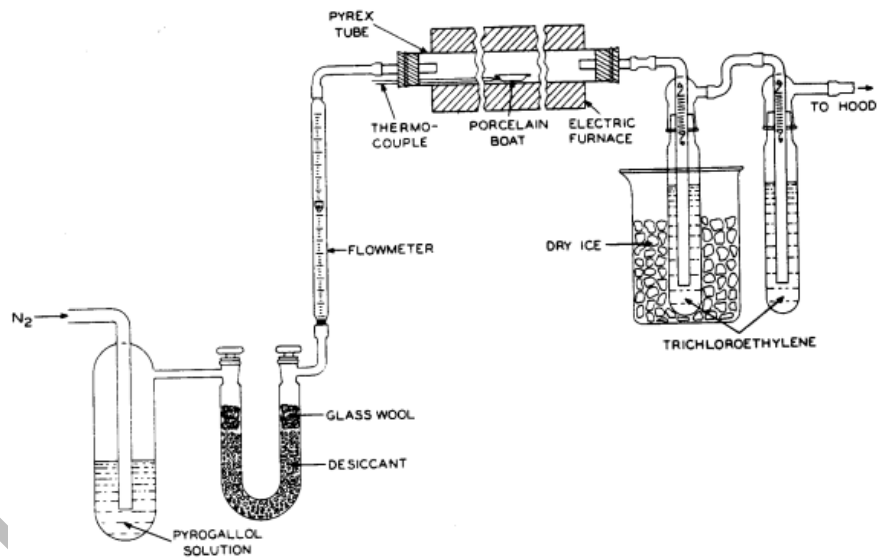


Figure 4 — Assembly of apparatus for carbon black determination

Annex B

(normative)

Determination of carbon black dispersion in polyethylene materials

B.1 Procedure

B.1.1 Place two clean microscope slides on a hot plate maintained at 170 °C to 210 °C. Place three specimens of pin-head size, each weighing about 5 mg, and each one cut from a separate granule, on one of the hot microscope slides, about 20 mm apart. Place a piece of metal shim 40-mm long, 20-mm wide and 0.03 mm thick at each end and cover the whole with the other hot microscope slide. Press the specimens by applying even pressure for 1 1/2 to 2 min, to the whole area of the face of the upper slide. After the specimens have been placed on the slides, these shall not remain on the hot plate for more than 3 min.

B.1.2 When the slides are cool enough to be handled examine the three specimens through a microscope at magnification of 200 ± 10 with a field of view of 10.1 mm diameter. Note shall also be made of any lack of uniformity of the background.

B.2 Reporting

The carbon black dispersion in the material under test shall be considered to be satisfactory, if the specimens show a uniform background free from white streaks.

Annex C (normative)

Determination of effect of heavy metals on water quality

C.1 Method of extraction

C.1.1 Three test specimens of approximately 500 mm² in surface area shall be taken from tank.

C.1.2 Each test specimen shall be pre-washed for a period of 6 h using tap water with pH of 7 to 8. The water shall be passed through the specimen at a velocity of 50 mm/s while the specimen is kept fully immersed with water. After washing, the specimen shall be filled with fresh solution of the distilled water acidified to pH of 4.5 ± 0.1 by bubbling a current of carbon dioxide through it, and both ends sealed with a material that does not contain any toxic substances nor interfere with the determinations of such constituents in the aqueous samples.

C.1.3 After maintaining the specimens at room temperature for 48 h, the solution shall be decanted into a suitable container for analysis as the first extraction.

C.1.4 The procedure shall be repeated a second and a third time. Retain these samples for the determination of the amount of metals and other toxic substances as second and third extractions.

C.1.5 The first extraction and the third extraction shall be analyzed for lead.

C.1.6 The third extraction shall also be analyzed for dialkyl tin (C4 and above) as tin.

C.1.7 When calcium and mercury are present; all three extracts shall be analyzed.

C.2 Method of analysis

Analysis for lead, tin, cadmium and mercury shall be carried out using atomic absorption.

Annex D (normative)

Determination of resistance to deformation test

D.1 Method 1 for cylindrical vertical tank

D.1.1 The water tank shall be placed on a flat level base. A circumferential measurement shall be made parallel to the base at a distance of one third the effective height from the bottom. The tank shall be filled up to the effective height at a minimum rate of 23 L/min with water at temperature of not less than 15 °C.

D.1.2 A continuous film of polyethylene shall be floated over the whole of the surface of water in tank to prevent evaporation.

D.1.3 The temperature of the tank and water shall be maintained at a temperature not less than 15 °C and after 7 days a circumferential measurement shall be made at level referred at level to in D.1.1. The difference between the two circumferential measurements shall be expressed as a percentage of the original circumferential measurement.

D.2 Method 2 for rectangular loft tank

D.2.1 The rectangular tank shall be placed on a level base. The internal length and width of the tank shall be measured on the centrelines, as shown in Figure 5 at the centre of effective height.

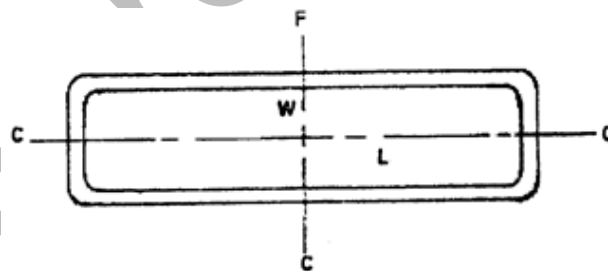


Figure 5— Centreline measurements

D.2.2 The tank shall be filled up to the effective height at a minimum rate of 23 L/min with water at a temperature not less than 15 °C. The lid shall close after filling the loft tank.

D.2.3 The temperature of the tank and water shall be maintained at not less than 15 °C and after 7 days measurements of length and width shall be made at previously determined centrelines.

D.2.4 The deformation in each direction shall be calculated as follows:

$$D_L = \frac{W_1 - W_2}{2L_1} \times 100$$

$$D_W = \frac{L_2 - L_1}{2W_1} \times 100$$

where

D_L the deformation of the longer side;

D_W the deformation of the shorter side;

W_1 the width at the start of the test;

W_2 the width at the end of test;

L_1 the length at the start of the test;

L_2 the length at the end of test.

Annex E (normative)

Determination of tensile properties

E.1 Apparatus

E.1.1 Testing machine, with grips that can be separated at one or more (as required) of the rates given in E.5.

E.1.1.1 Grips, for holding the test specimen, one being attached to a fixed or essentially stationary member of the machine and the other to a movable member. The grips are self-aligning; that is, they are attached to the fixed and movable member respectively in such a manner that they will move freely into alignment as soon as any load is applied, so that the long axis of the test specimen will coincide with the direction of the applied force through the centre line of the grip assembly. The test specimen is held in such a way that slip relative to the grips is prevented as far as possible.

E.1.1.2 Load indicator, suitable load-indicating mechanism capable of showing the total tensile force carried by the test specimen when held by the grips.

This mechanism is essentially free from inertia lag at the specified rate of testing and indicates the force with an accuracy of $\pm 1\%$ of the indicated value.

E.1.2 Extension indicator (when required), suitable instruments for determining, at any time the test, the distance between two fixed points of reference lines located within the middle parallel-sided part of the test specimen. It is desirable, but not essential, that this instrument shall automatically record this distance (or any change in it) as a function of the force on the test specimen or of the elapsed time from the start of the test, or both. If only distance as, function of elapsed time is recorded, force-time data are also taken. The instrument is essentially free of inertia lag at the specified speed of testing and is accurate to $\pm 1\%$ of strain or better.

The elongations between the reference lines at yield and at break of flexible plastics are measured to the nearest 7 mm by any convenient means. For the measurement of modulus of elasticity the instrument is capable of measuring the distance between the reference lines to an accuracy of $\pm 1\text{ mm}$.

E.1.3 Micrometers, dial-gauge micrometer, reading to at least 0.02 mm and provided with a flat circular foot that will apply a pressure of 9.81×10^{-3} to $29.43 \times 10^{-3} \text{ N/mm}^2$. To the test specimen, for measuring the thickness of test specimens of non-rigid materials.

E.2 Test specimens

E.2.1 The test specimen is cut from the obtained flat portion of the top of the bank with the knife-edged die. Reference lines, if used, are $25 \text{ mm} \pm 1 \text{ mm}$ apart and are equidistant from the ends of the middle parallel-sided part of the test specimen as shown in Figure 5.

E.2.2 It is necessary to apply reference lines to the test specimens. This is done with ink or other medium that will not affect the material being tested. Reference lines are not scratched, punched or impressed, upon the test specimen.

E.3 Number of test specimens

E.3.1 At least five test specimens are tested for each tank.

E.3.2 Test specimens that do not break with parallel portion are discarded and further test specimens are tested.

E.4 Speed of testing

E.4.1 The speed of testing is the rate of separation of grips of the testing machine during the test.

E.4.2 The speed of testing is preferably chosen from one of the following, but in any case is determined by the specification for the material being tested, or by agreement between those concerned (see also E.5.2.1):

E.4.2.1 With some types of testing machines the rates of separation of grips are virtually the same irrespective of whether the machine is running, idle or under load. With these machines, a ratio of separation of grips under load within the above tolerances can be obtained by setting the speed of the machine when it is idle.

E.4.3 If elastic modulus in tension is being determined, the preferred speed of testing is speed A or as is specified. Elastic modulus determinations are made with separate test specimens from those used to determine tensile strength and elongation whenever the speeds of testing are not the same.

E.5 Procedure

E.5.1 Measure the thickness of test specimens at several points to the nearest 1 % with the dial-gauge micrometer described in E.2.3. The width is taken to be the width measured to the nearest 0.05 mm of the middle parallel-sided part of the cutter shown in Figure 8.

E.5.2 Place the test specimen in the grips of the testing machine, taking care to align the long axis of the test specimen and the grips with an imaginary line joining the points of attachment of the grips to the machine. Tighten the grips evenly and firmly to a degree necessary to prevent the test specimen from slipping during the test but not the point where the specimen shall be crushed.

E.5.3 For the determination of properties other than modulus of elasticity and for all test specimens set the speed of testing at the specified value and start the machine.

E.5.3.1 For the test specimens, some or all of, the following shall be noted as required by the specification for the material:

- a) load at the yield point (see Note 1);
- b) distance between the reference lines at the yield point;
- c) load at break or the maximum load (see Note 2);
- d) distance between the reference lines at break.

E.5.3.2 The above information can be obtained from an autographically recorded stress--strain curve or may be directly observed.

NOTE 1 In cases where the yield point is not well defined, it is frequently necessary to define an offset yield point. This is done by specifying a point on the load/extension curve where the curve departs from linearity by a specified percentage elongation or extension (see Figure 10).

NOTE 2 When testing specimens whose cross-sectional area decreases considerably before break, the force may decrease to some extent after having reached a maximum value, so that the maximum force and the force at break are not the same. For such test specimens the force at break cannot be obtained by the use of testing machines that only register the maximum force. It is often difficult for the load to be read of the moment of break with sufficient accuracy; it is therefore recommended that the load at break be determined from a force/ extension diagram obtained from a tensile testing machine equipped with a recording mechanism.

E.6 Calculation and expression of results

E.6.1 The force at yield or the maximum force, or the force at break, as appropriate, is divided by the, original minimum cross-sectional area of the test specimen in square centimetres. The results are expressed in N/mm².

E.6.2 The extension at the yield point (see Figure 9) or the extension at the moment at break, as appropriate, is divided by the original distance between the reference lines and multiplied by 100. The elongation at yield or break is reported to two significant figures.

E.6.3 The elastic modulus is calculated from the initial linear portion of the force Vs extension curve, (see Figure 10) by dividing the difference in stress corresponding to a section of the straight-line by the corresponding difference in strain. For this purpose, the difference in stresses is the difference in force divided by the original cross-sectional area of the specimen in square centimetres and the difference in strain is the difference in extension divided by the original distance between the fixed points used for the measurement of extension under force.

E.6.4 For all five specimens, the arithmetic mean of all values is calculated to three significant figures (except for elongation for which the mean is calculated to two significant figures) and reported as the "average value" for the particular property in question.

E.6.5 If the standard deviation (estimated) is required, it is calculated as follows and is reported to two significant figures:

$$S = \sqrt{(\sum x^2 - n\bar{x}^2/n - 1)}$$

where

S the estimated standard deviation;

X the value of single observation;

n the number of observations;

\bar{x} the arithmetic mean of the set of observations.

E.7 Test report

The test report shall include the following as appropriate:

- a) manufacturer's principle dimensions, etc.;
- b) width and thickness of parallel portions;
- c) method of preparation of test specimen;
- d) conditioning procedures used;
- e) atmospheric conditions in test room;
- f) number of test specimen;
- g) speed of testing;
- h) tensile stress at maximum force or at break, or both average values;
- i) elongation at yield or at break, or both average values;
- j) elastic modulus, average value;
- k) standard deviations of the individual test results; and
- l) date of test.

Dimensions in millimetres

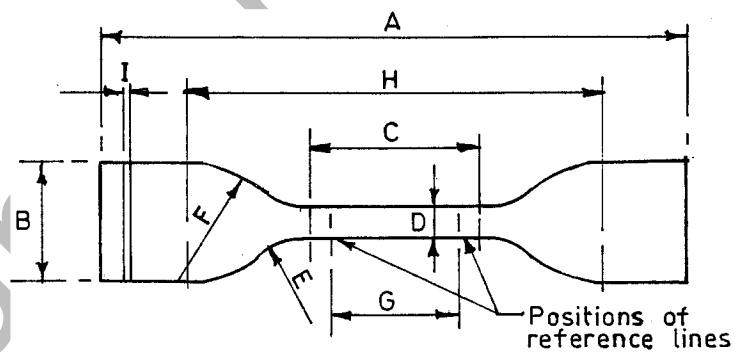


Figure 6: — Type 1 test specimen showing positions of reference lines (if used)

Tolerance on dimensions: $\pm 5\%$

Key

A Overall length, minimum 110

B	Width at ends	20 ± 0.5
C	Length of narrow parallel portion	60 ± 0.5
D	Width of narrow parallel portion	10 ± 0.5
E	Radius, minimum	60
F	Thickness	See text
G	Distance between reference lines	50 ± 0.5
H	Initial distance between grips	115 ± 5

Dimensions in millimetres

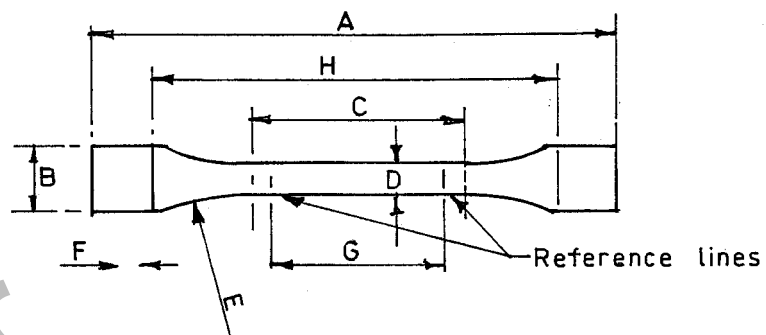


Figure 7: — Cutting edges of die-type 2 test specimen showing positions of reference lines (if used)

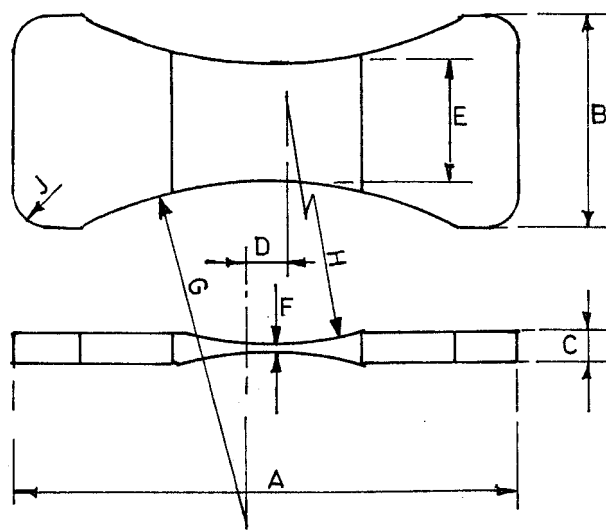
Key

Tolerance on dimensions $\pm 5\%$

A	Overall length	115
B	Width at ends	25 ± 1
C	Length of narrow parallel portion	33 ± 2
D	Width of narrow parallel portion	$6 + 0.4$
E	Small radius	14 ± 1

F	Large radius	25 ± 2
G	Distance between reference lines	25 ± 1
H	Initial distance between grips	80 ± 5
I	Thickness	See text

Dimension in millimetres



Tolerance on dimensions $\pm 5\%$

A	Overall length	110
B	Width at ends	45
C	Thickness at ends	6.5
D	Length of narrow parallel portion	9.5
E	Width of narrow parallel portion	25
F	Thickness of narrow portion	3.2
G	Side radius	75
H	face radius	75
J	End radius	6.5

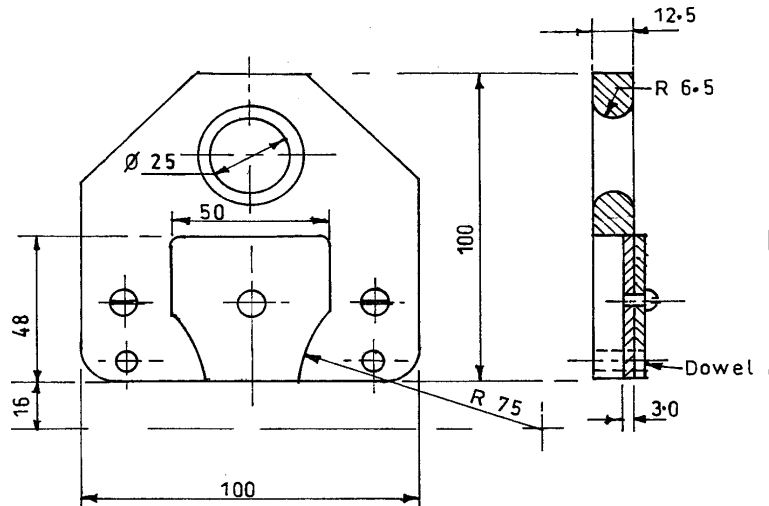


Figure 9 — Grip for type 3 test specimen

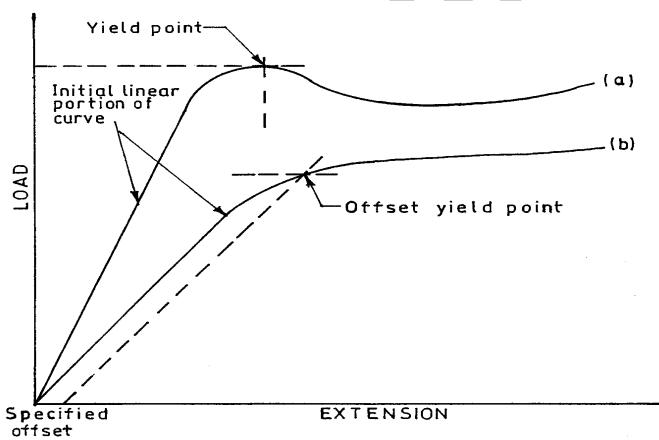


Figure 8— Load/Extension diagram

Tolerance on dimensions $\pm 5\%$

- (a) for a material for which a yield point can be determined
- (b) for a material for which an offset yield point had to be determined.

Annex F (informative)

Recommendations for installation of tanks and fittings

F.1 Tank installation

F.1.1 Vent pipe/overflow pipe is provided near the top with mosquito and insect proof cap

F.1.2 The flat base of cylindrical vertical or rectangular water storage tanks should be fully supported over its whole bottom area by a durable rigid, flat and level platform sufficiently strong to withstand without deflection the weight of the tank when filled fully with the water. In case, the tank is placed on a suitable M. S. platform then it is essential that the latter is free from sharp edges, corners or surface projections and shall be corrosion resistant.

NOTE The requirements for the construction of the reinforced cement concrete or pre-cast cement concrete depend on the capacity of the tank and location. Civil engineering will establish the viability of the geology that the water tank will be placed on and this will dictate site preparation and cost. The choice of materials of construction will be impacted by the whether the tank is located indoors, outdoors

F.1.3 Where required the tanks shall be suitably anchored. The tanks may also be provided with clamping devices.

F.1.4 the pipelines, valves and other fittings should be supported in such a manner that it is aligned properly so as not to produce any distortion in the water tank where the fitting is fixed.

F.1.5 the check nuts of the threaded connection should be placed after placing rubber gaskets and should not be over tightened. Under no circumstances should jointing compounds or putty be employed in contact with the Polyethylene water tanks. PTFE (poly-tetra-fluoroethylene) unsintered tape may be wrapped around the threaded Portion of the valves and connections to act as a sealant

G.1.6 Circular holes drilled for fixing threaded connections should have a clean edge free from notches. Holes can be drilled with a high speed steel hole saw cutter. Scratching or scoring the wall should not be done for setting out holes.

F.1.7 where the section of water tank has a change in profile which is accomplished with a radius, it is essential that the outer extremities of the threaded connections are clear of this radius.

F.1.8 the water storage tank should not be installed in close proximity to heaters or other direct sources of heat.

F.2 Fittings

F.2.1 For providing inlet, outlet and other connections. Usually full threaded G.I. brass connections are used which shall not produce any kind of harmful effect on potable water. Flat Surface may preferably be provided to fix outlet pipes at appropriate locations. The different sizes of threaded connections required to be fixed for different capacities of water storage tanks may be according to Table H.1.

F.2.2 The overflow pipes should be provided with non-corrodible mosquito-proof device of maximum clearance not more than 1.6 mm.

Table G.1 — Sizes of threaded connections

S/N	Capacity of water storage tank	Nominal bore size of threaded connection
i.	Up to 750	12.5
ii.	Above 750 and up to 2 000	25
iii.	Above 2 000 and up to 4 000	40
iv.	Above 4000 and up to 10000	50
v.	Above 10000	75

Bibliography

- [1] ISOARMSA *South African Tank Standard*

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