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Steel mesh reinforced polyethylene (PE) pipe fittings for water supply

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Table of changes

Change No.	Date	Scope

Abstract

Specifies the required properties, classification and geometrical characteristics of steel mesh reinforced polyethylene (PE) pipe fittings made by combining mesh-shaped steel reinforcement with polyethylene (PE) through injection moulding technology. Also specifies the requirements for raw materials, marking, packing, storage and handling of the pipe fittings.

Applies to steel mesh reinforced polyethylene (PE) pipe fittings intended to be used for the conveyance of water under pressure for general purposes, as well as for the supply of drinking water with temperatures not exceeding 80 °C.

Keywords

pipe fittings, polyethylene (PE), specifications, steel mesh reinforced, water supply.

Foreword

This South African standard was approved by National Committee StanSA SC 5140.14A, *Plastics pipes and fittings – Polyethylene*, in accordance with procedures of Standards South Africa, in compliance with annex 3 of the WTO/TBT agreement.

Annex A forms an integral part of this standard. Annex B is for information only.

The requirements in 12 (a) constitute, in terms of section 21(2) of the Standards Act 1993, (Act No. 29 of 1993), a self-declaration of conformity by the manufacturer, notwithstanding the implications of third-party certification mark that might also be displayed.

Contents

Page

Abstract

Keywords

Foreword

1 Scope 3

2 Normative references 3

3 Definitions 4

4 Requirements for materials 5

4.1 Requirements for PE compounds 5

4.1.1 General 5
4.1.2 Dispersion of carbon black 5
4.1.3 Dispersion of blue pigments 5
4.1.4 Thermal stability 5
4.1.5 Effects of materials on water quality 6
4.1.6 Melt flow rate and density 6

4.2 Requirements for steel plates 6

4.2.1 Steel plate 6
4.2.2 Coating 6

5 Requirements for dimensions of fittings 6

5.1 Electrofusion couplers 6
5.2 Reducers 7
5.3 Flange fittings 9
5.4 Tapping saddles 10
5.5 Pipe fittings with coned ends 10

6 Requirements for geographical characteristics and nominal pressures 15

6.1 Dimensions of the pipe fittings: nominal diameters, wall thicknesses, and nominal pressures 15
6.2 Wall thickness 15
6.3 Ovality 15

7 General requirements 15

7.1 Colour 15
7.2 Appearance 15
7.3 General requirements for electrofusion coupler 16

Contents *(concluded)*

Page

8 Requirements for pressure reduction factors 16

9 Requirements for mechanical characteristics 16

9.1 General 16
9.2 Hydrostatic and decohesive strength 16

10 Requirements for physical characteristics 17

10.1 Thermal stability of pipe fittings manufactured from PE 63 and PE 80 17
10.2 Weathering of non-black pipe fittings 17

11 Packing, transportation and storage 18

12 Marking 19

Annex A (normative) Pressure and structural design of the pipe fittings 20

Annex B (informative) Quality verification of steel mesh reinforced polyethylene (PE) pipe fittings for water supply 23

Bibliography 23

Steel mesh reinforced polyethylene (PE) pipe fittings for water supply

1 Scope

This standard specifies the required properties, classification and geometrical characteristics of steel mesh reinforced polyethylene (PE) pipe fittings made by combining mesh-shaped steel reinforcement with polyethylene through injection moulding technology. The requirements for raw materials, marking, packing, storage and handling of the pipe fittings are also specified. The steel mesh is made by winding and welding perforated steel plate to a tube.

This standard applies to steel mesh reinforced polyethylene (PE) pipe fittings intended to be used for the conveyance of water under pressure, for general purposes, as well as for the supply of drinking water, with temperatures not exceeding 80 °C.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be a reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards can be obtained from Standards South Africa.

2.1 Standards

ISO 6964, *Polyolefin pipes and fittings – Determination of carbon black content by calcinations and pyrolysis – Test method and basic specification.*

ISO 8085-3, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels – Metric series – Specification – Part 3: Electrofusion fittings.*

ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications – Classification and designation – Overall service (design) coefficient.*

ISO 13954, *Plastics pipes and fittings – Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm.*

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds.*

ISO/TR 10837, *Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings.*

SANS 130/ISO 1167 (SABS ISO 1167), *Thermoplastics pipes for the conveyance of fluids – Resistance to internal pressure – Test method.*

SANS 241, *Drinking water.*

SANS 370, *Steel mesh reinforced PE pipes for water supply – Specification.*

SANS 1133/ISO 1133 (SABS ISO 1133), *Plastics – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*.

SANS 3126/ISO 3126 (SABS ISO 3126), *Plastic pipes – Measurement of dimensions.*

SANS 9080/ISO 9080, *Plastics piping and ducting systems – Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation.*

SANS 11922-1/ISO 11922-1 (SABS ISO 11922-1), *Thermoplastics pipes for the conveyance of fluids – Dimensions and tolerances – Part 1: Metric series*.

2.2 Other publications

Guidelines for drinking water quality – Second edition – Volume 1: Recommendations, WHO, Geneva, 1993.

EC Council Directive 98/83/EC of 3rd November 1988 on the *quality of water intended for human consumption*, Official journal of the European Community, L229, pp.11 to 29.

3 Definitions

For purposes of this standard, the following definitions apply:

3.1
minimum wall thickness
$e_{y,\,min}$
specified minimum wall thickness at any point around the circumference of the pipe, in millimetres

3.2
nominal inside diameter
d_n
size designation based on the internal diameter of a pipe common to all components, other than flanges

NOTE The size designation is given as a convenient round number in millimetres.

3.3
nominal pressure
PN
specified maximum allowable operating pressure of the pipe at 20 °C, in bars

3.4
nominal wall thickness
e_n
specified wall thickness, in millimetres, identical with the minimum wall thickness at any point ($e_{y,\,min}$)

3.5
ovality of electrofusion coupler
difference between the measured maximum inside diameter and the measured minimum inside diameter in the same cross-section plate of the electrofusion coupler (see 5.1)

3.6
ovality of pipe fittings to be joined with electrofusion coupler
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-section plate of the pipe fitting (see 5.1 and 7.3)

3.7
pipe fitting with coned end
pipe fitting to be joined to other components of a piping system with electrofusion coupler, the coned end of which is injection moulded (see 5.5)

3.8
pressure reduction factors
factors of value smaller than 1, applied to obtain the maximum allowable operating pressure for elevated temperature operation of the pipe fittings specified in this standard

3.9
steel mesh
reinforcement of the pipe fittings specified in this standard, which is made by winding and welding a low carbon steel plate punched with holes to form a continuous tube-like mesh

4 Requirements for materials

4.1 Requirements for PE compounds

4.1.1 General

4.1.1.1 Pipe fittings shall be manufactured from PE compound containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of fittings conforming to this standard and for its end use. The additives shall be uniformly dispersed.

4.1.1.2 When determined in accordance with ISO 6964, the carbon black content in the compound shall be (2,25 % ± 0,25 %) by mass.

4.1.1.3 PE 63 and PE 80 resin that are classified in accordance with to SANS 9080 and ISO 12162, and are recommended for the manufacture of pipe fittings.

4.1.2 Dispersion of carbon black

When determined in accordance with ISO 18553, the dispersion of the carbon black shall be equal to or less than grade 3.

4.1.3 Dispersion of blue pigments

When determined in accordance with ISO 18553, the dispersion of blue pigments shall be equal to or less than grade 3.

4.1.4 Thermal stability

When determined in accordance with ISO/TR 10837, the induction time for materials PE 63 and PE 80 shall be either at least 20 min when tested at 200 °C, or an equivalent period when tested at 210 °C.

NOTE In case of dispute, a test temperature of 200 °C will be used.

4.1.5 Effects of materials on water quality

When used under conditions for which they are designed, materials in contact with or likely to come into contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

The concentrations of substances, chemicals and biological agents leached from materials in contact with drinking water, and measurements of the relevant organoleptic/physical parameters, shall not exceed the maximum values recommended by the World Health Organization in its publication *Guidelines for drinking water quality,* Volume 1: *Recommendations*, or as required by the EC Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption, whichever is the more stringent in each case. SANS 241 may apply as alternative, if users prefer to.

4.1.6 Melt flow rate and density

When measured in accordance with SANS 1133, the melt flow rate (MFR) shall conform to the following conditions:

a) the melt flow rate of the compound shall not deviate by more than ± 30 % from the value specified by the manufacturer of the raw material;

b) the change in MFR caused by processing, i.e. the difference between the measured value for material from the pipe fitting and the measured value for the compound, shall not be more than 25 %.

4.2 Requirements for steel plates

4.2.1 Steel plate

The steel reinforcement for pipe fittings production shall be made from normal low carbon steel plate or alloy steel plate with good weldability.

4.2.2 Coating

The steel plate shall be coated with metallic material with excellent corrosion resistance. The coating shall be clean, smooth, overall and free from scaling, dust or grease.

5 Requirements for dimensions of fittings

5.1 Electrofusion couplers

The requirements for electrofusion couplers are given in table 1 and figure 1.

Table 1 — Geometrical characteristics and nominal pressures of electrofusion couplers

1	2	3	4	5
Nominal inside diameter of corresponding pipe, *d*n mm	**Length of fusion zone, *l*, ≥** mm	***L*, ≥** mm	α	**Nominal pressure, *PN*** bar
50	140	194	30'	25
65	140	194	30'	25
80	140	194	30'	25
100	140	194	30'	25
125	140	194	30'	25
150	160	213	30'	20
200	180	232	30'	20
250	200	252	30'	20
300	230	291	30'	20
350	250	310	1°	16
400	270	329	1°	16
450	290	349	1°	16
500	290	368	1°	16

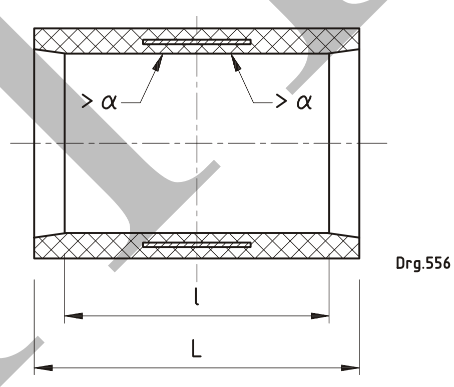

Figure 1 — Electrofusion couplers

5.2 Reducers

The requirements for reducers are given in table 2 and figure 2.

Table 2 — Geometrical characteristics and nominal pressures of reducers

1	2	3	4	5	6
Nominal inside diameter, d_1/d_2 mm	**External diameter of fusion zone and tolerance, D_1** mm	**External diameter of fusion zone and tolerance, D_2** mm	***L*** mm	**L_1** mm	**Nominal pressure, *PN*** bar
500/450	$545^{+0}_{-1,6}$	$495^{+0}_{-1,6}$	820	395	16
500/400	$545^{+0}_{-1,6}$	$440^{+0}_{-1,6}$	820	395	16
450/400	$495^{+0}_{-1,6}$	$440^{+0}_{-1,6}$	780	375	16
450/350	$495^{+0}_{-1,6}$	$390^{+0}_{-1,6}$	780	375	16
400/350	$440^{+0}_{-1,6}$	$390^{+0}_{-1,6}$	740	355	16
400/300	$440^{+0}_{-1,6}$	$337^{+0}_{-1,6}$	740	355	16
350/300	$390^{+0}_{-1,6}$	$337^{+0}_{-1,6}$	660	335	16
300/250	$337^{+0}_{-1,6}$	$287^{+0}_{-1,6}$	610	275	20
300/200	$337^{+0}_{-1,6}$	$234^{+0}_{-1,6}$	610	275	20
250/200	$287^{+0}_{-1,6}$	$234^{+0}_{-1,6}$	560	245	20
250/150	$287^{+0}_{-1,6}$	$182^{+0}_{-1,6}$	560	245	20
200/150	$234^{+0}_{-1,6}$	$182^{+0}_{-1,6}$	500	225	20
200/100	$234^{+0}_{-1,6}$	$128^{+0}_{-1,4}$	500	225	20
150/100	$182^{+0}_{-1,6}$	$128^{+0}_{-1,4}$	470	200	20
NOTE Not all sizes of reducers that conform to this standard are given in this table.					

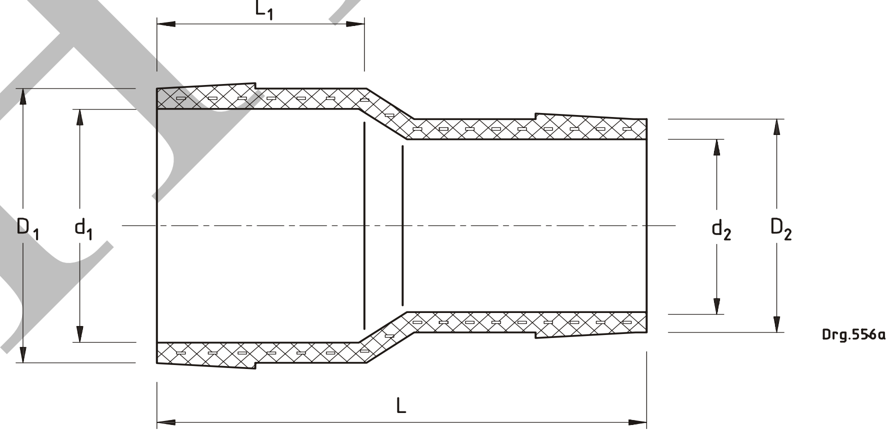

Figure 2 — Reducers

5.3 Flange fittings

The requirements for flange fittings are given in table 3 and figure 3.

Table 3 — Geometrical characteristics and nominal pressures of flange fittings

1	2	3	4	5	6	7
Nominal inside diameter, ***d_n*** mm	α	**Length of flange fitting,** ***L*** mm	***D*** mm	***D_1*** mm	**External diameter of fusion zone and tolerance, *D_2*** mm	**Nominal pressure,** ***PN*** bar
150	30'	220	280	241,5	$182^{+0}_{-1,6}$	20
200	30'	240	345	298,5	$234^{+0}_{-1,6}$	20
250	30'	270	405	362,0	$287^{+0}_{-1,6}$	20
300	30'	300	485	432,0	$337^{+0}_{-1,6}$	20
350	1°	310	520	470,0	$390^{+0}_{-1,6}$	16
400	1°	320	580	525,0	$440^{+0}_{-1,6}$	16
450	1°	330	640	585,0	$495^{+0}_{-1,6}$	16
500	1°	350	715	650,0	$545^{+0}_{-1,6}$	16
NOTE Not all sizes of flange fittings that conform to this standard are given in this table.						

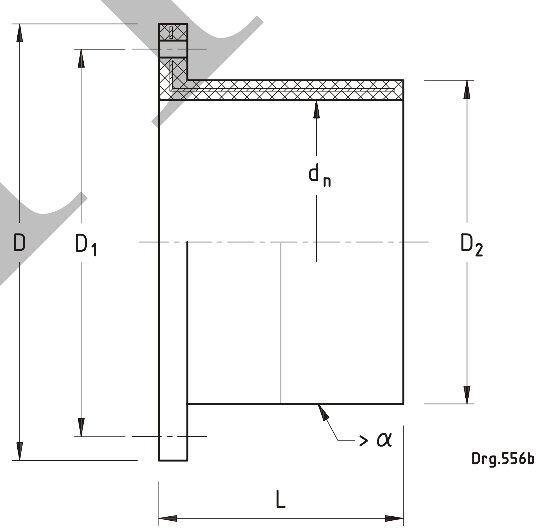

Figure 3 — Flange fittings

5.4 Tapping saddles

The requirements for tapping saddles are given in table 4 and figure 4.

Table 4 — Geometrical characteristics and nominal pressures of tapping saddles

1	2	3	4
Nominal inside diameter, d_n mm	***L*, ≥** mm	***h*, ≥** mm	**Nominal pressure, *PN*** bar
150	200	120	16
200	200	145	16
250	215	170	16
300	230	195	16

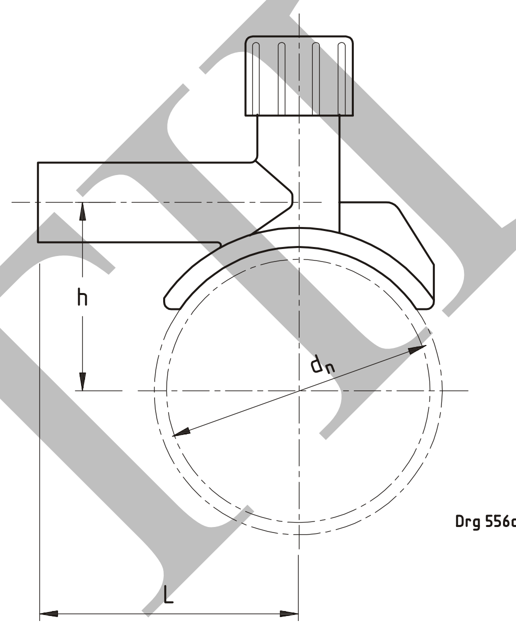

Figure 4 — Tapping saddles

5.5 Pipe fittings with coned ends

Pipe fittings with coned ends include: 45° bends, 90° bends, 22,5° bends, 11,25° bends and tees. The requirements for pipe fittings with flanged ends are given in tables 5, 6 and 7 and figures 5, 6 and 7.

Table 5 — Geometrical characteristics and nominal pressures of 90° bends

1	2	3	4	5
Nominal inside diameter, d_n mm	**Nominal wall thickness, e_n** mm	**L_1** mm	**External diameter of fusion zone and tolerance, D** mm	**Nominal pressure, *PN*** bar
50	12,5	205	$75^{+0}_{-1,1}$	25
65	12,5	215	$90^{+0}_{-1,2}$	25
80	12,5	225	$105^{+0}_{-1,3}$	25
100	14,0	240	$128^{+0}_{-1,4}$	25
125	15,5	255	$156^{+0}_{-1,6}$	25
150	16,0	280	$182^{+0}_{-1,6}$	20
200	17,0	320	$234^{+0}_{-1,6}$	20
250	18,0	360	$287^{+0}_{-1,6}$	20
300	18,0	405	$337^{+0}_{-1,6}$	20

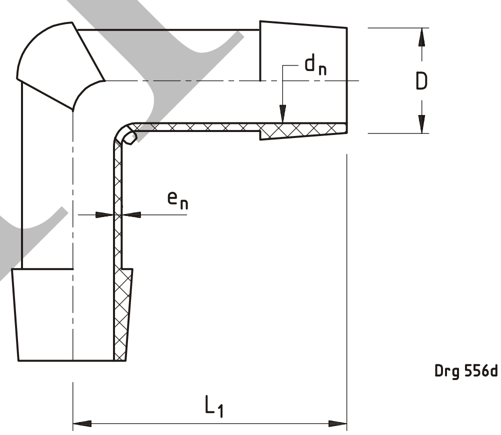

Figure 5 — 90° bend with coned end

Table 6 — Geometrical characteristics and nominal pressures of 45° bends

1	2	3	4	5
Nominal inside diameter, d_n mm	**Nominal wall thickness, e_n** mm	L_1 mm	**External diameter of fusion zone and tolerance, *D*** mm	**Nominal pressure, *PN*** bar
50	12,5	170	$75^{+0}_{-1,1}$	25
65	12,5	175	$90^{+0}_{-1,2}$	25
80	12,5	180	$105^{+0}_{-1,3}$	25
100	14,0	185	$128^{+0}_{-1,4}$	25
125	15,5	190	$156^{+0}_{-1,6}$	25
150	16,0	210	$182^{+0}_{-1,6}$	25
200	17,0	235	$234^{+0}_{-1,6}$	20
250	18,0	255	$287^{+0}_{-1,6}$	20
300	18,0	285	$337^{+0}_{-1,6}$	20
350	20,0	350	$390^{+0}_{-1,6}$	16
400	20,0	370	$440^{+0}_{-1,6}$	16
450	22,0	390	$495^{+0}_{-1,6}$	16
500	22,0	410	$545^{+0}_{-1,6}$	16

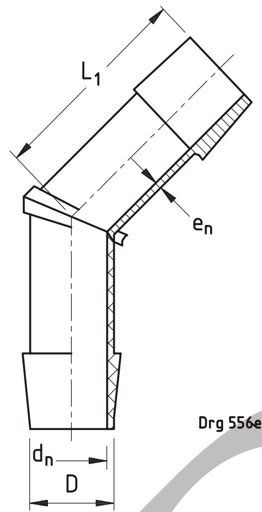

Figure 6 — 45° bend with coned end

Table 7 — Geometrical characteristics and nominal pressures of tees

1	2	3	4	5
Nominal inside diameter, ***d*~n~** mm	**Nominal wall thickness,** ***e*~n~** mm	***L*~1~** mm	**External diameter of fusion zone and tolerance,** ***D*** mm	**Nominal pressure,** ***PN*** bar
50	12,5	390	$75^{+0}_{-1,1}$	25
65	12,5	410	$90^{+0}_{-1,2}$	25
80	12,5	430	$105^{+0}_{-1,3}$	25
100	14,0	460	$128^{+0}_{-1,4}$	25
125	15,5	490	$156^{+0}_{-1,6}$	25
150	16,0	530	$182^{+0}_{-1,6}$	20
200	17,0	610	$234^{+0}_{-1,6}$	20
250	18,0	690	$287^{+0}_{-1,6}$	20

Table 7 (*concluded*)

1	2	3	4	5
Nominal inside diameter, d_n mm	**Nominal wall thickness, e_n** mm	**L_1** mm	**External diameter of fusion zone and tolerance, D** mm	**Nominal pressure, *PN*** bar
300	18,0	780	337 $^{+0}_{-1,6}$	20
350	20,0	900	390 $^{+0}_{-1,6}$	16
400	20,0	970	440 $^{+0}_{-1,6}$	16
450	22,0	1 050	495 $^{+0}_{-1,6}$	16
500	22,0	1 120	545 $^{+0}_{-1,6}$	16

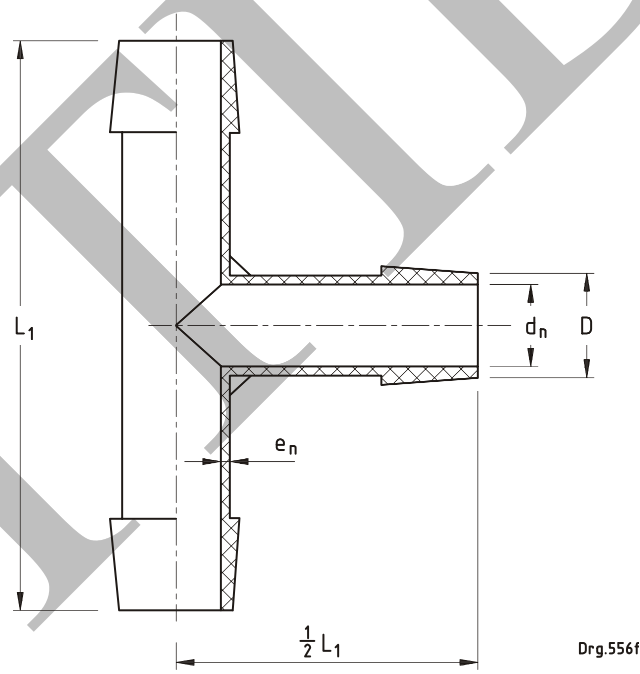

Figure 7 — Tee with coned end

6 Requirements for geometrical characteristics and nominal pressures

6.1 Dimensions of the pipe fittings: nominal diameters, wall thicknesses and nominal pressures

6.1.1 The requirements of the pipe fittings specified in this standard are consistent with those of pipes specified in SANS 370.

6.1.2 The dimensions of pipe fittings shall be measured in accordance with SANS 3126.

6.1.3 In this standard, the nominal pressures of the pipe fittings are so specified as to facilitate the manufacture and application of the fittings, as given in table 1 to table 7 (inclusive). The nominal pressures of the pipe fittings are consistent with the maximum-class nominal pressures of the pipes specified in SANS 370.

NOTE When the pipe fitting is working under pressure, the load is mainly sustained by the steel plate. The manufacturing cost for pipe fittings of different nominal pressures does not differ much as determined by the structural characteristics of the pipe fittings and mechanical principles.

6.2 Wall thickness

The wall thickness of the pipe fitting at any point shall not be less than that of the corresponding pipe. The tolerance on the wall thickness shall conform to the requirements of SANS 11922-1, grade T.

6.3 Ovality

The maximum and minimum outside diameter or inside diameter of the pipe fitting shall be measured in accordance with SANS 3126. The ovality of the pipe fittings shall conform to SANS 11922-1, as follows:

a) grade L for electrofusion couplers; and

b) grade M for other pipe fittings except electrofusion coupler.

7 General requirements

7.1 Colour

The fittings shall be black or blue or black with blue stripes.

NOTE For above ground installations, all blue components and components with non-black layers should be protected from direct UV light.

7.2 Appearance

7.2.1 When viewed without magnification, the internal surface and external surface shall be smooth, clean and free from scoring, discoloration, lines and cracks. The external surface may take on a natural contracting appearance. The pure PE surfaces of the coned end allows slight shrinkage.

7.2.2 The surface of the flange shall be cut smooth, clean and free from defects such as cavities, scoring and burs.

7.3 General requirements for electrofusion coupler

The heating wire of the electrofusion coupler shall be tightly located onto the inner surface of the fitting and the connector pins shall be firmly bonded to the fitting body.

Exposure of steel plate is not allowed on either internal surface or external surface.

The tolerance on resistance of the wire at 23 °C shall be in accordance with ISO 8085-3, as follows:

Maximum limit: stated value +10 % + 0,1 Ω.

Minimum limit: stated value –10 %.

8 Requirements for pressure reduction factors

The pressure reduction factors given in table 8 apply to pipe fittings that are used at temperatures above 20 °C for the conveyance of water which do not have adverse effects on the performance of the pipe fittings. The working pressure at elevated temperature shall be obtained by multiplying the nominal pressure given in table 1 to table 5 (inclusive), with the pressure reduction factors given in table 8.

Table 8 — Pressure reduction factors

1	2	3	4	5	6	7	8
Operating temperature (°C)	$0 < t \leq 20$	$20 < t \leq 30$	$30 < t \leq 40$	$40 < t \leq 50$	$50 < t \leq 60$	$60 < t \leq 70$	$70 < t \leq 80$
Pressure reduction factors	1	0,95	0,89	0,83	0,77	0,72	0,67

9 Requirements for mechanical characteristics

9.1 General

The pressure bearing capacity of the pipe fittings shall be determined according to annex A.

9.2 Hydrostatic and decohesive strength

9.2.1 The hydrostatic test and burst test shall be conducted in accordance with SANS 130. The pipe fittings shall comply with the requirements given in table 9.

9.2.2 The hydrostatic test and burst test shall be conducted on a piping assembly (figure 8 gives an example of the assembly for testing 45° bend). The mechanical characteristics of the fittings, which are revealed by the performance of the assembly, shall comply with table 9.

9.2.3 The peel decohesion test shall be conducted on a pipe assembly joined with electrofusion coupler. The test method is given in ISO 13954. The pipe fittings shall comply with the requirements given in table 9.

Table 9 — Mechanical performance tests

1	2	3
Test	**Test parameters**	**Requirements**
Hydrostatic strength at 20 °C (100 h)	Test pressure PN × 1,6 (bar)	No failure, no leakage
Hydrostatic strength at 80 °C (165 h)	Test pressure PN × 1,6 × 0,67 (bar)	No failure, no leakage
Burst test	Instantly increase test pressure to burst pressure	Burst pressure ≥ PN × 3
Peel decohesion test	Test temperature 20 °C	Percentage of brittle failure decohesion ≤ 33,3

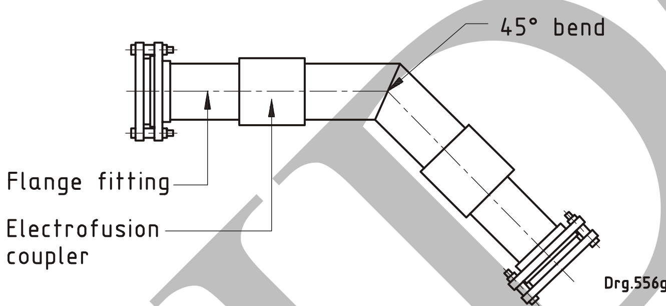

Figure 8 — Test assembly for 45° bend

10 Requirements for physical characteristics

10.1 Thermal stability of pipe fittings manufactured from PE 63 and PE 80

When determined in accordance with ISO/TR 10837, the induction time for test specimens taken from pipe fittings manufactured from PE 63 and PE 80 shall be either at least 20 min when tested at 200 °C, or an equivalent period when tested at 210 °C, provided the equivalence is supported by a clear correlation between results obtained at 200 °C or 210 °C respectively. The test specimens shall be taken from the inside surface of the pipe fitting.

10.2 Weathering of non-black pipe fittings

10.2.1 General

When the pipe fittings are manufactured using non-black compound, the effect of weathering shall be determined in accordance with the procedure given in 10.2.2. After exposure to a total solar energy of at least 3,5 GJ/m^2, the pipe fitting shall comply with the following requirements:

a) the mechanical characteristics shall meet the requirements given in table 9; and

b) the induction time, when measured in accordance with ISO TR 10837, shall be at least 10 min at 200 °C.

10.2.2 Procedure for exposure to outdoor weathering

10.2.2.1 Exposure aspects and site

Test racks and specimen fixtures shall be made from inert materials which will not affect the test results. Wood, non-corrosive aluminium alloys, stainless steel or ceramics have been found suitable. Brass, steel or copper shall not be used in the vicinity of test specimens. The test site shall be equipped with instruments to record the solar energy received and the ambient temperature.

The equipment shall be capable of supporting specimens of pipe fitting such that the exposed surface of the specimens is at 45° to the horizontal, facing towards the equator. Normally, the exposure site shall be an open ground well away from trees and buildings. For exposure in the northern hemisphere, no obstruction, including adjacent racks, in an easterly, southerly or westerly direction shall subtend a vertical angle greater than 20°, or in a northerly direction greater than 45°. For exposure in the southern hemisphere, corresponding provisions apply.

10.2.2.2 Test specimens

Test specimens shall be taken from internal wall of the pipe fittings within a random range of diameters. The batch of pipe fittings from which the specimens are selected shall comply with the requirements of this standard.

10.2.2.3 Procedure

10.2.2.3.1 Mark each specimen to identify it, and record the mounting position of each.

10.2.2.3.2 Expose the specimens to a total solar energy of at least 3,5 GJ/m^2.

10.2.2.3.3 Remove the specimens and test them in accordance with the clause 10.2.1. Where the specimen to be tested includes only part of the fitting cross-section, e.g. a tensile dumb-bell or part of the surface layer, it shall be taken from the weathered crown of the exposed specimen.

11 Packing, transportation and storage

11.1 Packing

The pipe fittings shall be first sealed in plastic bags, singly or in bulk, then packed in wooden or other type cases to avoid being damaged. Conformity certificate issued by quality control section shall be enclosed.

11.2 Transportation

Scratching, dropping pipe fittings onto hard surfaces and severe impact on or between the pipe fittings shall be avoided during transportation and handling. Measures shall be taken to protect the fittings from direct sunlight, rain or contamination.

11.3 Storage

The pipe fittings shall be kept far away from heat sources, and the ambient temperature shall not exceed 40 °C. The warehouse shall be well ventilated and the stack bed shall be flat and clean.

12 Marking

The marking shall be maintained for the life of the pipe fitting, and shall be so applied as not to adversely affect the fitting performance and far away from the observation holes.

If printing is used, the colouring of the printed information shall differ from the basic colouring of the fitting. The size of the marking shall be such that it is easily legible without magnification. All pipe fittings shall be marked with the minimum information as given below:

a) the standard number SANS 371 (see foreword);

b) the manufacturer's name or trademark (or both);

c) nominal internal diameter;

d) nominal pressure;

e) PE designation; and

f) production date.

Annex A
(normative)

Pressure and structural design of the pipe fittings

A.1 Load (hoop stress) sharing in the pipe fitting

When the pipe fitting works under nominal pressure, it should be within elastic limits. In the pipe, fitting the steel plate and plastics deform as a single unit, and therefore, experience equal strains. Thus, the following formula can be obtained:

$$\varepsilon_s = \frac{\sigma_s}{E_s}\ \varepsilon_p = \frac{\sigma_p}{E_p} \qquad (1) \qquad\qquad \frac{\sigma_p}{\sigma_s} = \frac{E_p}{E_s} = K \qquad (2)$$

where

ε_s is the average strain of steel mesh;

ε_p is the average strain of PE;

σ_s is the average stress of steel wires, in megapascals;

σ_p is the average stress of PE, in megapascals;

E_s is the elastic modulus of steel mesh, in megapascals;

E_p is the elastic modulus of PE, in megapascals;

K is a constant.

The above expression shows that within the elastic limit there is a fixed relationship between the load sustained by the plastics and that by the steel, i.e. the elastic modulus ratio between the plastics and the steel. The elastic modulus of steel is more than 200 times that of plastics, thus when the pipe fitting is subject to nominal pressure, the plastics only sustains a minor percent of the total stress, which is far below its allowable stress.

A.2 Formula for calculating maximum operating pressure (MOP) of the pipe fitting

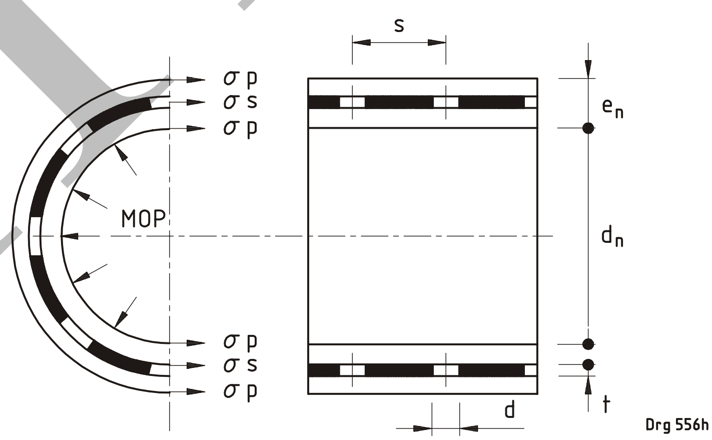

Figure A.1 — Cross-section in maximum hoop stress direction

According to figure A.1, the following equation can be obtained:

$$MOP \times d_n \times s = 2[(s-d)\sigma t_s + \sigma_p (e_n - t)s] \qquad (3)$$

By combining formula (2) and (3), the following formula is achieved:

$$MOP = \frac{2[\sigma_s t(s-d) + \sigma_p s(e_n - t)]}{d_n s} \geq PN \qquad (4)$$

where

- PN is the nominal pressure of the pipe fitting, in megapascals;
- MOP is the maximum operating pressure of the pipe fitting, in megapascals;
- d_n is the nominal diameter of the pipe fitting, in millimetres;
- e_n is the nominal wall thickness of the pipe fitting, in millimetres;
- σ_s is the standard allowable stress of steel mesh (normally one third of the tensile limit of the steel plate adopted);
- σ_p is the design stress of PE ($K\sigma_s$);
- t is the thickness of the steel plate, in millimetres;
- s is the distance between two adjacent holes in longitudinal direction, in millimetres;
- d is the diameter of the perforated holes in the steel plate, in millimetres.

In the above expression, the values of d_n, e_n, s and d are predetermined according to the pipe fitting series and the manufacturing process. Based on this predetermination, the materials for making the steel plate and PE designation shall be selected. Make calculations according to this method by adjusting the value of s to find a proper value for s, with which the required maximum working pressure MOP and safety factor n can be achieved. Finally, round the calculated MOP to obtain the nominal pressure PN.

A.3 Structural and pressure design of the pipe fittings

The procedure for structural and pressure design of the pipe fittings is given in figure A.2. When making verification to the calculation results with actual burst test data, the criterion can be $P_b/PN \geq 3$[1)].

1) $P_b/PN \geq 3$ is used to further verify the correctness of the calculation results and the safety degree. MOP = Pb is not mentioned.

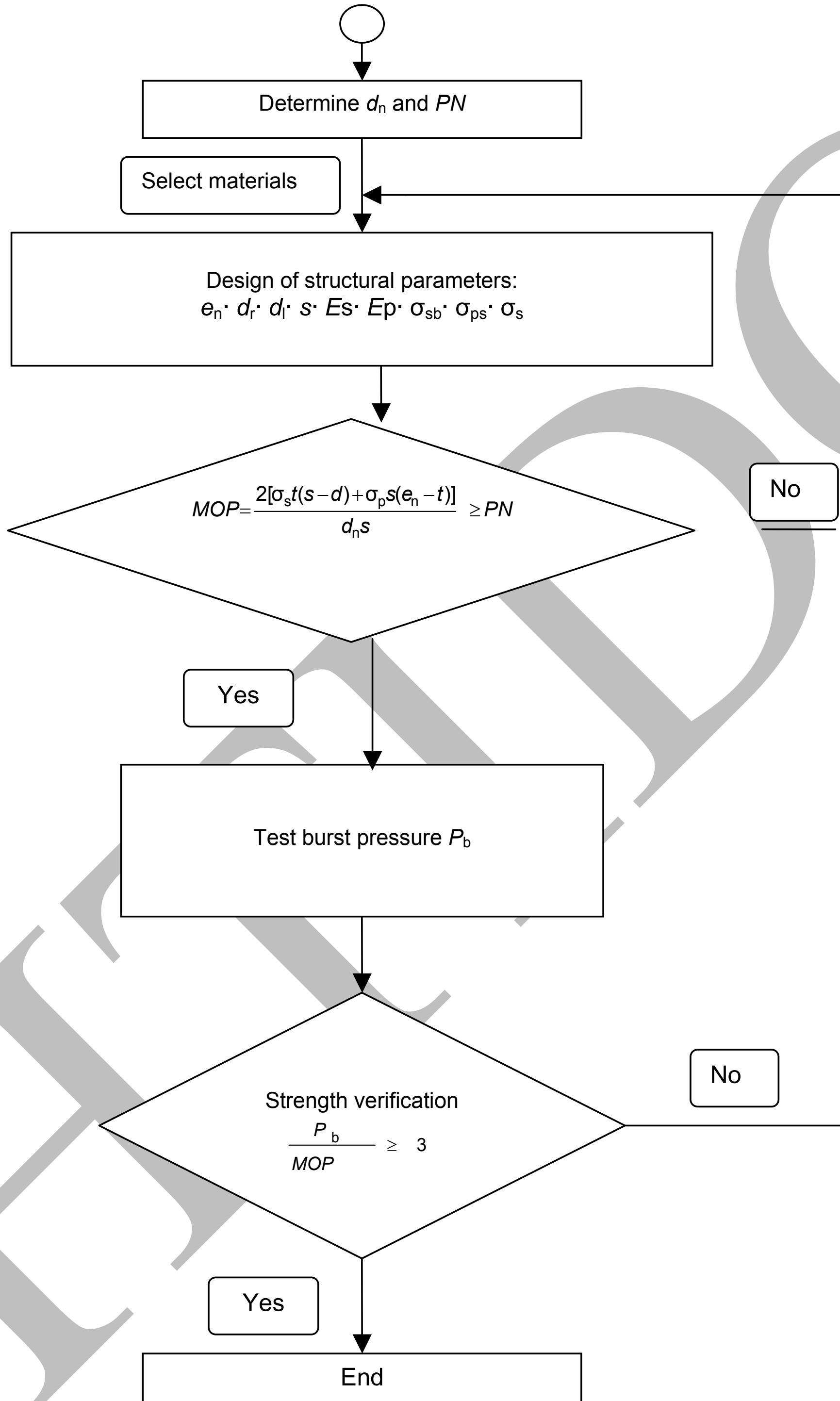

Figure A.2 — Procedure for structural pressure design of the pipe fitting

Annex B
(informative)

Quality verification of steel mesh reinforced polypropylene (PE) pipe fittings for water supply

When a purchaser requires ongoing verification of the quality of steel mesh reinforced polypropylene pipe fittings for water supply, it is suggested that instead of concentrating solely on evaluation of the final product, he also direct his attention to the manufacturer's quality system. In this connection it should be noted that SANS 9001 covers the provision of an integrated quality system.

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