AR 207
May 2019

Approval requirement 207

Pipes of oriented plasticized PVC (PVC-O)

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Foreword

This GASTEC QA Approval requirement has been approved by the Board of Experts product certification GASTEC QA, in which relevant parties in the field of gas related products are represented. This Board of Experts supervises the certification activities and where necessary require the GASTEC QA Approval requirement to be revised. All references to Board of Experts in this GASTEC QA Approval requirement pertain to the above mentioned Board of Experts.

This GASTEC QA Approval requirement will be used by Kiwa Nederland BV in conjunction with the GASTEC QA general requirements and the KIWA regulations for certification.

Approved by Board of Experts : May 20th 2019

Accepted by Kiwa Nederland B.V. : May 20th 2019

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1 Introduction

1.1 General

This GASTEC QA approval requirement in combination with the GASTEC QA general requirements include all relevant requirements, which are adhered by Kiwa as the basis for the issue and maintenance of a GASTEC QA certificate for pipes of oriented plasticized PVC (PVC-O).

This GASTEC QA Approval requirements replace the GASTEC QA Approval Requirements 207 “Pipes of oriented plasticized PVC (PVC-O) dated September 2015.

List of changes:

- Update to the new format for GASTEC QA approval requirements
- These approval requirements have been fully reviewed textually.
- All general requirements have been deleted and included in the GASTEC QA general requirements document
- Change of paragraphs

The product requirements have not changed.

1.2 Scope

These requirements apply to pipes which are made of oriented plasticized PVC (PVC-O). The intended use of these pipes is underground for the transport of gas of the 1st, 2nd and 3rd family gasses according to table 1 of NEN-EN 437 with a maximum operating pressure of 8 bar.

2 Definitions

In this approval requirement, the following terms and definitions are applicable:

Board of Experts: The Board of Experts Gastec QA.

Supplier: the party that is responsible for ensuring that the products meet and continue to meet the requirements on which the certification is based.

Manufacturer: the party that produces the product.(not necessary the supplier).

3 Product requirements

3.1 Material

3.1.1 General

The material from which the pipes are made shall be PVC-U compound. This compound shall consist substantially of PVC-U resin to which shall be added only those additives necessary to facilitate the production of pipes in accordance with this requirement. All additives shall be uniformly dispersed.

3.1.2 Rework material

The use of manufacturer's own reprocess able material produced the manufacture and works testing of products and conforming to the material requirements is permitted. No reprocess able or recyclable material obtained from external sourced shall be used.

3.2 Material classification

3.2.1 MRS Value

Oriented pipes made from a defined PVC-U compound and with a well-defined orientation level, in tangential and axial direction, shall be evaluated according to chapter 4.5. The minimum required strength (MRS) values shall be classified in accordance with 3.2.2 table 1.

3.2.2 Design stress

The design stress shall be based on the value of the lower confidence limit σLPL of the long term hydrostatic strength for the resistance to internal pressure as determined in accordance with ISO 9080. This σLPL value shall be converted into a minimum required strength (MRS) in accordance with ISO 12162. The MRS shall be divided by an overall service (design) coefficient *C* to give the design stress σ_s, which is expressed by the following equation.

$$\sigma_s = \frac{MRS}{C}$$

Pipe material classification number		315	355	400	450
MRS	MPa	31,5	35,5	40	45
C		2	2	2	2
σ_s	MPa	16	18	20	22,5

Table 1

3.3 Classification and selection of pipes

3.3.1 Classification

Pipes shall be classified to their nominal pressure PN. The nominal pressure PN, the pipe series S and the design stress, σ_S, are connected by the following relationship:

$$PN = \frac{10\sigma_S}{S}$$

$$S = \frac{SDR - 1}{2}$$

$$SDR = \frac{d_n}{e_n}$$

$$\sigma_S = \frac{MRS}{C}$$

Where
e_n is expressed in millimetres (mm)
PN is expressed in megapascals (MPa)
MRS is expressed in megapascals (MPa)
C is no dimensional

3.3.2 Calculation of wall thickness

The relationship between the nominal wall thickness e_n and the nominal outside diameter d_n is specified in ISO 4065. The values for nominal pipe wall thickness e_n for nominal pressure ratings PN, can be calculated by substituting the values for MRS, C, and d_n in the formula:

$$e_n = \frac{d_n}{2S_o + 1}$$

where S_o is the calculated preferred value of the nominal S series number of the pipe from 3.3.1. Values shall be rounded to one decimal place according to the rules of ISO 4065.

NOTE Nominal S numbers and their calculated values are given in ISO 4065 for the R10 series of preferred numbers. For the R20 series required for this International Standard, refer to ISO 3.

The nominal outside diameter and nominal wall thickness for the relevant nominal pressure and material classes are specified in table 2.

Material Class	Pressure class PN for design coefficient *C*=2,0	
315	8	
355	8	
400	10	
450	10	
Pipe series S numbers preferred and computed values (ISO 3) and standard dimension ratios (SDR)		
S	20,0	16,0
S_{calc}	19,953	15,849
SDR	41,0	33,0
d_n	**e_n mm**	
63	-	2,0
75	2,0	2,3
90	2,2	2,8
110	2,7	3,4
160	4,0	4,9
200	4,9	6,2
250	6,2	7,7
315	7,7	9,7

Table 2

3.4 General characteristics

3.4.1 Appearance

When viewed without magnification, the internal and external surface of the pipe shall be smooth, clean and free from scoring, cavities and other surface defects. The material shall not contain visible impurities. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

3.4.2 Colour

The pipe shall be yellow (RAL 1004), orange (RAL 1033) or alternatively marked with yellow or orange stripes.

3.4.3 Dimensions

3.4.3.1 Outside diameters and wall thickness

The outside diameter, wall thickness and out-of-roundness shall be in correspondence with table 3. The dimensions of the pipe shall be measured according to ISO 3126.

Nominal size DN	Mean outside diameter d_{em}		Out-of-roundness	Wall thickness *e*			
				SDR 41		SDR 33	
	Min	Max	Max	Min	Max	Min	Max
63	63	63,2	1,6			2,0	2,4
75	75	75,3	1,8	2,0	2,4	2,3	2,8
90	90	90,3	2,2	2,2	2,7	2,8	3,3
110	110	110,4	2,7	2,7	3,2	3,4	4,0
160	160	160,5	3,9	4,0	4,6	4,9	5,6
200	200	200,6	4,8	4,9	5,6	6,2	7,1
250	250	250,8	6,0	6,2	7,1	7,7	8,7
315	315	316,0	7,6	7,7	8,7	9,7	10,9

Table 3

3.4.3.2 Plain ends

Pipes with plain ends shall comply with following requirements:
a) the chamfer shall be between 5° en 15°;
b) the length of the chamfer shall be according to table 4.
c) the wall thickness at the end of the chamfer (see e1) shall not be less than 50 % of the minimum allowed wall thickness for the pipe according to table 3.

Nominal outside diameter d_e (mm)	**Length of the chamfer l_{min} (mm)**
$90 \leq d_n \leq 110$	5
$125 \leq d_n$	7

Table 4

4 Performance requirements and test methods

4.1 Resistance to hydrostatic pressure

Resistance to hydrostatic pressure shall be verified using the induced stresses derived from the analysis of the test data in accordance with ISO 9080. For a period of 10 h at 20 °C and at the time of 1 000 h at 20 °C, the 99,5 % LPL value shall be taken as the minimum stress level.

For a period of 1000 h at 60 °C, the 99,5 % LPL value established from analysis of test data at 60 °C in accordance with ISO 9080 can be taken as the minimum stress level. In case of a lack of data, alternatively, a value of 0,625 times the MRS value shall be taken as the minimum stress level.

When tested using end cap type A in accordance with ISO 1167-1:2006, and using the combinations of test temperatures and induced stresses so derived, the pipe shall not fail in less than the times stated above.

See 4.1.1 for the procedure to establish 20 °C test stress values for testing under provisional qualification.

4.1.1 Establishment of the pipe material classification

The minimum required strength of the pipe materials for the purpose of this International Standard shall be evaluated according to the procedures of ISO 9080.

Whenever there is a change in material the relevant type tests shall be carried in accordance with ISO 1452-2 as indicated in the relevant table.

4.1.1.1 Determination of pipe material classification

Procedure

Pipe material shall be designated by the material type (PVC-O) and the level of the minimum required strength (MRS) in accordance with Table 1. The pipe material shall have an MRS equal to the values as specified in table 1.

The MRS value for classification shall be derived from σ_{LPL} in accordance with ISO 12162. The σ_{LPL} is determined by analysis in accordance with ISO 9080, of hydrostatic pressure tests carried out in accordance with ISO 1167-1 and ISO 1167-2 and using end caps type A, tested with water in water.

4.2 Resistance to impact at 0 °C

Pipes shall be tested at 0 °C in accordance with ISO 3127, and shall have a true impact rate (TIR) of not more than 10 % when using masses given in table 5. The radius of the striker nose shall be R= 12,5 mm. The drop height shall be 2 meter.

Nominal size DN	Total mass kg
63	4
75	5
90	5
110	6,3
160	8
200	10
>225	12,5

Table 5

4.3 Resistance to weathering

The material shall be sufficiently stable after UV-exposure (weathering)

The resistance to weathering shall be performed according to NEN-EN-ISO 16871. In total 24 test pieces of a 63 mm pipe with a length of 1 meter shall be placed under an angle of 45°C. The test pieces shall be placed such that they form one surface area. The radiation shall be measured on location. After an exposure of 3,5 GJ/m^2 of radiation the test pieces are cut into 5 pieces of 20 cm each for further testing.

After exposure to weathering the test pieces are tested against the resistance to impact according to paragraph 4.1.2 using a mass of 1,2 kg. A maximum of 2 out of 100 test pieces may fail. It is allowed to stop the test if after 60 test no test piece has failed. The pipe is than considered to be resistant to weathering.

4.4 Resistance to gas

The resistance to gas shall be determined according to NEN 7230 chapter 4.2.10 using samples taken from a tube with a nominal diameter of 110 mm.

4.5 Determination of axial and tangential orientation factor

The axial and tangential orientation factor determined conforming to ISO 2505 shall be in accordance with table 6.

Orientation factor	315	355	400	450
λ_a	≥ 1,1	≥ 1,2	≥ 1,2	≥ 1,2
λ_r	≥ 1,6	≥ 1,6	≥ 1,6	≥ 1,6

Table 6

The test parameters and test procedure according to ISO 16422 Annex F shall be followed.

4.6 Degree of gelation

The pipe material shall show no visual decay after testing according to ISO 9852 (bath temperature 15 °C, immersion time 15 min., min.wall thickness 1,5 mm).

4.7 K-value

The K value of the PVC-U resin used shall be at least 64, when tested in accordance with ISO 1628-2.

4.8 Vicat softening temperature

When determined in accordance with ISO 2507-1, the Vicat softening temperature of the compound shall be not less than 80 °C.

5 Marking, instructions and packaging

5.1 Marking

The product shall be marked with the following information.

- GASTEC QA word mark or logo
- Manufacturers name or trademark
- Pipe material
- MRS value
- Nominal outside diameter and SDR classification
- Nominal pressure PN
- Production date or code

The pipes shall be permanently marked at intervals not greater than 1 meter.

5.2 Instructions

The supplier shall provide instructions. These instructions shall be in the Dutch language and describe that the product is Gastec QA certified. In addition the instructions shall contain information about:

- The use and installation of the product
- The conditions under which it shall be used
- How it can be determined if the product is correctly installed
- The way the product shall be stored
- The maximum shelf life of the product

5.3 Packaging

The product shall be pack in such a way that damaging under normal conditions is not possible.

6 Quality system requirements

The supplier shall make a risk assessment of the product and production process according to chapter 3.1.1.1 and 3.1.2.1 of the GASTEC QA general requirements. The risk assessments shall be available to Kiwa for review.

7 Summary of tests

This chapter contains a summary of tests to be carried out during:

- The initial product assessment;
- The periodic product verification;

7.1 Test matrix

Description of requirement	Clause	Test within the scope of		
		Initial product assessment	Product verification	
			Verification	Frequency
Product requirements	**3**			
Material	3.1			
General	3.1.1	X	X	Once a year
Rework material	3.1.2	X	X	Once a year
Material classification	3.2			
MRS value	3.2.1	X		
Design stress	3.2.2	X		
Classification and selection of pipes	3.3			
Classification	3.3.1	X		
Calculation of wall thickness	3.3.2	X		
General characteristics	3.4			
Appearance	3.4.1	X	X	Once a year
Colour	3.4.2	X		
Dimensions	3.4.3	X	X	Once a year
Performance requirements	**4**			
Resistance to hydrostatic pressure	4.1	X	X	Once a year
Establishment of the pipe classification	4.1.1	X		
Resistance to impact at 0°C	4.2	X	X	Once a year
Resistance to weathering	4.3	X		
Resistance to gas	4.4	X		
Determination of axial and tangential orientation factor	4.5	X	X	Once a year
Degree of gelation	4.6	X		
K-value	4.7	X		
Vicat softening temperature	4.8	X		
Infra-red analysis			X	Once a year
Marking and instructions	**5**			
Marking	5.1	X	X	Once a year
Instructions	5.2	X	X	Once a year
Packaging	5.3	X	X	Once a year

8 List of referenced documents and source

8.1 Standards / normative documents

All normative references in this Approval Requirement refer to the editions of the standards as mentioned in the list below.

NEN-EN 437: 2003+A1: 2009	Test gases- test pressure – appliance categories
NEN-EN-ISO 1167-1: 2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 1: General method
NEN-EN-ISO 1167-2: 2006	Thermoplastics pipes, fittings and assemblies for the conveyance of fluids - Determination of the resistance to internal pressure - Part 2: Preparation of pipe test pieces
NEN-EN-ISO 1628-2: 1999	Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscometers - Part 2: Poly(vinyl chloride) resins
NEN-EN-ISO 2505: 2005	Thermoplastics pipes - Longitudinal reversion - Test method and parameters
ISO 2507-1: 1995	Thermoplastics pipes and fittings - Vicat softening temperature - Part 1: General test method
NEN-EN-ISO 3126: 2005	Plastics piping systems - Plastics components - Determination of dimensions
ISO 3127: 1994	Thermoplastics pipes - Determination of resistance to external blows - Round-the-clock method
ISO 4065: 1996	Thermoplastics pipes - Universal wall thickness table
NEN 7230: 2011	Kunststofleidingsystemen voor gasvoorziening – buizen van slagvast polyvinylchloride (slagvast PVC) – eisen en beproevingsmethoden
NEN-EN-ISO 9080: 2012	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation
ISO 9852: 2007	Unplasticized poly(vinyl chloride) (PVC-U) pipes - Dichloromethane resistance at specified temperature (DCMT) - Test method
NEN-EN-ISO 12162: 2009	Thermoplastics materials for pipes and fittings for pressure applications - Classification, design coefficient and designation

NEN-ISO 16422: 2014	Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure – specifications
NEN-EN-ISO 16871: 2003	Plastics piping and ducting systems - Plastics pipes and fittings - Method for exposure to direct (natural) weathering