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Information and Guidance Note

GUIDANCE FOR THE SELECTION, PROPERTIES AND USE OF ELASTOMERIC SEALS AND SEALING COMPONENTS

CONTENTS

1. SCOPE AND GENERAL OBJECTIVES

This document is intended to form the basis for the development of harmonised standards for elastomeric sealing components used in water pipelines and fittings. It does not contain details of tests and test limits but identifies the properties which should be addressed in appropriate National Standards. Some guidance on selection, storage and use of elastomeric sealing components is also provided to assist in the development of appropriate tests. Note that some tests are already detailed and available in National Standards.

This guidance covers the selection, properties, storage and installation requirements used in pipelines and fittings for the Water Industry. It is restricted to drainage and potable water applications.

It covers 'O'-rings and other ring seals which are compressed during installation and operation to provide water tightness by their design and hydraulic pressure, and also the sliding and moving elastomeric components of valves and fittings which provide a seal.

This guidance also applies to composite seals when the elastomeric component is exposed to the water in the pipeline.

2. GENERAL PROPERTIES FOR PIPELINE SEALING COMPONENTS

Examples of polymers that may commonly be used in the formulation of seals and seal components are:-

natural rubber, styrene butadiene rubber, ethylene propylene terpolymer rubber, acrylonitrile butadiene rubber, polychloroprene rubber, provided that the compounded materials meet performance and quality requirements related to their use.

In particular, acceptable elastomeric materials should resist microbiological degradation, should not impair the quality of potable water and should not degrade in service to impair sealing performance. Some polymer materials will require special considerations for specific physical characteristics.

Since elastomeric materials are complex compounds and small changes to formulation and processing can affect performance, it is recommended that products are purchased that are certified to meet performance and quality requirements through an approved third party certification scheme.

3. RELEVANT TECHNICAL DEFINITIONS USED AND TYPES OF SEAL AVAILABLE

Elastomer - a material which shows rubber-like properties at the temperatures of use. Elastomers are normally, but not exclusively, lightly cross linked high molecular weight polymers with relatively low glass transition temperatures and with resistance to viscous flow at elevated temperature.

Compression set - after removal of compression stress, the component of the deformation not recovered.

Compression stress relaxation - the decay process over a period of time of the stress induced by compression deformation.

Sealing tightness - the ability to retain an effective seal against leakage.

Note Zero leakage is normally expected for fixed sealing components such as sealing rings and flange gaskets. In the case of sliding or moving components, a film of water may be permitted to be lost to assist lubrication and resistance to wear.

Working compression - the range of compression deformation over which the seal retains its functional performance under specified pressure conditions.

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TYPES OF SEAL -

(a) **Rolling ring seal -** ie, a seal which is rolled into the clearance between pipe spigot end and socket during installation.

(b) **Sliding ring seal -** a seal which is usually fixed onto the pipe spigot end or into the socket prior to assembly. The assembly may be assisted with the use of a lubricant compatible with the seal and sealing surfaces and should meet any contamination criteria in the case of potable water pipelines.

(c) **Flange gaskets -** flat section discs which may be clamped between pipe flanges to provide a seal over the whole width of the flange.

(d) **Lip seal -** in which the sealing power is partly provided by the pressure of water in the pipeline forcing contact between a moulded lip on the seal and the sealing surfaces of the pipe.

(e) **Coatings on valve faces and seats -** which provide a seal against internal pressure actuating on the closed valve.

(f) **Shaft or spindle seals -** in which the seal prevents leakage as a result of rotational movement of the shaft or spindle.

4. PERFORMANCE AND PRODUCT CONTROL CRITERIA

Performance and product quality control criteria are summarised in Table 1. It is useful to consider the need for these tests under three categories: (a) physical property measurements (b) ageing property measurements and (c) design factors. The actual values required will be dictated by the rubber type, formulation and cure as well as the design and end-use expectations for the component.

(a) **Physical properties** are normally measured for product quality control. These include tensile strength, elongation at break, hardness, abrasion and tear strength. Hardness properties are also used as a general means of characterising rubber components (see section 5).

(b) **Ageing properties** are normally determined by compression set, stress relaxation, water absorption, ozone resistance, effects of heat, micro-biological deterioration and resistance to chemicals. Many of these tests are time related and should be carried out over sufficiently long times to reflect performance in use. Predictable acceleration of the ageing process by heat is often limited. A sealing component requiring long term service in compression should be expected to retain a residual resiliance and sealing force under service conditions of temperature and hydrostatic pressure.

(c) **Design factors.** The acceptance of a sealing component to perform its function and maintain a seal under practical service conditions will be determined both by its physical and ageing properties as well as design factors. Design factors include sealing tightness, dimensional tolerances, appearance and finish, effect of the material on water quality, installation and assembly properties and interaction with other components. Some design factors are used for type approval of the rubber component, eg. effectiveness of the design for sealing tightness, whereas other design related factors are the basis of critical product quality control tests, eg. dimensions.

Table 1 Performance and product control test criteria, water (W) and drainage (D) pipelines.

Criteria	Performance	Product Control
Tensile strength	√	√
Elongation at break	√	√
Hardness	√	√
Compression set at 23°C 70 hours	√	
Compression set at 70°C 22 hours	√	
Stress relaxation	√	
Water absorption	√	
Low temperature hardness change		
Ozone test	√	
Splice test - where applicable	√	√
Accelerated ageing 70°C 168 hours followed by:	√	
Tensile strength change	√	
Elongation at break change	√	
Hardness change	√	
Microbiological deterioration	√	
Effects on water quality	W only	
Appearance and finish		√
Dimensional tolerances		√
Marking		√
Tear resistance	√	√
Special Considerations		
Resistance to chemicals	√	
Interaction with other components	√	
Installation/assembly properties	√	
Abrasion resistance	√	
Sealing tightness	√	
Adherence of coatings	√	
Certification	√	√

Specific test methods and limits should be developed for appropriate National Standards. A comprehensive range of acceptable test methods are identified in United Kingdom, German and Dutch specifications for rubber seal components (see BS 2494 and appropriate DVGW W 270 and KIWA NEN 7103 specifications for tests and test limits).

5. GUIDANCE ON SELECTION AND USE OF PIPELINE SEALING COMPONENTS

5.1 CATEGORIES OF USE

Table 2 Categories and examples of sealing component uses.

Category	Examples
1. Continuous static stress criteria.	Flange gaskets, rolling ring seals and other compression ring seals.
2. Static and frictional stress criteria.	Valve spindle seals and lip seals.
3. Moving components.	Valve faces and seats.

5.2 HARDNESS

Within each Type category, rubber sealing components are classified into several limiting hardness ranges, between 36 and 90 IRHD for category 1, 44 and 90 IRHD for category 2, and 60 and 90 IRHD for category 3. The hardness should be within 3° IRHD of the specified nominal.

The hardness required for the sealing ring is determined by the design of the joint and the material from which the pipe is made and is usually specified by the manufacturer of the joint for which it is to be used. The nominal ring hardness for composite rings containing more than one rubber compound refers to the part of the ring providing the sealing function, usually the softest part of the ring. It is advisable to use rubber with hardness of 76° IRHD or above in flange joints as softer materials may be distorted as the joints are tightened. After disassembly of joints, replacement rings may be required and the manufacturer of the joint should be consulted to ensure that rings of suitable hardness and design are ordered.

5.3 APPEARANCE AND FINISH

To provide an adequate seal, rubber sealing components should be smooth and free from air marks and other blemishes. The material forming the seal should also be homogeneous and free from porosity as judged without magnification on the surface or on any cut section.

The moulding flash should not impair the sealing properties.

5.4 DIMENSIONAL TOLERANCES

Rubber sealing components may be produced by moulding or by cutting and joining vulcanised lengths of extruded section. The dimensional tolerances should be specified.

5.5 SPLICE JOINTED RINGS

Rings manufactured from cut and joined lengths of extruded section should show no signs of separation at the splice joint. The two ends of the section at the joint should not be displaced relative to each other and any excess solution should have been carefully trimmed off the joint by the manufacturer.

5.6 MARKING

Each seal or parcel of seals where the marking is not practicable, should be marked clearly and durably, as listed below, such that the sealing capability is not impaired.

(a) Nominal size
(b) Manufacturer's identification
(c) Standard with the seal type as a suffix, eg BS 2494: W
(d) The quarter and year of manufacture.

The following information is also desirable:

(e) The abbreviation for the rubber, eg EPDM - Ethylene - Propylene Diene Terpolymer
(f) The type of joint for which the seal is intended.

5.7 EFFECTS ON WATER QUALITY

Seals in contact with potable water should meet the requirements for the National regulations for effects of materials on water quality. (See Annex 1).

5.8 MICROBIOLOGICAL DETERIORATION

Rubber sealing ring materials have been shown to degrade in service by microbiological attack. Accelerated tests have now been developed which should be included in performance based specifications (eg BS 2494). The alternative is to specify formulations which are known to be acceptable with the disadvantage of restricting future development of materials.

5.9 RESISTANCE TO CHEMICALS

For seals to be used in drainage applications, the effect of chemicals that may present in trade effluents on the rubber should be considered. For specific applications, the manufacturer of the joint should be consulted and given full details of any chemicals likely to be present in the effluent.

5.10 STORAGE

The following points should be noted:-

(a) The storage temperature should be below 25°C and preferably below 15°C.
(b) The seals should be protected from light, in particular strong sunlight and artificial light with a high ultra-violet content.

(c) The seals should not be stored in a room with any equipment capable of generating ozone, eg mercury vapour lamps, high voltage electrical equipment, which may give rise to electric sparks or silent electrical discharges.
(d) The seals should be stored in a relaxed condition free from tension, compression or other deformation. For instance, they should not be suspended from any part of the circumference.
(e) The seals should be maintained in a clean condition.

5.11 PIPE SEALING RING INSTALLATION

Special care should be taken to ensure that sealing rings are not displaced or distorted during the jointing operation. It is advisable to lubricate the rings evenly with a lubricant suitable for use with the rubber compound from which rings are made. The manufacturer should be contacted for his recommendations. For all potable water applications, the lubricant should comply with national regulations for effect of materials on water quality.

5.12 INTERACTION BETWEEN SEAL COMPONENTS AND OTHER MATERIALS

Any interaction affecting the physical properties of the seal material or adherence of the seal in the case of moving components, need to be assessed; eg after compression contact at elevated temperature.

5.13 QUALITY ASSURANCE CERTIFICATION

It is recommended that products are purchased that are certified to meet performance and quality control requirements through an approved third party certification scheme.

This third party certification scheme should confirm:

(i) The product description;
(ii) acceptable instructions for processing and control of the manufacturing process to be recognised quality management system standards;
(iii) information on the permitted composition of the product and tolerance for ingredients.

ANNEX 1

Specifications concerning the characteristics of rubber gaskets for pipelines for the conveyance of potable water

Group of Tests	Tests	COUNTRY					
		Belgium	Germany	UK	France	Italy	The Netherlands
Organoleptic characteristics	Taste	√	√	√	√		√
	Odour	√	√	√			√
	Colour	√	√	√			
	Turbidity	√	√	√			
	Tendency to foam		√				
Toxicity	Cytotoxicity			√	√		
Overall migration	Overall migration	√				√	
	TOC	√	√		√		
	COD	√					
	BOD_7				√		
Specific migration	Positive list	√	√		√	√	√
	Migration of specific substances		√		√	√	√
	Toxic metals			√	√		
Microbiological proliferation	Visible growth		√				
	Counting of specific bacteria	√			√		
	MDOD						
	mean dissolved oxygen difference	√		√			
Microbiological deterioration	Microbiological deterioration			√	√		√
Oxidant consumption	Consumption of						
	Cl_2		√		√		
	ClO_2				√		
	O_3				√		
	KMO_4				√		