13 Gaskets

13 Gaskets

Buried ductile iron pipelines are almost without exception assembled using push-in joints. The gaskets for the TYTON® and STANDARD systems are extremely important. They are chambered compression gaskets with special fixing profiles. Their sealing function is ensured throughout the entire working life of the pipeline. The requirements for the material of the gasket concentrate on tightness over the long term. By using different source materials the rubber can be adapted to the requirements of the relevant medium.

13.1 General

It is not possible to provide constant checking and monitoring of buried pipelines. Therefore the long-term reliability of the gaskets in the pipe joints is particularly important.

The reliability and durability of the sealing material used contributes to a high degree to the security of the pipeline. This security serves to protect our most essential food – drinking water.

Gaskets are also a reliable means of preventing impurities and pollution of the groundwater caused by the escape of waste water and gases. The different fields of application often demand the use of different types of gaskets which need to be produced from high quality elastomer materials. The need for joints which are going to remain tight over the long term is reflected in a range of requirements for strength, resistance to deformation under pressure (resilience), ageing characteristics and chemical resistance.

By far the largest number of iron pipes are used in buried pipelines with push-in joints. Because of this the TYTON® and STANDARD systems have gained huge significance over the course of decades of practical applications.

A decisive factor in the tightness of push-in joints is the adaptability of a profiled rubber gasket. Because of its high degree of elasticity and durability, rubber is a particularly good sealing material.

Although in the past only gaskets made of vulcanised natural rubber (NR) were used, over the last 25 years or so gaskets have been exclusively made of synthetic rubber, which is superior to natural rubber in terms of chemical and temperature resistance as well as durability. EPDM (ethylene propylene diene monomer) is used for drinking water and NBR (acrylonitrile butadiene elastomer) is used for waste water. The field of application for push-in joints according to EN 545 [13.01], e.g. for drinking water, ranges from 0 °C to 50 °C for EPDM gaskets.

For waste water as per EN 598 [13.02] the upper limit for NBR gaskets depending on nominal sizes 45 °C (up to and including DN 200) and 35 °C (above DN 200).

For applications above these temperatures it is recommended that other synthetic elastomers are used, such as FPM (fluoro rubber) because of their resistance at higher temperatures.

Materials standard EN 681-1 [13.03] applies to gaskets in drinking water and waste water pipelines.

In the context of European construction products regulations, EN 681-1 [13.03] has since been harmonised to include the CE marking requirement. The national requirements for the production and testing of gaskets for push-in joints in ductile iron pipes are summarised in DVGW test specification VP 546 [13.04], to become DVGW worksheet W 384 [13.05].

13.2 Types of gaskets

13.2.1 TYTON® gasket

The profile of the TYTON® gasket is shown in cross-section in **Fig. 13.1.** It consists of a combination of two types of rubber: the one with a hardness of 55 IRHD (International Rubber Hardness Degree) is designed for optimum sealing function and long-term elasticity (sealing part).

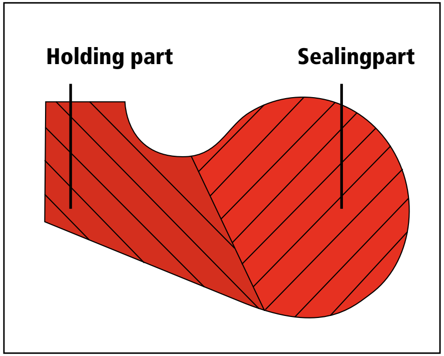

Fig. 13.1:
Cross-section of a TYTON® gasket

Fig. 13.2:
TYTON® gasket DN 300

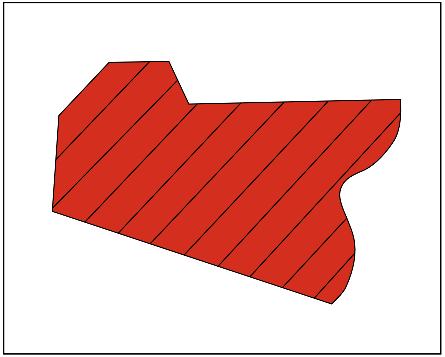

Fig. 13.3:
Cross-section of a STANDARD gasket

Fig. 13.4:
STANDARD gasket DN 300

The other part, with a hardness of 85 IRHD, has the job of keeping the gasket in place during the assembly of the joint (holding part).

Because the sealing part adapts itself to fit between the inside of the push-in joint and the outside of the pipe, high restoring forces are produced. The effect is to seal the joint, not only under low and high internal pressures but also in case of positive and negative outside pressures.

The TYTON® gasket **(Fig. 13.2)** is standardised in DIN 28603 [13.06] for the nominal sizerange from DN 80 to DN 1400. Depending on the area of use, as a rule it consists of synthetic rubber qualities EPDM or NBR.

13.2.2 STANDARD gasket

Fig. 13.3 shows the STANDARD gasket in cross-section. As with the TYTON® gasket the joint is sealed by the restoring force of the radially compressed ring.

The gasket consists of a homogenous rubber material with a hardness of 67 IRHD. The STANDARD gasket **(Fig. 13.4)** is standardised in DIN 28603 [13.06] for the nominal sizerange from DN 80 to DN 2000.

13.2.3 Flat gaskets

Flat gaskets are used for sealing flanged joints **(Fig. 13.5)**. The sealing effect is produced by the fact that two flanges are pressed against each

Fig. 13.5:
Example of a flat gasket to DIN EN 1514-1 [13.07]

other by means of bolts and nuts. Between the two flanges is the gasket, which ensures the sealing function by means of high contact pressure.

Flat gaskets generally consist of rubber with a hardness of < 80 IRHD. A steel core vulcanised into the rubber effectively prevents the joint from being displaced or blown out under high stresses.

Flat gaskets are available for all current nominal sizes, e.g. DN 80 to DN 2000, and for nominal pressures up to PN 63 (depending on nominal size). Their dimensions are specified in EN 1514-1 [13.08]. National requirements for production and testing can be found in DVGW test specification VP 547 [13.09], to become DVGW worksheet W 385 [13.10].

13.3 Properties

Elastomer gaskets have the task of reliably sealing pipe joints over decades. The following properties are essential:

- hardness,
- tensile strength,
- elongation at break,
- compression set,
- stress relaxation,
- resistance to ageing,
- behaviour in the cold,
- ozone resistance,
- chemical resistance.

13.3.1 Hardness

The hardness of rubber is its relative resistance to the penetration of an object. In order to test hardness, the test methods according to Shore-A and IRHD are used. In EN standards, rubber hardness is stated according to IRHD.

In order to determine rubber hardness according to Shore-A, simple hand-held test apparatus can be used **(Fig. 13.6)**. Measurement according to IRHD is more complicated. Therefore it is only used if there are higher requirements set for the measurement in terms of precision and reproducibility. The hardness depends on the composition of the rubber and its vulcanisation. Because these parameters necessarily modify other properties of a rubber material as well, the requirements for gasket materials are often summarised as hardness classes. The hardness of push-in joint gaskets is coordinated with the geometric shape and construction of the pipe joint.

Hardness is determined over the whole ring or on standard test pieces taken from the gasket or on sample plates of the mixture used.

Fig. 13.6:
Durometer for measuring rubber hardness according to Shore-A

13.3.2 Tensile strength and ultimate elongation

Tensile strength and ultimate elongation are properties of rubber which are easily determined. Ageing effects, which can be traced back to oxidative degradation, can easily be recognised by changes in tensile strength and ultimate elongation among other things.

13.3.3 Compression set

Good compression behaviour is necessary in order to ensure the function of the gasket even when the joint moves.

The sealing chamber gap of the pipe joint which is formed between socket and pipe must be permanently filled with rubber even during the settlement of the pipe in such a way that the gasket applies sufficient contact pressure force to the sealing surfaces.

Plastic (= permanent) deformations of the gasket, referred to as the compression set (CS), are to be taken into account right from the point of determining the dimensions and tolerances of all connection parts and when selecting the quality of rubber to be used.

$$CS = \frac{b}{a} \cdot 100\ [\%] \qquad (13.1)$$

The compression set according to **Equation 13.1** is determined on cylindrical specimens which are pressed together for a specified length of time at a given temperature in the axial direction by 25 % **(Fig. 13.7, a)**.

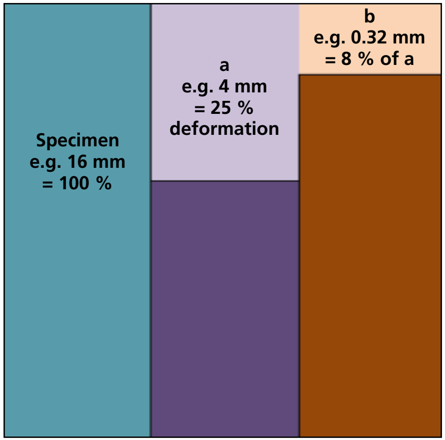

Fig. 13.7:
Definition of the compression set (CS) according to equation 13.1

With an ideal elastic behaviour, the specimen would resume its initial dimensions after the pressure is released. However the test shows that the specimen retains a slight permanent deformation **(Fig. 13.7, b)**, which is referred to as the compression set and stated as a % of the total deformation a.

13.3.4 Stress relaxation

As well as the compression set, stress relaxation is another measure of the elasticity of a rubber gasket. For the seal to have good durability, the gasket must have the lowest possible degree of stress relaxation.

Compressive stress relaxation (CSR) and compression set (CS) are identically loaded in the test period (25 % deformation). While with the CS it is the deformation path which determines the result, with CSR it is the residual stress which gives the result.

Stress relaxation is more difficult and expensive to determine and requires a longer time, which is why the compression set is preferred for routine testing.

The restoring force occurring with a constantly held deformation is measured as a function of time. The decrease in the restoring force over time, measured as a % of the initial value, is the stress relaxation.

13.3.5 Ageing

For a joint to remain tight and problem-free over decades, in addition to the elastic properties, the ageing behaviour of the rubber has a decisive role to play. Ageing is essentially influenced by light, oxygen, temperature and medium.

Therefore ISO 2230 [13.11] specifies that gaskets should be stored in cool and dark conditions.

The ageing behaviour is usually tested by means of a 7-day ageing test at +70 °C. Here the changes in hardness, tensile strength and elongation at breakmeasurements are compared with the condition as new.

13.3.6 Behaviour in the cold

At low temperatures, the hardness of rubber increases. This behaviour is reversible and does not cause any loss of quality. When it warms up again the rubber reverts to its original properties.

The change in properties brought about by cooling should however not exceed a certain level with rubber gaskets so that no difficulties occur during assembly at low temperatures. The following note has therefore been included in the assembly instructions for gaskets for ductile iron pipes:

Practical tip:
At temperatures below 0 °C gaskets may be subject to a certain increase in hardness. With assembly temperatures below 0 °C the gaskets should therefore be stored at a temperature above +10 °C wherever possible in order to simplify assembly. The gaskets should only be taken out of storage (e.g. in a heated contractor's shed) shortly before assembling the joints. In order to test the behaviour of the gaskets when cold, the increase in hardness after storage in the cold is measured (70 hours at -10 °C). For higher requirements there is also the possible option of cold testing at -25 °C as per EN 681-1 [13.03].

13.3.7 Ozone resistance

A particular form of oxidative degradation – ozone cracking – is tested by checking ozone resistance.

For the test, a specimen of rubber is stretched and exposed to an ozone-charged atmosphere at a specified temperature and for a certain time. At the end of the test, no cracks should be visible on the surface of the rubber.

13.3.8 Chemical resistance

When they are used in drinking, untreated and industrial water pipelines, gaskets for push-in joints are not subject to any particular stresses as regards their chemical resistance.

However, for use in sewage drains and pipelines the gasket's resistance to waste water is to be established in accordance with EN 681-1 [13.03].

This is tested and evaluated on the basis of the change in volume of a specimen in accordance with ISO 1817 [13.12] after 7 days storage in distilled or deionised water at 70 °C. More far-reaching requirements are to be determined in accordance with EN 681-1 [13.03].

13.3.9 Time of storage

In order to guarantee a supply of gaskets which meets market requirements, longer-term storage is usual and necessary. In individual cases this may lead to storage for a number of years; however, because of the special formulation of the gaskets as regards their length of use, this is possible without problem as long as the prescribed storage conditions are observed.

According to ISO 2230 [13.11] the storage period should not exceed the storage times stated in **Table 13.1** (extract).

Table 13.1:
Extract from storage times as per ISO 2230 [13.11]

Material [a]	Storage time [b]	Extended storage time [b]
NR, SBR	5 years	+ 2 years
NBR, HNBR, IIR, CIIR, BIIR	7 years	+ 3 years
EPDM, FKM, VMQ	10 years	+ 5 years

[a] Selection specific to application as per ISO 2230 [13.11]
[b] Checking and evaluation as per ISO 2230 [13.11]

13.4 Gaskets for drinking water pipelines

TYTON® and STANDARD gaskets for use in drinking water pipelines are predominantly in EPDM as per EN 681-1 [13.03]. They should not affect the colour, the odour, the taste and the bacteriological properties of the drinking water.

The requirements for these gaskets are determined in DVGW test specification VP 546 [13.04], to become DVGW worksheet W 384 [13.05] in future. This defines the requirements with respect to hygiene in the rubber guidelines of the German Environmental Agency (UBA) [13.13] and the requirements with respect to microbiology of DVGW worksheet W 270 [13.14].

13.5 Gaskets for sewage drains and pipelines

Sewage drains and pipelines must be durably tight. For this reason, in addition to a functioning pipe and joint system, the gasket requires a rubber quality which offers the most durable possible resistance to the conditions to be expected in a sewage pipeline, above all from aggressive media. As a rule, gaskets in NBR are used for this.

In order to provide evidence of the resistance of NBR material against the organic impurities most commonly found in waste water, extensive investigations have been carried out [13.15], [13.16] and [13.17].

More far-reaching information on gaskets as regards technique and application can be found in **Chapters 8 and 9**.

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