Test Methods for Special Properties of the most important Sealing Materials

O-RING PRÜFLABOR RICHTER

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The standard tests, such as hardness, tensile test, compression set, etc., can be carried out on standard specimens made from test plates of all elastomeric sealing materials. However, some sealing materials have special features in the polymer or the compound that are characteristic only for them. Usually there are two or more variations of this parameter (columns "Parameter" and "Property of Parameter") and thus resulting special properties (column "Effect of Parameter") of the material. The following table is intended to list the possible test methods that can be used to track down these special properties.

Note for the user: You can start anew in the table with each row via the Material column. It is structured in such a way that you do not need the knowledge from previous rows, as everything is explained again in the respective row. Please note that this table does not claim to be complete, it only covers the most frequently occurring special properties in our daily testing work. If you cannot find your special requirement in this list, please do not hesitate to contact us.

Material	Parameter	Property of Parameter	Effect of Parameters	Possible Test Method
NBR	ACN-contentt	high	• Low cold flexibility • Good oil and hydrocarbon resistance	➢ DSC (Differential Scanning Calorimetry - determination of glass transition temperature) ➢ TR 10 test (ASTM D 1329/ ISO 2921 test to determine cold flexibility) ➢ Immersion tests (to determine oil and hydrocarbon resistance)
		low	• Good cold flexibility • Low oil and hydrocarbon resistance	

Material	Parameter	Property of Parameter	Effect of Parameters	Possible Test Method
NBR	Plasticiser content	high	• High shrinkage in paraffin-based oil	➢ IRM 901 test (IRM 901 is a paraffinic oil that extracts the plasticiser from the compound). ➢ TGA (Thermogravimetric Analysis = determination of the compound components, including the plasticiser content).
NBR	Use of ozone protection agents (waxes or PVC content)	high	• Delayed cracking (ozone cracks occur to a lesser extent when the gasket is strained and exposed to ambient air).	➢ Ozone test (after immersion in ozone, the damage is assessed on the basis of reference images, see ISO 1431, DIN 53509) ➢ TGA (Thermogravimetric analysis = determination of compound components, also used as PVC detection (chlorine separation); ozone protection is sometimes improved by a PVC content in the polymer).
NBR	Curing system	Sulphur	• Standard curing	➢ CS (= compression set test, gives an indirect indication of the cross-linking)
		Peroxide	• Improved compression set	
NBR / PVC-Blends	PVC-content	high	• Improved hydrocarbon resistance • Lower cold flexibility • Poorer long-term sealing effect • Improved ozone resistance	➢ TGA (thermogravimetric analysis = determination of the ingredients of the compound, also used, among other things, as PVC detection (chlorine separation)). ➢ CS (= compression set test, provides information on plastic deformation under long-term and/or high-temperature load) ➢ Immersion tests in high swelling media (e.g. IRM 903)
HNBR	Hydrogenation	partially hydrogenated	• Moderate heat and ozone resistance	➢ Ozone test (after exposure to ozone, the damage is assessed on the basis of reference images). ➢ Heat ageing (change in hardness after exposure to hot air).
		fully hydrogenated	• Improved heat and ozone resistance	
EPDM	Curing System	sulphur	• Poor CS after 24h / 150°C • Relatively high elongation at break	

Material	Parameter	Property of Parameter	Effect of Parameters	Possible Test Method
			• Good tear propagation resistance	➢ CS (= compression set test 24h at 150°C: Sulphur-cured compounds have a CS >50% even after perfect vulcanisation). ➢ Tensile test (to determine the elongation at break) ➢ Tear propagation resistance (an elastomer sample is torn under defined conditions and the resistance it offers against this is measured).
		Peroxide	• Good CS after 24h / 150°C • Poor tear propagation resistance	
EPDM	Ethylene content in the polymer	high (i.e. >60 – 65%)	• High stability • Poor cold flexibility	➢ TR 10 test (ASTM D 1329/ ISO 2921 test to determine cold flexibility) ➢ CS at low temperatures (the compression set at low temperatures determines the resilience of a compressed material in the cold). ➢ Comparison of CS, stress relief methods A+B (in accordance with ISO 815) (Method B gives significantly worse values than method A, as the polymer is already partially frozen at room temperature).
EPDM	Diene content in the polymer	high (i.e. >6%)	• Poor ageing resistance • Poor long term CS	➢ Heat ageing (After exposure to hot air, the test specimens are subjected to mechanical tests. The results are compared with the initial condition). ➢ Significant differences can already be seen after 70h at 150°C. ➢ Long-term CS (compression set test over a period of at least 168h/150°C for compounds with peroxide cross-linking).
EPDM	Plasticiser content	high	• Poor ageing resistance • Shrinkage in silicone oil, acetone, brake fluid or water	➢ Volume change after heat ageing (70h at 150°C). ➢ TGA (thermogravimetric analysis = determination of ingredients of the compound) High proportion of volatile substances, low proportion of pyrolysable substances.

Material	Parameter	Property of Parameter	Effect of Parameters	Possible Test Method
				➢ Negative volume change (=shrinkage) after immersion in silicone oil, acetone, brake fluid or water
FKM	Curing System	Bisphenol	• Good CS • Higher processing reliability • Poorer resistance to hot water and highly additivated oils	➢ CS in hot water (= compression set test in the medium hot water) ➢ Immersion in additivated oils (after immersion in hot additivated oils, the test specimens are subjected to mechanical tests. The results are compared with the initial condition).
		Peroxide	• Improved resistance to hot water and highly additivated oils	
FKM	Fluorine content	low	• Low glass transition temperature • Higher swelling in FAM B	➢ DSC (Differential Scanning Calorimetry - determination of glass transition temperature) ➢ TR 10 test (ASTM D 1329/ ISO 2921 test to determine cold flexibility) ➢ Immersion in FAM B or M15 (immersion in FAM B or M15, which causes many elastomers to swell strongly ==> a mere swelling test is sufficient!)
VMQ	Heat stabiliser	high	• Very good heat resistance	➢ Heat ageing (After exposure to hot air, the test specimens are subjected to mechanical tests. The results are compared with the initial condition. ==> Usual temperatures are 200-250°C).
VMQ	Sufficient Post-curing after processing (4h/200°C)	done	• Good CS	➢ CS (= compression set test 24h at 150°C: Sufficiently post-cured mixtures have a CS < 10-20%).
		Not done	• Poor CS	➢ CS (= compression set test 24h at 150°C: Inadequately post-cured mixtures have a DCSVR of > 30-40%).
VMQ	Polymer blend	Polymer with low vinyl content mixed with small amount of	➢ Good tear propagation resistance (as crack propagation is prevented by different polymer structure)	➢ Tear propagation resistance in accordance with ISO 34-1 Meth. A strip test (an elastomer sample is torn under defined conditions and the resistance

Material	Parameter	Property of Parameter	Effect of Parameters	Possible Test Method
		polymer with high vinyl content		it offers against this is measured. Good values for tear propagation resistance are >10N/mm)
VMQ	Calcium carbonate filled blend	Necessary quantity to improve tear propagation resistance	• Good tear propagation resistance (>10 N/mm according to ISO 34-1 Meth. A, as free calcium carbonate particles serve as a centre of energy dissipation and prevent crack propagation).	➢ Tear propagation resistance in accordance with ISO 34-1 Meth. A strip test (an elastomer sample is torn under defined conditions and the resistance it offers against this is measured. Good values for tear propagation resistance are >10N/mm).
PU (Elasto-mer, kein TPE!)	Predominant type of polyol in the polymer	Subtype AU (polyether-urethane rubber)	• Poor hydrolysis resistance (= poor hot water resistance)	➢ FTIR spectroscopy (non-destructive testing to determine the polymer type, using an infrared spectrum). ➢ Hydrolysis test (after immersion in hot water, the test specimens are subjected to mechanical tests. The results are compared with the initial state).
		Subtype EU (polyether-urethane rubber)	• Improved hydrolysis resistance	
TPE-U = Thermo-plast. Elastomer	Sufficient Post-curing after processing	Sufficitently done	• High strength properties	➢ Tensile test (Tempered materials usually have up to twice the strengths of untempered materials).

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