General Technical Data and Materials

Technical Principles

General Technical Data

ISO Tolerances, Selection – in µm –

Nominal dimension range [mm]		Piston guides	Groove base for two-piece piston seals	Groove base for piston seals	Simmerring shaft		piston rods		Simmerring (housing), rod guides, wiper housing		Groove base for rod seals		Simmerring housing, special cases
									Cylinder bores				
over	to	h8	h9	h10	h11	f7	f8	e8	H8	H9	H10	H11	f8
1,6	3	0	0	0	0	−6	−6	−14	14	25	40	60	20
		−14	−25	−40	−60	−16	−20	−28	0	0	0	0	6
3	6	0	0	0	0	−10	−10	−20	18	30	48	75	28
6	10	0	0	0	0	−13	−13	−25	22	36	58	90	35
		−22	−36	−58	−90	−28	−35	−47	0	0	0	0	13
10	14	0	0	0	0	−16	−16	−32	27	43	70	110	43
14	18	−27	−43	−70	−110	−34	−43	−59	0	0	0	0	16
18	24	0	0	0	0	−20	−20	−40	33	52	84	130	53
24	30	−33	−52	−84	−130	−41	−53	−73	0	0	0	0	20
30	40	0	0	0	0	−25	−25	−50	39	62	100	160	64
40	50	−39	−62	−100	−160	−50	−64	−89	0	0	0	0	25
50	65	0	0	0	0	−30	−30	−60	46	74	120	190	76
65	80	−46	−74	−120	−190	−60	−76	−106	0	0	0	0	30
80	100	0	0	0	0	−36	−36	−72	54	87	140	220	90
100	120	−54	−87	−140	−220	−71	−90	−126	0	0	0	0	36
120	140	0	0	0	0	−43	−43	−85	63	100	160	250	106
140	160	−63	−100	−160	−250	−83	−106	−148	0	0	0	0	43
160	180												
180	200	0	0	0	0	−50	−50	−100	72	115	185	290	122
200	225	−72	−115	−185	−290	−96	−122	−172	0	0	0	0	50
225	250												
250	280	0	0	0	0	−56	−56	−110	81	130	210	320	137
280	315	−81	−130	−210	−320	−108	−137	−191	0	0	0	0	56

Nominal dimension range [mm]		Piston guides	Groove base for two-piece piston seals	Groove base for piston seals	Simmerring shaft		piston rods		Simmerring (housing), rod guides, wiper housing		Groove base for rod seals		Simmerring housing, special cases
									Cylinder bores				
over	to	h8	h9	h10	h11	f7	f8	e8	H8	H9	H10	H11	f8
315	355	0	0	0	0	−62	−62	−125	89	140	230	360	151
355	400	−89	−140	−230	−360	−119	−151	−214	0	0	0	0	62
400	450	0	0	0	0	−68	−68	−135	97	155	250	400	165
450	500	−97	−155	−250	−400	−131	−165	−232	0	0	0	0	68

Tbl. 1 Selection of ISO dimensions

Production tolerances

In the following chapter on materials will consider the technological quality of the highly elastic materials from Simrit, elastomers and plastomers as well as their applications with reference to their physical and chemical properties.
However, the dimensional accuracies achievable on the finished part with the above mentioned materials are also important. Designers and users very frequently aim for tolerance standards used for metal parts in mechanical engineering when they consider the tolerances required and the rules governing tolerances. However, narrow tolerances are generally not possible during the manufacture of sealing components and parts made of highly elastic materials.
The tolerances specified in DIN 7715 are generally applicable for sealing components and parts made of highly elastic materials, and assuming that there are no special requirements for specific products tolerance level M3 is considered applicable.
Deviations from the values specified in DIN 7715 must be agreed in consultation between user and manufacturer.

Permissible deviations for soft rubber parts (extract from DIN 7715 Part 2)

Dimension terms

A differentiation is to be made between two kinds of permissible dimensional deviations F and C for all moulded parts within the tolerance classes.

F: Deviations dimensions related to the mould. Dimensions that are not influenced by factors that affect shape such as compression and lateral offset between different moulded parts (high and low part, cores). See dimensions w, x and y in → Fig. 1.

C: Deviations in dimensions related to the mould closing. Dimensions that may be changed by changes in the density of the compression and the lateral offset between different moulded parts. See dimensions s, t, u and z in → Fig. 1.

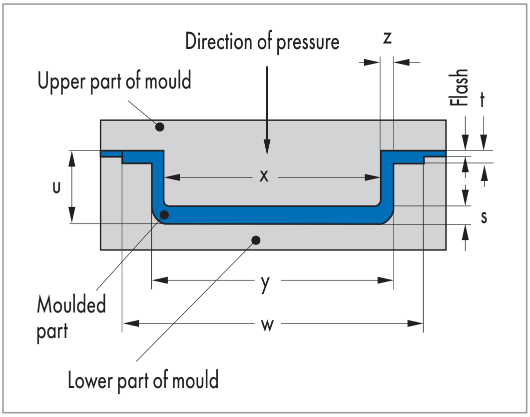
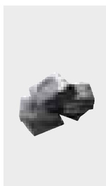


Fig. 1 Mould and moulded part



Nominal dimension range [mm]		Class M 1		Class M 2		Class M 3		Class M 4	
		F ±	c ±	F ±	c ±	F ±	c ±	F ±	c ±
over	to	Permissible deviations of dimensions in mm							
	6,3	0,10	0,10	0,15	0,20	0,25	0,40	0,50	0,50
6,3	10,0	0,10	0,15	0,20	0,20	0,30	0,50	0,70	0,70
10,0	16,0	0,15	0,20	0,20	0,25	0,40	0,60	0,80	0,80
16,0	25,0	0,20	0,20	0,25	0,35	0,50	0,80	1,00	1,00
25,0	40,0	0,20	0,25	0,35	0,40	0,60	1,00	1,30	1,30
40,0	63,0	0,25	0,35	0,40	0,50	0,80	1,30	1,60	1,60
63,0	100,0	0,35	0,40	0,50	0,70	1,00	1,60	2,00	2,00
100,0	160,0	0,40	0,50	0,70	0,80	1,30	2,00	2,50	2,50
Permissible deviations in %									
160		0,30	*)	0,50	*)	0,80	*)	1,50	1,50
*) Values only on agreement									

Tbl. 2 Extract from DIN 7715

Regardless of the values given in the tables, product-related tolerances are shown in:

DIN 3760 for rotary shaft seals
DIN ISO 3302-1 accuracy level M2 for diameter ranges of moulded diaphragms without fabric reinforcement
DIN ISO 3302-1 accuracy level M3 for diameter ranges of moulded diaphragms with fabric reinforcement and/or metal insert.
DIN 16901, Part 2 for manufactured parts made of injection moulded thermoplastics
DIN 7168 for machined parts made of PTFE or other thermoplastics

If tolerances must be less than in DIN 7168 for functional reasons, the "reduced material tolerances" given in → Tbl. 3 must be maintained. In exceptional cases consultation with us is recommended.

Nominal dimension range [mm]		Tolerance according to DIN 7168 average	Reduced working tolerances range
over	to		
	6	±0,1	0,10
6	30	±0,2	0,15
30	65	±0,3	0,20
65	120	±0,3	0,30
120	200	±0,5	0,40

Tbl. 3 Extract from DIN 7168

Nominal dimension range [mm] over	to	Pressed, bored and stamped parts	Flange thickness of pressed parts	Cut-outs and parts cut with a template	Batch vulcanised parts: Diameter	Batch vulcanised parts: Profile in cross-section and by the metre	Hoses and discs cut from hose: Outside Ø ground	Hoses and discs cut from hose: Outside Ø not ground	Hoses and discs cut from hose: Inside diameter	Hoses and discs cut from hose: Cut height
	3	±0,2[a]	±0,10	±0,3[b]	−0,15	±0,3[b]	±0,1	±0,3[b]	−0,15	±0,15
3	6	±0,2[a]	±0,15	±0,4[b]	−0,20	±0,4[b]	±0,1	±0,4[b]	−0,20	±0,20
6	10	±0,3[a]	±0,20	±0,5[b]	−0,25	±0,5[b]	±0,1	±0,5[b]	−0,25	±0,20
10	18	±0,3[a]	–	±0,6[b]	−0,30	±0,6[b]	±0,2	±0,6[b]	−0,30	±0,30
18	30	±0,4[a]	–	±0,8[b]	−0,40	±0,8[b]	±0,2	±0,8[b]	−0,40	±0,40
30	40	±0,5[a]	–	±1,0[b]	−0,50	±1,0[b]	±0,2	±1,0[b]	−0,50	±0,50
40	50	±0,5[a]	–	±1,0	−0,80	±1,2[b]	±0,2	±1,0[b]	−0,50	–
50	80	±0,6[a]	–	±1,0	−0,80	±1,2[b]	±0,3	±1,2[b]	−0,80	–
80	120	±0,8[a]	–	±1,0	−1,00	±1,4[b]	±0,3	±1,4[b]	−1,00	–
120	180	±1,0[a]	–	±1,2	−1,40	±1,6[b]	±0,4	±1,6[b]	−1,40	–
180	250	±1,3[a]	–	±1,2	−2,00	–	–	±2,0[b]	−2,00	–
250	315	±1,6[a]	–	±1,5	−2,80	–	–	±2,5[b]	−2,80	–
315	400	±2,0[a]	–	±1,5	−3,50	–	–	±3,0[b]	−3,50	–
400	500	±2,5[a]	–	±2,0	−4,50	–	–	±3,5[b]	−4,50	–
500		±0,5%[a]	–	±0,5%	−6,00	–	–	±1,0[b]	−6,00	–

Tbl. 4 Simrit tolerances derived from DIN 7715

a) Values corresponding to DIN 7715 accuracy level "fine"

b) Values corresponding to DIN 7715 accuracy level "average"

c) Values corresponding to DIN 7715 accuracy level "coarse"

Dimensional units – Selection –

Basic size	Basic unit	Unit character
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electrical current	Ampère	A
Temperature	Kelvin	K
Luminous intensity	candela	csd
Amount of substance	mol	mol

Tbl. 5 Base dimensions, base units

Size	Unit	Formula symbol	Units symbol
Acceleration	metres by seconds squared	b	m/s^2
Density	kilogram by cubic metre	ρ	kg/m^3
Pressure	Newton/m^2, Pascal	p	N/m^2, Pa
Energy, work	Joule	A, E	Nm = Ws
Area	square metre	A	m^2
Speed	meter by second	V	m/s
Force	Newton	F	N
Tension	Newton by square metre	σ	N/m^2, Pa
Viscosity (dynamic)	Pascal second	η	Pa S
Viscosity (kinematic)	square metre by second	μ	m^2/s
Volume	cubic metre	V	m^3
Electrical Voltage	Volt	V	W/A
Electrical resistance	Ohm	Ω	V/A
Electrical conductivity	Siemens	S	1/Ω
Inductance	Henry	H	Vs/A
Electric charge	Coulomb	C	As
Frequency	Hertz	Hz	1/s
Power	Watt	W	J/s
Luminous flux	lumen	1 m	cd sr
Illuminance	lux	1 x	1 m/m^2

Tbl. 6 Derived SI units with their own unit names

Size	Unit	Other commonly used official units
Angular momentum	N · m · s	–
Torque	Nm, J	–
Speed	2 · x · rad/s	s^{-1}
Modulus of elasticity	PA	N/mm^2, bar
Enthalpy	J	kJ
Enthalpy, specific	J/kg	kJ/kg
Entropy	J/K	kJ/K
Entropy, specific	J/kg · K	kJ/kg · K
Geometrical moment of inertia	m^4	cm^4
Force	N	kN, MN
Gas constant	J/kg · K	kJ/kg · K
Calorific value	J/kg, J/m^3	kJ/kg, kJ/m^3
Linear momentum	N · s	–
Mass moment of inertia	kg · m	g ·m, t · m^2
Moment	N · m	–
Unit conductance	W/m · K^4	–
Volume, specific	m^3/kg	–
Coefficient of heat transfer	W/m · K	–
Heat capacity	J/K	kJ/K
Heat capacity, specific	J/kg · K	kJ/kg · K
Thermal conductivity	W/m · K	–
Section modulus	m^3	cm^3

Tbl. 7 Further statutory, derived units of mechanics

Power of ten	Prefix	Prefix symbol
Decimal multiples		
10^{1}	deca	da
10^{2}	hecto	h
10^{3}	kilo	K
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
Decimal fractions		
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

Tbl. 8 Decimal multiples and decimal fractions of units

The rules allow decimal multiples and decimal fractions of units to be expressed by prefixing syllables.

Conversion tables

Force: 1 Newton (N) = 1 kg m/s²			
	N	kp	dyn
1 N	1	0,102	10^{5}
1 kp	9,81	1	$9{,}81 \cdot 10^{5}$
1 dyn	10^{-5}	$1{,}02 \cdot 10^{-6}$	1
–			

Energy, work, amount of heat: 1 Nm = 1 Joule (J) = 1 Ws				
	Nm	kWh	kpm	cal
1 Nm	1	$0{,}278 \cdot 10^{-6}$	0,102	0,238
1 kWh	$3{,}6 \cdot 10^{6}$	1	$0{,}367 \cdot 10^{6}$	$0{,}86 \cdot 10^{6}$
1 kpm	9,81	$2{,}72 \cdot 10^{-6}$	1	2,335
1 cal	4,19	$1{,}17 \cdot 10^{-6}$	0,428	1

Power: Watt (W) = 1 Nm/s = 1 J/s			
	W	kW	hp
1 W	1	10^{-3}	$1{,}36 \cdot 10^{-3}$
1 kW	10^{3}	1	1,36
1 hp	736	0,736	1
–			

Tbl. 9 Conversion factors for force, energy, work, heat and power units

Pressure, mechanical tension

1 Pascal (Pa) = 1 N/m² : 1 MPa (10^{6} Pa) = 1 N/mm² = 0,102 kp/mm²							
	Pa	MPa	bar	kp/cm²	mm Hg	atm	mWs
1 Pa = 1 N/m²	1	10^{-6}	10^{-5}	$1{,}02 \cdot 10^{-5}$	$7{,}50 \cdot 10^{-3}$	$9{,}87 \cdot 10^{-6}$	$1{,}02 \cdot 10^{-4}$
1 MPa = 1 N/mm²	10^{6}	1	10	10,2	$7{,}50 \cdot 10^{3}$	9,87	102
1 bar	10^{5}	0,1	1	1,02	750	0,987	10,2
1 kp/cm² (at)	9,81 · 104	$9{,}81 \cdot 10^{-2}$	0,981	1	736	0,968	10
1 mm Hg (Torr)	133	$1{,}33 \cdot 10^{-4}$	$1{,}33 \cdot 10^{-3}$	$1{,}36 \cdot 10^{-3}$	1	$1{,}32 \cdot 10^{-3}$	$1{,}36 \cdot 10^{-2}$
1 atm	1,013 · 105	0,1013	1,013	1,033	760	1	10,33
1 mWs	9,81 · 103	$9{,}81 \cdot 10^{-3}$	$9{,}81 \cdot 10^{-2}$	0,1	73,6	$9{,}68 \cdot 10^{-2}$	1

Tbl. 10 Conversion factors for pressure and mechanical tension units

units no longer permitted after 31.12.1977 (shaded cells)

Materials – Basics Concepts

Simrit processes highly elastic materials, polyurethane, thermoplastics and duroplastics to manufacture seals and moulded components.

General information on these materials is given below, particularly an overview of the materials, their structure and possible applications as well as their limitations in use.

- Natural and synthetic rubbers
  are high polymers, that can be changed to the highly elastic state by vulcanisation.

- Rubber and vulcanised rubbers are unspecified terms, which can be used to refer to base polymer as well as to vulcanised rubber. Vulcanisate
  is the vulcanised rubber.

- Elastomers
  are cross-linked polymers that are capable of absorbing large reversible deformations. They have the same meaning as vulcanised rubber.

- Thermoplastics
  are not cross-linked high polymers that can be permanently deformed by the action of pressure and temperature; they have a low degree of soft elastic properties.

- Thermoplastic elastomers
  are not cross-linked high polymers. The are proc-essed like thermoplastics and have highly elastic properties.

- Duroplastics
  are highly cross-linked polymers that have hard elastic properties at very low deformation.

The main structural features of polymer materials are explained in detail in DIN 7724.

Codes

Overview of codes for materials

Elastomers		
Chemical name for the base polymers	code according to	
	ASTM D 1418	ISO 1629
Acrylonitrile butadiene rubber	NBR	NBR
Hydrogenated acrylonitrile-butadiene rubber	HNBR	HNBR
Chlorine butadiene rubber	CR	CR
Carboxylated nitrile rubber	XNBR	XNBR
Acrylate rubber	ACM	ACM
Ethylene-acrylate rubber	AEM	AEM
Silicone rubber		
Methyl polysiloxane	MQ	MQ
Vinyl-methyl polysiloxane	VMQ	VMQ
Phenyl-vinyl-methyl polysiloxane	PVMQ	PVMQ
Phenyl-methyl polysiloxane	PMQ	PMQ
Fluorosilicone rubber		
Fluoromethyl polysiloxane	FVMQ	FVMQ
Fluoro elastomer	FKM	FKM
Perfluoro elastomer	FFKM	FFKM
Polyurethane rubber		
Polyester-urethane rubber	AU	AU
Polyether-urethane rubber	EU	EU
Ethyleneoxide-epichlorhydrin rubber	ECO	ECO
Epichlorhydrin polymer	CO	CO
Chlorosulfonated polyethylene	CSM	CSM
Natural rubber	NR	NR
Isoprene rubber	IR	IR
Polybutadiene rubber	BR	BR
Styrene-butadiene rubber	SBR	SBR
Ethylene propylene diene rubber	EPDM	EPDM
Ethylene propylene copolymer	EPM	EPM
Butyl rubber	IIR	IIR
Chlorobutyl rubber	CIIR	CIIR
Bromobutyl rubber	BIIR	BIIR
ASTM = American Society for Testing and Materials; ISO = International Organization for Standardization; DIN = Deutsches Institut für Normung e.V.		

Tbl. 11 Overview of codes for materials

Thermoplastics		
Chemical name of the base materials	Code according to	
	DIN 7728, Part 1, ISO 1043.1	ASTM D 1600
Polytetrafluoroethylene	PTFE	PTFE
Ethylene tetrafluoroethylene copolymer	E/TFE	E/TFE
Perfluoroalkoxy copolymer	PFA	PFA
Polyvinyl chloride	PVC	PVC
Acrylonitrile-butadiene styrene	ABS	ABS
Styrene acrylonitrile	SAN	SAN
Polypropylene	PP	PP
Polyamide	PA	PA
Polyoxymethylene (polyacetal)	POM	POM
Polyphenylene oxide	PPO	PPO
Polysulphone	PSU	PSU
Polyetherblockamide	PEBA	PEBA
Polyether ketone	PEEK	PEEK
Polyetherimide	PEI	PEI

Tbl.12 Codes for thermoplastics

Thermoplastic rubbers	
Chemical name for the base polymers	ASTM code D 1418
Block polymer of styrene and butadiene	YSBR
Polyetherester	YBPO
Thermoplastic polyolefin	TPO

Tbl. 13 Codes for thermoplastic rubbers

Duroplastics		
Chemical name for the materials	Code according to	
	DIN ISO 1043.1	ASTM D 1600
Unsaturated polyester	UP	UP
Phenol formaldehyde	PF	PF
Urea formaldehyde	UF	UF
Glass fibre reinforced, unsaturated polyester resin	UP-GF	–

Tbl. 14 Codes for duroplastics

Simrit material codes

Materials from Simrit are named using codes and prefixed or suffixed code numbers, e.g. 72 NBR 902.

The prefix number describes the hardness of the material in Shore A.
The group of letters identifies the base polymer as per DIN/ISO 1629.
The number after the group of letters is an internal Simrit compound code number.

Summary of some trade names for elastomers and plastics

Elastomers	
Chemical name	**Trade names**
Acrylonitrile-butadiene rubber (NBR)	Perbunan, Hycar, Chemigum, Breon, Butakon, Europrene N, Butacril, Krynac, Paracril, Nipol, Nitriflex
Chlorine butadiene rubber (CR)	Neoprene, Baypren, Butaclor, Denka Chloroprene
Acrylate rubber (ACM)	Cyanacryl, Europrene AR, Noxtite PA, Nipol AR
Ethylene acrylate (AEM)	Vamac
Silicone rubber (VMQ, FVMQ and PVMQ)	Silopren, Silastic, Silicone, Rhodorsil
Fluoro elastomer (FKM)	Viton, Fluorel, Tecnoflon, Dai El, Noxtite
Perfluoro elastomer (FFKM)	Kalrez, Simriz, Chemraz
Polyurethane (AU and EU)	Vulkollan, Urepan, Desmopan, Adipren, Estane, Elastothane, Pellethane, Simputhan
Ethyleneoxide-epichlorhydrin rubber (ECO)	Epichlomer, Hydrin, Gechron
Styrene-butadiene rubber (SBR)	Buna Hüls, Buna SB, Europrene, Cariflex S, Solprene, Carom
Ethylene propylene diene rubber (EPDM)	Dutral, Keltan, Vistalon, Nordel, Epsyn, Buna AP, Royalene, Polysar EPDM
Butyl rubber (IIR)	Enjay Butyl, Esso Butyl, Polysar Butyl
Chlorosulfonated polyethylene (CSM)	Hypalon

Tbl. 15 Elastomers (trade names)

Plastics for seal applications	
Chemical name	**Trade names**
Acrylonitrile-butadiene styrene (ABS)	Cycolac, Novodur, Terluran
Acetal resin polyoxymethylene (POM)	Delrin, Hostaform C, Ultraform
Polyamide (PA)	Durethan, Dymetrol, Nylon, Rilsan, Ultramid, Vestamid
Polybutyleneterephthalate (PBTP)	Crastin, Pocan, Ultradur, Vestodur
Polyethylene (PE)	Alathon, Baylon, Hostalen, Lupolen
Polycarbonate (PC)	Lexan, Makrolon
Polyphenylene oxide (PPO)	Noryl
Polypropylene (PP)	Hostalen PP, Novolen
Polystyrene (PS)	Hostyren, Lustrex, Vestyron
Polytetrafluoroethylene (PTFE)	Algoflon, Fluon, Halon, Hostaflon, Teflon
Ethylene tetrafluoroethylene copolymer (ETFE)	Tefzel
Polyvinyl chloride (PVC)	Breon, Hostalit, Plaskon
Perfluoroalkoxy copolymer (PFA)	Teflon-PFA
Phenolic resin hard fabric	Ferrozell, Pertinax

Tbl. 16 Plastics for seal applications (trade names)

Classification according to ASTM D 2000/SAE J 200

This classification system is intended to assist the user in selecting the required materials from Simrit. It also enables the materials to be specified by using simple qualitative characteristics for Shore hardness, strength values, temperature and swelling behaviour, etc.

The following example illustrates the classification of the material 72 NBR 872 using this classification system. For detailed information on this system see the Annual Book of ASTM Standards "Rubber" Volume 09.01 and 09.02.
The ASTM classification for the individual Simrit materials can be found in the tables. For further information on materials from Simrit as per ASTM D 2000 consult www.simrit.de.

72 NBR 872 = M2 BG 714 B14 B34 EA14 EF11 EF21 EO14 EO34 F17		
Basic requirements		
M 2 BG 714		
M	=	values in SI units
2	=	quality
B	=	type (specified by heat resistance)
G	=	class (specified by resistance to swelling)
7	=	hardness as per Shore A = 70 ± 5
14	=	tensile strength = 14 MPa
Supplementary requirements		
B 14		
B	=	compression set
1	=	test duration 22 hours, solid test specimens
4	=	test temperature 100 °C
B 34		
B	=	compression set
3	=	test duration 22 hours, laminated test specimens
4	=	test temperature 100 °C
EA 14		
EA 1	=	swelling in distilled water, test duration 70 hours
4	=	test temperature 100 °C
EF 11		
EF 1	=	swelling in reference fuel A (isooctane), test duration 70 hours
1	=	test temperature 23 °C
EF 21		
EF 2	=	swelling in reference fuel B (isooctane): toluene/70:30), test duration 70 hours
1	=	test temperature 23 °C
EO 14		
EO 1	=	swelling in ASTM oil no. 1, test duration 70 hours
4	=	test temperature 100 °C
EO 34		
EO 3	=	swelling in IRM 903*, test duration 70 hours
4	=	test temperature 100 °C
F 17		
F 1	=	test of low temperature resistance method A, test duration 3 min.
7	=	test temperature −40 °C
* replacement product for ASTM oil No. 3		

Tbl. 17 Classification of a material from Simrit by example of 72 NBR 872

Testing and Interpretation Test Results

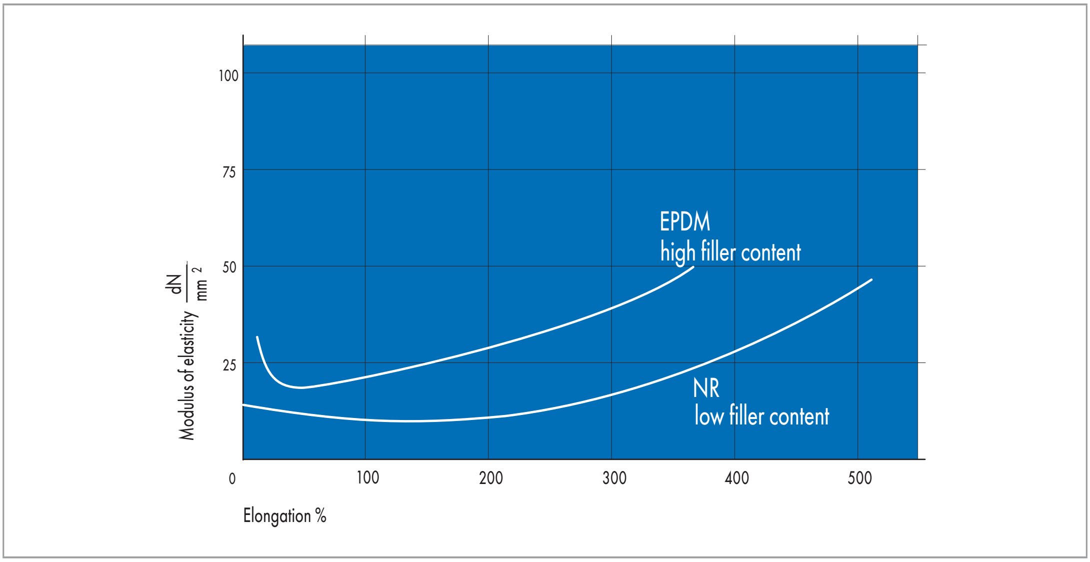
Highly elastic materials differ from other material not simply by the fact that they are "elastic". The properties are different in many aspects. The usual terminology from materials testing such as hardness or tensile strength must be interpreted differently by the engineer. New terms such as ageing resistance or deformation speed appear. There are virtually no constants; most properties are highly dependent on the temperature and other external factors, some are even dependent on the size and structure of the relevant test specimens or moulded parts.
There is a large number of synthetic rubbers. And these have a yet larger number of variations in the material composition. However, there are limits to how material properties can be combined. As an example, with NBR it is not possible to combine high oil resistance with optimum low temperature behaviour.
A range of material properties is interlinked due to chemical and physical reasons. If one property is changed, then other properties inevitably change as well. This may be an advantage for the specific application, but it may also have disadvantages.
taking this aspect into consideration, unnecessary requirements should not be placed on the material when drawing up specifications. This approach smoothes the way to a material to suit the requested application.

Physical properties

Hardness

The most common parameter used to characterise highly elastic materials is hardness. Testing is performed using test equipment to Shore A or D and IRHD. The highly elastic materials from Simrit are generally tested to Shore A.
In the test laboratory the measurements are performed under the conditions specified by DIN 53 505. Hardness according to Shore can also be measured with a handheld device. However, measurement uncertainties can often not be excluded here.
In many cases, however, usable relative or comparable values can be obtained if the standards are observe, and the following is heeded during measurements:

Higher measured values will be obtained if the sample is not thick enough.
The same applies if the contact pressure is too high. Conversely, measurements too close to the edge, e.g. on moulded parts that are too small, yield excessively low values.
The test specimens should be as flat as possible and not lie with a cavity. Always keep the sample and the measuring instrument parallel and observe the time for taking readings accurately.
Another measurement method in the test laboratory is to determine the international rubber hardness degrees (IRHD; DIN ISO 48) by means of the measurement of the penetration depth of a defined sphere under a defined force. With highly elastic materials the IRHD value is approximately equal to the Shore A hardness. Measured values determined by the two methods may be very different for materials that tend to be subject to plastic deformation.
A variant of this method with correspondingly reduced sphere diameter (0,4 mm) makes it possible to measure small and thin samples (referred to as micro-hardness, DIN ISO 48 Method M). This method is frequently used for measuring manufactured components. With this method there are, in addition to the above mentioned differences due to the various measurement processes, effects due to also additional influences resulting from the differences of the specimen surface caused the various measurement processes (unevenness, e.g. by grinding, curves because of the geometry of the component, surface hardening, coefficient of friction), which can result in even greater differences in values. Measured values derived from finished components generally do not conform to the values measured on the standard test specimens. When stating the hardness the measurement method must always be included, e.g. hardness 80 Shore A or hardness 72 IRHD. When testing the hardness of finished components the method must always be precisely defined by the supplier and the customer to prevent inaccuracy.
The tolerance for hardness measurements and hardness figures is generally ±5 degrees of hardness. This apparently relatively large range is necessary to take into account differences in various devices and testers and also the unavoidable production scatter.



Graph 1 Dependency of the modulus of elasticity on deformation (tensile trials) for two different vulcanisation processes

Tensile stress and modulus of elasticity

Like the hardness, tensile stress and modulus of elasticity are parameters for the deformability of elastic materials. The tensile stress measured in tensile trials in accordance with DIN 53504 at 100 or 300% elongation is defined as the force required for the related deformation divided by the original cross-section of the test specimen. The tensile stress is frequently incorrectly described as "modulus". The modulus of elasticity or elongation modulus is the tensile stress divided by the relative change in length (elongation). It is not a constant for highly elastic materials. Hooke's law $\sigma = E \cdot \varepsilon$, according to which the tension σ is proportional to the elongation ε, where the modulus of elasticity E represents the proportionality constant, is applicable to rubber only in a very limited deformation range, which can be different from material to material. The modulus of elasticity can increase and decrease with the elongation → Graph 1

The modulus of elasticity depends on the so called form factor, the ratio of loaded to unloaded surface on the component or test specimen. In this regard the loaded surface is considered to be an area under tension or compression (without the mating surface) and the unloaded area is the total of all areas where the specimen can freely stretch or compress. Both areas are measured in unloaded status. Thus the form factor F for an axially loaded cylinder is

$F = d/4h$ (d = diameter, h = height)

Additional modules

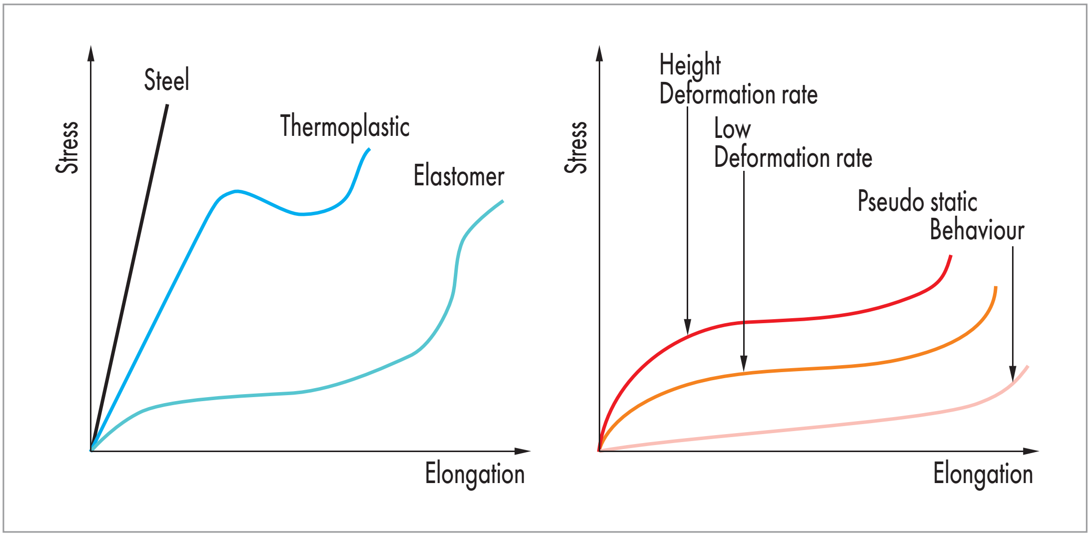
Other modules are also significant for the deformation properties. Shear modulus or modulus of elasticity in shear and dynamic moduli are important for vibration processes. They will not be described in more detail here.
Test procedures are defined in publications such as DIN 53513, DIN EN ISO 6721 and ASTM D 945 (YERZLEY testing).

Relationships between deformation properties and their parameters

Based on the prior statements, only an approximate relationship can be expected between the individual measurement parameters. The following approximation is applicable for shear modulus G and modulus of elasticity E, for highly elastic materials

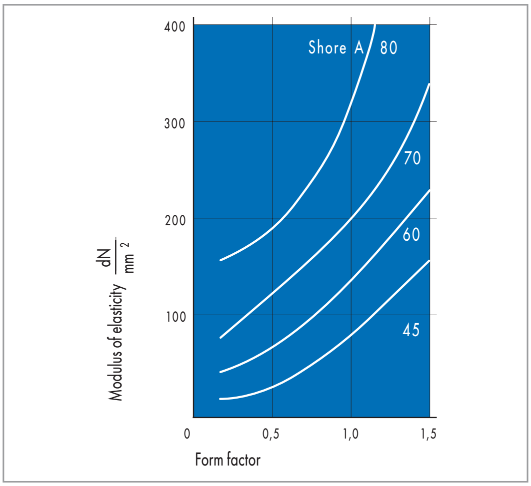
$G = 1/3\ E.$

The approximate relationship applies between the hardness in Shore A or IRHD and the modulus of elasticity at 5–10% compression, which is shown graphically in → Graph 4 .
However, the hardness is not generally related with the moduli for larger deformations, even if in general a material with greater hardness has higher moduli at the same time.



Graph 2 Tension-elongation graph.
Left: comparison of steel, thermoplastic, elastomer
Right: behaviour of elastomers at different deformation speeds.

The common factor in all deformation properties is that they are highly dependent on temperature and time. Time-dependency means that the speed of deformation (e.g. withdrawl velocity in tensile trials or the frequency for the dynamic modulus) or the time at which the measured value is read (e.g. measurement of hardness) affect the measured values.
There is no such thing as "the" modulus of elasticity of a highly elastic material, which is occasionally requested!



Graph 3 Dependency of the modulus of elasticity on the form factor (20% compression) at various hardness

Tensile strength and elongation at break

These values are only limited qualitative characteristics for assessing possible application options and service life of elastomer components, because only in exceptional cases are they subject to tensions or elongations that come close to the fracture values of the material. For example, in diaphragms the elongation near the clamping flange can reach very high values, which can lead to premature failure. In such cases the solution of the problem is not only to be found in the material but also in the design, as shown at the beginning of this chapter.
The values for tensile strength and elongation at break determined in accordance with DIN 53504 are used to compare the characteristics of materials, for identification and operation inspection as well as for determining the resistance against destructive influences (aggressive media, ageing).

Resistance to tear propagation

Additional information is obtained by testing the resistance to tear propagation in accordance with DIN ISO 34-1 as the force that is applied to a defined specimen for tear propagation based on the thickness of the sample. The values found here are to be used as a scale for the sensitivity of elastomers to tear propagation of cuts or cracks and are not required along with the tensile strength.

Because the results of the tear propagation test depend strongly on the specific test conditions and particularly on the shape of the specimen, the sequence used in the laboratory on the laboratory specimens for the various test methods does not need to match the sequence in practice. The test procedures and specimen shape must be given with the derived measured values.

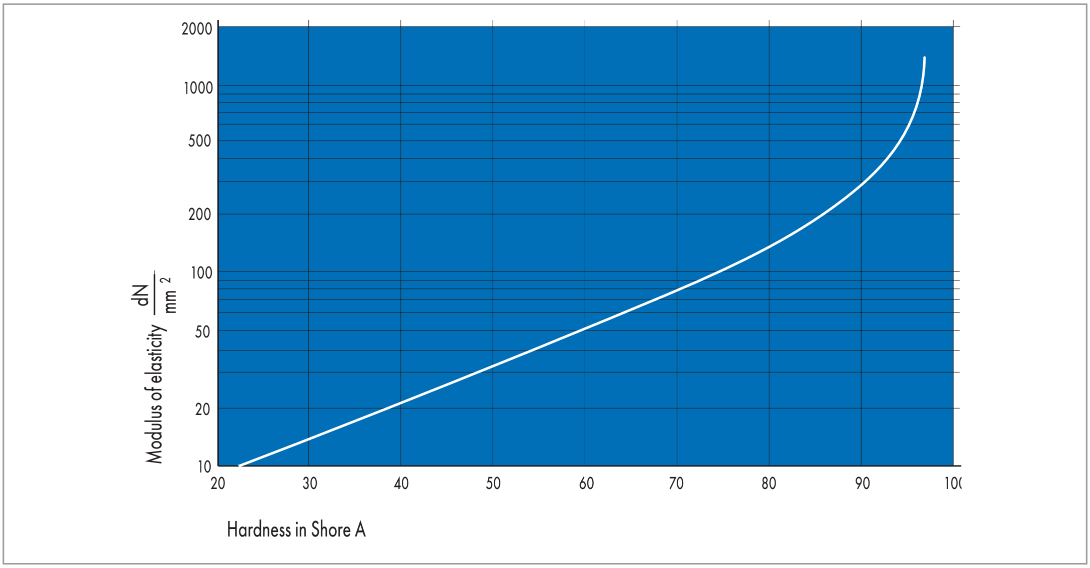
Elasticity and damping

The elasticity is, like the deformability, dependent on the temperature and particularly on the time sequence of the deformation process. The testing of impact elasticity for sealing components in accordance with DIN 53512 does not tell the user much about the elastic behaviour under operating conditions. It is frequently more useful to measure the spring back or the lasting deformation under test conditions, which can be selected in accordance with the operating conditions.
The mechanical damping is the reciprocal property to the elasticity. It can be determined using the method given for the measurement of the dynamic modulus.

A body is elastic if it resumes its original shape immediately after a forced deformation (e.g. steel spring). A body that retains its deformation is plastic or viscous (e.g. plasticine). A viscous-elastic component is comparable to both, where the elastic predominates in the case of highly elastic materials. A key feature of viscous-elastic behaviour is that the spring back to the original status does not occur immediately on release, but it is only attained gradually depending on the conditions. This is also significant for sealing components and can be specified by appropriate laboratory tests. The viscoelasticity is the actual cause for the specific physical behaviour of the highly elastic materials. Typical viscous-elastic characteristics are compression set, tensile relaxation and creep (→ Graph 7 and → Graph 9).

Other physical properties

Physical properties such as thermal expansion, friction behaviour, electric characteristics, permeability to gases or fluids etc. may be important for special applications. These issues will not be covered in further detail here.



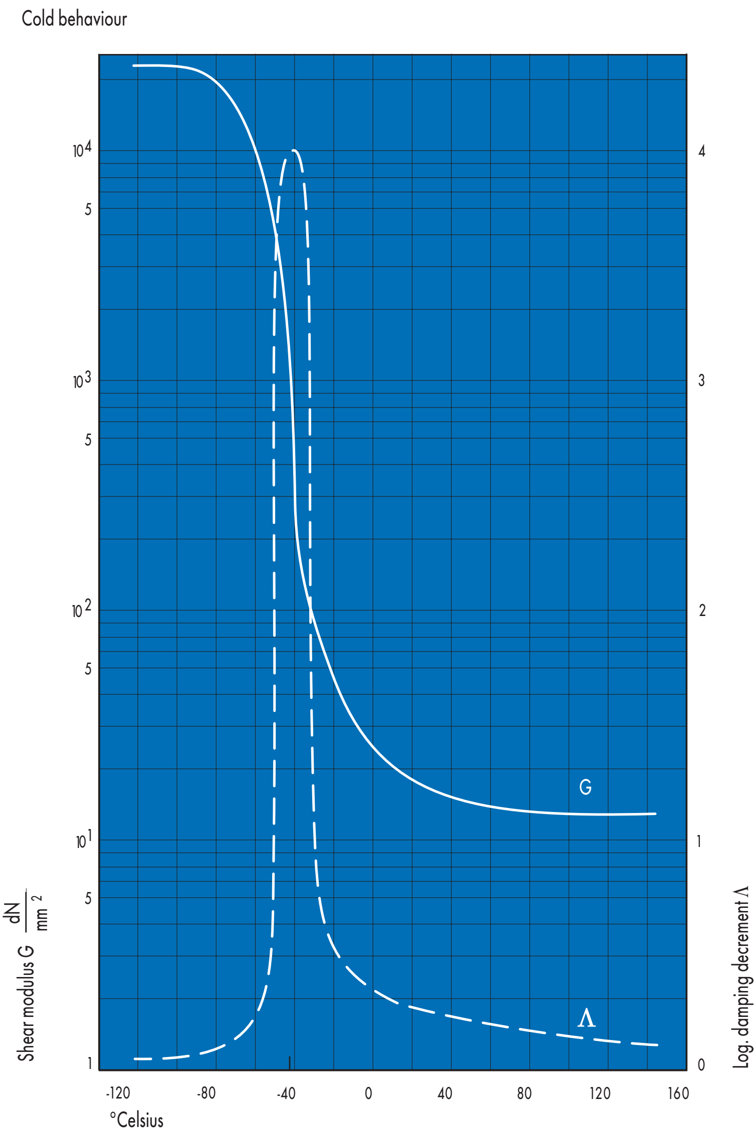
Graph 4 Relationship between hardness in Shore A and modulus of elasticity at approximately 10% compression set (form factor 0,2)

Temperature behaviour

As previously mentioned, the temperature has a significant influence on the physical properties of the highly elastic materials. → Graph 5 shows the dependence of the dynamic shear modulus G on the temperature (shear modulus measured in the torsion vibration test in accordance with DIN EN ISO 6721). The highly elastic region can be seen from right to left with an almost constant modulus, then with a steep rise the transition range and finally there is the glass state region, in which the rubber is hard and brittle, again with an almost constant modulus. When the temperature rises the cold brittleness disappears. The freezing process is therefore reversible. The transition from highly elastic to the glass state is particularly important, because in many cases it shows the low temperature limit. This transition, as shown in → Graph 4, is not sharp but extends over a specific range.

The range of the transition from the highly elastic range to the glass state is characterised by the glass transition temperature T_g (temperature of maximum of log. damping decrement Λ). However, this value can only be a general reference for the low temperature limit of the material, because in the practical application of an elastomer component it depends completely on the type of load involved. The same material will reach its load limit at a higher temperature when subjected to a sudden load at very high deformation speed than, for example, during a slow deformation. The torsion vibration test can be used to differentiate between different materials, but the temperature limit in practice must be tested when using the corresponding components.

Example:
With static contact seals heat is produced by the friction that occurs during motion. At temperatures where the risk of hardening due to freezing already exists, the frictional heat can suffice to keep the seal elastic, or quickly place the seal in a functional operating state after start of the motion. The testing of the low temperature behaviour is only worth while in the form of a material comparison in conjunction with experience on the engineering application.
The differences between various materials for low temperature use limits derived from the torsion vibration test and from use in practice are very close in many cases. If the cold limit for a material has been determined in practical trial (frequently very difficult to determine), the T_g values for the other materials can be used to make relatively reliable forecasts of their low temperature behaviour under practical use.



Graph 5 Torsion vibration test in accordance with DIN 53 445.
Dynamic shear modulus G and logarithmic decrement Λ of a material from Simrit based on CR

The situation is similar for the comparison of standard cold values that were measured under different laboratory test methods as for the comparison between the low-temperature limits determined in practical use and the glass transition state temperature measured in the torsion vibration test. Deviations of only a few degrees but also of 30 to 40 degrees can be found between different test methods.

The standard cold value must always include the measurement method used to determine it. The same methods as described above are applicable for transfer to the component behaviour in practical use. Various standard laboratory methods for characterising the low-temperature behaviour are described briefly below:

Differential Thermo-Analysis (DTA), Differential Scanning Calorimetry (DSC)

In this method (DIN 3761 Part 15) a small rubber specimen and an inert reference specimen are heated at a constant heating rate. The temperature difference between the sample and the reference sample is applied to the temperature. A constant of negative temperature difference is specified by change of the specific heat of the rubber material when the glass transition range is reached. The turning point of the glass stage of the DTA curve defines the standard cold value T_R.

Temperature retraction test

In this test (ASTM D 1329-79) a rod-shaped rubber specimen in elongated state is frozen in a temperature controlled bath and temperatures T_R 10, T_R30, ... are measured at which the elongation of the sample has been reduced by 10, 30, ... percent.

Cold brittleness temperature with impact load

The cold brittleness temperature T_s (DIN 53 546) is the temperature at which (after an increase in the temperature of surrounding coolant) all test specimens just do not break under a defined impact loading.
In addition information on the low-temperature behaviour can be derived from relatively simple tests. Examples are the cold bending test over a mandrel at a defined bending speed or the Shore hardness measurement at various temperatures.

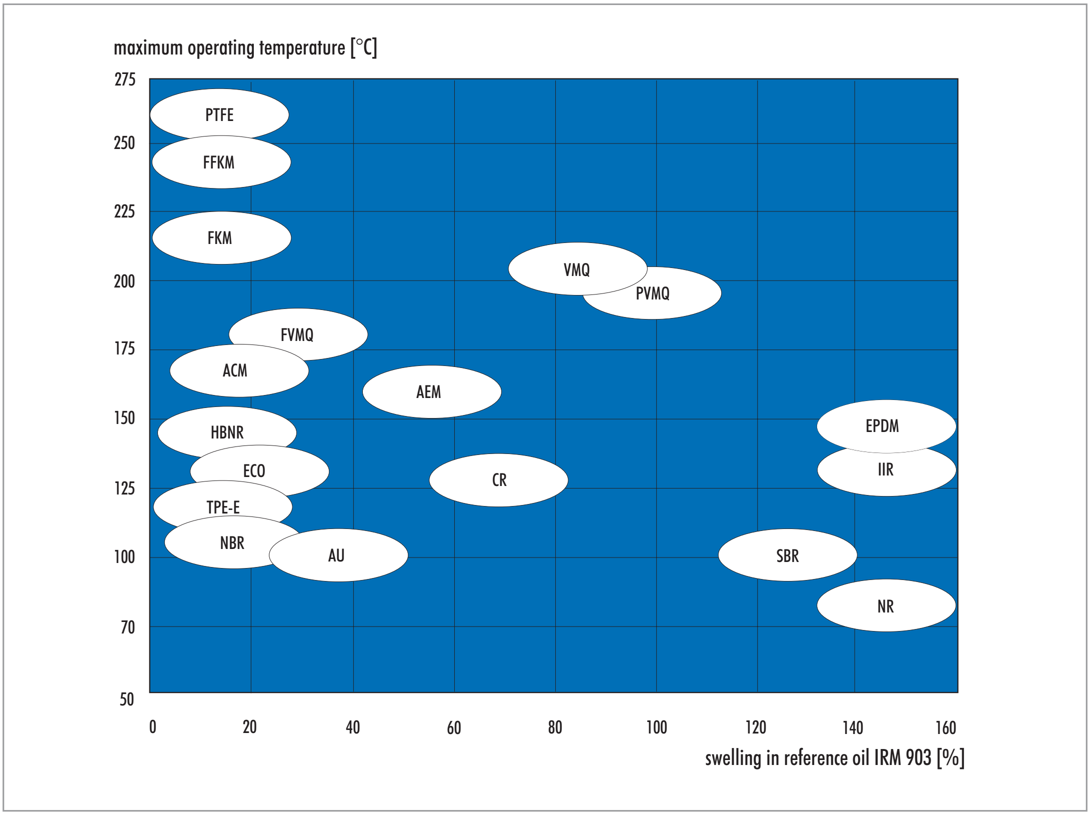
For example, the temperature at which the Shore A hardness is 90 points can be defined as the standard cold temperature. The sequence of the compression set at low temperatures also provides information on the temperature flexibility of the material. For example, the temperature at which the compression set is at 50% can be defined as the standard cold temperature.

Media resistance

The changes to the highly elastic materials caused by environmental and/or operating conditions are often much more significant than the initial values of the technological properties. The behaviour of the materials must be tested under practical conditions.

Swelling and chemical corrosion

The correct choice of a suitable material for seals frequently depends on the chemical resistance and the swelling behaviour of the material. The user should always be aware of which fluids or gaseous media come into contact with the material. The temperatures of the media also play an important role.
The consequences of a chemical effect are similar to those of ageing in hot air, i.e. softening or hardening, reduction of strength, elongation at break and elasticity, loss of tension and creep. Another result is volumetric change by swelling or shrinkage depending on whether additional materials are absorbed or extractable substances are dissolved out.A minor increase in volume by swelling is not a danger to the function of the elastomer seal with suitable design. In contrast, volume shrinkage will adversely affect the sealing function in the form of leakage. There are no elastomers that meet all requirements for oil resistance, heat and cold resistance equally. Therefore, the ambient medium and the temperature conditions of the application must be considered when selecting a suitable sealing material. The basic chemical principle applies: "the same substance dissolves the same substance". This means that polar elastomers (e.g. NBR) in polar media (e.g. glycol) swell greatly while non-polar elastomers such as EPDM in non-polar media (e.g. mineral oil) are not resistant. For more information on the suitability of elastomer materials in selected sealing media see the appendix to this chapter. (→ Page 948).



Graph 6 Heat and oil resistance (in ASTM Oil No. 3) of elastomers (in accordance with ASTM D 2000)

The testing behaviour against fluids, steams and gases is performed in accordance with DIN ISO 1817 in the medium used in the application, or in standardised testing fluids (e.g. ASTM Oil No. 1, IRM 902* and IRM 903**, ASTM Reference Fuel A, B and C, FAM test fuels).

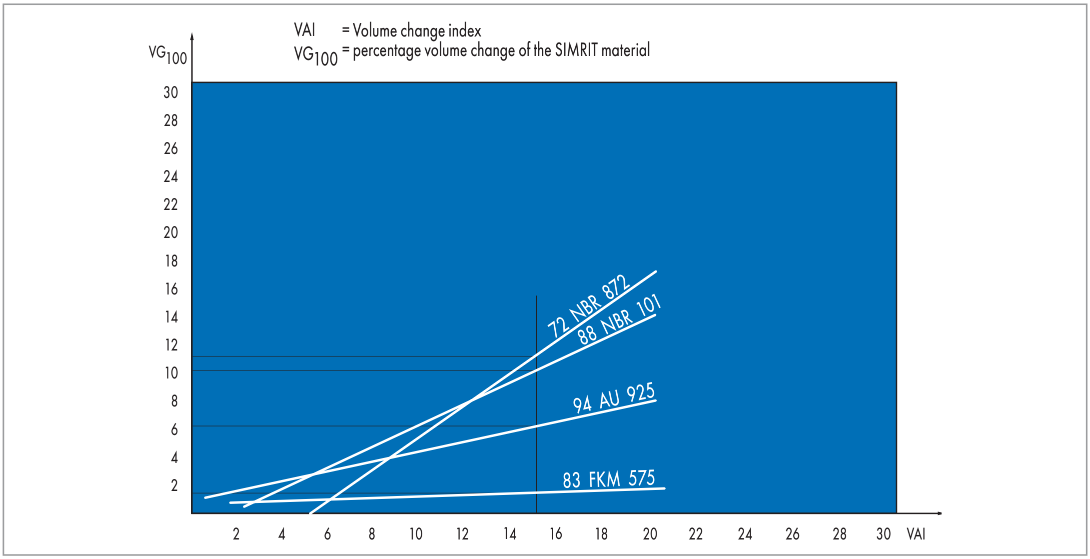
* Replacement product for ASTM Oil No. 2

** Replacement product for ASTM Oil No. 3

Volumetric change index

The regularity of the swelling effect of mineral oils in contact with highly elastic materials can be tested on standard reference elastomers. Such a NBR standard reference elastomer (SRE) has already been proposed as test material NBR 1 and is also standardised under DIN 53538. The volumetric change determinated on this SRE under standardised conditions in a mineral oil is referred to as the volumetric change index (VA) of the tested oil in accordance with a VDMA proposal.

If an elastomer material is left to swell to its saturation state in any oils, there is a linear relationship between the observed volumetric change of the elastomer in the oils and the volumetric change determined on the standard reference elastomer (SRE) in the same oils, i.e. the VAI of the oils, observed under similar conditions. If the maximum volumetric change of an elastomer in various oils is plotted on a coordinate system over the VAI values of the same oils, a straight line is derived that characterises the swelling behaviour (QVH) of the elastomer. A straight QVH line can be plotted for every elastomeric material. The maximum volumetric changes of the associated elastomers can be forecast for all oils with known VAI. These QVH straight lines are available for all materials from Simrit. Using this diagram, materials being considered for the respective applications can be combined with the suitable oils. The volumetric change index (VAI) is not specified by the oil manufacturers.



Graph 7 Swelling behaviour of materials from Simrit

Example: the following volumetric change values occur in a mineral oil with VAI 15:

Materials from Simrit	Volumetric change
83 FKM 575	1%
94 AU 925	6%
88 NBR 101	10%
72 NBR 872	15%

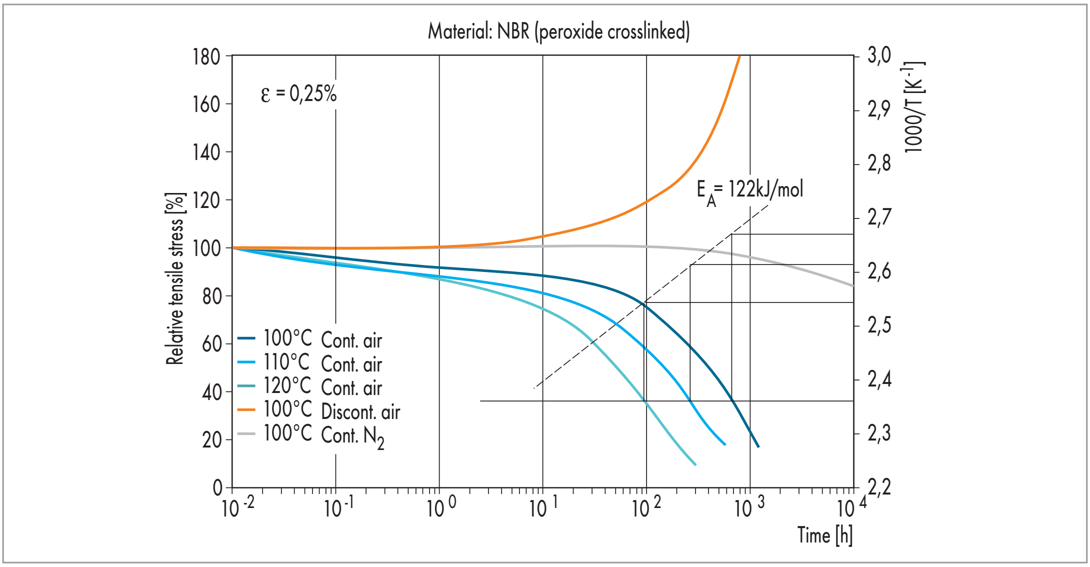
Heat resistance, ageing behaviour

Like all organic chemical products, the polymers on which highly elastic materials are based can be altered by the action of oxygen, wear and/or other media. As a result of these processes, referred to as ageing, important properties such as hardness, flexibility, elasticity can be adversely changed. The material can become susceptible to cracking and may break.
Heat accelerates the ageing processes. Exposure to light and radiation may also have destructive effects. The higher the temperature to which the material is subjected the lower the service life of a component. This means that there are different permissible maximum operating temperatures for short-term and continuous loading for the individual materials.

The respective limits depend primarily on the base polymer. Ageing can be tested over a reduced period by storage in a heating cabinet (DIN 53508). However, the test temperature and the actual operating temperature should be too different.
The changes in hardness, tensile strength and elongation at break as well as the compression set or the tensile relaxation are included in the assessment of the ageing behaviour.

Chemical tensile relaxation

An exact assessment of the ageing behaviour and an in-depth examination of the ageing mechanism enables measurement of the chemical tensile relaxation at various temperatures. Comparative measurements are also conducted in nitrogen or in fluid media to allow a better assessment of the various chemical ageing influences. An Arrhenius plot of the results enables extrapolation to long exposure periods at lower temperatures.



Graph 8 Predicted service life based on extrapolation of measured values of the tensile stress relation (material: NBR wetted with peroxide) measured in air and nitrogen at various temperatures. E = elongation, E_A = activation energy of the ageing process.

In thick test specimens the diffusion of the oxygen or ozone into the elastomer is the limiting factor for destruction of the elastomer matrix and the associated ageing processes. Therefore, thick elastomer components age more slowly than thin components in practice The known crack formation on stretched rubber parts exposed to weather is primarily caused by the ozone in the air. Procedures for testing ozone resistance are described in DIN 53509.

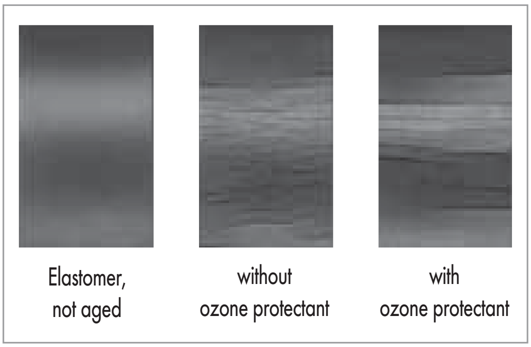


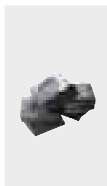
Fig. 2 Damage to elastomer by the effect of ozone

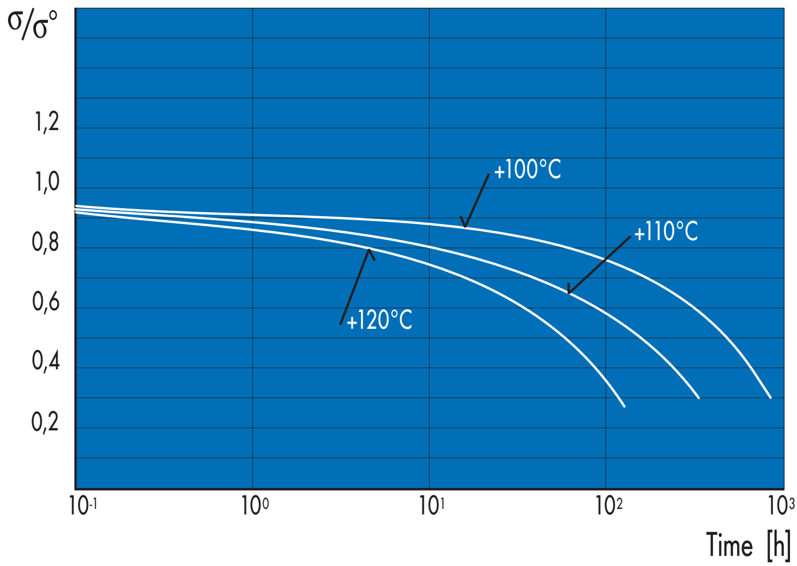
Service life

Static continuous load and continuous deformation

If an elastomer component is constantly deformed for a period, a certain degree of deformation remains after relaxation. The residual deformation, which is measured in a compression test in accordance with DIN ISO 815 and is given as a percentage of the original deformation, is referred to as compression set.

The compression set depends largely on the temperature and the duration of deformation. At lower temperatures the influence of the viscoelasticity is stronger and at higher temperatures the influence of ageing (for more information see → Explanation of DIN ISO 815).





Graph 9 Compressive stress relaxation of an elastomeric material at various temperatures

The compression set can be connected with the function of sealing components in same cases, e.g. for O-rings. The flow behaviour, the vulcanisation status and the heat resistance influence the test value. This means that the measurement of the compressive stress relaxation is more suitable (DIN 53537), because it gives a direct scale for the reduction of the contact pressure over time of a constantly deformed seal.
If highly elastic components are under constant load instead of constant deformation, the deformation increases over time. This is referred to as creep. Compression set, tensile relaxation and creep are related phenomena with the same causes. If the test temperatures for the base polymer are below the maximum permissible continuous operation temperature, compressive stress relaxation and creep follow an approximate logarithmic time law, i.e in practical terms they come to a stop after some time.

Dynamic loading, fatigue and service life

Destruction of rubber parts is the result of dynamic loading far more often than exceeding the strength or elongation limits once. Under continuously repeated deformation, the material is damaged as a result of internal friction, where initially small cracks can occur, which grow and ultimately lead to fracture.
Standardised methods for test conditions are specified in publications such as DIN 53522 and 53533.

Resistance to wear

This important property for friction loading is also strongly dependent on the operating conditions, such as the type of lubrication, material and roughness of the mating surface, sliding speed, slip, contact pressure, temperature.
Wear tests should therefore only be conducted with the finished product and under conditions as close as possible to the operating conditions.

Material models

The measured mechanical, thermal and dynamic values are the basis for the development of material models. Other than,for example, metal and ceramic materials, there is no linear connection between tension and elongation for elastomers. As a result it is not sufficient to use linear-elastic material models for simulations. Special models, referred to as hyperelastic material models, are used. They can be used to describe the behaviour of even very large elongations.

In addition to the static non-linear behaviour of elastomers the stiffness of the material depending on the speed of loading must be considered. Simrit has developed optimised material models for this purpose, which are still applicable for larger material deformations (>150%).

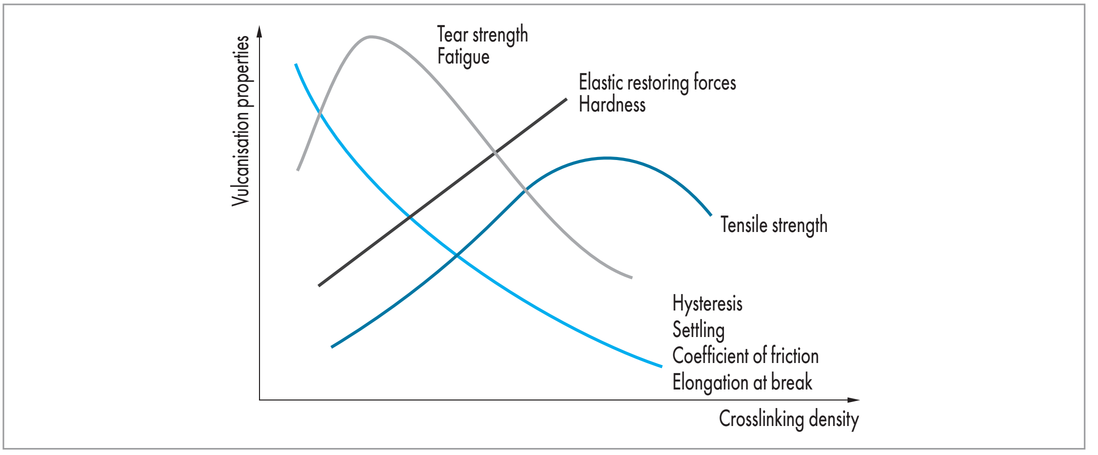
Additional information from component analyses and ageing tests lead to numerical analyses that give a comprehensive view of the service life of elastomer seals. Simulations with appropriate FEM models are used for optimising the topology and shapes of mechanically loaded components with consideration of moderate non-linearities and assurance of component function. For more information please contact your Simrit representative.

Properties of seal materials

The properties of a Simrit material are primarily determined by the base polymer. However, they can be varied in many ways depending in the mixing ration and can be adapted to the required application.

Cross-linking density

The cross-linking system determines the processing properties, the chemical structure of the polymer network and the physical properties of the elastomers. The two most common cross-linking types are sulphur cross-linking and peroxide cross-linking. Sulphur cross-linking is used primarily in cross-linking diene rubbers such as NR, SBR, BR, NBR or CR. Peroxide cross-linking can be used to cross-link rubbers without double links in the main chain. It also offers improved heat resistance, particularly with NBR. In addition to the rubber type, the degree of linked chemical inks between the polymer chains during vulcanisation depends primarily on the type and amount of the selected cross-linking system and is referred to as cross-linking degree or cross-linking density. The cross-linking density is very important for material properties such as hardness, tensile strength, elongation at break, friction, shrinkage behaviour and fatigue. With increasing cross-linking density modulus of elasticity, hardness and elasticity increase, while elongation at break, damping, lasting deformation decrease, and resistance to tear propagation and tensile strength reach and pass through a maximum.



Graph 10 Influence of cross-linking density on the elastomer properties

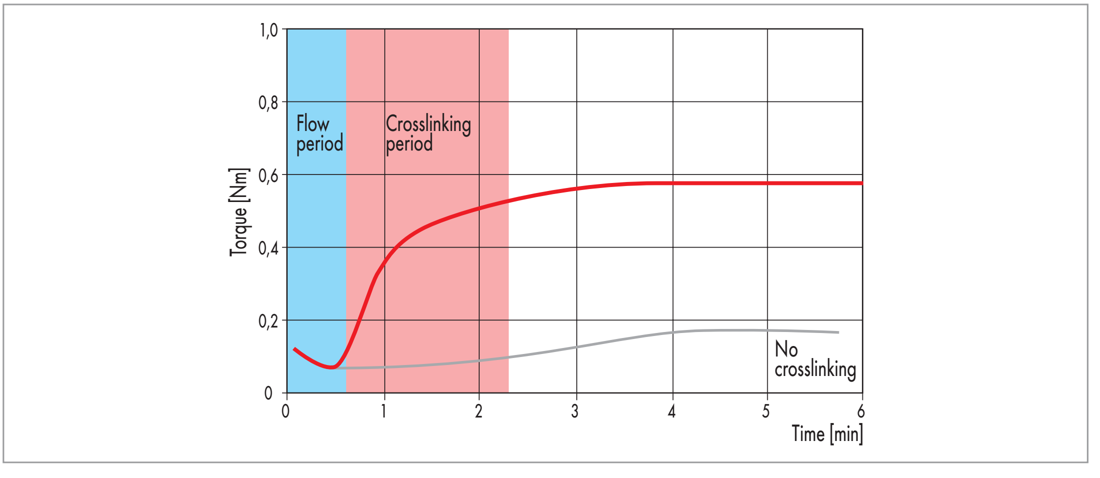
This means that at a specific cross-linking density an optimum for all material properties cannot be achieved. In general the cross-linking density is selected to achieve the appropriate physical properties for the application. The cross-linking reaction can be measured over time and used for assessment of the cross-linking degree by measurement of the torque, which is approximately proportional to the cross-linking degree. The vulcameter curve shows information on the mixture viscosity at the vulcanisation temperature. Three characteristic sections are distinguished: → Graph 10

1) The flow period covers the time interval from the start of measurement to the start of cross-linking, i.e. to the increase of torque. It identifies the range of viscous flow, which is used to fill the mould. During this period the torque initially decreases.

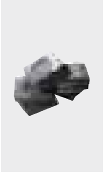
2) The cross-linking period shows information on the required times for the material to transition to the stable shape status.

3) Complete cross-linking is achieved when all possible cross-linking points have formed.

The characteristic properties and the resulting main areas of application of materials from Simrit are described in general terms below. Refer to the material tables for more detailed differences between individual materials.



Graph 11 Cross-linking characteristics of elastomers by measurement of the torque



General Material Descriptions

Elastomeric materials

ACM (Acrylate rubber)

It is a polymer made of ethyl acrylate or butyl acrylate with a minor addition of the monomers required for cross-linking. Elastomers based on ACM are more heat resistant than those based on NBR or CR. Simmerrings, O-Rings and moulded components made of material based on ACM are primarily used at higher temperature ranges and in oils with additives for which materials from Simrit of NBR are no longer sufficient, however materials based on fluorine elastomer and silicone rubber are not yet necessary. Resistance to ageing and to ozone are very good.

- Good swelling resistance in: mineral oils (engine, gearbox, ATF oils), also with additives.
- Heavy swelling in: aromatic and chlorinated hydrocarbons, alcohols, brake fluids with a glycol ether base, flame retardant hydraulic fluids. Hot water, steam, acids, alkalis, and amines have a destructive effect on the material
- Thermal application range: approx. −25 °C to +150 °C.

AEM (Ethylene-acrylate rubber)

Is a polymer made of ethylene methyl acrylate with carboxyl groups. Ethylene-acrylate rubber is more heat resistant than ACM and has properties between those of ACM and FKM.

- Good swelling resistance in: mineral oils with additives and based on paraffin, water and coolants. Good resistance to weather and ozone
- Heavy swelling in: ATF and transmission oils, mineral oils rich in aromatics, brake fluid on a glycol ether base, concentrated acids and phallic acid esters
- Thermal application range: approx. −40 °C to +150 °C.

AU (Polyurethane)

Polyurethane is a highly molecular organic material, in which the chemical structure is characterised by a large number of urethane groups. within specific temperature limits polyurethane has the characteristic elastic properties of rubber. Three components characterise the structure of the material:

- polyol
- diisocyanate
- chain extender.

Depending on the type, amount and reaction condition they are the determining factors for the properties of the resulting polyurethane material.
Polyurethanes have the following properties:

- high mechanical strength
- good wear resistance
- modulus of elasticity variable over a wide range
- good flexibility
- wide hardness range with good elasticity, (polyurethane closes the gap between stretchable softrubber types and brittle plastics)
- very good ozone and oxidation resistance
- good swelling resistance in mineral oils and greases, water, water-oil mixtures, aliphatic hydrocarbons
- application temperature range −30 °C to +80 °C, high-load resistant types up to above +100 °C in mineral oils.

Not resistant to polar solvents, chlorinated hydro-carbons, aromatics, brake fluids with glycol ether base, acids and alkalis.

BR (Polybutadiene rubber)

It is a polymer made of butadiene. It is characterised by high elasticity, abrasion resistance, very good heat and cold resistance properties and light elongation at break. It is used as blending agent with NR and SBR for tyres, drive belts, conveyor belts etc.

- Good swelling resistance in: dilute acids and bases, in alcohols and water.
- Heavy swelling in: hydro-carbons
- Thermal application range: approx. −60 °C to +100 °C.

CSM (Chlorosulfonated polyethylene)

- Good swelling resistance in: hot water, steam, water lye, oxidising media, acids, bases, polar organic media, ketones, flame retardant hydraulic fluids of the Group HFC and some types of the Group HFD, brake fluids on a glycol ether base
- Average swelling resistance in: aliphatic hydrocarbons and greases. Resistant in oxidising media, inorganic and organic acids and bases
- Heavy swelling in: aromatic and chlorinated hydrocarbons and esters
- Thermal application range: approx. −20 °C to +120 °C.

CR (Chlorine butadiene rubber)

It is a polymer based on chlorine butadiene. Elastomers with corresponding composition of Compound are characterised by chemical resistance, good resistance to ageing, weathering, ozone and flame resistance.

- Good swelling resistance in: mineral oils with high aniline point, greases, many refrigerants and water (with special composition of Compound)
- Average swelling resistance in: mineral oils, low molecular aliphatic hydro-carbons (petrol, isooctane)
- Heavy swelling in: aromatics, e.g. benzene, toluene, chlorinated hydro-carbons, esters, ethers, ketones
- Thermal application range: approx. −45 °C to +100 °C depending on composition (transient up to 130 °C).

ECO (Ethyleneoxide-epichlorhydrin rubber) CO (Polyepichlorhydrine)

It is a polymer made of epichlorhydrine and ethylene oxide.
Materials based on this rubber are characterised by low gas permeability, good resistance to ozone and weathering.

- Good swelling resistance in: mineral oils and greases, plant and animal-based oils and greases as well as aliphatic hydro-carbons, such as propane, butane etc. and petrol as well as water
- Heavy swelling in: aromatic and chlorinated hydrocarbons, flame retardant hydraulic fluids of the Group HFD
- Thermal application range: approx. −40 °C to +140 °C.

EPDM (Ethylene propylene diene rubber)

It is a polymer made of ethylene, propylene and a small proportion of a diene. Ethylene propylene rubber (EPM) is a polymer made of ethylene and propylene. Moulded parts and sealing components made of EPDM are preferred in washing machines, dishwashing machines and plumbing fittings. Seals made of this material are also used in hydraulic system with flame retardant hydraulic fluids of the Group HFC and Group HFD and in hydraulic brake systems. Elastomers made of EPDM have good resistance to ozone, ageing and weathering and are therefore ideal for manufacture of profile strips and sealing strips that are exposed to weathering.

- Good swelling resistance in: hot water, steam, water lye, oxidising media, acids,
  bases, polar organic media, ketones, flame retardant hydraulic fluids of the Group HFC and some types of the Group HFD, brake fluids on a glycol ether base
- Heavy swelling in: mineral oils and greases, petrol and aliphatic as well as aromatic and chlorinated hydro-carbons. Special lubricants are required for extra lubrication of the seals
- Thermal application range: approx. −50 °C to +150 °C.

FFKM (Perfluoro elastomer Simriz)

Special perfluorinated (i.e. completely free of hydrogen) monomers and corresponding compounding and process technologies can be used to manufacture materials with highly elastic properties that are very close to PTFE in media resistance and thermal resistance. Seals made of perfluororubber are used everywhere extreme safety standards are applicable and higher maintenance and repair costs exceed the price of the seals. Preferred areas are the chemical industry, oil-producing and processing industry, instrumentation and power station construction and aerospace industry.

- Thermal application range: −15 °C to +230 °C.

FKM (Fluoro elastomer)

Polymerisation of vinylidene fluoride (VF) and selective application of variable proportions of hexafluoropropylene (HFP), tetrafluoroethylene (TFE), 1-hydropentafluoropropylene (HFPE) and perfluor (methylvinylether) (FMVE) can be used to manufacture co, ter or tetrapolymers with various structures and fluoro content of 65–71% and as a result with different media resistance and cold flexibility. They are cross-linked by diamines, bisphenols or organic peroxides.
The special significance of the materials based on FKM is their high temperature resistance and chemical stability.
The gas permeability is low. In vacuum conditions elastomers made of FKM show minimum weight loss.
The resistance to ozone, weathering and light tearing is very good, as is the flame resistance.
Amines may have a destructive effect on the material and require a selection of suitable types as well as special composition of compound. A special elastomer group is copolymers made of TFE and propene with a relatively low fluoro content (57%). Materials using these elastomers have outstanding resistance to hot water, steam as well as amines or media containing amines with low swelling resistance to mineral oils.

- Good swelling resistance in: mineral oils and greases (including with most additives), fuels as well as aliphatic and aromatic hydro-carbons, some flame retardant hydraulic fluids and synthetic aeroplane engine oils.Newly developed peroxide cross-linked materials also have good resistance to media that have little or no compatibility to conventional FKM. For example, they are: alcohols, hot water, steam and fuels containing alcohol.
- Heavy swelling in: polar solvents and ketones, flame retardant hydraulic fluids, type: Skydrol, brake fluid on a glycol ether base
- Thermal application range: approx. −20 °C to +200 °C (transient up to +230 °C).
  Special types: −35 °C to +200 °C.

With suitable shaping and material compositions specially developed for such applications
seals and moulded components can also be used at lower temperatures.

FVMQ (fluorosilicone rubber fluoromethyl polysiloxane)

It is a methyl vinyl silicone rubber with fluorine-containing groups. Elastomers made of this synthetic rubber are significantly more resistant to swelling in fuels, mineral and synthetic oils than those made of silicone rubber.

- Thermal application range:
  approx. −80 °C to +175 °C
  (transient up to +200 °C).

HNBR (Hydrogenated acrylonitrile-butadiene rubber)

Made of normal NBR polymer by full or partial hydrogenation of butadiene components containing double bonds. With peroxide cross-linking this increases the heat and oxidation stability. High mechanical strength and improved abrasion resistance characterise the materials manufactured of it. Media resistance similar to NBR.

- Thermal application range:
  approx. −30 °C to +150 °C.

NBR (Acrylonitrile-butadiene rubber)

It is a polymer made of butadiene and acrylonitrile. The acrylonitrile content can be between 18 and 50% and it influences the following properties of the NBR sealing materials manufactured of it:

- swelling resistance in mineral oils, greases and fuels
- elasticity
- cold flexibility
- gas permeability
- compression set.

For example, an NBR material with 18% ACN content has a very good low-temperature flexibility up to approx. −38 °C with moderate oil and fuel resistance, while one with 50% ACN content and optimum oil and fuel resistance only has low-temperature flexibility up to only approx. −3 °C. With increasing ACN content the elasticity and gas permeability is reduced while the compression set is worse.
Materials from Simrit based on this synthetic rubber are suitable for a very large number of applications with their good technological properties.

In particular, the proven Simmerrings, sealing components for hydraulics and pneumatics as well as O-Rings are manufactured in large numbers of materials based on NBR. Freudenberg has more experience than all other seal manufacturers with this base elastomer.

- Good swelling resistance in: aliphatic hydro-carbons, e.g. propane, butane, petrol, mineral oils (lubricating oils, hydraulic oils of groups H, H-L and H-LP) and mineral-oil-based grease, flame retardant hydraulic fluids of the HFA, HFB and Group HFCs, plant and animal-based oils and greases, light heating oil, diesel fuel. Some materials are particularly resistant to: hot water up to temperatures of +100 °C (sanitary valves), inorganic acids and bases at reasonable concentration and temperature.
- Average swelling resistance in: fuels with high aromatic content (super fuels).
- Heavy swelling in: aromatic hydro-carbons, e.g. benzene, chlorinated hydro-carbons, e.g. trichlorethylene, flame retardant hydraulic fluids of the Group HFD, esters, polar solvents as well as in brake fluids on a glycol ether base.
- Thermal application range: depending on the composition of compound between −30 °C and +100 °C, transient up to 130 °C; at higher temperatures the material hardens. With special mixtures the cold flexibility is up to −55 °C.

NR (natural rubber)

It is a high polymer isoprene. The vulcanisates are characterised by high mechanical strength and elasticity as well as good low temperature behaviour. It is preferably used in manufacture of torsional oscillation dampers, engine mounts, machine bearings, rubber-metal suspension components, diaphragms, moulded parts etc.

- Good swelling resistance in: acids and bases at low concentration as well as in alcohols and water at not excessively high temperatures and concentration. Brake fluids on a glycol ether base, e.g. ATE-SL at temperatures up to 70 °C.
- Heavy swelling in: mineral oils and greases, fuels and aliphatic, aromatic and chlorinated hydro-carbons.
- Thermal application range: approx. −60 °C to +80 °C.Natural rubber may soften after initial hardening under extended effect of higher temperatures.

Silicone rubbers
VMQ (vinyl-methyl polysiloxane)
PVMQ (phenyl-vinyl-methyl polysiloxane)

They are high polymer organosiloxanes that are particularly noted for high thermal resistance, good cold flexibility, good dielectric properties, very good resistance to attack by oxygen and ozone, particularly low temperature dependency of technological properties. The gas permeability at room temperature is higher than for other elastomers. This is particularly important for thin-walled diaphragms.
The material is decomposed by depolymerisation when exposed to oxygen at higher temperatures.

- Average swelling resistance in: mineral oils (comparative to materials based on CR) and brake fluids on a glycol ether base. It can be used in water up to about +100 °C. Sufficient resistance in aqueous salt solutions, single and multiple value alcohols.
- Heavy swelling in: low molecular esters and ethers, aliphatic as well as aromatic hydro-carbons. Concentrated acids and alkalis, water and steam temperatures above approx. 100 °C have a destructive effect on the material.
- Thermal application range: approx. −60 °C to +200 °C (transient up to +230 °C). Components that only become brittle below −100 °C can be manufactured from special mixtures.

SBR (Styrene-butadiene rubber)

It is a polymer made of butadiene and styrene.SBR materials are preferred for manufacturing sealing components for hydraulic brakes.

- Good swelling resistance in: inorganic and organic acids and bases as well as in alcohols and water, brake fluids on a glycol ether base.
- Heavy swelling in: mineral oils, lubricating greases, petrol and aliphatic, aromatic and chlorinated hydro-carbons.
- Thermal application range: approx. −50 °C to +100 °C.

IIR (Butyl rubber)
CIIR (Chlorine butyl rubber)
BIIR (Bromine butyl rubber)

They are polymers made of isobutylene and chlorinated or
brominated isobutyls and a small proportion of isoprene. Elastomers of IIR have a very good resistance to weathering and ageing. The gas and vapour permeability of these materials is low. Some materials have a very good electrical insulating capacity.

- Good swelling resistance in: brake fluids on a glycol ether base, inorganic and organic acids and bases, hot water and steam up to 120 °C, hydraulic fluids of the Group HFC and some types in the Group HFD.
- Heavy swelling in: mineral oils and greases, petrol and aliphatic as well as aromatic and chlorinated hydro-carbons.
- Thermal application range: approx. −40 °C to +120 °C.

XNBR (Carboxylated nitrile rubber)

They are terpolymers or blends made of butadiene, acrylonitrile and (meth)acrylic acid. The main properties correspond to those of the NBR polymer, but they are characterised by improved wear behaviour in dynamic sealing applications. The cold flexibility is restricted compared to the comparable NBR types.

- Thermal application range: approx. −25 °C to +100 °C (transient up to +130 °C).

TPE (Thermoplastic rubbers)

TPEs have properties between those of elastomers and thermoplastics. TPEs are multi-phase systems with a hard and a soft phase. The hard segments are layered together to form a crystalline structure that is laminated with soft segments. A pseudo-crosslinked structure is formed.

Categorisation of TPEs

TPE-O	Thermoplastic rubber based on olefins e.g. (YEPDM)
TPE-S	Thermoplastic rubber based on styrene (YSBR)
TPE-E	Thermoplastic rubber based on esters (YBBO)

YEPDM (Olefin thermoplastic rubber)

Properties are comparable to EPDM, i.e. very good chemical resistance, but not resistant to oil.
The products cannot be used above a temperature limit of 120 °C.

YBBO (Copolyester TPE)

YBBOs are characterised by:

- high tensile strength
- high tensile modulus
- good stretchability
- excellent resistance to solvents
- resistance to oxidising acids
- aliphatic hydro-carbons
- alkaline solutions, various greases and oils.

Strongly oxidising acids and chlorinated solvents cause strong swelling.

YSBR (Thermoplastic rubber containing styrene)

The hard phase is styrene, the soft butadiene.
Properties:the mechanical properties are comparable to SBR. Hard or softer products are obtained depending on the ratio of styrene/butadiene. Above 60 °C creep and loss of tensile strength are encountered. The cold resistance extends up to −40 °C. Good chemical resistance to water, dilute acids and alkalis, alcohols and ketones. YSBR is not resistant to non-polar solvents, fuels and oils.

Thermoplastic materials

Products made of thermoplastic material are used in large quantities today in all areas of engineering, including for seals and moulded components.

The softer types (polyethylene, soft PVC, thermoplastic elastomers) compete with highly elastic materials in many applications, while the mechanically strong plastics (polyamides, acetal resins) are being used in applications that were formerly reserved exclusively for metals.

Sealing components and construction parts made of thermoplastic materials are different depending on the base materials. In many cases they can be varied by including specific additives and can be designed specifically for the purpose of the manufactured component.

Some characteristic properties and the resulting major areas of application are described below. For more information see the material tables.

ETFE (ethylene tetrafluoroethylene copolymer)

It is an injection-mouldable fluoroplastic with very good chemical and thermal properties, which however to do quite reach the values of PTFE.
Upper application temperature approx. +180 °C.

PA (Polyamide)

Is characterised by very high strength values. The high wear resistance, the tough material structure, the damping capacity and the good dry-running characteristics make this material particularly suitable for machine elements of various types (gearwheels, plain bearings, guide strips, cams etc.).
Upper application temperature +120 °C to +140 °C.

PBTP (Polybutylenterephtalate)

PBTP is a partially crystalline, thermoplastic polyester material. In hydraulics unfilled or filled types are used depending on the load involved.

PBTP has the following properties:

- high stiffness and hardness
- good sliding properties
- low wear
- very low water absorption (= high dimensional stability)
- temperature application range −30 °C to +120 °C (shape resistance)

Resistant to all lubricants and all hydraulic fluids used in hydraulics, dilute alkalis, acids and alcohols. Not resistant to strong alkalis and acids.

PFA (Perfluoroalkoxy copolymer)

It is an injection-mouldable fluoroplastic with similar chemical and physical properties to those of PTFE. Both materials are particularly suitable for manufacturing high-quality moulded and injection-moulded parts.
Upper application temperature approx. +260 °C.

POM (Polyoxymethylene), (Polyacetal)

Is one of the mechanically highly loadable thermoplastics. Its stiffness, hardness and strength combined with outstanding form stability even at higher temperatures (up to approx. +80 °C) make it suitable for replacement of die-cast, brass or aluminium parts. The low water absorption is particularly worth noting. It retains its form better than moulded polyamide parts even when exposed to moisture. Acetal resins are attacked by acids.
Temperature application range −40 °C to +140 °C

PP (Polypropylene)

It is resistant to hot water and water lye, resists boiling and can withstand sterilisation temperatures of +120 °C for short periods. Preferred use in pumps, motor vehicles and domestic appliances.

PPO (Polyphenylene oxide)

It is a tough, rigid material that is primarily characterised by good dimensional stability, low tendency to creep and low water absorption. It has high puncture resistance and a virtually constant low loss factor.
PPO is hydrolysis-resistant but not oil-resistant. Various properties of polyamides, acetal resins and PPO can be substantially improved with glass fibres. For example, the tensile strength in general can be more than twice as high as that of unreinforced material. The heat resistance is significantly improved and notched impact strength, which without glass fibre reinforcement falls quickly as the temperature falls, remains virtually unchanged. The compression strength is also increased and the tendency to cold flow is reduced. The linear thermal expansion is significantly reduced. It is in the general range of die-cast metal.
Upper application temperature short term approx. +130 °C, extended period approx. +90 °C.

PTFE (Polytetrafluoroethylene)

PTFE is a thermoplastic polymer made of tetrafluoroethylene. This non-elastic material is characterised by a series of outstanding properties:
The surface is smooth and repellent. This makes it suitable for use in all applications in which adhesion of residues is to be avoided.

PTFE is physiologically safe at operating temperatures up to +200 °C. The coefficient of friction is very low with most mating materials. Static and dynamic friction are virtually identical.
The electrical insulation properties are extraordinarily good. They are virtually independent of the frequency as well as temperature and weathering effects. The chemical resistance is superior to all other elastomers and other thermoplastics. The swelling resistance is good in almost all media.
Liquid alkali metals as well as some fluorine compounds attack PTFE at higher pressures and temperatures.

The thermal application range is between approx. −200 °C to +260 °C. At −200 °C PTFE still has some elasticity; the material can therefore be used for seals and design components, e.g. for liquid gases.

Note the following when using parts of pure PTFE:

- that the material is permanently deformed from a specific load by creep or cold flow,
- that the abrasion resistance is low,
- that the thermal expansion, as with most plastics, is about 10 times higher compared to metals,
- that the thermal conductivity is low, so the heat dissipation in bearings and moving seals may become a problem,
- that the material is not elastic rubber but horn-like similar to polyethylene.

For the above reasons designs with elastomeric seals cannot be converted to PTFE without other modifications. For lip seals an additional contact pressure by springs or other means is required.
PTFE is filled with graphite, glass fibres, bronze and carbon to give it special properties.

PVC (Polyvinyl chloride)

is currently frequently used instead of the formerly used elastomer materials because of its good technological and chemical properties.
The materials based on PVC have rubber-like properties in contract to the other thermoplastics described in this section. PVC is used for: bellows, faceplates, seals, covers, sleeves, caps, bushes and moulded air-duct components.

Thermal application range: −35 °C to +70 °C

High-load resistant thermoplastic polycondensates "high-tech, engineering plastics´"

These products are generally very expensive because of the very complex manufacturing techniques required in many cases. They are always used for moulded components where other plastics would certainly fail but metallic properties would cause problems, particularly in the electrical industry.

All materials have good strength properties and a high temperature resistance (+140 °C to +200 °C).

Special features of the individual materials:

polyethersulfane (PESU)
- resistant to water
- not resistant to brake fluids

polysulfane (PPSO)
- not usable in boiling water
- specific solvents, esters, ketones, aromatics, chlorinated hydro-carbons destroy the material by formation of tension cracks.

polyphenylene sulphide (PPS)
- greater chemical resistance than the other products
- not tough and sensitive to notching because of crystalline structure

polyether ketone (PEEK)
- very good chemical resistance
- universally usable
- reinforced types can be used up to +180 °C

polyetherimide (PEI)
- amorphous and transparent
- Ketones and chlorinated hydro-carbons attack this material.

Duroplastics

Materials that do not soften or melt in heat. They retain their shape better when hardened than uncrosslinked plastics.

The most important product groups are:
- Phenol formaldehyde masses (PF)
- Unsaturated polyester resins (UP)
- Polyimides (PI).

PF (Phenol formaldehyde)

The reaction of phenol with formaldehyde results in resin-like condensation products – novolak or resol resins. DIN-classified masses have different filler and reinforcement materials. The mechanical and technical properties are extremely useful. Tempered components can be subjected to temperatures up to +300 °C for short periods.
Other general properties:
- temperature range −30 °C to +120 °C
- hard and very strong
- low tendency to creep
- low flammability
- sensitive to notching
- not for use with food
- resistant to organic solvents, weak acids and alkalis, salt solutions.

PI (polyimides)

They are derived from bis-maleinimide. Under polymerisation duroplastic polyimides with different molecular structures are formed. The general characteristic of these heterocyclic polymers is the imide-ring within the main chain. Polyimide components are characterised by high temperature resistance up to more than +260 °C, and even above +300 °C for short periods, while retained most of their mechanical properties. The materials are also characterised by good sliding and wear properties, which can be improved even more with suitable additives. The electrical properties and radiation resistance of polyimide are outstanding.
The materials are generally resistant to solvents, greases, fuels, oils and dilute acids. Strong acids, alkalis and hot water attack polyimides.

UP (Unsaturated polyester resins)
Reaction products of
- unsaturated dicarboxylic acid ester
- diol
- dicarboxylic acid and styrene.

They are used as injection-moulding materials, bulk-moulding compounds (BMC) or track material, sheet-moulding compounds (SMC).
Processing by presses and injection moulding.

Properties:unlike phenol resins
- lower shrinkage
- lower water absorption
- easier to colour
- better price
- suitable for contact with food
- good notch and impact sensitivity.

Seals and moulded components of Simriz

Perfluoro elastomers (FFKM) offer the widest range of chemical and thermal resistance and compatibility among the elastomer sealing materials. Freudenberg Simrit manufactures seals of the all-round perfluoro elastomer Simriz.

These sealing materials
- have almost the same resistance as pure PTFEs
- also have the great advantage of high elasticity
- they are also characterised compared to conventional elastomers by a much longer service life.

The universal usability
of these perfluoro elastomers is based on their resistance to aggressive media and their usability in unusually wide temperature ranges. Simriz offers reliable sealing of:
- chlorinated and high-polar organic solvents, such as chloroform, dichloromethane, alcohols, lower aldehydes, ketones, esters and ether, N-methyl pyrrolidone, cellosolve, nitrated hydrocarbons, amines, amides
- aromatics such as benzene, toluene or xylene.

Simriz is also particularly suitable for sealing:
- strong inorganic acids and alkalis such as sulphuric acid, hydrochloric acid, nitric acid and their mixtures as well as sodium and potassium hydroxide or ammonia,
- strong organic acids and bases, e.g. formic acid or ethylene diamine.

Simriz seals are also top in their temperature limits. They remain
- cold flexible down to −12 °C and
- can be used up to +300 °C without problems.

Safe solutions for many applications
Simriz seals are excellently suited for all sealing applications under high chemical and/or thermal loads. Simriz is the ideal seal for:
- analysis technology
- systems and mechanical engineering
- aerospace industry
- machines and units
- mineral oil processing
- medical technology
- pharmaceutical industry
- pumps
- processing technology
- packaging machines.

Tell what form your seal should be. We will supply it.
Seals and moulded components of Simriz are manufactured in standard sizes of the ISC O-Ring range by Simrit or customised to your requirements.
ISC O-Rings, ISC O-Ring special shapes or moulded components of Simriz can be designed precisely for your application or requirements.

Solutions for complex requirements
High pressure, cyclic temperatures, static or dynamic loading, chemical and abrasive attack by the sealing fluid form a matrix of requirements for a seal which can become extremely complex.
We will be pleased to work with you to develop customised solutions for safe and reliable sealing in such difficult cases. High temperature and FDA materials on enquiry. Our technicians will be pleased to assist you with your requirements.

Standard materials for Simmerrings

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C): Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrada-ble hydraulic fluids			Flame retardant hydraulic fluids				Other media					Comment
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic esters	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	Air	
72 NBR 902	M 2 BG 710	−40	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	90	–	–	–	100	
75 FKM 585	M 2 HK 710	−30	150	150	140	150	150	1)	1)	150	150	+	+	+	⊗	⊗	–	150	+	–	⊗	⊗	200	
75 FKM 595	M 2 HK 810	−30	150	150	140	150	150	1)	1)	150	150	+	+	+	⊗	⊗	–	150	+	–	⊗	⊗	200	
PTFE 10/F56101	–	−80	150	150	140	150	150	1)	1)	150	150	+	+	+	+	+	150	150	+	+			200	
75 NBR 106200	M 2 BG 710	−40	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	90	–			120	

1) When using NBR and FKM materials in synth. lubricants, polyglycols (PAG) and polyalphaolefins (PAO) the maximum operating temperature must be specified by means of testing or a trial run.

*	operating limits defined by the medium	+	resistant, in general not used for these media
**	additional lubrication recommended	⊗	of limited resistance
***	resistance depends on the HFD type	–	not resistant

Special materials for Simmerrings

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																					Comment
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrada-ble hydraulic fluids			Flame retardant hydraulic fluids				Other media					
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	
70 NBR 110558	–	−30	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	⊗	–	90	–	90	90	100	
70 NBR 803	–	−25	90	90	⊗	90	90	1)	1)	90	90	⊗	⊗	⊗	⊗	⊗	–	–	⊗	–			100	FDA
73 NBR 91589	–	−20	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	90	–			90	
80 NBR 94207	M 7 BG 910	−25	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	90	–			100	
90 NBR 129208	M 7 BG 910	−30	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	90	–			100	
82 NBR 132919	M 6 BG 814	−40	100	100	80	100	100	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	⊗	–			100	
75 HNBR 260258	M 2 BG 714	−30	120	120	100	120	120	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	⊗	–	⊗	⊗	130	
80 HNBR 172267	M 7 BG 814	−30	120	120	100	120	120	1)	1)	100	100	⊗	⊗	⊗	⊗	⊗	–	–	⊗	–	⊗	⊗	130	
70 FKM 260737	M 7 BG 814	−30	150	150	140	150	150	1)	1)	150	150	+	+	+	⊗	⊗	–	150	+	–	⊗	⊗	200	
75 FKM 170055	M 7 BG 814	−30	150	150	140	150	150	1)	1)	150	150	+	+	+	⊗	⊗	–	150	+	–	⊗	⊗	200	

1) When using NBR and FKM materials in synth. lubricants, polyglycols (PAG) and polyalphaolefins (PAO) the maximum operating temperature must be specified by a test run.

*	operating limits defined by the medium	+	resistant, in general not used for these media
**	additional lubrication recommended	⊗	of limited resistance
***	resistance depends on the HFD type	–	not resistant

Standard materials for hydraulic components

Material	ASTM D 2000	Permissible low temperature °C	Mineral lubricants: Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Synthet. lubri-cants: Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	Mineral. hydr. fluids: HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569: HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *: Group HFA	Group HFB	Group HFC	Group HFD ***	Other media: Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	Comment
94 AU 925	M 7 BG 910	−30	+	+	⊗	+	110	⊗	+	110	110	50	80	40	50	50	40	⊗	–	–	40	–	100	
98 AU 928	M 7 BG 910	−25	+	+	⊗	+	110	⊗	+	110	110	50	80	40	50	50	40	⊗	–	–	40	–	100	
95 AU V142	–	−30	+	+	⊗	+	110	⊗	⊗	110	110	50	80	40	50	50	40	–	–	–	40	–	100	
95 AU V149	–	−30	+	+	⊗	+	110	⊗	⊗	110	110	50	80	40	50	50	40	–	–	–	40	–	100	
94 AU 985	M 7 BG 910	−30	+	+	⊗	+	100	⊗	+	100	100	60	80	50	60	60	50	⊗	–	–	80	–	100	
93 AU V167	–	−30	+	+	⊗	+	100	⊗	⊗	100	100	60	80	50	60	60	40	–	–	–	60	–	80	
93 AU V168	–	−30	+	+	⊗	+	100	⊗	⊗	100	100	60	80	50	60	60	40	–	–	–	60	–	80	
70 FKM K655	–	−10	150	150	140	150	150	150	150	150	150	80	100	80	55	60	60	150	150	–	⊗	⊗	200	
HGWH G517	–	−50	+	+	+	+	+	+	+	120	120	+	+	+	60	60	60	80	–	–	90	–	120	
HGWH G600	–	−40	+	+	+	+	+	+	+	120	120	+	+	+	60	60	60	80	–	–	90	–	120	
88 NBR 101	M 7 BG 910	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	+	100	
90 NBR 109	M 7 BG 910	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	+	100	
80 NBR 709	M 6 BG 814	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	90	100	
72 NBR 872	M 2 BG 714	−35	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	90	100	
80 NBR 878	M 7 BG 814	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	+	100	
80 NBR 99033	M 7 BG 814	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	+	90	
80 NBR 99035	M 7 BG 814	−30	100	100	80	100	100	80	80	100	100	80	80	80	55	60	60	–	80	–	90	+	90	
85 NBR B203	–	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
70 NBR B209	M 2 BG 710	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
89 NBR B217	M 2 BG 910	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
81 NBR B219	M 2 BG 810	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
79 NBR B246	M 2 BG 810	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
87 NBR B247	M 2 BG 910	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
70 NBR B276	M 2 BG 710	−30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	

Material	ASTM D 2000	Permissible low temperature °C	Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrada-ble hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media					Comment
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	
75 NBR B281	M 2 BG 821	–30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
90 NBR B283	M 2 BG 910	–30	100	100	80	100	100	80	80	100	100	80	80	60	55	60	60	–	80	–	100	90	100	
PA 4112	–	–30	+	+	+	+	+	+	+	130	130	+	+	+	55	60	60	90	–	–	90	–	100	
PA 4201	–	–30	+	+	+	+	+	+	+	120	120	+	+	+	55	60	60	80	–	–	90	–	100	
PA 6501	–	–30	+	+	+	+	+	+	+	120	120	80	80	50	60	60	60	80	–	–	60	–	+	
PF 48	–	–50	+	+	+	+	+	+	+	120	120	+	+	+	55	60	60	80	–	–	90	–	120	
POM 20	–	–40	+	+	+	+	+	+	+	100	100	+	+	+	55	60	60	80	–	–	80	–	100	
POM PO202	–	–40	+	+	+	+	+	+	+	110	110	+	+	+	60	60	60	80	–	–	80	–	+	
POM PO530	–	–40	+	+	+	+	+	+	+	110	110	+	+	+	60	60	60	80	–	–	80	–	+	
PTFE B502	–	–40	+	+	+	+	+	+	+	200	200	80	100	80	–	–	–	200	+	+	–	+	200	
PTFE B504	–	–40	+	+	+	+	+	+	+	200	200	80	100	80	–	–	–	200	+	+	–	+	200	
PTFE B602	–	–30	+	+	+	+	+	+	+	200	200	80	100	80	–	–	–	200	+	+	–	+	200	
PTFE GM201	–	–30	+	+	+	+	+	+	+	100	100	80	100	60	60	60	60	150	+	+	100	+	200	
PTFE/15 177026	–	–80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200	
PTFE/25 177027	–	–80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200	
PTFE/25 177030	–	–80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200	
PTFE/40 177024	–	–80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200	
PTFE/60 177023	–	–80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200	
97 TPE 113TP	–	–30	+	+	⊗	+	100	⊗	⊗	110	110	60	80	50	60	60	40	–	–	–	60	–	+	

* operating limits defined by the medium

** for static use only; dynamic use requires an additional test

*** resistance depends on the HFD type

\+ resistant, in general not used for these media

⊗ of limited resistance

– not resistant

Special materials for hydraulic components

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrad-able hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
94 AU 20889	M 7 BG 910	–25	+	+	⊗	+	110	⊗	+	110	110	60	80	50	60	60	50	⊗	–	–	80	–	110
92 AU 21100	-	–50	+	+	⊗	+	80	⊗	+	100	100	50	70	40	50	50	40	–	⊗	–	50	–	80
80 EPDM L700	M 2 CA 810	–40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	100	–	+	150	130	150
85 FKM 580	M 3 HK 910	–5	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	80	⊗	200
75 FKM 595	M 2 HK 710	–5	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	80	⊗	200
86 FKM K664	M 2 HK 910	–10	150	150	140	150	150	150	150	150	150	80	100	80	55	60	60	150	150	–	–	–	200
90 HNBR 136428	M 4 DH 910	–25	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	80	–	120	120	130
85 HNBR 137891	M 4 CH 910	–25	120	100	100	100	120	100	120	120	120	80	⊗	100	55	60	60	–	80	–	120	120	120
80 HNBR 150351		–25	120	120	100	120	140	100	120	140	140	80	80	100	55	60	60	–	80	–	120	120	140
70 HNBR U463	-	–25	120	120	100	120	120	120	120	120	120	80	⊗	100	55	60	60	–	80	–	120	120	130
80 HNBR U464	-	–25	120	120	100	120	120	120	120	120	120	80	⊗	100	55	60	60	–	80	–	120	120	130
70 NBR B262	M 2 BG 710	–35	100	100	80	100	100	80	80	100	100	80	⊗	60	55	60	60	–	80	–	80	90	100
75 NBR B280	M 2 BG 810	–45	80	80	60	80	80	60	60	80	80	60	⊗	60	55	60	60	–	80	–	80	80	80
PTFE B604	-	–30	+	+	+	+	+	+	+	200	200	80	100	80	–	–	–	200	+	+	–	+	200
PTFE M202	-	–30	+	+	+	+	+	+	+	100	100	80	100	60	60	60	60	150	+	+	100	+	200
97 TPE 106 TP	-	–30	+	+	⊗	+	100	⊗	⊗	110	110	60	80	50	60	60	40	–	–	–	60	–	140

* operating limits defined by the medium
** for static use only; dynamic use requires an additional test
*** resistance depends on the HFD type

\+ resistant, in general not used for these media
⊗ of limited resistance
– not resistant

Standard materials for pneumatic components

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrada-ble hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
90 AU 924	M 7 BG 910	−30	+	+	⊗	+	100	⊗	⊗	110	110	60	60	40	50	50	40	–	–	–	–	–	100
94 AU 925	M 7 BG 910	−30	+	+	⊗	+	100	⊗	⊗	110	110	60	60	40	50	50	40	–	–	–	–	–	100
80 AU 941/20994	M 7 BG 814	−40	+	+	⊗	+	80	⊗	⊗	80	80	60	60	40	50	50	40	–	–	–	–	–	80
85 AU 942/20991	M 7 BG 815	−40	+	+	⊗	+	80	⊗	⊗	80	80	60	60	40	50	50	40	–	–	–	–	–	80
88 NBR 101	M 7 BG 910	−20	100	100	80	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	+	+	100
90 NBR 108	M 7 BG 910	−20	100	100	80	100	100	80	80	100	100	80	⊗	80	+	+	+	–	80	–	90	+	90
72 NBR 708	M 7 BG 714	−20	+	+	+	+	100	80	80	100	100	80	⊗	80	+	+	+	–	80	–	90	+	100
80 NBR 709	M 2 BG 714	−20	100	100	80	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	90	90	100
80 NBR 99079	M 6 BG 814	−25	+	+	+	+	100	80	80	100	100	80	⊗	80	+	+	+	–	80	–	90	+	100
80 NBR 186349	M 6 BG 814	−25	+	+	+	+	100	80	80	100	100	80	⊗	80	+	+	+	–	80	–	+	+	100
PA 4201	-	−30	+	+	+	+	+	+	+	120	120	+	+	+	55	60	60	80	–	–	90	–	100
PTFE 552/40	-	−80	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200
PTFE 25-177025	-	−100	+	+	+	+	+	+	+	200	200	80	100	100	+	+	+	150	+	+	150	+	200

* operating limits defined by the medium

** for static use only; dynamic use requires an additional test

*** resistance depends on the HFD type

\+ resistant, in general not used for these media

⊗ of limited resistance

– not resistant

Special materials for pneumatic components

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C): Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrad-able hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retard-ant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
93 AU V167	-	–30	+	+	⊗	+	100	⊗	⊗	100	100	60	80	50	60	60	40	–	–	–	60	–	80
93 AU V168	-	–30	+	+	⊗	+	100	⊗	⊗	100	100	60	80	50	60	60	40	–	–	–	60	–	80
75 FKM 595	M 2 HK 710	–5	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	+	–	⊗	⊗	200
75 FKM 99104	M 2 HK 807	–5	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	+	+	200
80 HNBR 150351	M 4 DH 910	0	120	120	100	120	140	100	120	140	140	80	⊗	100	55	60	60	–	–	–	120	120	140

* operating limits defined by the medium
** for static use only; dynamic use requires an additional test
*** resistance depends on the HFD type

+ resistant, in general not used for these media
⊗ of limited resistance
– not resistant

Note:
The specified minimum operating temperature is only a recommended value, because not only the material but also the seal type, the housing and the operating conditions may influence the function. The maximum operating temperatures may be exceeded, but this may involve a reduced service life. The influence of the media (e.g. unsuitable lubricants) may reduce the temperature limits.

Standard materials for ISC O-Rings

			Media to be sealed with information on continuous temperature (in °C): Mineral lubricants					Synthet. lubricants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media					
Material	ASTM D 2000	Permissible low temperature °C	Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	Comment
70 EPDM 281	M 4 CA 714	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	+	150	130	150	KTW
70 EPDM 291	M 4 CA 714	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	+	180	130	150	KTW
70 FKM 576	M 2 HK 710	–25	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	⊗	⊗	200	
70 FKM 598	M 2 HK 707	–25	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	⊗	⊗	200	
80 FKM 610	M 2 HK 810	–25	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	⊗	⊗	200	
70 NBR 34004	M 2 BG 714	–30	100	100	90	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	
72 NBR 872	M 2 BG 714	–35	100	100	90	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	
88 NBR 156	M 7 BG 910	–30	100	100	90	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	KTW
90 NBR 34006	M 7 BG 910	–30	100	100	90	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	

* operating limits defined by the medium

** for static use only; dynamic use requires an additional test

*** resistance depends on the HFD type

\+ resistant, in general not used for these media

⊗ of limited resistance

– not resistant

Special materials for ISC O-Rings

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C): Mineral lubricants					Synthet. lubricants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media					Comment
			Motor oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	
70 ACM 360	M 3 DH 710	–15	130	130	130	130	130	–	⊗	130	130	–	–	–	–	–	–	–	⊗	–	–	–	150	
70 CR 746	M 2 BE 714	–30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100	
60 EPDM 280	M 4 CA 614	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	+	150	130	100	KTW
60 EPDM 290	M 4 CA 614	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	+	180	130	150	KTW
75 EPDM 168348	M 6 DA 807	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	+	+	–	+	150	130	150	FDA
85 EPDM 282	M 4 CA 814	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	100	100	–	+	150	130	150	KTW
85 EPDM 292	M 4 CA 814	–40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	+	180	130	150	KTW
75 FKM 153740	M 2 HK 810	–25	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	+	+	200	
75 FKM 602	M 2 HK 710	–20	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	150	130	200	
75 FKM 99104	M 2 HK 807	–30	150	150	140	150	150	150	150	150	150	80	100	100	55	60	60	150	150	–	+	+	200	
60 FVMQ 565	M 2 FE 606	–60	150	150	140	150	150	+	150	150	150	+	+	+	55	60	60	–	150	–	⊗	⊗	175	
70 HNBR 150531	M 2 DH 710	–20	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	+	–	120	120	130	
75 HNBR 181070	M 2 DH 710	–20	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	+	–	120	120	130	FDA
90 HNBR 136428	M 4 DH 910	–25	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	+	–	120	120	130	
60 NBR 181	M 5 BG 607	–25	100	100	80	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	
60 NBR 692	M 2 BG 617	–40	100	100	80	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	90	90	100	
62 NBR152	M 2 BG 614	–30	+	+	+	+	+	+	+	+	+	80	⊗	80	+	+	+	–	+	–	100	90	100	
70 NBR 150	M 2 BG 714	–20	100	100	80	100	100	80	80	100	100	80	⊗	80	55	60	60	–	80	–	100	90	100	
75 NBR 168350	M 2 BG 706	–20	+	+	+	+	+	+	+	+	+	80	⊗	80	+	+	+	–	+	–	100	90	100	FDA
80 NBR 709	M 6 BG 814	–30	100	100	80	100	100	80	100	100	100	80	⊗	80	55	60	60	–	80	–	90	90	100	
84 NBR 772	M 4 BK 814	–20	100	100	80	100	100	80	100	100	100	80	⊗	80	55	60	60	–	80	–	90	90	100	
75 Simriz 484	-	–10	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	230	FDA
75 Simriz 495	-	–15	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	260	
58 VMQ 518	M 5 GE 605	–50	130	130	⊗	130	130	–	⊗	130	130	–	–	–	⊗	⊗	⊗	–	⊗	⊗	+	+	180	
60 VMQ 571	M 5 GE 606	–50	130	130	⊗	130	130	–	⊗	130	130	–	–	–	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	180	
78 VMQ526	M 5 GE 806	–50	130	130	⊗	130	130	–	⊗	130	130	–	–	–	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	180	

* operating limits defined by the medium

** for static use only; dynamic use requires an additional test

*** resistance depends on the HFD type

\+ resistant, in general not used for these media

⊗ of limited resistance

– not resistant

Standard materials for bellows

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegrada-ble hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
45 NBR 670	M5 BG 507	−30	100	80	80	100	100	⊗	⊗	100	100	⊗	⊗	⊗	+	+	+	–	⊗	⊗	⊗	⊗	100
50 CR 879	M2 BC 510	−40	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
42 CR 764	M2 BC 410	−40	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100

* operating limits defined by the medium
** for static use only; dynamic use requires an additional test
*** resistance depends on the HFD type

\+ resistant, in general not used for these media
⊗ of limited resistance
– not resistant

Materials for diaphragms

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																					Comment
			Mineral lubricants					Synthet. lubricants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media					
			Motor oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air	
60 CIIR 172153	–	–35	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	⊗	⊗	100	
50 CR 879	M 2 BC 510	–40	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100	
64 ECO 150777	–	–30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	–	⊗	⊗	100	
60 EPDM 266	–	–40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	50	–	+	130	110	130	
60 EPDM 280	–	–40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	50	–	+	150	130	150	
70 EPDM 281	M 4 CA 714	–40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	50	–	+	150	130	150	
75 EPDM 168348	–	–40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	50	–	+	150	130	150	FDA
75 FKM 153740	M 2 HK 810	–25	150	150	140	150	150	150	150	150	150	80	100	100	55	60	–	150	150	–	⊗	⊗	200	
75 FKM 180497	–	–20	150	150	140	150	150	150	150	150	150	80	100	100	55	60	–	+	+	–	100	⊗	200	FDA
60 FVMQ 565	M 2 FE 606	–60	150	150	140	150	150	+	150	150	150	+	+	+	55	60	–	–	150	–	⊗	⊗	175	
70 HNBR 150531	M 2 DH 710	–20	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	+	–	120	120	130	
75 HNBR 181070	M 2 DH 710	–20	120	120	100	120	120	100	120	120	120	80	⊗	100	55	60	60	–	+	–	120	120	130	
50 NBR 253	M 5 BG 510	–45	+	+	+	+	+	+	+	+	+	⊗	–	+	55	60	60	–	⊗	–	⊗	⊗	90	
50 NBR 254	–	–50	+	+	+	+	+	+	+	+	+	⊗	–	+	55	60	60	–	⊗	–	⊗	⊗	90	
50 NBR 842	M 2 BG 514	–30	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	80	–	⊗	⊗	100	
50 NBR 153750	–	–20	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	60	–	100	90	100	
60 NBR 181	M 5 BG 607	–20	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	80	–	100	90	100	
60 NBR 185695	M 2 BG 617	–20	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	80	–	100	90	100	
70 NBR 150	M 2 BG 714	–20	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	80	–	100	90	100	
70 NBR 888	M 2 BF 714	–50	80	80	70	80	100	+	+	80	80	80	⊗	+	55	60	60	–	⊗	–	⊗	⊗	90	
75 NBR 168350	M 2 BG 706	–20	100	100	80	100	100	80	100	100	100	80	⊗	100	55	60	60	–	+	–	100	90	100	
50 VMQ 78599	M 5 GE 505	–50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180	
58 VMQ 518	M 5 GE 605	–50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180	
60 VMQ 571	M 5 GE 605	–50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180	

* operating limits defined by the medium
** for static use only; dynamic use requires an additional test
*** resistance depends on the HFD type

\+ resistant, in general not used for these media
⊗ of limited resistance
– not resistant

Standard materials for vibration control

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubricants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
NR 11, NR 13	AA	−50	–	–	–	–	–	⊗	⊗	–	–	–	–	60	–	–	+	–	–	+	60	60	60
NR 39	AA	−50	–	–	–	–	–	⊗	⊗	–	–	–	–	60	–	–	+	–	–	+	60	60	90
NBR 68	BG	−35	100	100	80	100	100	80	80	100	100	80	⊗	60	55	60	60	–	80	–	90	90	80

Special materials for vibration control

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubricants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
CR 56	BE	−30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
AEM 33	EE	−25	130	130	130	130	130	–	⊗	130	130	–	–	–	–	–	–	–	–	–	–	–	150
EPDM 22	CA	−40	–	–	–	–	–	⊗	–	–	–	–	–	–	–	–	60	100	–	100	150	130	120
ACM 18	DH	−20	130	130	130	130	130	–	⊗	130	130	–	–	–	–	–	–	–	⊗	–	–	–	150

*	operating limits defined by the medium
**	for static use only; dynamic use requires an additional test
***	resistance depends on the HFD type
+	resistant, in general not used for these media
⊗	of limited resistance
–	not resistant

Materials for extrusion

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
40 CR 174240	–	−30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
55 CR 852	–	−30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
67 CR 215595	–	−30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
70 CR 853	–	−30	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	⊗	–	–	⊗	⊗	⊗	100
58 EPDM 215550	–	−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	130	110	150
60 EPDM 266		−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	130	110	130
60 EPDM 274		−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	130	110	130
60 EPDM 280	M 4 CA 614	−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	150	130	130
70 EPDM 275		−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	150	130	130
70 EPDM 291	M 4 CA 714	−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	180	150	150
70 EPDM 177602	–	−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	150	130	130
80 EPDM 269	–	−40	–	–	–	–	–	⊗	–	–	–	–	–	⊗	–	–	60	100	–	+	150	130	130
50 FKM 104800	–	−40	+	+	+	+	+	+	+	+	+	+	+	+	⊗	⊗	–	+	150	–	⊗	⊗	200
70 FKM 598	M 2 HK 707	−25	150	150	140	150	150	150	150	150	150	80	100	100	⊗	⊗	–	150	150	–	⊗	⊗	200
70 FKM 215450	M 2 HK 707	−25	150	150	140	150	150	150	150	150	150	80	100	100	⊗	⊗	–	150	150	–	⊗	⊗	200
72 FKM 588	–	−15	+	+	+	+	150	150	150	150	150	80	100	100	⊗	⊗	–	+	150	–	⊗	⊗	200
60 FVMQ 143026		−60	150	150	140	150	150	+	150	150	150	150	140	150	150	60	60	–	80	–	100	90	175
70 HNBR 150531	M 2 DH 710	−40	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	130
40 NBR 106	–	−25	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
40 NBR 830	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
50 NBR 121	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
55 NBR 103	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
55 NBR 761	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
58 NBR 774	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
60 NBR 122	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
60 NBR 692	M 2 BG 617	−40	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	90
62 NBR 152	M 2 BG 614	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
64 NBR 104	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
70 NBR 221		−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
70 NBR 803	M 2 BG 708	−25	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100

Material	ASTM D 2000	Permissible low temperature °C	Media to be sealed with information on continuous temperature (in °C)																				
			Mineral lubricants					Synthet. lubri-cants		Mineral. hydr. fluids		Biodegradable hydraulic fluids as per VDMA 24568 & DIN 24569			Flame retardant hydraulic fluids as per VDMA 24317 & DIN 24320 *				Other media				
			Engine oils	Transmission oils	Hypoid transmission oils	ATF oils	Greases	Polyalkyleneglycols (PAG)	Polyalphaolefins (PAO)	HLP as per DIN 51524 Part 2	HLVP as per DIN 51524 Part 3	HETG rapeseed oil *	HEES – synthetic ester	HEPG polyglycols**	Group HFA	Group HFB	Group HFC	Group HFD ***	Heating oil EL and L	Brake fluid DOT 3/DOT 4	Water	Water lye	air
70 NBR 888	M 2 BF 714	−50	80	80	70	80	100	+	+	80	80	⊗	⊗	+	55	60	60	–	⊗	–	⊗	⊗	90
70 NBR 127501		−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
70 NBR 172436	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
70 NBR 173216	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
70 NBR 215544	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
72 NBR 872	M 2 BG 714	−35	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
72 NBR 156603	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
75 NBR 168350	–	−20	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
79 NBR 105	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 709	M 6 BG 814	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 157260	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 175336	–	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 151	M 6 BG 814	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 101	M 7 BG 910	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 156	M 7 BG 910	−30	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
80 NBR 108	M 7 BG 910	−20	120	120	100	120	120	100	120	120	120	80	80	100	55	60	60	–	80	–	100	90	100
45 SBR 721	–	−30	–	–	–	–	–	–	–	–	–	–	–	–	⊗	⊗	⊗	–	–	+	+	+	100
52 SBR 630	–	−30	–	–	–	–	–	–	–	–	–	–	–	–	⊗	⊗	⊗	–	–	+	+	+	100
65 SBR 250327	–	−30	–	–	–	–	–	–	–	–	–	–	–	–	⊗	⊗	⊗	–	–	+	+	+	100
50 VMQ 511	M 5 GE 505	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
50 VMQ 570	M 5 GE 505	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
50 VMQ 114721	–	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
50 VMQ 114723	–	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
58 VMQ 518	M 5 GE 605	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
60 VMQ 129396	–	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180
78 VMQ 526	M 5 GE 806	−50	⊗	⊗	⊗	⊗	⊗	–	⊗	⊗	⊗	–	–	–	⊗	⊗	⊗	–	–	⊗	+	+	180

* operating limits defined by the medium

** for static use only; dynamic use requires an additional test

*** resistance depends on the HFD type

\+ resistant, in general not used for these media

⊗ of limited resistance

– not resistant

Chemical resistance

The information in the following table has been processed and compiled from our own testing, recommendations or our suppliers of base materials and experience reports from our customers.
However, this information can only be used as a general guide. It cannot be transferred to all operating conditions without additional testing.
With the variety of factors affecting seals and moulded components the chemical resistance is a very important factor but still only part of the overall operating conditions. Other factors that must be considered include the selection of material by Simrit and the shape of the sealing component:

- rotational speed and stroke length
- stroke speed for parts with axial movement
- static or dynamic loading
- surface characteristics of metal components
- type of material of machine components to be sealed.

If there are no special instructions given in the table, standard purity, concentration and room temperature are specified with the media. In case of doubt, particularly with untested or new applications, we recommend consulting us to allow us to conduct special testing if necessary.
The elastomers listed in the table are referred to with their chemical names as well as the codes specified in ASTM D 1418.

The chemical names, generally used names or trade names have been used for the media.

Explanation of material codes	
ACM	Acrylate rubber
AU	Polyurethane
CR	Chlorine butadiene rubber
CSM	Chlorosulfonated polyethylene
EPDM	Ethylene propylene diene rubber
FFKM	Perfluoro elastomer
FKM	Fluoro elastomer
FVMQ	Fluorosilicone rubber
HNBR	hydrogenated acrylonitrile-butadiene rubber
IIR	butyl rubber
NBR	Acrylonitrile butadiene rubber
NR	Natural rubber
PTFE	polytetrafluoroethylene
SBR	Styrene-butadiene rubber
VMQ	silicone rubber

Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
acetaldehyde with acetic acid, 90/10%	20	○	⊙	○	◑	◑	●	○	○	○	◑	○	◑	●	◑	○
acetamide	20	⊙	⊙	⊙	⊕	⊕	●	⊙	⊕	⊕	⊕	⊕	⊙	●	⊙	⊙
acetic acid, aqueous, 25 to 60%	60	⊙	⊙	⊙	●	●	●	⊙	⊙	○	●	○	○	●	○	⊙
acetic acid, aqueous, 85%	100	⊙	⊙	⊙	⊕	⊕	●	⊙	⊙	○	⊕	○	○	●	○	⊙
acetic anhydride	20	⊙	⊙	●	●	●	●	○	⊙	○	●	○	◑	●	●	⊙
acetic anhydride	80	⊙	⊙	◑	⊕	⊕	◑	○	⊙	○	⊕	○	○	●	◑	⊙

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acetone	20	○	○	○	⊕	●	●	○	○	○	●	○	●	●	●	○
acetophenone	20	⊙	⊙	⊙	⊕	⊕	●	⊙	⊙	⊙	⊕	⊙	⊙	●	⊙	⊙
acetylene	60	●	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●
acrylic acid ethyl ester	20	○	○	⊙	⊙	⊕	●	○	○	○	◑	○	⊙	●	⊙	○
acrylonitrile	60	⊙	⊙	○	⊙	⊕	●	○	○	○	○	○	○	●	○	○
adipic acid, aqueous	20	⊕	⊕	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
air, clean	80	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
air, oily	80	●	●	●	●	○	●	●	●	●	○	●	○	●	◑	●
alaum, aqueous	60	⊙	○	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
alaum, aqueous	100	⊙	⊙	●	●	●	●	●	⊕	●	●	●	○	●	●	⊕
allyl alcohol	80	⊙	○	◑	◑	●	●	○	⊙	◑	●	◑	●	●	●	⊙
aluminium sulphate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
aluminium sulphate, aqueous	100	⊙	○	◑	●	●	●	○	⊕	●	●	●	◑	●	●	⊕
ammonia liquor	40	○	○	◑	●	●	●	○	◑	●	●	●	●	●	●	◑
ammonia, 100%	20	⊙	○	◑	●	●	◑	○	⊙	◑	●	◑	●	●	●	⊙
ammonium acetate, aqueous	60	⊙	○	◑	●	●	●	○	⊕	●	●	●	●	●	●	⊕
ammonium carbonate	60	⊙	○	◑	●	●	●	○	⊕	●	●	●	●	●	●	⊕
ammonium chloride, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
ammonium fluoride, aqueous	20	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
ammonium fluoride, aqueous	100	⊙	⊙	◑	●	●	●	○	⊕	●	●	●	○	●	●	⊕
ammonium fluoride, aqueous	20	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
ammonium fluoride, aqueous	100	⊙	⊙	◑	●	●	◑	○	⊕	●	◑	●	○	●	●	⊕
ammonium nitrate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
ammonium nitrate, aqueous	100	⊙	⊙	◑	●	●	●	○	⊕	●	●	●	○	●	●	⊕
ammonium phosphate, aqueous	60	⊙	○	◑	●	●	●	○	⊕	●	●	●	●	●	●	⊕
ammonium sulphate	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
ammonium sulphate	100	⊙	○	◑	●	●	●	○	⊕	●	●	●	○	●	●	⊕

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ammonium sulphide, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
ammonium sulphide, aqueous	100	⊙	○	◑	●	●	●	○	⊕	◑	●	◑	○	●	◑	⊕
amyl acetate	20	⊙	⊙	⊙	⊕	●	●	○	⊙	○	●	○	●	●	○	⊙
amyl alcohol	60	⊙	○	◑	●	●	●	○	⊕	◑	●	◑	●	●	●	⊕
aniline	60	⊙	○	○	⊙	⊙	●	○	○	○	⊙	○	○	●	○	○
aniline chlorohydrate	20	⊙	○	◑	◑	◑	●	●	⊕	◑	◑	◑	○	●	○	◑
aniline chlorohydrate	100	⊙	○	⊕	⊙	⊙	●	⊙	⊙	○	⊙	○	○	●	○	⊙
anisole	20	⊙	⊙	○	⊙	⊙	●	⊙	⊙	○	⊙	○	○	●	○	⊙
anthraquinone sulphonic acid, aqueous	30	⊙	○	⊙	●	●	●	⊙	⊙	◑	●	◑	●	●	●	⊙
anti-freeze (automotive)	60	⊙	○	●	●	●	●	●	●	●	●	●	●	●	●	●
antimony chloride, aqueous	20	●	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
antimony trichloride, dehydrated	60	⊙	⊙	◑	●	●	●	⊙	⊙	●	●	●	●	●	●	⊙
aqua regia	20	○	○	○	○	○	●	○	○	○	○	○	○	●	○	○
arsenic acid, aqueous	100	⊙	⊙	◑	●	●	●	○	⊕	●	●	●	○	●	●	⊕
arsenic acid, aqueous	60	⊕	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
asphalt	100	⊕	⊙	⊙	⊙	⊙	●	⊕	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
ASTM fuel A	60	◑	●	◑	◑	○	●	●	●	●	○	●	○	●	○	○
ASTM fuel B	60	○	○	○	○	○	●	●	●	◑	○	◑	○	●	○	○
ASTM fuel C	60	○	○	○	○	○	●	●	◑	○	○	○	○	●	○	○
ASTM Oil No. 1	100	●	◑	●	○	○	●	●	●	●	○	●	○	●	○	●
ASTM Oil No. 2	100	●	◑	◑	○	○	●	●	●	●	○	●	○	●	○	●
ASTM Oil No. 3	100	●	◑	◑	○	○	●	●	●	◑	○	●	○	●	○	◑
ATE brake fluid	100	○	⊙	◑	⊙	●	⊕	○	●	○	●	○	●	●	●	●
ATF oil	100	○	◑	◑	○	○	●	●	●	●	○	●	○	●	○	◑
aviation fuels JP3 (MIL-J-5624)	20	◑	◑	○	○	○	●	●	●	◑	○	●	○	●	○	○
aviation fuels JP4 (MIL-J-5624)	20	◑	◑	○	○	○	●	●	◑	◑	○	●	○	●	○	○
aviation fuels JP5 (MIL-J-5624)	20	◑	◑	○	○	○	●	●	◑	◑	○	●	○	●	○	○

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aviation fuels JP6 (MIL-J-25656)	20	◑	◑	○	○	○	●	●	◑	◑	○	●	○	●	○	○
barium hydroxide, aqueous	60	⊙	○	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
barium salts, aqueous	60	⊙	○	◑	●	●	●	●	●	●	●	●	●	●	●	●
battery acid (sulphuric acid)	60	⊙	○	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
beef tallow emulsion, sulphurated	20	⊙	⊙	◑	●	○	●	●	◑	●	○	●	○	●	○	◑
beer	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
benzaldehyde, aqueous	60	⊙	○	○	⊙	◑	●	●	⊙	○	◑	○	◑	●	◑	⊙
benzene	20	○	○	○	○	○	●	◑	◑	○	○	○	○	●	○	○
benzoic acid, aqueous	60	⊙	○	◑	●	●	●	●	●	●	●	●	●	●	●	●
benzyl alcohol	60	⊙	○	⊙	⊕	⊕	●	⊙	◑	⊙	⊕	⊙	⊕	●	⊕	◑
biogas	20	⊕	◑	●	●	⊙	●	●	○	●	⊙	●	○	●	○	●
bisulphite alkali	50	⊙	○	◑	●	●	◑	⊙	⊕	◑	●	◑	●	●	●	⊕
bitumen	60	⊙	⊙	○	⊙	⊙	●	●	⊙	○	⊙	○	⊙	●	⊙	⊙
black liquor	100	⊙	⊙	◑	●	●	●	●	⊙	◑	●	◑	◑	●	◑	⊙
blast-furnace gas	100	●	⊕	◑	◑	◑	●	●	●	◑	◑	◑	○	●	◑	●
bleach	60	⊙	○	◑	●	●	●	◑	⊙	○	◑	○	○	●	◑	⊙
bone oil	60	●	●	○	○	○	●	●	●	●	○	●	○	●	○	◑
borax, aqueous	60	⊙	○	◑	●	●	●	●	●	●	●	●	●	●	●	●
boric acid, aqueous	60	⊙	○	◑	●	●	●	●	●	●	●	●	●	●	●	●
brake fluids (glycol ether)	80	○	⊙	◑	⊕	●	⊕	⊙	●	○	●	○	●	●	●	●
bromine vapours	20	⊙	⊙	○	◑	⊕	⊕	⊙	⊙	○	⊕	○	○	●	○	⊙
bromine water, cold saturated	20	⊙	⊙	○	◑	⊕	⊕	⊙	⊙	○	⊕	○	○	●	○	⊙
bromine, liquid	20	⊙	⊙	○	◑	⊕	⊕	⊙	⊙	○	⊕	○	○	●	○	⊙
bromobenzene	20	⊙	⊙	⊙	⊙	⊙	⊕	⊕	⊕	⊙	⊙	⊙	⊙	●	⊙	⊙
bromochloromethane	20	⊙	⊙	⊙	◑	◑	◑	◑	◑	⊙	◑	⊙	⊙	●	⊙	⊙
bunker oil	60	⊕	⊙	⊙	⊙	⊙	⊕	⊕	⊕	◑	⊙	◑	⊙	●	⊙	⊙
butadiene	60	⊙	⊕	◑	○	○	●	●	●	⊕	○	⊕	○	●	○	◑

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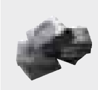

Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
butane, gaseous	20	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	⊕
butanediol, aqueous	20	⊙	⊕	◑	●	●	●	◑	⊕	●	●	●	●	●	●	⊕
butanediol, aqueous	60	⊙	○	●	●	●	⊕	⊕	⊕	●	●	●	◑	●	●	⊕
butanol, aqueous	20	◑	●	○	●	●	●	◑	●	◑	●	●	●	●	●	●
butanol, aqueous	60	⊙	○	◑	●	●	●	⊙	⊕	○	●	○	●	●	●	⊕
butter	20	⊕	●	●	⊙	⊙	●	●	●	●	⊙	●	⊙	●	⊙	●
butter	80	⊕	⊕	◑	⊙	⊙	●	●	⊕	●	⊙	●	○	●	○	⊕
butyl acetate	20	⊙	⊙	○	○	◑	●	○	⊙	○	◑	○	◑	●	○	⊙
butyl alcohol	60	⊙	○	◑	●	●	●	⊙	⊕	○	●	○	●	●	●	⊕
butyl phenol	20	○	○	○	○	○	●	◑	⊙	○	○	○	○	●	○	○
butylene glycol	60	⊙	●	●	●	●	●	◑	●	●	●	●	●	●	●	●
butylene, liquid	20	⊕	●	◑	⊙	⊙	●	●	●	●	⊙	●	○	●	○	⊕
butynediol	20	⊙	●	◑	●	●	◑	◑	⊕	●	●	●	●	●	●	⊕
butyraldehyde	20	⊙	⊙	⊙	◑	◑	◑	⊙	⊙	⊙	◑	⊙	◑	●	◑	⊙
butyric acid, aqueous	20	⊙	⊕	◑	⊕	⊕	●	●	⊕	●	⊕	●	○	●	⊕	⊕
calcium bisulphite, aqueous	20	⊙	●	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
calcium chloride, aqueous	100	⊙	○	●	●	●	●	●	●	●	●	●	○	●	●	●
calcium hydroxide, aqueous	20	⊙	○	●	●	●	●	●	●	●	●	●	●	●	●	●
calcium hypochloride, aqueous	60	○	○	◑	●	●	●	◑	⊙	○	●	○	○	●	○	⊙
calcium nitrate, aqueous	40	⊙	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
calcium phosphate, aqueous	20	⊙	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●
camphor	20	⊙	⊙	◑	○	○	●	◑	⊙	●	○	●	○	●	○	⊙
camphor oil	20	⊙	⊙	○	◑	○	●	◑	⊙	◑	○	●	○	●	○	⊙
carbolineum	60	⊙	⊙	⊙	◑	◑	●	⊕	⊕	⊙	◑	⊙	⊙	●	⊙	⊙
carbolineum	80	○	●	○	○	○	●	●	●	○	○	○	○	●	○	○
carbon dioxide, dry	60	●	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●
carbon disulphide	20	⊙	○	○	◑	○	●	●	⊙	○	○	○	○	●	○	○

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carbon monoxide, dry	60	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
carbon monoxide, wet	20	●	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
carbon tetrachloride	60	⊙	⊙	○	○	○	●	●	⊙	○	○	○	○	●	○	⊙
cellosolve	20	⊙	⊙	⊙	◑	◑	⊕	⊙	⊙	⊙	◑	⊙	⊙	●	⊙	⊙
chloral hydrate, aqueous	60	⊙	⊙	○	◑	◑	●	◑	⊙	○	◑	○	○	●	○	⊙
chloramine, aqueous	20	⊕	⊕	●	●	●	◑	⊙	⊕	●	●	●	●	●	●	⊕
chloric acid, aqueous	80	⊙	⊙	○	◑	◑	●	◑	⊙	○	◑	○	○	●	○	⊙
chlorinated lime, aqueous	60	⊙	○	○	●	●	●	●	⊙	○	●	○	○	●	○	⊙
chlorine water, saturated	20	⊙	⊙	○	●	●	●	●	⊙	○	◑	○	○	●	○	⊙
chlorine, dry gaseous	20	⊙	◑	○	◑	◑	◑	◑	⊙	○	◑	○	○	●	○	⊙
chlorine, liquid	20	⊙	⊙	○	◑	◑	◑	◑	⊙	○	◑	○	○	●	○	⊙
chlorine, wet gaseous	20	⊙	⊙	○	◑	◑	◑	◑	⊙	○	◑	○	○	●	○	⊙
chloroacetic acid	60	⊙	○	◑	●	●	◑	⊙	⊙	◑	●	◑	○	●	○	⊙
chlorobenzene	20	○	⊕	○	○	○	◑	◑	○	○	○	○	○	●	○	○
chloroform	20	⊙	○	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
chlorsulphonic acid	20	○	⊙	○	○	○	⊕	⊙	○	○	○	○	○	●	○	○
chromic acid, aqueous	60	⊙	⊙	○	●	⊕	●	●	⊙	○	⊕	○	○	●	○	⊙
chromic acid/sulphuric acid/water, 50/15/35%	40	⊙	⊙	○	●	⊕	●	●	⊙	○	⊕	○	○	●	○	⊙
citric acid, aqueous	60	⊙	⊙	◑	●	●	●	☆	⊕	●	●	●	●	●	●	⊕
clophen A types	100	⊕	○	○	⊙	⊙	●	●	●	○	⊙	○	○	●	○	●
clophen T 64	100	⊕	○	○	⊙	⊙	●	●	⊕	○	⊙	○	○	●	○	◑
coconut oil	80	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	●
coconut oil	80	⊕	⊕	◑	⊙	⊙	●	●	⊕	●	⊙	●	○	●	○	⊕
coconut oil	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	●
coconut oil alcohol	20	⊕	⊙	●	◑	◑	●	●	⊕	●	◑	●	◑	●	◑	⊕
cod liver oil	20	●	●	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
coking-oven gas	80	⊙	⊙	○	○	○	●	●	⊕	○	○	○	○	●	○	⊕

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copper chloride, aqueous	20	●	●	◑	●	●	●	●	●	●	●	●	●	●	●	●
copper fluoride, aqueous	50	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
copper nitrate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
copper sulphate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
corn oil	60	⊕	⊕	◑	⊙	○	●	●	⊕	●	○	●	○	●	○	⊕
cotton-seed oil	20	⊕	●	◑	◑	◑	●	●	⊕	●	◑	●	◑	●	◑	⊕
cresol, aqueous	45	⊙	●	○	○	○	●	●	⊙	○	○	○	○	●	○	⊙
crotonaldehyde	20	⊙	⊕	⊙	●	●	◑	○	⊙	⊙	●	⊙	◑	●	◑	⊙
crude oil	20	●	●	◑	◑	○	●	●	●	◑	○	●	○	●	○	◑
cyclohexane	20	◑	●	○	⊙	○	●	●	◑	●	○	●	○	●	○	◑
cyclohexanol	20	⊙	●	○	○	○	●	⊙	◑	●	○	●	○	●	○	⊙
cyclohexanone	20	⊙	⊙	○	⊙	○	●	⊙	⊙	○	○	○	○	●	○	⊙
cyclohexanone	20	⊙	⊙	○	○	○	●	⊙	⊙	○	○	○	○	●	○	⊙
cyclohexylamine	20	⊙	⊙	○	○	○	◑	○	⊙	○	○	○	○	●	○	⊙
decahydronaphtaline (decalin)	20	◑	⊙	○	○	○	◑	◑	⊙	○	○	○	○	●	○	⊙
decahydronaphtaline (decalin)	60	◑	⊙	○	○	○	◑	◑	⊙	○	○	○	○	●	○	⊙
Desmodur T	20	○	◑	○	○	○	◑	⊙	⊙	○	○	○	○	●	○	⊙
Desmophen 2000	80	⊕	⊙	⊕	⊕	⊕	⊕	⊕	⊕	●	⊕	●	⊕	●	●	⊕
detergent, synthetic	60	○	⊕	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
detergents	100	⊙	⊙	◑	●	●	◑	◑	⊙	●	●	●	○	●	◑	⊙
dextrine, aqueous	60	⊙	○	●	●	●	●	●	●	●	●	●	●	●	●	●
dextrose, aqueous	80	⊙	⊙	●	●	●	●	●	●	●	●	●	○	●	●	●
diacetone alcohol	20	⊙	⊕	◑	●	●	●	⊙	⊕	◑	●	◑	●	●	●	⊕
dibenzyl ether	20	⊙	⊙	○	◑	◑	●	○	⊙	○	◑	○	○	●	○	⊙
dibuthylether	20	⊙	⊙	○	◑	◑	●	○	⊙	○	◑	○	○	●	○	⊙
dibuthylphtalate	20	⊙	●	○	⊕	⊕	●	●	●	○	⊕	○	○	●	○	●
dibuthylphtalate	60	⊙	⊕	○	⊕	⊕	●	◑	●	○	⊕	○	○	●	○	●

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dibuthylsebacate	60	⊙	⊕	○	○	○	◑	⊙	◑	○	○	○	○	●	○	◑
dichloracetic acid	60	⊙	○	○	●	●	◑	○	⊙	○	●	○	○	●	○	⊙
dichlorbenzene	20	⊙	⊙	○	○	○	●	●	◑	○	○	○	○	●	○	⊙
dichlorbutylene	20	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
dichlorethane	20	○	○	○	⊙	○	◑	◑	⊕	○	○	○	○	●	○	○
dichlorethylene	20	⊙	⊙	○	⊙	⊙	◑	◑	⊙	○	⊙	○	○	●	○	⊙
dichlormethane	20	○	○	○	○	○	●	●	⊙	○	○	○	○	●	○	○
diesel fuel	60	◑	◑	◑	○	○	●	●	●	●	○	●	○	●	○	◑
diethyl ether	20	⊙	⊙	○	○	○	●	○	⊙	○	○	○	○	●	○	⊙
diethyl sebacate	20	⊙	⊙	○	◑	◑	◑	◑	⊙	○	◑	○	○	●	○	⊙
diethylamine	20	⊙	⊙	○	●	●	◑	○	⊙	◑	●	◑	○	●	○	⊙
diethylene glycol	20	⊙	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
diglycolic acid, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
dihexylphtalate	60	⊙	⊙	○	○	⊙	◑	○	⊙	○	⊙	○	○	●	○	⊙
diisobutylketone	60	⊙	⊙	○	⊕	●	◑	○	⊙	○	●	○	◑	●	○	⊙
dimethylamine	20	⊙	⊙	○	●	●	◑	○	⊙	○	●	○	○	●	○	⊙
dimethylether	20	⊙	⊙	○	●	●	◑	○	⊙	○	●	○	◑	●	○	⊙
dimethylformamide	60	⊕	○	○	◑	◑	◑	○	⊕	○	◑	○	◑	●	○	○
dinonylphtalate	30	⊙	⊙	○	○	⊙	◑	○	⊙	○	⊙	○	○	●	○	⊙
dioctylphtalate	60	○	⊙	○	○	⊙	●	◑	⊙	○	⊙	○	○	●	○	⊙
dioctylsebacate	60	⊙	⊙	○	⊙	⊙	◑	○	⊙	○	⊙	○	○	●	○	⊙
dioxane	60	⊙	⊙	○	◑	◑	⊕	○	⊙	○	◑	○	◑	●	◑	⊙
dipentene	20	⊕	⊕	○	○	○	●	●	⊕	◑	○	◑	○	●	○	⊕
diphenyl	20	⊙	⊕	○	○	○	●	●	⊙	○	○	○	○	●	○	⊙
diphenyl oxide	100	⊙	⊙	⊙	⊙	⊙	⊕	⊙	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
engine oils	100	●	◑	◑	○	○	●	●	●	●	○	●	○	●	○	◑
epichlorhydrine	20	⊙	⊙	⊙	⊙	◑	⊕	○	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙

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essential oils	20	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
ethane	20	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
ethanol (spirits)	20	⊙	◑	◑	●	●	●	☆	●	◑	●	◑	●	●	●	◑
ethanol (spirits)	80	⊙	○	○	●	●	●	☆	⊕	○	●	○	●	●	●	⊕
ethanol (spirits) with acetic acid (fermentation mixture)	60	⊙	⊙	○	●	●	●	☆	⊙	○	●	○	●	●	●	⊙
ethanol (spirits) with acetic acid (fermentation mixture)	20	⊙	⊙	◑	●	●	●	☆	⊙	○	●	○	●	●	●	⊙
ethyl acetate	20	⊙	⊙	⊙	◑	◑	◑	○	⊙	○	⊕	○	○	●	○	⊙
ethyl acetate	60	⊙	○	○	○	○	◑	○	⊙	○	○	○	○	●	○	⊙
ethyl acrylate	20	○	⊙	⊙	⊙	⊕	◑	○	○	○	◑	○	⊙	●	⊙	○
ethyl benzene	20	○	⊕	○	○	○	●	◑	◑	○	○	○	○	●	○	○
ethyl chloride	20	○	◑	◑	⊕	◑	●	◑	⊙	◑	◑	◑	◑	●	◑	○
ethylene chloride	20	○	◑	◑	⊕	◑	●	◑	⊙	◑	◑	◑	◑	●	◑	○
ethylene chlorohydrin	60	⊙	⊙	○	◑	◑	◑	○	⊙	○	◑	○	○	●	○	⊙
ethylene diamine	60	○	○	○	⊕	●	◑	○	⊙	○	●	○	◑	●	◑	○
ethylene glycol	100	⊙	○	◑	⊕	●	●	●	⊕	●	●	●	○	●	●	◑
ethylene trichloride	20	⊙	⊙	⊙	⊙	⊙	◑	⊕	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
ethylether	20	○	○	○	○	◑	●	○	○	○	◑	○	◑	●	○	○
exhaust gases, contained hydrogen fluoride, traces	60	⊕	⊙	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
exhaust gases, contained nitrous gases, traces	60	○	⊙	●	●	●	●	●	◑	⊕	◑	⊕	○	●	⊕	○
exhaust gases, contained nitrous gases, traces	80	○	⊙	●	●	●	●	●	◑	⊕	◑	⊕	○	●	⊕	○
exhaust gases, containing carbon dioxide	60	●	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●
exhaust gases, containing carbon monoxide	60	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
exhaust gases, containing hydrochloric acid	60	⊙	⊙	●	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
exhaust gases, containing sulphur dioxide	60	⊙	⊙	●	●	●	●	●	⊕	◑	●	◑	◑	●	◑	⊕
exhaust gases, containing sulphuric acid	60	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	◑	●	◑	⊕

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exhaust gases, containing sulphuric acid	80	⊙	⊙	◑	●	●	●	●	⊕	○	●	○	◑	●	◑	⊕
FAM test fuels DIN 51604-A	20	⊙	●	○	○	○	●	●	●	◑	○	◑	○	●	○	○
FAM test fuels DIN 51604-C	20	○	○	○	○	○	●	☆	◑	○	○	○	○	●	○	○
fatty acids	100	⊙	⊙	◑	◑	⊙	●	●	⊙	◑	⊙	◑	⊙	●	⊙	⊙
fatty alcohol	20	●	⊙	●	◑	◑	●	●	⊕	●	◑	●	◑	●	◑	●
ferric chloride, aqueous	40	⊙	⊕	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
fertiliser salt, aqueous	60	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
firedamp	20	●	⊕	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
fish oil	20	●	⊕	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
fluorine, dry	60	⊙	⊙	⊙	⊙	⊙	⊕	⊙	⊙	○	⊙	○	○	●	⊙	⊙
fluorobenzene	20	○	⊙	○	○	○	●	◑	○	○	○	○	○	●	○	○
fluorocarbon oils	100	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	●	⊕	●
fluorosilicic acid	100	⊙	⊙	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	⊕	○	●	⊕	⊕
fluorosilicic acid, aqueous	60	⊙	⊙	◑	●	●	●	●	⊙	●	●	●	●	●	●	⊙
formaldehyde, aqueous	60	○	⊙	◑	●	●	◑	⊙	⊕	◑	●	◑	●	●	●	⊕
formamide	60	⊙	⊙	○	●	●	●	◑	⊙	○	●	○	●	●	⊕	⊙
formic acid, aqueous	60	⊙	○	○	◑	◑	●	⊙	⊙	○	◑	○	◑	●	◑	⊙
freon as per DIN 8962 R 11	20	⊙	⊙	◑	⊙	⊙	⊙	◑	⊕	◑	⊙	●	⊙	●	⊙	⊙
freon as per DIN 8962 R 113	20	⊙	◑	●	⊙	⊙	⊙	◑	⊕	◑	⊙	●	⊙	●	⊙	⊙
freon as per DIN 8962 R 114	20	⊙	●	●	●	●	⊙	⊕	⊕	◑	●	●	●	●	●	⊙
freon as per DIN 8962 R 12	20	⊙	●	●	◑	◑	⊙	◑	⊙	◑	◑	●	◑	●	◑	⊙
freon as per DIN 8962 R 13	20	⊙	◑	●	●	●	⊙	◑	⊙	◑	●	●	⊙	●	●	⊙
freon as per DIN 8962 R 134a	20	⊙	⊙	●	⊙	●	○	○	⊕	◑	⊙	◑	⊙	●	⊙	⊙
freon as per DIN 8962 R 22	20	⊙	◑	●	●	●	⊙	○	⊕	○	●	○	●	●	●	⊙
fruit juices	100	⊙	○	◑	●	●	●	●	⊕	◑	●	◑	○	●	●	●
furan	20	⊙	○	⊙	⊙	⊙	◑	○	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
furfural	20	⊙	○	⊙	⊙	⊙	◑	⊙	⊙	○	⊙	○	⊙	●	⊙	⊙

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furfuryl alcohol	20	⊙	○	⊙	⊙	⊙	◑	⊙	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
furnace gases, dry	60	⊙	⊙	◑	●	●	●	●	●	○	●	○	●	●	●	●
gas oil	80	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
gas water	40	○	⊙	○	○	○	●	●	○	●	○	●	○	●	○	○
gasohol	20	○	○	○	○	○	●	☆	◑	○	○	○	○	●	○	○
gelatine, aqueous	40	◑	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
glacial acetic acid	60	⊙	○	○	◑	◑	◑	○	⊙	○	◑	○	○	●	○	⊙
glucose, aqueous	80	⊙	⊙	◑	●	●	●	●	●	●	●	●	◑	●	●	●
glue	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
glycerine, aqueous	100	⊙	⊙	◑	●	●	●	●	●	●	●	●	◑	●	●	●
glycerol chlorohydrine	60	⊙	⊙	○	◑	◑	◑	⊙	⊙	○	◑	○	◑	●	◑	⊙
glycine, aqueous, 10%	40	⊕	⊙	●	◑	●	●	●	⊕	◑	●	◑	◑	●	◑	⊕
glycol, aqueous	100	⊙	○	◑	●	●	●	◑	⊕	●	●	●	◑	●	●	◑
glycolic acid, aqueous, 37%	20	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
greases, mineral, animal or vegetable	80	●	●	◑	◑	○	●	●	●	●	○	●	○	●	○	●
heating oil, mineral	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
Henkel P 3 solution	100	⊙	⊙	◑	●	●	●	⊙	⊕	●	●	●	◑	●	●	⊕
heptane	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	○
hexachlorobutadiene	20	⊙	⊙	⊙	⊙	⊙	●	●	⊙	○	⊙	○	○	●	○	⊙
hexachlorocyclohexane	20	⊙	◑	⊙	⊙	⊙	●	●	⊕	⊙	⊙	⊙	○	●	○	⊙
hexaldehyde	20	⊙	⊙	○	⊙	⊙	◑	⊙	⊙	○	⊙	○	○	●	○	⊙
hexane	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	○
hexanetriol	20	⊙	⊙	◑	●	●	●	●	●	●	●	●	⊕	●	⊕	●
hexene	20	●	●	◑	◑	○	●	●	●	◑	○	◑	○	●	○	⊕
hydraulic fluids, oil-in-water emulsions HFA	55	⊙	⊙	◑	○	○	●	☆	⊕	●	○	●	○	●	○	⊕
hydraulic fluids, polyglycol water HFC	60	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●

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hydraulic fluids, water-oil emulsions HFB	60	⊙	⊙	◑	○	○	●	☆	⊕	☆	○	☆	○	●	○	⊕
hydraulic fluids, hydraulic oils DIN 51524	80	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
hydraulic fluids, phosphoric acid ester HFD	80	○	○	○	○	☆	●	☆	○	○	☆	○	○	●	○	○
hydrazine hydrate	20	⊙	◑	◑	●	●	◑	⊙	◑	◑	●	◑	○	●	◑	⊙
hydrobromic acid, aqueous	60	⊙	○	◑	●	●	⊕	⊙	⊙	◑	●	◑	⊕	●	⊕	⊙
hydrochloric acid, conc.	20	⊙	⊙	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
hydrochloric acid, conc.	80	⊙	⊙	○	●	●	●	◑	⊙	○	●	○	○	●	○	⊙
hydrochloric acid, dilute	20	⊙	○	◑	●	●	●	●	⊙	◑	●	●	●	●	●	⊙
hydrocyanic acid	20	⊙	⊙	◑	●	⊕	●	⊕	⊕	⊕	●	⊕	⊕	●	⊕	●
hydrofluoric acid, conc.	20	⊙	⊙	⊙	◑	◑	◑	⊙	⊙	⊙	◑	⊙	⊙	●	◑	⊙
hydrogen	20	●	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
hydrogen chloride gas	60	⊙	⊙	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
hydrogen peroxide, aqueous	20	⊙	⊙	○	●	●	●	●	◑	○	●	○	○	●	○	◑
hydrogen phosphide	20	⊙	⊙	◑	●	●	◑	◑	⊕	○	●	○	●	●	⊕	⊕
hydrogen sulphide, aqueous	60	⊙	⊙	◑	●	●	●	●	⊙	◑	●	◑	◑	●	●	⊙
hydrogen sulphide, dry	60	⊙	⊕	◑	●	●	●	●	⊕	◑	●	◑	◑	●	◑	⊕
hydroquinone, aqueous	20	◑	⊙	◑	●	●	●	●	⊕	●	●	●	◑	●	◑	⊕
hydrosulphite, aqueous	40	⊙	⊙	◑	●	●	◑	⊙	⊕	◑	●	◑	●	●	●	⊕
hydroxyl amine sulphate, aqueous	35	⊙	⊙	◑	●	●	◑	⊙	●	●	●	●	●	●	●	●
ink	20	●	●	●	●	●	●	◑	●	◑	●	●	●	●	●	●
iodine tincture	20	⊙	○	◑	●	●	●	●	◑	●	●	●	●	●	●	◑
iodoform	20	⊙	⊙	⊙	⊙	●	●	●	⊙	⊙	●	⊙	⊙	●	⊙	⊙
isobutyl alcohol	20	○	○	●	●	●	●	●	◑	◑	●	◑	●	●	●	●
isooctane	20	●	◑	◑	○	○	●	●	●	●	○	●	○	●	○	◑
isophorone	20	⊕	◑	⊕	⊕	●	◑	⊕	⊕	⊕	●	⊕	⊕	●	⊕	⊕
isopropanol	60	○	⊙	◑	●	●	●	☆	●	◑	●	◑	●	●	●	●

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Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
isopropyl acetate	80	○	⊙	○	◑	◑	◑	○	○	○	◑	○	○	●	○	○
isopropyl chloride	20	○	○	○	○	○	●	●	◑	○	○	○	○	●	○	○
isopropyl ether	60	○	○	○	⊙	⊙	●	○	○	○	⊙	○	⊙	●	○	○
kerosine	20	●	●	○	○	○	●	●	●	◑	○	●	○	●	○	◑
lactam	80	⊙	⊙	○	○	○	◑	○	⊙	○	○	○	○	●	○	⊙
lactic acid, aqueous 10%	40	⊙	●	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
lanolin	50	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	●
lanolin (wool grease)	60	●	●	◑	◑	○	●	●	●	●	○	●	◑	●	◑	●
lauryl alcohol	20	⊕	⊕	●	◑	◑	●	●	⊕	●	◑	●	◑	●	◑	⊕
lavender oil	20	◑	⊕	○	⊙	⊙	●	●	◑	◑	⊙	◑	⊙	●	⊙	⊙
lead acetate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	◑	●	●	●	●	●	⊕
lead acetate, aqueous	100	⊙	○	◑	●	●	●	○	⊕	◑	●	●	○	●	●	⊕
lead nitrate, aqueous	20	⊕	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
lemon juice, undiluted	20	⊙	⊕	◑	⊕	⊕	●	☆	⊕	●	⊕	●	●	●	●	●
linoleic acid	20	⊙	⊕	⊙	⊙	⊙	●	◑	⊕	◑	⊙	◑	⊙	●	⊙	◑
linseed oil	60	⊕	◑	●	◑	◑	●	●	⊕	●	◑	●	◑	●	◑	●
liqueurs	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
lithium chloride, aqueous	20	⊙	●	◑	●	●	●	●	●	●	●	●	●	●	●	●
lithiumbromide, aqueous	20	⊙	●	◑	●	●	●	●	●	●	●	●	●	●	●	●
machine oils, mineral	80	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
magnesium chloride, aqueous	100	○	⊙	◑	●	●	●	●	⊕	●	●	●	⊙	●	●	⊕
magnesium sulphate, aqueous	100	○	⊙	◑	●	●	●	●	⊕	●	●	●	⊙	●	●	⊕
maleic acid anhydride	60	⊙	⊙	⊙	⊙	⊙	●	●	⊕	⊙	⊙	⊙	⊙	●	⊙	⊙
maleic acid, aqueous	100	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	○	●	○	⊕
margarine	80	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	●
menthol	60	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
mercury	60	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

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mercury salts, aqueous	60	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
mesityl oxide	20	⊙	⊕	⊙	⊙	◑	⊕	⊕	⊕	⊕	◑	⊕	⊙	●	⊙	⊙
methane	20	●	⊕	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
methanol	60	⊙	⊙	◑	●	●	●	☆	●	◑	●	◑	●	●	●	◑
methoxy butanol	60	⊙	⊕	◑	◑	◑	●	●	⊕	●	◑	●	○	●	○	⊕
methyl acrylate	20	○	○	○	○	○	◑	○	○	○	○	○	○	●	○	○
methyl amine, aqueous	20	⊙	⊙	⊙	●	●	◑	○	⊙	○	●	○	◑	●	◑	⊙
methyl bromide	20	○	○	○	○	○	●	●	⊕	○	○	○	○	●	○	○
methyl chloride	20	○	○	○	○	○	●	●	⊙	○	○	○	○	●	○	○
methyl chlorine	20	⊙	◑	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
methyl ethyl ketone	20	○	○	○	◑	◑	●	○	○	○	◑	○	○	●	○	○
methyl isobuthyl ketone	20	○	○	○	○	◑	◑	○	○	○	◑	○	○	●	○	○
methyl methacrylate	20	○	○	○	○	○	◑	○	○	○	○	○	○	●	○	○
milk	20	⊙	●	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
milk of lime	80	⊙	⊙	◑	⊕	⊕	●	●	⊙	○	⊕	○	○	●	◑	⊙
mineral oil	100	●	◑	○	○	○	●	●	●	●	○	●	○	●	○	◑
mineral water	60	⊙	⊕	◑	●	●	●	●	●	●	●	●	●	●	●	●
mixed acid I (sulphuric acid/ nitric acid < D % 0 >/water)	20	○	○	◑	●	●	●	●	○	○	●	○	○	●	○	○
mixed acid II (sulphuric acid /phosphoric acid/water)	40	⊙	⊙	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
molasses	100	⊙	⊙	◑	◑	◑	●	●	⊕	●	◑	●	○	●	○	⊕
monobromobenzene	20	○	○	○	○	○	●	◑	○	○	○	○	○	●	○	○
monochloracetic acid ethyl ester	60	○	○	○	◑	◑	●	◑	○	○	◑	○	○	●	○	○
monochloracetic acid methyl ester	60	○	○	○	○	●	●	◑	○	○	●	○	○	●	○	○
morpholine	60	⊙	⊙	○	◑	◑	⊕	⊙	⊕	○	◑	○	○	●	○	⊕
myricyl alcohol	20	●	⊕	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
naftolen ZD	20	⊕	⊙	○	○	○	●	●	⊕	◑	○	◑	○	●	○	⊙

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naphta	20	◑	○	○	⊙	⊙	●	●	◑	○	⊙	○	⊙	●	⊙	⊙
naphthalene	60	⊙	⊙	○	○	○	●	●	⊙	○	○	○	○	●	○	⊙
naphtoic acid	20	⊙	⊙	⊕	⊙	⊙	●	●	●	◑	⊙	◑	⊙	●	⊙	⊙
natural gas	20	●	●	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
natural gas	20	⊕	◑	●	●	⊙	●	●	○	●	⊙	●	○	●	○	●
nickel acetate, aqueous	20	⊙	○	◑	●	●	◑	⊕	⊕	●	●	●	●	●	●	⊕
nickel chloride, aqueous	20	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
nickel sulphate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
nitric acid, conc.	80	⊙	○	○	●	○	⊕	○	⊙	○	○	○	○	●	○	⊙
nitric acid, dilute	80	⊙	⊙	◑	●	◑	●	◑	⊙	◑	◑	◑	○	●	◑	◑
nitric acid, fuming	60	⊙	○	○	○	○	⊕	○	⊙	○	○	○	○	●	○	⊙
nitrobenzene	60	○	○	○	○	○	◑	○	○	○	○	○	○	●	○	○
nitrogen	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
nitrogen tetraoxide	20	⊙	⊙	⊙	⊙	○	⊕	⊙	⊙	⊙	○	⊙	⊙	●	⊙	○
nitroglycerine	20	⊙	⊙	⊙	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
nitroglycol, aqueous	20	⊙	⊕	◑	●	●	●	●	⊕	○	●	○	⊕	●	⊕	⊕
nitromethane	20	○	○	⊙	◑	◑	◑	○	○	○	◑	○	◑	●	◑	○
nitropropane	20	○	○	○	◑	◑	⊕	○	○	○	◑	○	◑	●	◑	○
nitrous gases	20	○	○	○	●	●	●	●	○	○	●	○	○	●	○	○
nitrous oxide	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
n-Propanol	60	⊙	○	◑	●	●	●	◑	●	◑	●	◑	●	●	●	●
octane	20	⊙	⊕	⊙	⊙	⊙	●	●	◑	⊕	⊙	⊕	⊙	●	⊙	⊙
octyl alcohol	20	⊙	⊙	●	●	●	●	●	◑	◑	●	◑	◑	●	◑	◑
octyl cresol	20	○	⊙	○	○	○	◑	◑	○	⊙	○	⊙	○	●	○	○
oleic acid	60	●	⊙	◑	○	○	●	●	◑	●	○	●	○	●	○	◑
oleum, 10%	20	○	○	○	◑	◑	●	●	○	○	◑	○	○	●	○	○
oleyl alcohol	20	●	○	●	●	●	●	●	●	●	●	●	●	●	●	●

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olive oil	60	●	⊕	●	◑	◑	●	●	●	●	◑	●	◑	●	◑	●
o-nitrotoluene	60	○	⊙	○	○	○	⊕	○	○	○	○	○	○	●	○	○
oxalic acid, aqueous	100	⊙	⊙	○	●	●	●	●	⊙	○	●	○	○	●	◑	⊙
ozone	20	◑	⊕	◑	●	●	●	●	●	◑	◑	○	○	●	○	●
palm kernel fatty acid	60	⊕	⊕	●	○	○	●	●	⊕	●	○	●	○	●	○	⊕
palmitic acid	60	⊕	⊕	◑	○	○	●	●	⊕	◑	○	◑	○	●	○	⊕
paraffin	60	⊕	⊕	●	○	○	●	●	⊕	●	○	●	○	●	○	⊕
paraffin emulsions	40	●	●	●	○	○	●	●	●	●	○	●	○	●	○	●
paraffin oil	60	●	●	●	○	○	●	●	●	●	○	●	○	●	○	●
pectin	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
pentachlorodiphenyl	60	⊙	⊙	○	○	○	⊕	⊙	⊙	○	○	○	○	●	○	⊙
pentane	20	⊕	⊕	◑	○	○	●	●	⊕	●	○	●	○	●	○	⊕
peracetic acid, < 1%	40	○	○	○	○	●	●	●	○	○	○	○	○	●	○	○
peracetic acid, < 10%	40	○	○	○	○	◑	●	☆	○	○	○	○	○	●	○	○
perchloric acid	100	⊙	⊙	○	●	●	●	●	⊙	○	●	○	○	●	○	⊙
perchloroethylene	60	⊙	⊙	○	○	○	●	●	⊙	○	○	○	○	●	○	○
petrol	60	○	○	◑	○	○	●	●	●	◑	○	◑	○	●	○	○
petrol-benzene mixture, 50/50%	20	○	◑	○	○	○	●	●	◑	○	○	○	○	●	○	○
petrol-benzene mixture, 60/40%	20	○	◑	○	○	○	●	●	◑	○	○	○	○	●	○	○
petrol-benzene mixture, 70/30%	20	○	●	○	○	○	●	●	●	○	○	○	○	●	○	○
petrol-benzene mixture, 80/20%	20	○	●	○	○	○	●	●	●	○	○	○	○	●	○	○
petrol-benzene-ethanol, 50/30/20%	20	○	○	○	○	○	●	☆	◑	○	○	○	○	●	○	○
petroleum	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	◑
petroleum ether	60	●	●	◑	○	○	●	●	●	◑	○	●	○	●	○	◑
phenol, aqueous, up to 90%	80	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
phenyl benzene	20	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
phenyl ethyl ether	20	○	○	○	○	○	◑	○	○	○	○	○	○	●	○	○

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phenyl hydrazine	60	⊙	⊙	○	○	○	●	◑	⊙	◑	○	◑	○	●	○	⊙
phenyl hydrazine chlorohydrate, aqueous	80	⊙	⊙	○	◑	●	◑	◑	⊙	◑	●	◑	○	●	○	⊙
phosgene	20	⊙	⊙	⊙	⊕	⊕	⊕	⊕	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
phosphoric acid, aqueous	60	⊙	⊙	◑	●	●	●	●	⊙	○	●	○	◑	●	●	⊙
phosphorus oxychloride	20	⊙	⊙	⊙	⊕	⊕	⊕	⊕	⊙	○	⊙	○	⊙	●	⊕	⊙
phosphorus trichloride	20	⊙	⊙	○	●	●	◑	◑	⊙	○	●	○	●	●	⊕	⊙
photo developer	40	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
photo emulsions	20	⊙	⊙	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
photo fixing baths	40	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
phthalic acid, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	○	●	⊕	⊕
pickling solution (leather pickling)	20	⊙	⊙	⊕	◑	◑	◑	◑	⊙	⊕	◑	⊕	⊙	●	⊙	⊙
picric acid	20	⊙	◑	●	◑	◑	●	●	◑	◑	◑	◑	◑	●	◑	⊙
picric acid, aqueous	20	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
Pine needle oil	20	⊙	⊕	○	⊙	⊙	●	●	⊕	◑	○	◑	○	●	○	⊙
pinene	20	⊙	◑	◑	◑	⊙	●	●	◑	◑	⊙	◑	⊙	●	⊙	⊙
pine-needle oil	60	●	●	○	○	○	●	●	●	◑	○	◑	○	●	○	◑
piperidine	20	⊙	⊙	⊙	⊙	⊙	⊕	⊙	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
potash, aqueous	40	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
potassium acetate, aqueous	20	⊙	◑	◑	●	●	●	●	⊕	◑	●	●	●	●	●	⊕
potassium bisulphate, aqueous	40	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium borate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium bromate, 10%	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium bromide, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium carbonate, aqueous	40	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
potassium chlorate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	○	●	○	◑	●	◑	⊕
potassium chloride, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium chromate, aqueous	20	⊙	○	◑	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕

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1) test temperature in °C

Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
potassium cyanide, aqueous	40	⊙	⊕	◑	●	●	●	●	●	●	●	●	●	●	●	●
potassium cyanide, aqueous	80	⊙	○	◑	●	●	●	●	●	◑	●	◑	○	●	○	●
potassium dichromate, aqueous 40%	20	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	○	●	◑	⊕
potassium hydroxide, 50%	60	○	○	◑	●	●	◑	○	○	◑	●	◑	◑	●	◑	○
potassium iodide, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	◑	●	●	⊕
potassium nitrate, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
potassium perchlorate, aqueous	80	⊙	⊙	◑	●	●	●	●	⊕	○	●	○	○	●	○	⊕
potassium permanganate, aqueous	40	⊙	⊙	◑	●	●	●	●	⊙	○	●	○	○	●	◑	⊙
potassium persulphate, aqueous	60	⊙	⊙	○	●	●	●	●	⊙	○	●	○	○	●	◑	⊙
potassium sulphate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
propane, liquid/gaseous	20	●	●	●	⊙	⊙	●	●	●	●	⊙	●	○	●	○	●
propargyl alcohol, aqueous	60	⊕	⊙	●	●	●	●	●	⊕	●	●	●	◑	●	⊕	⊕
propionic acid, aqueous	60	⊙	⊙	◑	⊕	⊕	●	●	⊙	●	⊕	●	⊙	●	⊕	⊙
propylene glycol	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
propylene oxide	20	⊙	⊙	⊙	⊙	⊙	◑	⊙	⊙	○	⊙	○	⊙	●	⊙	⊙
pyridine	20	○	○	○	⊙	⊙	⊕	○	○	○	⊙	○	○	●	○	○
pyrrole	20	⊙	⊙	⊙	⊙	○	⊕	⊕	◑	⊙	○	⊙	○	●	○	◑
rapeseed oil	20	◑	◑	◑	◑	◑	●	●	●	◑	◑	◑	⊙	●	⊙	⊙
refrigerant as per DIN 8962 R 11	20	⊙	⊙	◑	⊙	⊙	⊙	◑	⊕	◑	⊙	●	⊙	●	⊙	⊙
refrigerant as per DIN 8962 R 113	20	⊙	◑	●	⊙	⊙	⊙	◑	⊕	◑	⊙	●	⊙	●	⊙	⊙
refrigerant as per DIN 8962 R 114	20	⊙	●	●	●	●	⊙	⊕	⊕	◑	●	●	●	●	●	⊙
refrigerant as per DIN 8962 R 12	20	⊙	●	●	◑	◑	⊙	◑	⊙	◑	◑	●	◑	●	◑	⊙
refrigerant as per DIN 8962 R 13	20	⊙	◑	●	●	●	⊙	◑	⊙	◑	●	●	⊙	●	●	⊙
refrigerant as per DIN 8962 R 134a	20	⊙	⊙	●	⊙	●	○	○	⊕	◑	⊙	◑	⊙	●	⊙	⊙
refrigerant as per DIN 8962 R 22	20	⊙	◑	●	●	●	⊙	○	⊕	○	●	○	●	●	●	⊙
sagrotan	20	⊙	○	◑	●	●	●	●	●	◑	●	◑	●	●	●	●
salicylic acid	20	⊙	●	●	●	●	●	●	⊙	●	●	●	●	●	●	⊙

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[1] test temperature in °C

Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
salt water	20	⊙	⊙	●	●	●	●	●	●	●	●	●	●	●	●	⊙
sea water	20	⊙	◑	◑	●	●	●	●	●	●	●	●	●	●	●	●
silicic acid, aqueous	60	⊙	⊙	◑	●	●	●	●	⊙	●	●	●	●	●	●	⊙
silicone grease	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	○
silicone oil	20	●	●	●	●	●	●	●	●	●	●	●	◑	●	●	○
silver nitrate, aqueous	100	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	⊙	●	◑	⊕
silver salts, aqueous	60	⊙	⊙	◑	●	●	●	●	●	◑	●	◑	◑	●	◑	●
skydrol	20	○	○	○	⊙	◑	◑	○	○	○	⊕	○	○	●	○	○
soap solution, aqueous	20	⊙	●	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
soda, aqueous	60	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
sodium benzoate, aqueous	40	⊙	⊕	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium bicarbonate	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium bicarbonate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium bisulphite, aqueous	100	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium chlorate	20	⊙	⊙	○	●	●	●	●	⊕	○	●	○	○	●	○	⊕
sodium chloride	100	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	⊙	●	●	⊕
sodium hydroxide	20	○	⊙	◑	●	●	●	○	○	◑	●	◑	◑	●	◑	○
sodium hypochlorite, aqueous	20	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	○	●	○	⊕
sodium nitrate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium nitrite	60	⊙	⊙	◑	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
sodium phosphate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium silicate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium sulphate, aqueous	20	◑	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium sulphate, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium sulphide	40	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sodium sulphide	100	⊙	⊙	◑	●	●	●	●	⊕	◑	◑	◑	○	●	◑	⊕
sodium thiosulphate	60	⊕	⊙	●	●	●	●	●	⊕	○	●	○	●	●	●	⊕

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spermaceti	20	⊕	⊕	◑	○	○	●	●	⊕	●	○	●	○	●	⊙	⊕
spindle oil	60	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	●
starch syrup	60	⊙	⊙	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
starch, aqueous	60	⊙	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●
steam	130	⊙	○	○	◑	●	○	☆	○	○	●	○	○	●	○	○
steam	130	⊙	○	○	◑	●	○	☆	○	○	●	○	○	●	○	○
stearic acid	60	●	●	◑	●	●	●	●	●	●	●	●	○	●	●	●
stoddard solvent	20	●	●	○	○	⊙	●	●	●	●	⊙	●	⊙	●	⊙	⊙
styrene	20	⊙	⊙	○	○	○	⊕	◑	⊙	○	○	○	○	●	○	○
succinic acid, aqueous	60	⊙	○	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
sugar syrup	60	⊙	⊙	⊙	●	●	●	●	⊕	●	●	●	●	●	⊕	⊕
sulphur	60	⊙	⊕	⊙	●	●	●	●	⊕	⊙	●	⊙	⊙	●	⊙	⊕
sulphur chloride	20	⊙	⊙	○	◑	⊙	●	●	●	○	⊙	○	⊙	●	⊙	⊙
sulphur dioxide, aqueous	60	⊙	⊙	○	●	●	●	●	⊙	○	●	○	○	●	◑	⊙
sulphur dioxide, dry	80	⊙	⊙	○	●	●	●	●	⊕	○	●	○	○	●	◑	⊕
sulphur dioxide, liquid	60	⊙	⊙	○	●	●	●	●	⊙	○	●	○	○	●	⊙	⊙
sulphur hexafluoride	20	⊕	⊕	●	●	●	●	●	●	●	●	●	⊕	●	●	●
sulphuric acid, conc.	50	⊙	○	○	●	●	●	◑	⊙	○	●	○	○	●	◑	○
sulphuric acid, dilute	20	⊙	⊙	○	●	●	●	●	⊙	◑	●	◑	◑	●	◑	⊙
sulphuryl chloride	20	⊙	⊙	○	●	◑	●	●	⊙	○	◑	○	◑	●	◑	⊙
tallow	60	⊕	⊙	◑	○	○	●	●	⊕	●	○	●	○	●	○	⊕
tannic acid	60	◑	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
tannin	40	⊙	●	●	●	●	●	●	⊕	◑	●	◑	●	●	●	⊕
tanning extract	20	◑	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●
tar	20	⊙	⊙	○	○	○	●	⊕	⊙	○	○	○	○	●	○	⊙
tar oil	20	⊙	⊙	○	○	○	●	⊕	⊙	○	○	○	○	●	○	⊙
tartaric acid, aqueous	60	⊙	⊙	◑	●	●	●	●	●	●	●	●	●	●	●	●

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[1] test temperature in °C

Medium	°C[1]	ACM	AU	CR	CSM	EPDM	FFKM	FKM	FVMQ	HNBR	IIR	NBR	NR	PTFE	SBR	VMQ
tetrachlorethane	60	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
tetrachloroethylene	60	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
tetraethyl lead	20	⊙	⊙	○	○	⊙	●	●	◑	◑	⊙	◑	⊙	●	⊙	⊙
tetrahydrofuran	20	⊙	⊙	○	○	○	◑	○	⊙	○	○	○	○	●	○	⊙
tetrahydronaphthalene (tetralin)	20	⊙	⊙	○	○	○	●	●	⊕	○	○	○	○	●	○	⊙
thionyl chloride	20	⊙	⊙	○	●	●	●	●	⊙	○	●	○	◑	●	◑	⊙
thiophen	60	⊙	⊙	○	○	○	⊕	○	⊙	○	○	○	○	●	○	⊙
tin(II) chloride, aqueous	80	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
titanium tetrachloride	20	◑	●	◑	●	●	●	◑	◑	●	●	●	●	●	●	◑
toluene	20	○	○	○	○	○	●	◑	○	○	○	○	○	●	○	○
town gas, benzene-free	20	●	●	◑	○	○	●	●	●	●	○	●	○	●	○	●
transformer oil	60	●	●	○	○	○	●	●	●	◑	○	●	○	●	○	◑
transmission Fluid type A	20	●	●	◑	◑	⊙	●	●	●	●	⊙	●	⊙	●	⊙	◑
triacetin	20	⊙	⊙	◑	◑	●	⊕	⊙	⊙	◑	●	◑	◑	●	○	⊙
tributoxyethyl phosphate	20	⊙	⊙	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
tributyl phosphate	60	⊙	○	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
trichloroacetic acid, aqueous	60	⊙	⊙	○	◑	◑	●	○	⊙	◑	◑	◑	◑	●	◑	⊙
trichloroethyl phosphate	20	⊙	⊙	○	⊙	⊙	◑	○	⊙	○	⊙	○	⊙	●	⊙	⊙
trichloroethylene	20	⊙	○	○	○	○	●	◑	⊙	○	○	○	○	●	○	○
tricresyl phosphate	60	⊙	◑	○	○	◑	⊕	◑	⊕	○	◑	○	○	●	○	⊙
triethanolamine	20	⊙	⊙	◑	◑	◑	◑	⊙	⊙	○	◑	○	○	●	⊕	⊙
triethylaluminium	20	⊙	⊙	⊙	⊙	⊙	◑	◑	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
triethylborane	20	⊙	⊙	⊙	⊙	⊙	●	●	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
triglycol	20	⊙	⊕	●	●	●	●	●	⊕	●	●	●	●	●	●	⊕
trimethylol propane, aqueous	100	⊙	⊙	◑	◑	◑	●	●	⊕	○	◑	○	◑	●	⊕	⊕
trinitrotoluene	20	⊙	⊙	◑	◑	⊙	●	◑	◑	⊙	⊙	⊙	⊙	●	⊙	⊙
trioctyl phosphate	60	⊙	⊙	○	◑	◑	●	◑	⊕	○	◑	○	○	●	⊙	⊙

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trisodium phosphate	20	⊙	⊕	◑	●	●	●	●	●	●	●	●	●	●	●	●
turpentine	60	⊕	○	○	○	○	●	●	⊙	◑	○	◑	○	●	○	⊙
turpentine oil	20	⊕	⊙	○	○	○	●	●	⊙	◑	○	◑	○	●	○	⊙
urea, aqueous	60	⊙	⊙	◑	●	●	●	●	⊕	●	●	●	●	●	●	⊕
vaseline	60	●	⊕	●	◑	○	●	●	●	●	○	●	○	●	○	◑
vaseline oil	60	●	⊕	●	◑	○	●	●	●	●	○	●	○	●	○	◑
vinyl acetate	20	⊙	⊙	⊙	⊙	⊙	◑	⊙	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
vinyl chloride, liquid	20	⊙	⊙	⊙	⊙	⊙	◑	⊙	⊙	⊙	⊙	⊙	⊙	●	⊙	⊙
water	100	○	○	◑	●	●	◑	◑	⊕	●	●	●	◑	●	●	◑
wax alcohol	60	⊕	⊕	◑	○	○	●	●	⊕	◑	○	●	○	●	⊙	⊕
whisky	20	⊙	●	●	●	●	●	●	●	●	●	●	●	●	●	●
white lye	100	⊙	⊙	◑	●	●	◑	○	⊙	◑	●	◑	○	●	●	⊙
white oil	20	●	⊕	◑	◑	⊙	●	●	●	●	⊙	●	⊙	●	⊙	●
white spirit	60	●	⊕	◑	○	○	●	●	⊕	◑	○	●	○	●	○	⊕
wine	20	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●	●
xylamon	20	○	◑	○	○	○	●	◑	⊙	○	○	○	○	●	○	⊙
xylene	20	○	○	○	○	○	●	◑	○	○	○	○	○	●	○	○
yeast, aqueous	20	⊙	⊕	●	●	●	●	●	●	●	●	●	●	●	●	●
zeolite	20	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
zinc acetate	20	●	●	◑	◑	●	●	●	●	◑	●	◑	●	●	○	●

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Suggestion for Storage

(in conformity with the revision of ISO 2230 dated 16.09.1992)

Storage conditions

The storage temperature must be below 25 °C; the items must be stored away from sources of direct heat and must not be exposed to direct sunlight. The relative air humidity must be such that no condensation occurs when the temperature in the storage room changes. The effect of ozone and ionising radiation must always be excluded.

Packaging

All materials for bins, for covering and wrapping must be free of substances that have a decomposing effect on elastomers.
Suitable packaging materials include soda paper, aluminium foil or opaque
PE foil (min. 0,075 mm thick).

The packaged items must be labelled as follows:

a)	part/article number of manufacturer	ISC O-Ring 20-2/335674
b)	description of polymer	72 NBR 872
c)	quarter and year of manufacture of the elastomer part	1/99
d)	the classification of the elastomer (group)	group 2
e)	number of packages	10 pieces
f)	name or trademark of manufacturer Simrit	

The elastomer products are divided into three groups:

		1st storage time in years	1st extension in years
Group 1	NR, AU, EU, SBR	5	2
Group 2	NBR, HNBR, ACM, AEM, XNBR, ECO, CIIR, CR, IIR	7	3
Group 3	FKM, VMQ, EPDM, FVMQ, PVMQ, FFKM, CSM	10	5

Additional extensions are possible under certain circumstances, but only after consultation with the relevant technical department. The technical department will conduct appropriate tests and will decide whether the products can continue to be used or must be discarded.

Suggestions for the assessment of elastomer parts after the first storage time:

1) Test in accordance with the respective product specifications. If such action is not included in the product specifications:

2) Visual inspection
Every part or every component in the representative sample must be checked as follows:
   - lasting deformation such as folds or flats
   - mechanical damage such as cuts, cracks, abrasions or detached layers
   - crack formation on the surface, observed under a 10x magnifying glass
   - changes of status of the surface such as hardening, softening, tackiness, discoloration and dirt.

The inspected features of the stored parts or components must be recorded. If the tests yield recordable results, the records must include the acceptable confidence interval of the average values of every test parameter.

A record must also contain the following:

a) the stored quantity of every item or every component, the date of first packaging, the date of storage

b) the date of each subsequent re-packaging

c) the manufacturer's batch number

d) the number of parts or components that form a representative sample of these parts or components.

Summary of the Mentioned Standards

DIN 3760	Rotary shaft lip type seals
DIN 3761	Rotary shaft lip type seals for automobiles
DIN 3771	Fluid systems – O-rings
DIN 7168	General tolerances for linear and angular dimensions and geometrical tolerances
DIN 7715	Permissible deviations for soft rubber parts (extract from DIN 7715 part 2)
DIN 7716	Rubber products Requirements for storage, cleaning and maintenance
DIN 7724	Polymeric materials; grouping of polymeric materials based on their mechanical behaviour
DIN 9088	Aerospace series - Storage life of rubber products
DIN 16901	Plastic mouldings; tolerances and acceptance conditions for linear dimensions
DIN 24320	Fire-resistant fluids - Hydraulic fluids of categories HFAE and HFAS - Characteristics and requirements
DIN 51524	Hydraulic fluids – Hydraulic oils – HL, HLP, HVLP
DIN 51604	FAM testing fluid for polymer materials, Composition and requirements
DIN 52612	Testing of thermal insulating materials Determination of the thermal conductivity with the guarded hot plate apparatus, Procedure and evaluation
DIN EN ISO 6721	Testing of polymer materials Torsion vibration test
DIN EN ISO 1183	Testing of plastics and rubber Determination of the density
DIN 53504	Testing of rubber Tensile trials
DIN 53505	Testing of rubber Shore A and D hardness test
DIN ISO 34-1	Testing of rubber Determination of the tear strength of elastomers; Trouser test piece
DIN 53508	Testing of soft rubber Accelerated ageing
DIN 53509	Testing of rubber Resistance of rubber to ozone cracking
DIN 53512	Testing of rubber Determination the rebound resilience of rubber
DIN 53513	Testing of rubber and elastomers Determination of the viscoelastic properties of elastomers on exposure to forced vibration atnon-resonant frequencies
DIN 53516	Testing of rubber and elastomers Determination of abrasion resistance
DIN ISO 815	Testing of rubber Determination of the compression set. Thermal Testing Procedures.
DIN 53533	Testing of elastomers; Testing of heat generation and service life during the fatigue test (flexometer test)
DIN 53538	Testing of elastomers; Standard reference elastomers For characterising service fluids with respect to their action on vulcanised nitrile rubbers
DIN 53545	Testing of elastomers; Determination of low-temperature behaviour of elastomers; principles and test methods

DIN 53546	Testing of elastomers; Impact test for the determination of the low-temperature brittleness point
DIN ISO 1817	Testing of rubber and elastomers Determination of the behaviour of rubber and elastomers when exposed to fluids and vapours
DIN ISO 48	Elastomers and thermoplastic elastomers Tensile strength.
DIN ISO 1629	Rubber and latex Difference and abbreviations
VDMA 24317	Hydraulic fluids Flame retardant hydraulic fluids Minimum technical requirements
ASTM D 395	Test Methods for Rubber Property-Compression Set
ASTM D 471	Standard test method for rubber property-effect of Liquids
ASTM D 746	Test method for brittleness temperature of plastics and elastomers by impact
ASTM D 945	Test methods for rubber properties in compression or shear (Mechanical-Oscillograph)
ASTM D 1418	Practice for rubber and rubber latices - Nomenclature
ASTM D 1600	Abbreviations of terms relating to plastics
ASTM D 2000	Classification system for rubber products in automotive applications

DIN Standard Leaflets can be obtained from:
Beuth-Vertrieb GmbH,
D-10719 Berlin, Uhlandstraße 175,
as well as
D-50672 Cologne, Friesenplatz 16
ASTM standards can also be obtained from
Beuth-Vertrieb. Summary of applicable standards