Hallite
Fenner Advanced Sealing Technologies

Design Information

Hallite Sealing Products are available from MARYLAND METRICS
P.O. Box 261 Owings Mills, MD 21117 USA
ph: (410)358-3130 (800)638-1830 fx: (410)358-3142 (800)872-9329
web: http://mdmetric.com email: sales@mdmetric.com

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HALLITE Design Information Brochure

1) Use & Fitting of Seal
Our quality control methods for material and manufacturing processes ensure that all seals leaving our factories are in a condition capable of giving a long and reliable service life.

2) Housing & Installation Data

3) Housing Design
Hallite Seals' product data sheets give information indicating the allowable extrusion gap a seal can see at pressure during its working life.

4) Housing Design & Seal Options
Hallite's wide range of products can be applied to a selection of some of the most popular cylinder designs servicing the worlds fluid power industry.

5) Products & Typical Fluid Compatibility

6) Operating Conditions
From many years of application experience with sealing hydraulic equipment, we know that it is necessary to link the three main operating features of speed, pressure and temperature to achieve a satisfactory seal performance.
After carefully considering each product we are able to specify the maximum speed and pressure with a temperature range within which the seal will operate safely.

7) Storage of Seals
Most Polymeric items including vulcanized rubber and other elastomers tend to change their properties during storage and may become unserviceable.
The following recommendations indicate the most suitable conditions for storing, whether as a single item or composite product.

8) Surface Roughness
Surface roughness has a very important influence on the life and leakage performance of a reciprocating sealing system. Piston Rods are generally hard chrome plated

Use and fitting of seals

Our quality control methods for material and manufacturing processes ensure that all seals leaving our factories are in a condition capable of giving a long and reliable service life.

We have found from many years experience, that premature seal failure can be avoided if the following recommendations are considered at the design and manufacturing stage of the cylinder:

1 Specify piston and gland bearings which are adequately proportioned to support the cylinder loads.

  As a result of mounting misalignments and / or the working action of the cylinder, piston and gland bearings will be subjected to side-loading, causing damage to the rod or the tube surface and hence the seal, if the bearings are inadequate.

2 Ensure that seals are stored distortion free in a cool, dry and dark place prior to fitting.(See page 17)

3 Check that the seal housing is free from damage likely to harm the seal. Remove all sharp edges and burrs from metal parts, paying particular attention to ports, grooves and threads over or through which the seal passes during assembly.

4 Clean all seal housing areas, ensuring that all metallic particles and other contaminants have been removed. Check that other surfaces adjacent to the passage of the seal on fitting are also free of dirt, swarf or other contaminants. Check that both static and dynamic housing surface finishes meet specifications.

5 Where the difference between a thread diameter over which the seal must pass and the seal diameter is small, use some form of protection over the thread, such as a fitting sleeve made of hard plastic.

6 Check that the seal is of the correct type, part number and size, and that the specified material is correct. If there is any doubt regarding the material contact your local Hallite sales office.

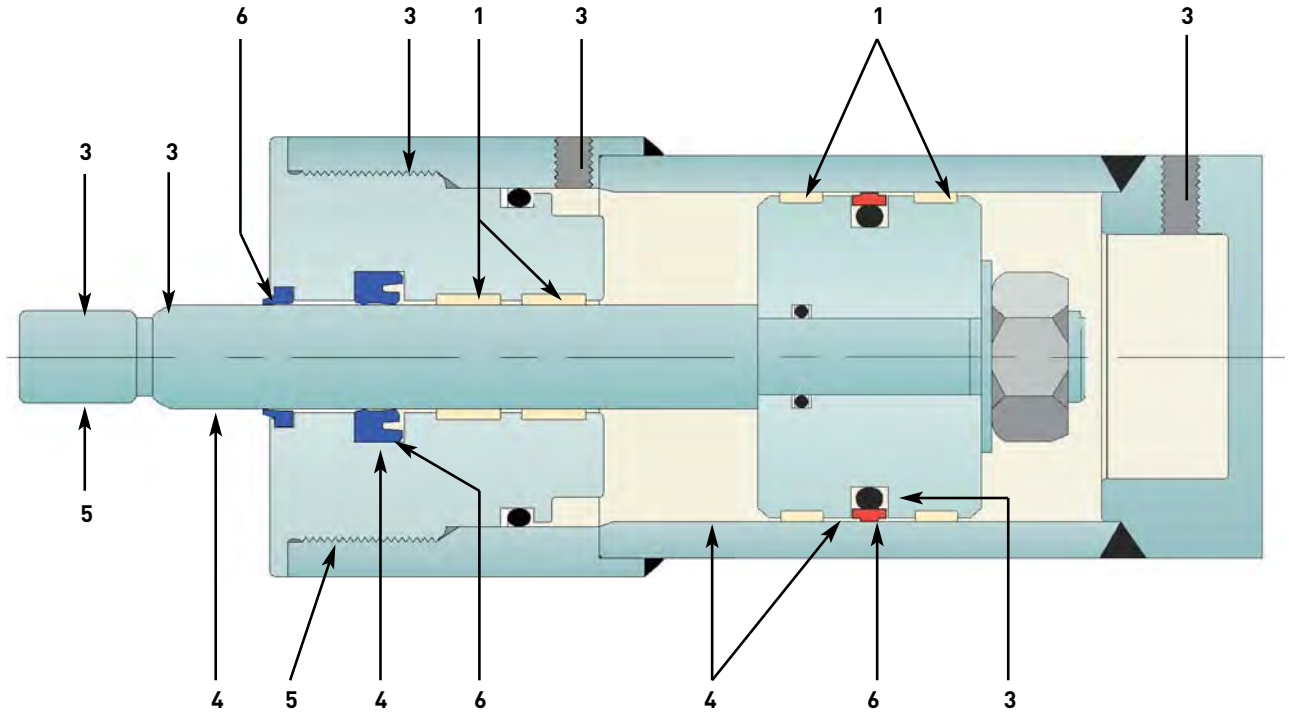
7 Lubricate all seals and metal components liberally with clean operating fluid or a compatible grease prior to assembly. N.B. Silicone grease should not be used in normal hydraulic applications.

8 Where seals fitted to sub-assemblies, such as pistons, are awaiting further fitting operations, ensure that the seals are not subjected to any misaligned or localised loading which will cause local deformation. Ensure that sub-assemblies remain clean.

9 The use of metal levers is not recommended but should they be used it is imperative that they are completely smooth and free from nicks and burrs. When using them ensure that the metal surfaces adjacent to the seal are not damaged.

10 Flush the hydraulic system thoroughly before connecting the cylinder to it.

Typical hydraulic cylinder layout showing installation features to be considered for satisfactory seal life.



Hallite 87, 506 & 533 bearing strip

Hallite 87 strip is a low friction bronze filled PTFE compound produced in a flat tape style ready for easy cutting to size to suit individual applications and is particularly effective in friction conscious applications such as servo cylinders.

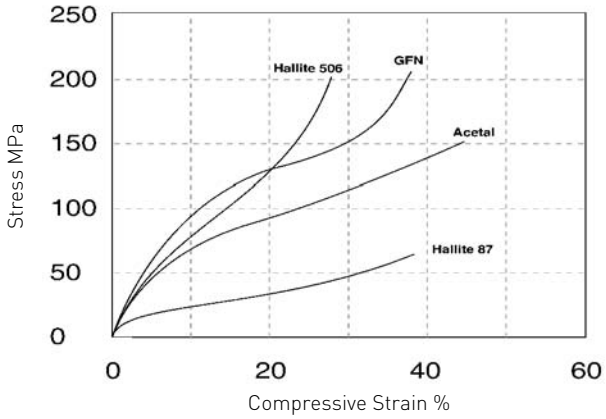
Hallite 506 can be supplied in spiral lengths, generally in 10 metre, as individual cut bearings and also in 10 metre lengths packed flat in a box dispenser. Hallite 506 bearing strip is manufactured to extremely accurate thickness tolerances, ensuring reliable cylinder alignment. Other sizes of type 506 are available on request, special sections and diameters can also be produced to suit individual requirements.

Bearing Type	Standard material
87	PTFE + Bronze
506	Polyester + PTFE
533	GFN

Bearing strip housing tolerances

As tolerances are not specified "on line" for types 87 & 506, please refer to the information below and on the next page for tolerances as indicated on the product's data sheet.

Compressive bearing stress versus strain for non metallic materials



Hallite 506 specified tolerances

	Bearing length L_1	Bearing cross section S
Tolerances (in)	-0.005 to -0.025	-0.001 to -0.003

Hallite 506 specified tolerances

	Bearing length L_1	Bearing cross section S
Tolerances (mm)	-0.1 to -0.6	-0.02 to -0.08

Hallite 533 specified tolerances

	Bearing length L_1	Bearing cross section S
Tolerances (in.)	-0.000 to -0.010	-0.001 to -0.004

Hallite 87 specified tolerances

	Bearing length L_1	Bearing cross section S
Tolerances (mm)	-0.1 to -0.5	+0.03 to -0.05

Specified tolerances

Nominal sizes mm		Shafts (outside diameter) Units 0.001 mm								Bores (inside diameter) Units 0.001 mm				
over	to	f8	f9	h8	h9	h10	h11	js10	js11	H8	H9	H10	H11	Js11
1.6	3	-6 -20	-6 -31	0 -14	0 -25	0 -40	0 -60	+20 -20	+30 -30	+14 0	+25 0	+40 0	+60 0	+30 -30
3	6	-10 -28	-10 -40	0 -18	0 -30	0 -48	0 -75	+24 -24	+37.5 -37.5	+18 0	+30 0	+48 0	+75 0	+37.5 -37.5
6	10	-13 -35	-13 -49	0 -22	0 -36	0 -58	0 -90	+29 -29	+45 -45	+22 0	+36 0	+58 0	+90 0	+45 -45
10	18	-16 -43	-16 -59	0 -27	0 -43	0 -70	0 -110	+35 -35	+55 -55	+27 0	+43 0	+70 0	+110 0	+55 -55
18	30	-20 -53	-20 -72	0 -33	0 -52	0 -84	0 -130	+42 -42	+65 -65	+33 0	+52 0	+84 0	+130 0	+65 -65
30	50	-25 -64	-25 -87	0 -39	0 -62	0 -100	0 -160	+50 -50	+80 -80	+39 0	+62 0	+100 0	+160 0	+80 -80
50	80	-30 -76	-30 -104	0 -46	0 -74	0 -120	0 -190	+60 -60	+95 -95	+46 0	+74 0	+120 0	+190 0	+95 -95
80	120	-36 -90	-36 -123	0 -54	0 -87	0 -140	0 -220	+70 -70	+110 -110	+54 0	+87 0	+140 0	+220 0	+110 -110
120	180	-43 -106	-43 -143	0 -63	0 -100	0 -160	0 -250	+80 -80	+125 -125	+63 0	+100 0	+160 0	+250 0	+125 -125
180	250	-50 -122	-50 -165	0 -72	0 -115	0 -185	0 -290	+92 -92	+145 -145	+72 0	+115 0	+185 0	+290 0	+145 -145
250	315	-56 -137	-56 -186	0 -81	0 -130	0 -210	0 -320	+105 -105	+160 -160	+81 0	+130 0	+210 0	+320 0	+160 -160
315	400	-62 -151	-62 -202	0 -89	0 -140	0 -230	0 -360	+115 -115	+180 -180	+89 0	+140 0	+230 0	+360 0	+180 -180
400	500	-68 -165	-68 -223	0 -97	0 -155	0 -250	0 -400	+125 -125	+200 -200	+97 0	+155 0	+250 0	+400 0	+200 -200
500	630	-76 -186	-76 -251	0 -110	0 -175	0 -280	0 -440	+140 -140	+220 -220	+110 0	+175 0	+280 0	+440 0	+220 -220
630	800	-80 -205	-80 -280	0 -125	0 -200	0 -320	0 -500	+160 -160	+250 -250	+125 0	+200 0	+320 0	+500 0	+250 -250

Nominal sizes in.		Shafts (outside diameter) Units 0.001 in.								Bores (inside diameter) Units 0.001 in.				
over	to	f8	f9	h8	h9	h10	h11	js10	js11	H8	H9	H10	H11	Js11
0.04	0.12	-0.3 -0.9	-0.3 -1.2	0 -0.6	0 -1.0	0 -1.6	0 -2.5	+0.8 -0.8	+1.3 -1.3	+0.6 0	+1.0 0	+1.6 0	+2.5 0	+1.3 -1.3
0.12	0.24	-0.4 -1.1	-0.4 -1.6	0 -0.7	0 -1.2	0 -1.8	0 -3.0	+0.9 -0.9	+1.5 -1.5	+0.7 0	+1.2 0	+1.8 0	+3.0 0	+1.5 -1.5
0.24	0.40	-0.5 -1.4	-0.5 -1.9	0 -0.9	0 -1.4	0 -2.2	0 -3.5	+1.1 -1.1	+1.8 -1.8	+0.9 0	+1.4 0	+2.2 0	+3.5 0	+1.8 -1.8
0.40	0.71	-0.6 -1.6	-0.6 -2.3	0 -1.0	0 -1.6	0 -2.8	0 -4.0	+1.4 -1.4	+2.0 -2.0	+1.0 0	+1.6 0	+2.8 0	+4.0 0	+2.0 -2.0
0.71	1.19	-0.8 -2.0	-0.8 -2.8	0 -1.2	0 -2.0	0 -3.5	0 -5.0	+1.8 -1.8	+2.5 -2.5	+1.2 0	+2.0 0	+3.5 0	+5.0 0	+2.5 -2.5
1.19	1.97	-1.0 -2.6	-1.0 -3.4	0 -1.6	0 -2.5	0 -4.0	0 -6.0	+2.0 -2.0	+3.0 -3.0	+1.6 0	+2.5 0	+4.0 0	+6.0 0	+3.0 -3.0
1.97	3.15	-1.2 -3.0	-1.2 -4.1	0 -1.8	0 -3.0	0 -4.5	0 -7.0	+2.3 -2.3	+3.5 -3.5	+1.8 0	+3.0 0	+4.5 0	+7.0 0	+3.5 -3.5
3.15	4.73	-1.4 -3.6	-1.4 -4.8	0 -2.2	0 -3.5	0 -5.0	0 -9.0	+2.5 -2.5	+4.5 -4.5	+2.2 0	+3.5 0	+5.0 0	+9.0 0	+4.5 -4.5
4.73	7.09	-1.6 -4.1	-1.6 -5.6	0 -2.5	0 -4.0	0 -6.0	0 -10.0	+3.0 -3.0	+5.0 -5.0	+2.5 0	+4.0 0	+6.0 0	+10.0 0	+5.0 -5.0
7.09	9.85	-2.0 -4.8	-2.0 -6.5	0 -2.8	0 -4.5	0 -7.0	0 -12.0	+3.5 -3.5	+6.0 -6.0	+2.8 0	+4.5 0	+7.0 0	+12.0 0	+6.0 -6.0
9.85	12.41	-2.2 -5.2	-2.2 -7.3	0 -3.0	0 -5	0 -8.0	0 -12.0	+4.0 -4.0	+6.0 -6.0	+3.0 0	+5.0 0	+8.0 0	+13.0 0	+6.5 -6.5
12.41	15.75	-2.5 -6.0	-2.5 -8.0	0 -3.5	0 -6.0	0 -9.0	0 -14.0	+4.5 -4.5	+7.0 -7.0	+3.5 0	+6.0 0	+9.0 0	+14.0 0	+7.0 -7.0
15.75	19.69	-2.8 -6.5	-2.8 -8.8	0 -4.0	0 -6.0	0 -10.0	0 -16.0	+5.0 -5.0	+8.0 -8.0	+4.0 0	+6.0 0	+10.0 0	+16.0 0	+8.0 -8.0
19.69	24.80	-3.0 -7.0	-3.0 -9.9	0 -4.3	0 -6.9	0 -11.0	0 -17.3	+5.5 -5.5	+8.7 -8.7	+4.3 0	+6.9 0	+11.0 0	+17.3 0	+8.7 -8.7
24.80	31.49	-3.1 -8.1	-3.1 -11.0	0 -4.9	0 -7.9	0 -12.6	0 -19.7	+6.3 -6.3	+9.8 -9.8	+4.9 0	+7.9 0	+12.6 0	+19.7 0	+9.8 -9.8

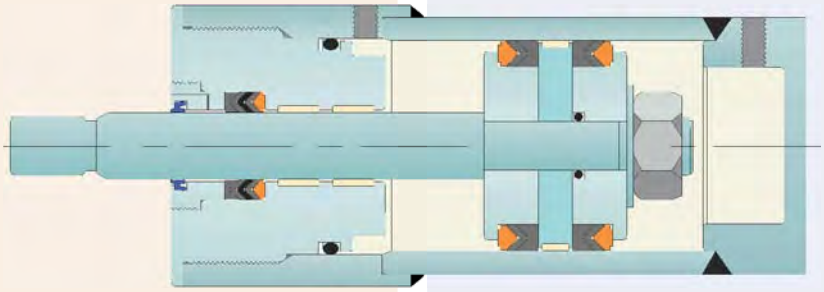
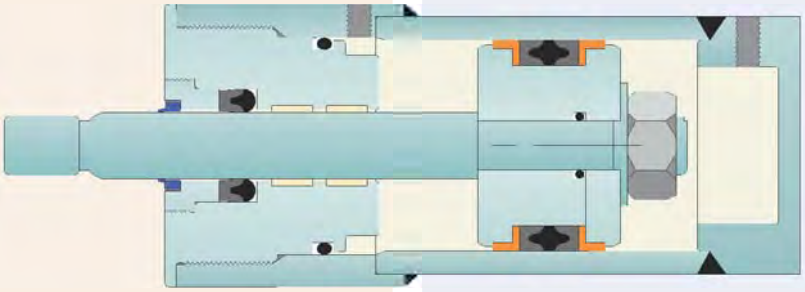
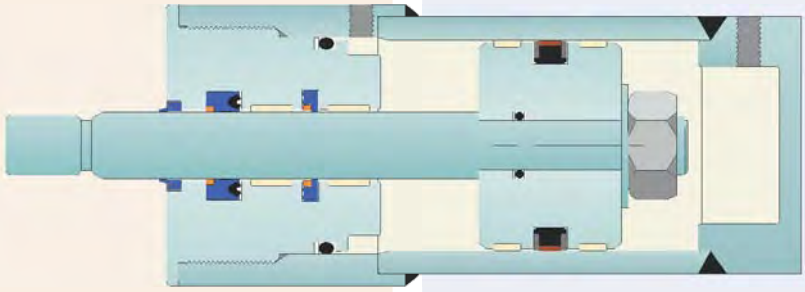
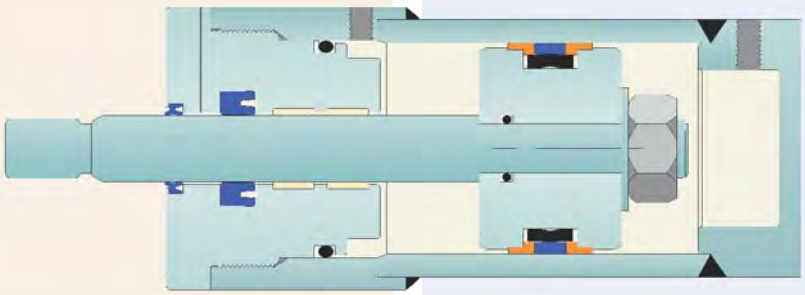
Tolorances extracted from BS 1916 &BS 4500 (ISO 286) with kind permission of British Standards Institution

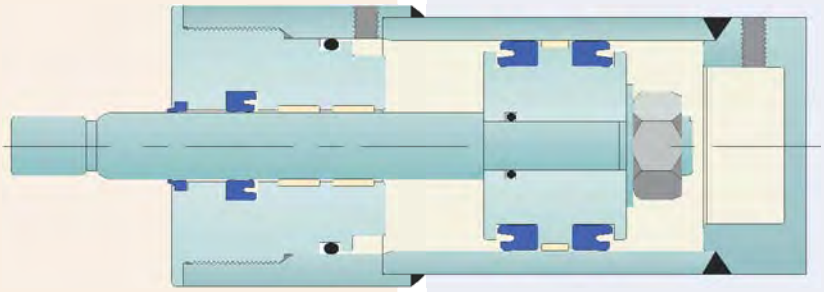
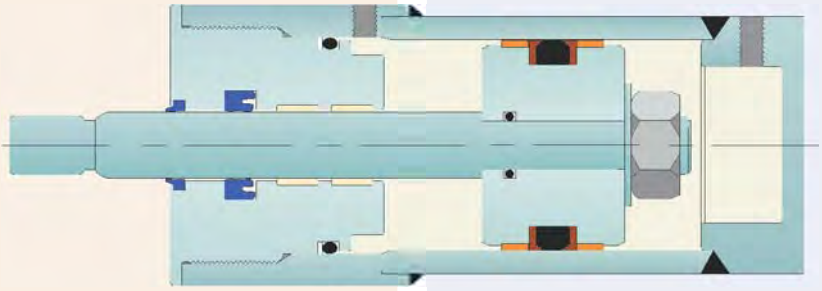
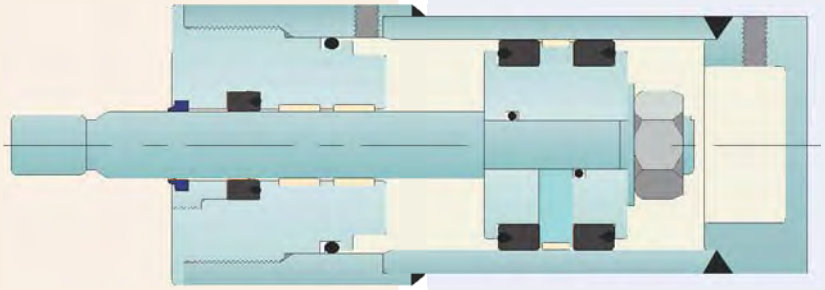
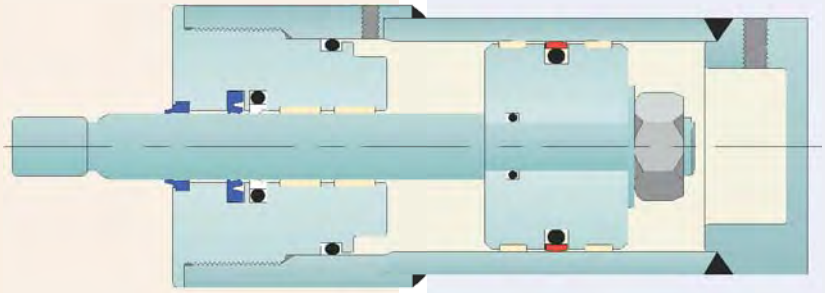
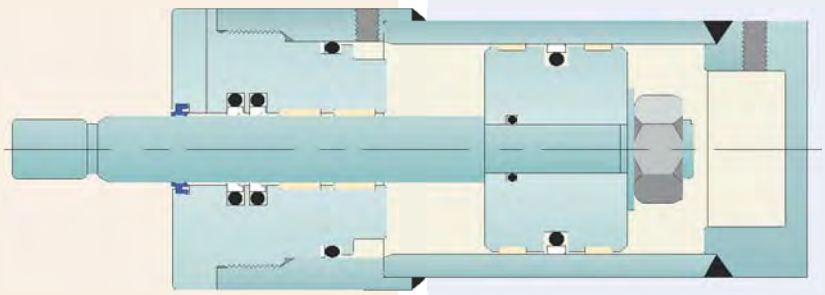
Cylinder housings and seal options

The following diagrams illustrate how Hallite's wide range of products can be applied to a selection of some of the most popular cylinder designs servicing the world's fluid power industry.

The diagrams show different gland and piston arrangements to illustrate alternative sealing methods currently in use and a suitable Hallite product.

If the application which you are interested in is of a non-standard nature please contact Hallite's technical department.

Gland		Piston
Heavy duty Type 13, 14		**Heavy duty** Type 51, 52
Heavy duty Type 18		**Heavy duty** Type 58
Heavy duty Type 621, 652, 653		**Heavy duty** Type 730, 735
Medium duty Type 601, 605		**Medium duty** Type 753

Gland		Piston
Medium duty Type 601, 605		**Medium duty** Type 606
Medium duty Type 605		**Medium duty** Type 53
Medium duty Type 513		**Medium duty** Type 511, 512
Light to Medium duty Type 616, 16		**Light to Medium duty** Type 754, 755 770
High speed light duty Type 16		**High speed light duty** Type 54

Hallite Seals' product data sheets give information indicating the allowable extrusion gap a seal can see at pressure during its working life. The extrusion gap can be calculated using the tolerance build ups within the cylinder and any dilation that may occur under pressure.

Maximum extrusion gap = F max (see drawing below).

F max is the maximum extrusion gap for the seal

Minimum metal to metal clearance = F min (see drawing below).

F min for cylinders with minimal side loading should be > 0.1mm (0.004").

Rods

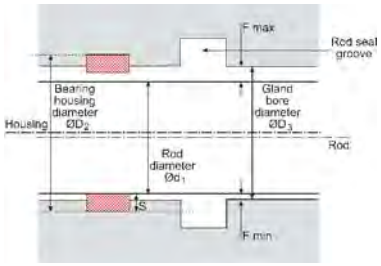
Maximum extrusion gap

$$F\ max = \frac{(ØD3\ max + ØD2\ max)}{2} - S\ min - Ød1\ min$$

Minimum metal to metal clearance (extrusion gap)

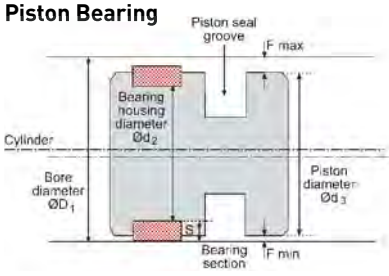
$$F\ min = S\ min - \frac{(ØD2\ max - ØD3\ min)}{2}$$

Rod Bearing



Note: Rod is not concentric with gland, because of clearances. (shown exaggerated)

Piston Bearing



Note: Piston is not concentric with cylinder bore, because of clearances. (shown exaggerated)

Pistons

Maximum extrusion gap

$$F\ max = ØD1\ max - S\ min - \frac{(Ød3\ min + Ød2\ min)}{2} + dilation$$

Minimum metal to metal clearance (extrusion gap)

$$F\ min = S\ min - \frac{(Ød3\ max - Ød2\ min)}{2}$$

Calculate both F max and F min.

Ensure the F min is greater than 0.1mm (0.004") and F max is less than the maximum extrusion gap stated on the seal data sheet at the application's working pressure.

For built-in metal bearings, the extrusion gap calculation is simpler.

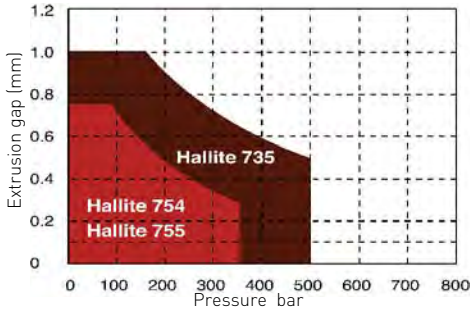
For F max:
Rod = ØD3 max - Ød1 min
Piston = ØD1 max - Ød3 min + dilation

F min must be zero

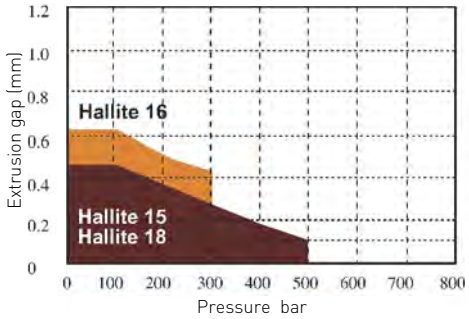
Extrusion is closely linked to pressure and temperature. In general, the best seal performance and life is provided by specifying the smallest possible extrusion gap.

The figures shown for the extrusion gap within the operating conditions of Hallite's product data sheets, relate to the maximum permissible, worst case situation with the gap all on one side.

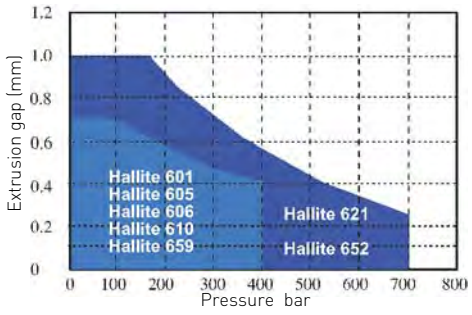
Type 735, 754, 755



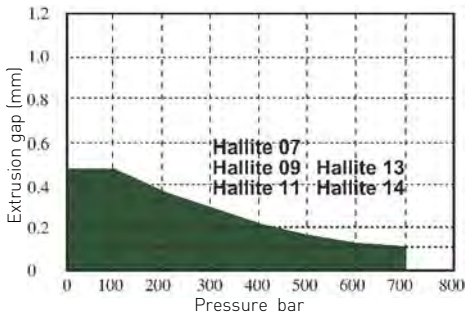
Type 15, 16, 18



Type 601, 605, 606, 610, 621, 652, 659



Vee pack sets



Products and Typical Fluid Compatibility

D = Dynamic Application, S = Static Application
R = Recommended, P = Possible , NS = Not Suitable

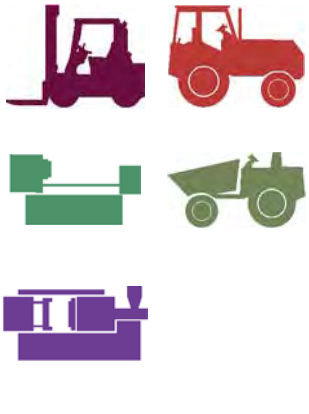
Product	Fluids Based on Mineral Oil		Water Based Fluids								Other Fluid Types					
			HFA (5/95)		HFB (60/40 invert emulsion)		HFC (water glycol)		Water		HFD (Phosphate ester Aryl type)		Synthetic esters (HEES, HFDU)		Air/Nitrogen	
	D	S	D	S	D	S	D	S	D	S	D	S	D	S	D	S
Rod Seal																
16	R	P	P	P	P	P	P	P	P	P	R[1]	P[1]	R	P	P	NS
605,610,616	R	R	P	P	R	R	P	P	P	P	NS	NS	R	P	P	P
621,652	R	R	R	R	R	R	P	P	P	P	NS	NS	R	P	P	P
653	R	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	P	NS	NS	NS
Rod/Piston seals																
15,18	R	R	P	R	R	R	R	R	P	R	P[2]	P[2]	P	P	P	P
511,512,513	R	R	P	P	P	P	P	P	P	P	NS	NS	R	R	P	P
601	R	R	P	R	R	R	P	P	P	P	NS	NS	R	R	P	P
DA Piston seals																
50,53,64,68	R	R	P	R	R	R	P[3]	P[3]	P	R	NS	NS	P	P	NS	P
51,52,56,58	R	R	P	R	R	R	R	R	P	P	P[2]	P[2]	P	P	NS	P
54	R	P	P	R	P	P	P	P	P	P	R[1]	P[1]	R	P	P	NS
65,77	R	R	P	R	R	R	R	R	P	P	NS	NS	P	P	NS	P
714	R	NS	NS	NS	NS	NS	NS	NS	NS	NS	P[1]	NS	R	NS	NS	NS
730	R	R	R	R	R	R	NS	NS	P	P	NS	NS	R	P	NS	P
735	R	P	NS	NS	P	P	P	P	NS	NS	NS	NS	R	P	NS	NS
753	R	R	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	R	P	NS	NS
754,755	R	R	P	R	P	R	NS	NS	P	P	NS	NS	R	R	P	P
764	R	R	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	R	R	P	P
770	R	R	P	P	P	P	NS	NS	P	P	NS	NS	R	R	P	P
SA Piston Seals																
606,659	R	R	P	P	R	R	P	P	P	P	NS	NS	R	P	P	P
Unitised Piston																
720	R	P	NS	NS	NS	NS	NS	NS	NS	NS	P[4]	P[4]	R	P	NS	NS
Vee Packs																
07,09,11,13,14	R	P	P	P	R	P	R	P	P	P	P[2]	P[2]	P	P	NS	NS

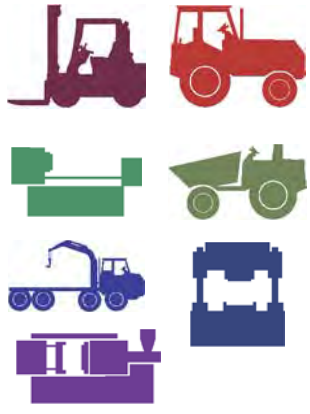
1 Suitable energiser material required e.g. FKM,EPDM. N.B. NBR unsuitable.
2 Suitable compounds required e.g FKM,EP. N.B. NBR unsuitable.
3 Use PA backing rings, not polyester.
4 Suitable seal set required.

In view of the variation in formulation of oils and other hydraulic fluids, the compatibility of all combinations should be confirmed by testing and field service performance for each application.

Operating conditions

Cylinder specification		Light duty	Medium duty	Heavy duty
Pressure	**Max**	350 bar 5000 psi	500 bar 7500 psi	700 bar 10000 psi
	Normal	160 bar 2300 psi	250 bar 3600 psi	400 bar 6000 psi
	Working	No Pressure Peaks	Intermittent Pressure Peaks	Regular Pressure Peaks
Design		Lower operating stresses Rigid well aligned mounting, minimal side loading.	Steady operating stresses with intermittent high stress, some side loading.	Highly stressed for majority of its working life. Side loading common.
Condition of Fluid		Good system filtration no cylinder contamination likely.	Good system filtration but some cylinder contamination likely.	Contamination unavoidable from internal and external sources.
Working Environment		Clean and inside a building. Operating temperature variations limited.	Mixture of indoor and outdoors but some protection from the weather.	Outdoors all the time or a dirty indoor area. Wide variations in temperature, both ambient and working. Difficult service conditions.
Usage		Irregular with short section of stroke at working pressures. Regular usage but at low pressure.	Regular usage with most of the stroke at working pressure.	Large amount of usage at high pressure with peaks throughout the stroke.
Typical Applications		Machine tools Lifting equipment Mechanical handling Injection moulding machines Control and robot equipment Agricultural machinery Packaging equipment Aircraft equipment Light duty tippers	Heavy duty lifting equipment Agricultural equipment Light duty off-road vehicles Cranes and lifing platforms Heavy duty machine tool Injection moulding machines some Auxiliary mining machinery Aircraft equipment Presses Heavy duty tippers (telescopic) Heavy duty mechanical handling	Foundry and metal fabrication plant Mining machinery Roof supports Heavy duty earth moving machinery Heavy duty off-road vehicles Heavy duty presses





Pressure, Speed, Temperature Range

From many years of application experience with sealing hydraulic equipment, supported by the results from an extensive test programme, we know that it is necessary to link the three main operating features of speed, pressure, and temperature to achieve a satisfactory seal performance. After carefully considering each product we are able to specify the maximum speed and pressure with a temperature range within which the seal will operate safely.

If your operating conditions do not comply with those recommended please send your details to your local Hallite sales office.

Storage conditions

Most polymeric items including vulcanized rubber and other elastomers tend to change their properties during storage and may become unserviceable. This may be due to hardening, softening, cracking, crazing or other degradation and may be the result of oxygen, ozone, light, heat and/or humidity.

The following recommendations indicate the most suitable conditions for storing elastomeric items, whether as a single item or composite product.

1 Temperature
Storage temperatures should not exceed 50° C (120°F). Low temperatures are not permanently harmful provided the rubber items are handled carefully and not distorted. When taken from low temperatures items should be raised to approximately 30°C (70°F)before they are used.

2 Humidity
Optimum humidity is about 65% in a draft-free atmosphere.

3 Light
Protection from direct sunlight and strong artificial light with a high ultraviolet content is important. Unless packed in opaque containers, it is advisable to cover windows with red or orange screens or coatings.

4 Oxygen and Ozone
Elastomeric items should be protected from circulating air wherever possible. As ozone is particularly harmful to rubber, storage rooms should be free from equipment that may give rise to electric sparks or discharge. Wrapping, storage in airtight containers or other suitable means should be used for vulcanised rubber items.

5 Deformation
Where possible, rubber items should be stored in a relaxed position, free from tension or compression. Laying the item flat and avoiding suspension or crushing keeps it free from strain and minimises deformation.

6 Contact with Liquid and Semi-Solid Material
Contact with liquids and semi-solid materials, particularly solvents, such as oils or greases should be avoided unless so packed by the manufacturer.

7 Contact with Metals
Metals such as manganese, iron and copper, or copper alloys can have a harmful effect on rubber. A layer of paper, polyethylene or cellophane will keep these separated.

8 Contact with Non-Metals
Contact with other rubbers or creosotes should be avoided.

9 Stock Rotation
Elastomers should be stored for as short a period as possible, and strict stock rotation should be practiced.

10 Cleaning
Organic solvents such as trichloroethylene, carbon tetrachloride and petroleum are the most harmful agents. Soap and water and methylated spirits are the least harmful, and all parts should be dried at room temperature before use.

11 Shelf Life
The table shows the storage life of seal components made from the more common materials under ideal conditions. Storing under less than ideal conditions will reduce the life.

Careful inspection of the following should be made before installation after storage:

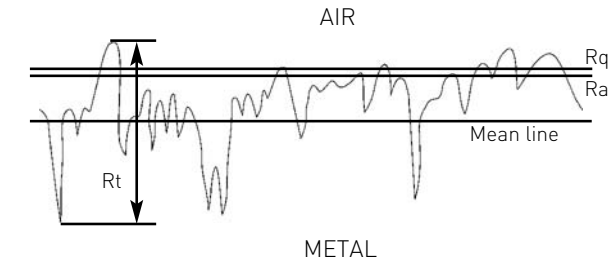
a Mechanical damage
b Permanent distortion
c Cracks or surface crazing
d Tackiness or surface softening/hardening

Thin components (less than 1.6mm {1/16in}) tend to be more critically affected.

The appearance of 'bloom' is relatively unimportant, except in certain non-toxic applications.

Base Polymer (ISO Designation)	Primary storage period (years)	Extension of storage period after re-inspection (years)
FLUOROCARBON (FKM) ETHYLENE PROPYLENE (EPDM)	10	5
NITRILE (NBR) HYTHANE (EU) THERMOPLASTIC POLYESTER ELASTOMER	7	3
POLYUERETHANE (AU)	5	2
ENGINEERING THERMOPLASTICS: ACETAL (POM) POLYAMIDE (PA) GLASS FILLED NYLON (PA) PTFE POLYPHENYLENE SULPHIDE (PPS)	UNLIMITED	
ENGINEERING THERMOSETS: TYPE 506 BEARING STRIP	UNLIMITED	

Surface roughness has a very important influence on the life and leakage performance of a recipricating sealing system.



Note : The vertical scale is 40 times the Horizontal scale

Definitions

Many parameters can be used to describe surface finishes and these are explained in ISO 4287 and ISO 4288. Those in most common use in the fluid power industry include:-

Ra, which is defined as the arithmetical mean deviation of the assessed profile. The inch equivalent parameter is CLA (centre line average). A surface finish of 0.4 µm Ra is exactly equivalent to 16 µin CLA.

Rt, which is the total height of the profile.There is no mathematical relationship between Ra and Rt.

Rq, which is the root mean square deviation of the assessed profile. The equivalent term in inches is RMS (Root Mean Square). The Rq (RMS) of a surface is approximately 10% greater than the Ra (CLA) value.

The surface roughness parameters given above do not give any indication of the sharpness of the surface. The peaks of the profile should be well rounded as sharp surface finishes can lead to rapid seal wear.

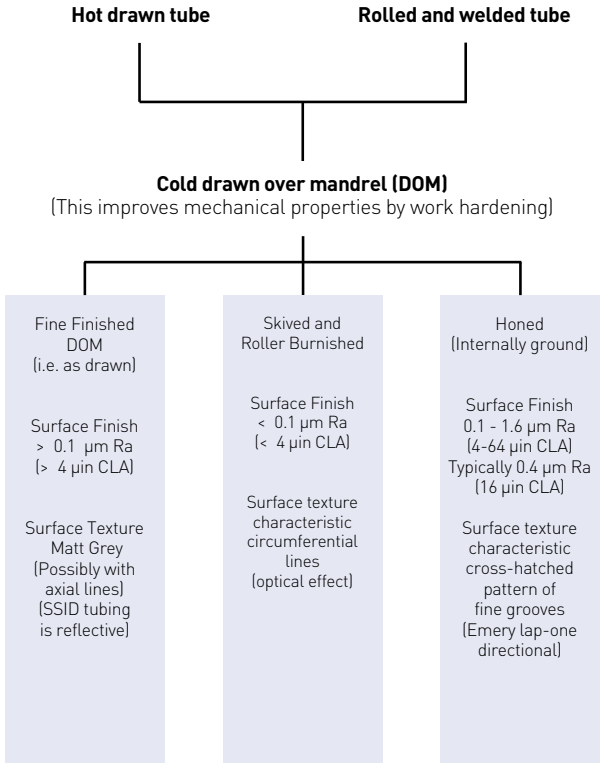
Dynamic surface finishes

Piston rods are generally hard chrome plated. The hardness should be at least 67 Rockwell C. This gives an excellent tribological surface and provided the rods are produced by an established supplier within a surface finish range of 0.1 to 0.3 µm Ra (4-12 µin CLA) no major problem should ensue, although the optimum surface finish may well depend on the seal material.

Bore surface finishes can be more problematic. The typical methods of obtaining a bore finish are summarised in the figure below. Drawn over mandrel (DOM) tubing, as is, can be adequate, or a potential disaster depending on the actual surface texture achieved and the application. Increasing use is being made of Special Smooth Inside Diameter (SSID) DOM tubing, but in certain circumstances, mainly when the seal is being driven into the pressure, it can lead to wear of the seal through flow erosion. Such DOM tubing requires careful specification. The consistency of roller burnished or honed tube is to be preferred. Skived and roller burnished tubing is very smooth (less than 0.1µm Ra) (4 µin CLA) and may be too smooth for rubber sealing elements in some applications. True honed tube, produced between (0.1 and 0.4 µm Ra) (4-16 µin CLA) is the most expensive, but has the best finish.

Static surface finishes

The static sealing surface finish must not be ignored in the control of leakage. Generally, these are fine turned and should be free from chatter marks.



Methods of manufacturing of tubes for hydraulic cylinders and resulting surface textures.

Hallite Seals

Hallite produces high performance hydraulic sealing solutions for the world's fluid power industry. The company enjoys an enviable reputation for high quality and reliability within the mobile hydraulics, mining, off-highway, construction, agriculture, mechanical handling and automation markets.

Hallite products, engineered in a wide variety of advanced materials, are chosen by leading manufacturers for their exceptional performance in the most demanding, safety-critical high specification applications.

Hallite operations are located in Australia, Canada, China, France, Germany, Italy, the UK and the USA. All Hallite locations are committed to providing quality seals in the shortest possible time. Hallite combines carefully chosen and managed stocks in local markets, supported by a fast track moulding capability. Most locations can now boast a CNC machining cell, branded Hallite Service, which can provide immediate delivery for non-standard and breakdown situations.

Additionally a worldwide network of service partners completes the global presence and ensures the full range of Hallite products is readily accessible.

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