DICKOW PUMPEN

Metal bellows seals

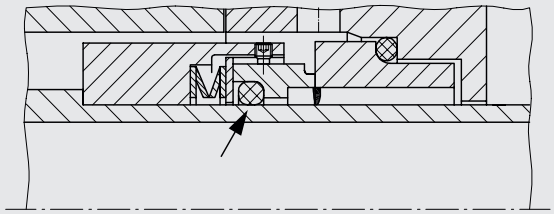
Type N6, N9, N10, N11, N13

General / advantages

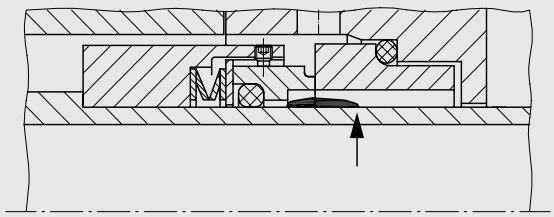
Pusher type mechanical seals with O-ring or other elastomeres utilize springs to keep the faces together. For bellows seals, the bellows itself acts as a spring to close the faces, provides a dynamic seal force, and transmits the torque from the shaft to the face. Hence, the bellows seal offers a number of advantages over other pusher type seals.
These can be summarized as follows:

- No shaft sleeve is required because no moving parts or sliding elastomeres are in contact with the shaft.
- Independent from direction of rotation.
- Easy assembly.
- A wide range of applications. Higher and lower temperatures can be covered by elimination of the organic elastomeres.
- No hang-up on the shaft sleeve:

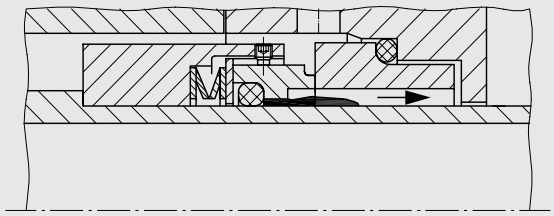
Hang-up of the seal can also be generated by fretting due to corrosion or wear of the shaft sleeve in the area of the O-ring or the elastomere.



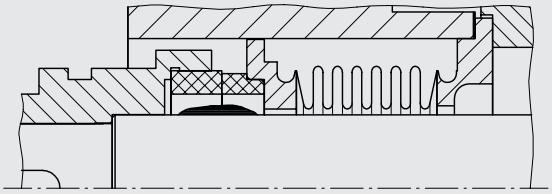
Wear between the seal faces must be eliminated by the spring. The spring must move the complete rotating part with the O-ring.



Every leakage can build up on the sleeve surface, especially when handling fluids which react with the atmosphere.



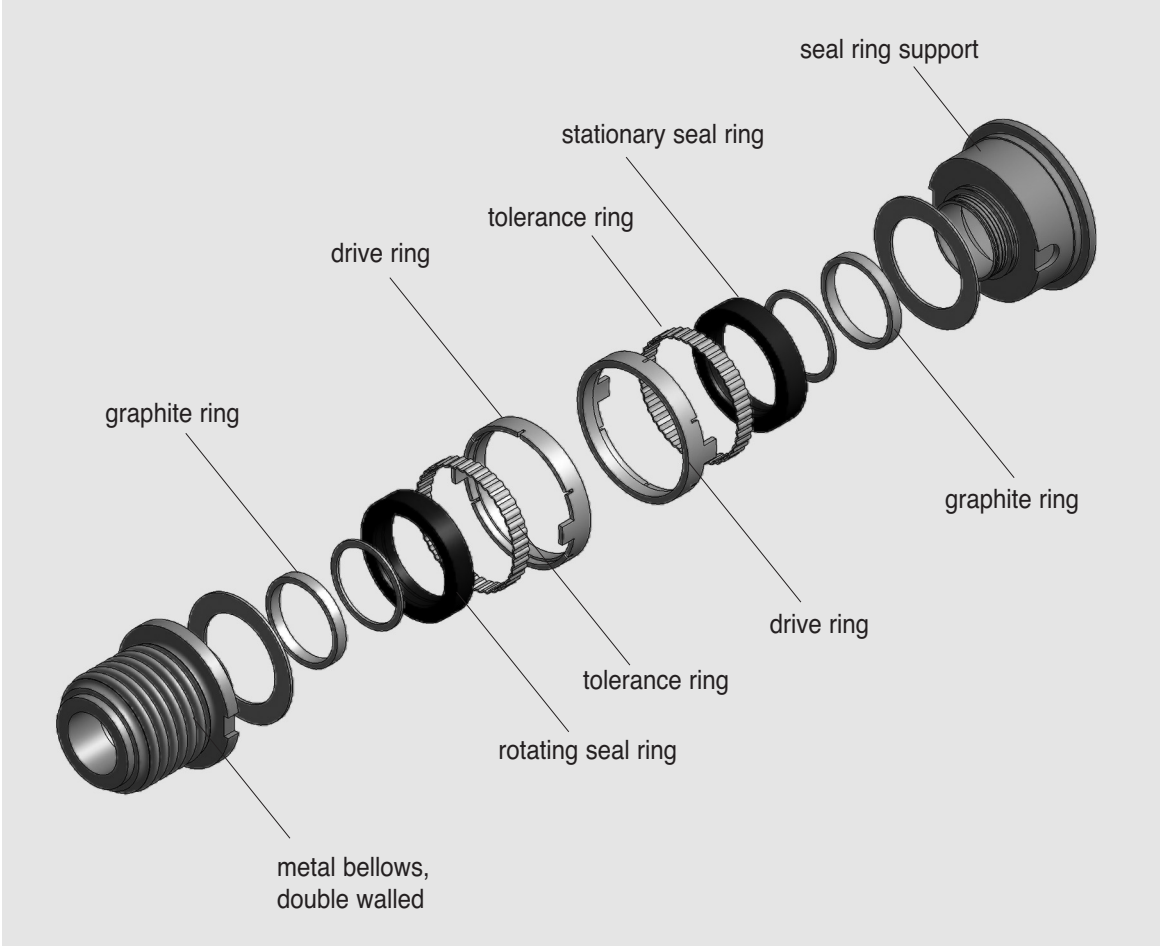
Finally, the build up product prevents any movement of the O-ring. The seal shows heavy leakage although the faces are still in a good shape.



The absence of sliding elastomeres eliminates drag or hang-up which is probably the biggest single cause of failure at O-ring type mechanical seals.

The DICKOW metal bellows seals of the N-series utilize a double walled rolled bellows, welded to adapter pieces on both sides. The N-seals are designed for single stage volute casing pumps with impellers in overhung position.

High-temperature design
with elastically beared SiC-seal rings



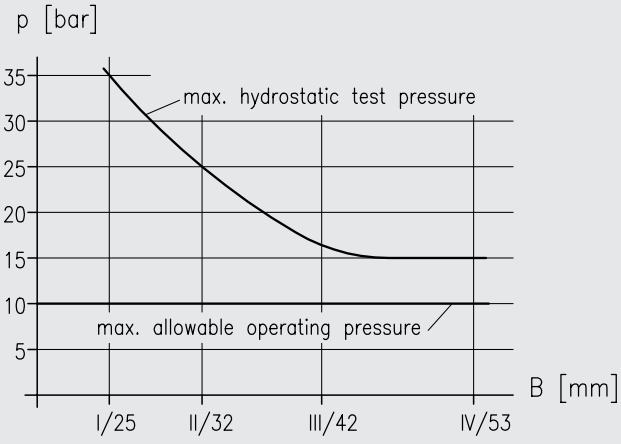
When designing SiC-seal rings, the special attributes of this material must be considered.
For example, the different thermal expansion coefficients of SiC and the metallic seal parts cause special problems in designing the connection between these parts. Shrink-fitted connection can be used for temperatures up to 150°C (300°F) only.

At higher temperatures, thermal stresses will deform the faces of the SiC-seal rings and the seal starts leaking. The problem has been solved by bearing the seal rings with elastic parts. Inside, the SiC-rings are located on graphite rings. Outside, the SiC-rings are pressed into the shells with elastic metallic rings. The shells are positively held by the adapter pieces.

Rotating bellows (N9, N10, N11, N13)

Rotating bellows are recommended for fluids containing solids. Any particles will be thrown out off the bellows by the centrifugal forces and therefore, clogging is prevented; a common failure with the small springs used in face-type seals.

Allowable pressure on the seal faces

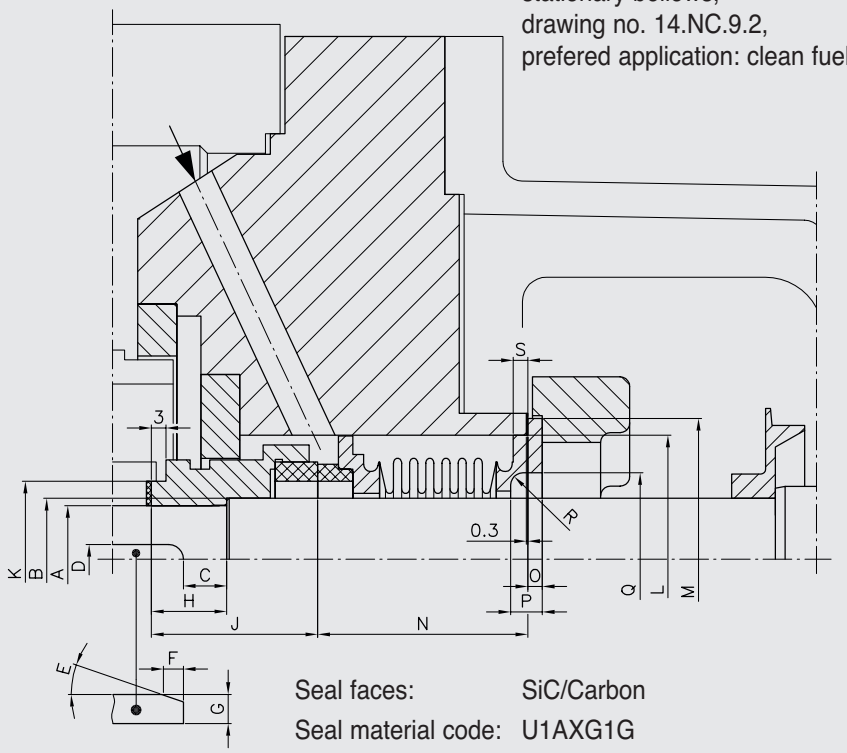


It should be considered that in pumps with balancing holes and wear rings (NCL-types) and in pumps with back vanes (NCLo-types), the seal pressure is remarkably lower than the pump discharge pressure.

Seal arrangement drawings for DICKOW NCL-pumps

Mechanical seal N6i

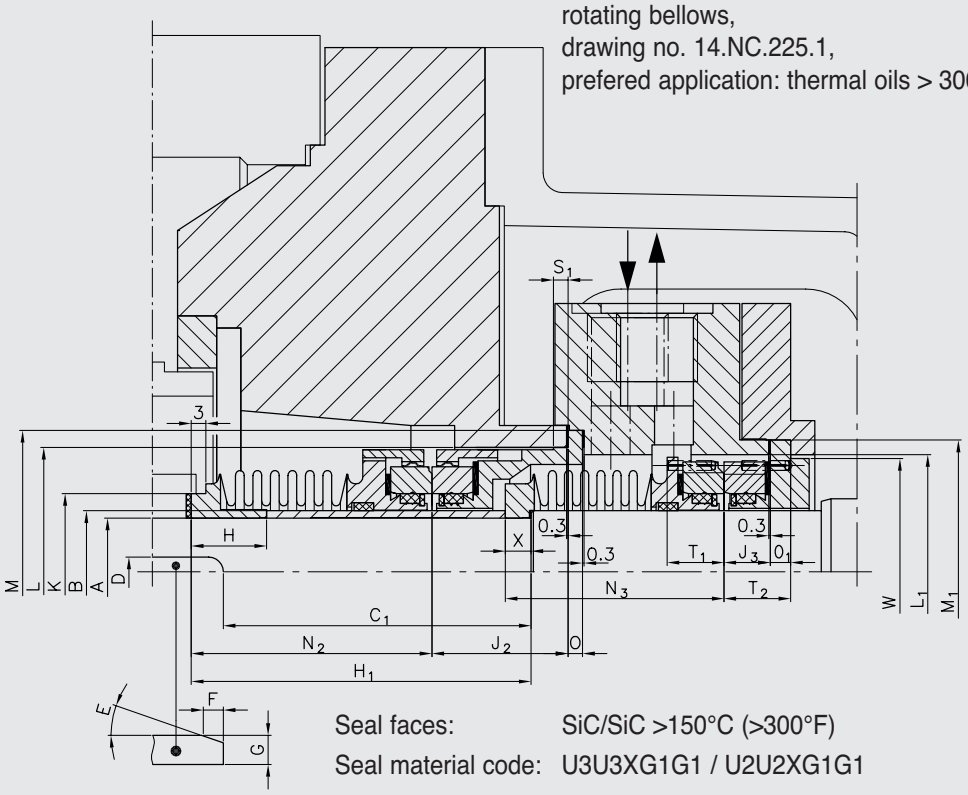
single, internal circulation,
stationary bellows,
drawing no. 14.NC.9.2,
prefered application: clean fuels



Seal faces: SiC/Carbon
Seal material code: U1AXG1G

Mechanical seal N9

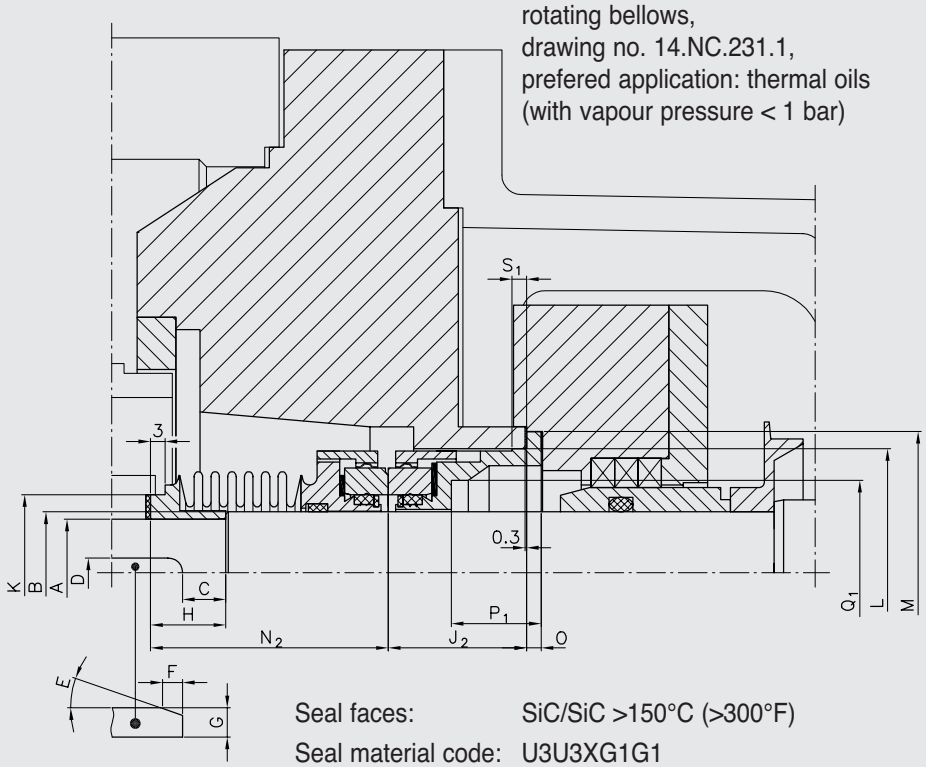
double tandem, dead end, Plan 52,
rotating bellows,
drawing no. 14.NC.225.1,
prefered application: thermal oils > 300°C



Seal faces: SiC/SiC >150°C (>300°F)
Seal material code: U3U3XG1G1 / U2U2XG1G1

Mechanical seal N10q

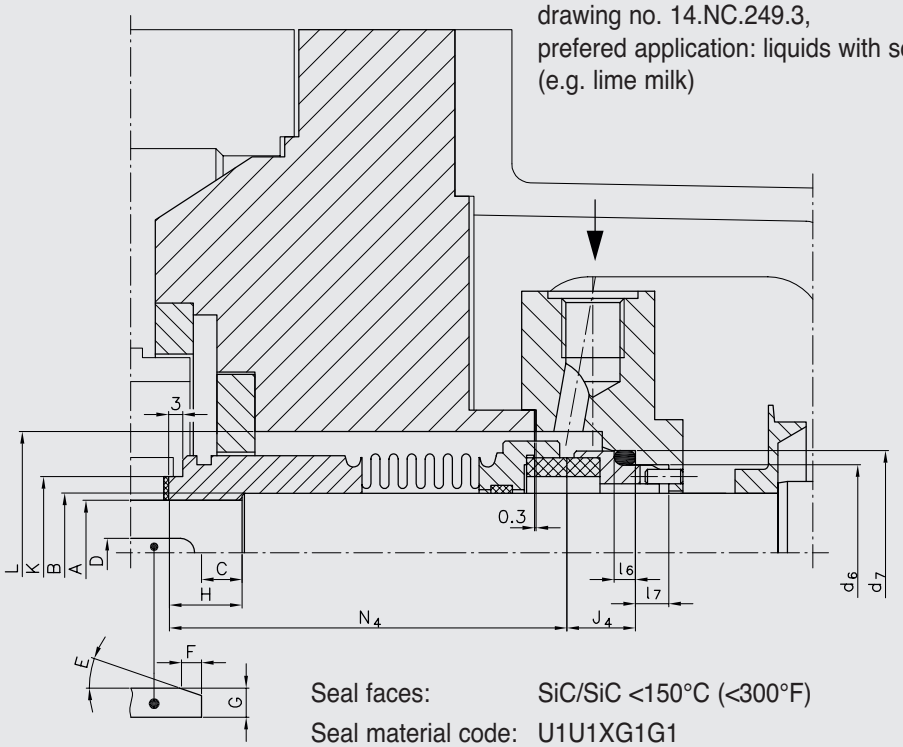
single, dead end,
rotating bellows,
drawing no. 14.NC.231.1,
prefered application: thermal oils
(with vapour pressure < 1 bar)



Seal faces: SiC/SiC >150°C (>300°F)
Seal material code: U3U3XG1G1

Mechanical seal N11

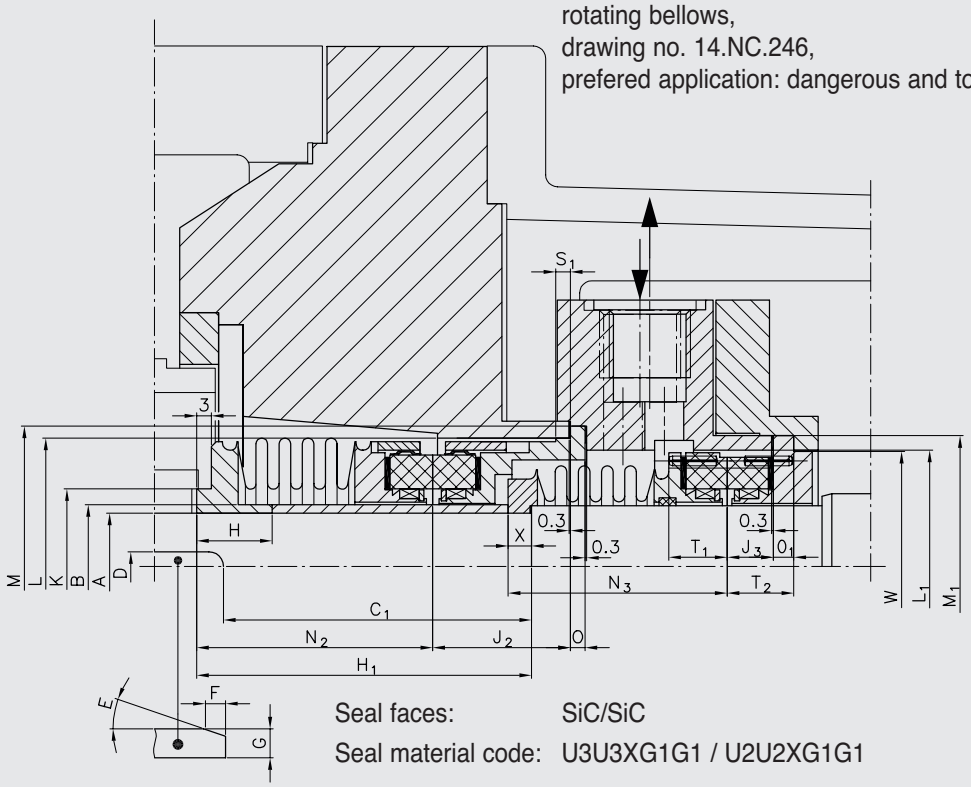
single, external flush,
rotating bellows,
drawing no. 14.NC.249.3,
prefered application: liquids with solids
(e.g. lime milk)



Seal faces: SiC/SiC <150°C (<300°F)
Seal material code: U1U1XG1G1

Mechanical seal N13

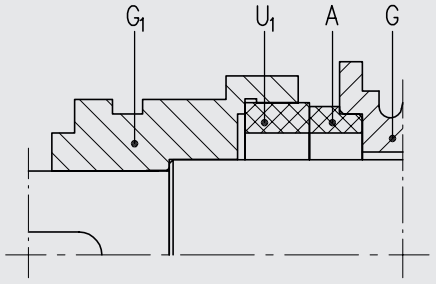
double, dead end, Plan 53,
rotating bellows,
drawing no. 14.NC.246,
prefered application: dangerous and toxic liquids



Seal faces: SiC/SiC
Seal material code: U3U3XG1G1 / U2U2XG1G1

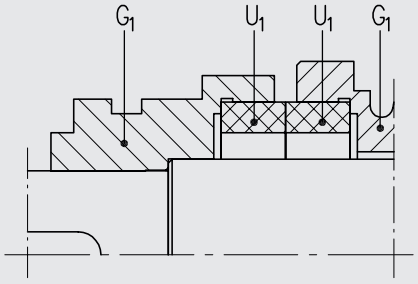
Seal faces

SiC/Carbon shrink-fitted, U1AXG1G



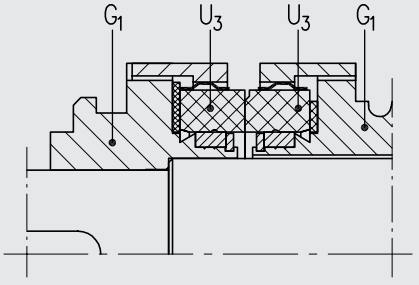
Clean liquids without solids <150°C

SiC/SiC shrink-fitted, U1U1XG1G1



Liquids with solids <150°C

SiC/SiC elastic mounted, U3U3XG1G1



Liquids with solids, residues >150°C

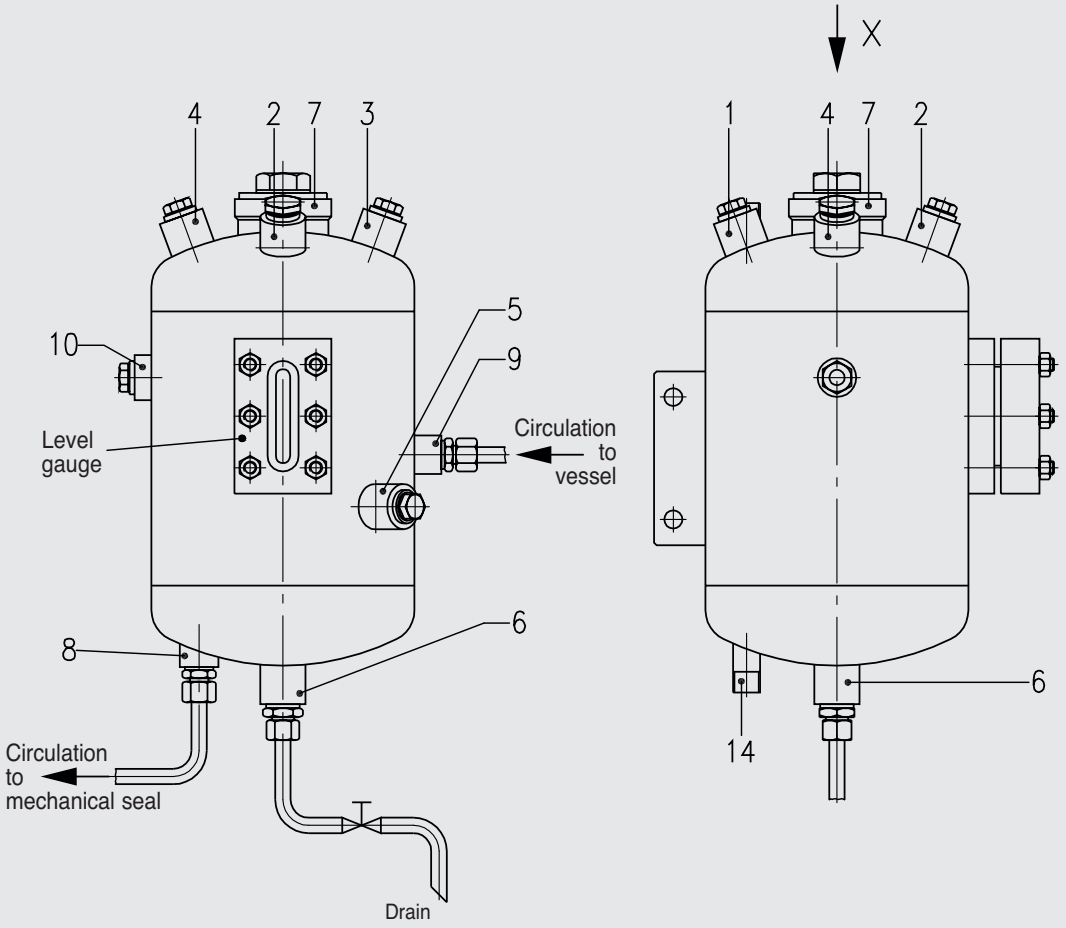
Dimensions

Frame size	0/20	I/25	II/32	III/42	IV/53
A_{h6}	18	22	28	38	48
$A_{h6\ max.}$	18	22	30	40	52
B_{h6}	20	25	32	42	53
$B_{h6\ max.}$	20	25	34	44	56
$C_{+0,2}$	10	10	14	12	15
$C_{1+0,2}$	--	63,3	85,5	79,7	95,9
D	6	6	8	10	14
$D_{max.}$	6	6	8	12	16
E	27°	20°	24,5°	21°	18°
F	4,1	7	6,2	9	11,5
G	4	6	7	8	9
$G_{max.}$	4	6	7	8	10
H	17	15,5	19,5	19,5	25
H_1	--	68,8	91,1	87,2	105,8
J	31	34	38	40,5	60,5
J_1	28,5	31	38	40,5	60,5
J_2	29,8	28	31	38,8	49
J_3	6,5	9,5	9,5	9,5	10,5
J_4	15,8	16,8	17,8	18,1	20,7
$K_{-0,2}$	36	32	41	50	65
$L_{H8\ min.}$	44	51	65	75	95
L_1	46	48	65	75	95
$M_{h6\ min.}$	54	58	74	85	105
$M_{1\ h6}$	50	54	74	85	105
$N_{min.}$	47,3	43	54	54	63
$N_{1\ min.}$	49,8	51	61	61	73
$N_{2\ min.}$	48,5	48,5	60,5	56	74
$N_{3\ min.}$	45	45	53	59	79
$N_{4\ min.}$	82	84	100	107,7	135
$O_{min.}$	3	3	4	4	4
$O_{1\ min.}$	2,5	4,2	5	3,5	3,5
P	5	6,5	11,5	8	10
P_1	20	15	18,5	18	33
Q	35	35,5	48	56	69
Q_1	35	44	55	69	84
R	2,5	2,5	2,5	1,5	1,5
S	5	3	3	3	3
S_1	5	3	5	3,8	3
T	16	16	19	24,5	34
T_1	8,8	11,8	12	13,5	14
T_2	9	17,5	14,5	19	24
U_{h8}	35	35	45	55	70
$V_{+0,1}$	47	47	61	75	90
W	44	47,5	--	84,5	104,5
X	--	5,3	10,3	11,3	13,3
$d_{1\ h6}$	--	33	43	53	65
$d_{4F\ H8}$	--	51	65	75	95
$d_{6\ +\ 0,2}$	36	42	54	65	77
$d_{7\ H8}$	40	48	61	73	85
d_8	--	3	4	4	4
$l_{1K\ \pm\ 0,5}$	--	42,5	45	47,5	52,5
l_6	4	5	6	6	6
l_7	9	9	9	9	9

The dimensions (except the dark lined dimensions) comply with the standard design of DICKOW Chemical pumps, series NC, and are adjustable to the different pump constructions (available installation space must be specified). The dark lined dimensions are binding.

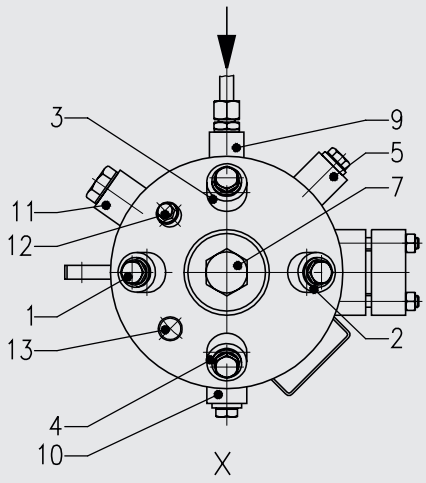
Thermosiphon vessel / accessories

Thermosiphon vessel



Standard connections:

1 Barrier pressure connection (Nitrogen) G1/2, plugged
2 Pressure gauge G1/2
3 Universal connection G1/2, plugged
4 Filling connection G1/2, plugged
5 Temperature probe connection G1/2, plugged
6 Drain G1/2, with ball valve
7 Connection for level switch G2, plugged
8 Outlet to mechanical seal G3/8
9 Inlet to vessel G3/8
10 Connection for optoelectronic level detector G1/2, plugged
11 Connection for pressure accumulator G3/4, plugged
12 Connection for refilling unit G1/8, plugged
13 Cooling water outlet G1/2
14 Cooling water inlet G1/2



Material:

Vessel 1.4571 (18.10 CrNi Stainless Steel), respectively Carbon Steel, piping 1.4571

Design data:

Volume 8 l, design pressure 25 bar, design temperature 200°C (392°F)

Assembly

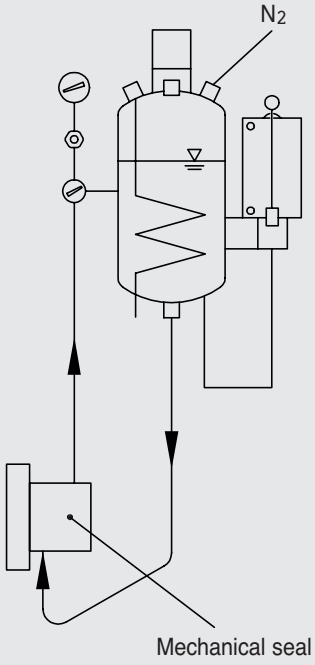
Connection direct to the intermediate casing or through a supporting structure to the base plate. Buffer fluid for the mechanical seal circulates through the connections 8 + 9.

Function / operation

The DICKOW-Thermosiphon vessels are used for supplying buffer fluid to double and tandem seal arrangements for a wide range of applications. They act as convenient fluid reservoirs. The exchange of fluid takes place by thermosiphon principle and by forced circulation with pumping screw or ring. Duties for vessels and their accessories:

- to absorb leakage,
- to monitor the leakage rate (e.g. through periodic reading of the level in the vessel),
- to lubricate and to cool the outboard mechanical seal in a tandem arrangement,
- to prevent icing,
- to protect against dry run,
- to stabilize the lubrication film between the seal faces,
- to separate pumped fluid from the atmosphere for preventing possible reactions,
- to keep off abrasive solids from the seal faces (back-to-back seal arrangement with pressurized vessel).

Diagram of the Thermosiphon system



Pressurization

Tandem seal arrangement

Tandem mechanical seals operate with non-pressurized fluid reservoir (Plan 52),
no nitrogen connection required.

Double seal arrangement

Double mechanical seals operate with pressurized fluid reservoir (Plan 53),
usually pressurized by nitrogen.

The pressure of the barrier fluid must be appr. two bar higher than the pressure on the product seal side.

Required barrier pressure with circulation 02 (dead end):

Suction pressure + appr. 2 bar

Cooling / heating

If requested, the vessel can be fitted with an additional heat exchanger.

Monitoring systems

The proper function of the seal arrangement can be monitored with pressure switch, level switch and PT100-temperature probe.

According to ATEX directive 94/9/EC, thermosiphon vessels must be monitored in hazardous areas. As a minimum protection a level switch is required.

Recommended applications

Liquid			Recommended mechanical seal							Liquid information				
(Explanations: page 12)	Concentration %	Temperature °C	Arrangement	Circulation	Auxiliary piping	Material: Slide ring	Material: Seal ring	Material: Gaskets	Material: Other parts	Danger notice	MAK-value	Melting point °C	Boiling point °C	Density kg/m³
Acetaldehyde (Ethanol)		<150	N13	02	53	U3	U3	G	G1	C	50	-124	21	780
Acetate →	Acetic ester													
Acetic acid		<80	N9i	01	52	U3	U3	C1	G1	A,E	10		118	1050
Acetic ester:														
Butyl acetate		<80	N9	01	52	U3	U3	G1	G1	E	200	-77	126	882
Isobutyl acetate		<40	N9i	01	52	U3	U3	G1	G1	E	200	-99	118	870
Acetone		<30	N11e	11		A	U1	G	G1	E	1000	-95	56	791
		>30	N9i	01	52	U3	U3	G	G1					
Alcohol →	Ethanol													
Aluminium oxide		<150	N10	02		U3	U3	C1	G1					1400
Aluminium sulphate			N9i	01	52	U3	U3	C1	G1	R				
Ammonia water	<10	<40	N9i	01	52	U3	U3	C1	G1					
Benzole			N13	02	53	U3	U3	C1	G1	C,E		6	80	879
Benzyl alcohol		<100	N6i	01		U1	A	C1	G			-15	205	1045
Bituminous emulsion		<85	N10	02		U3	U3	C1	G1					
Bonder liquid			N9	02	52	U3	U3	C1	G1					
Butanol		<60	N6i	01		U1	A	C1	G	E			>80	≈ 800
Butyl alcohol →	Butanol													
Calcium chloride		<25	N6	02		U1	A		G1			30		1680
		<100	N9	02	52	U3	U3		G1	R				
Calcium hydroxide →	Lime milk													
Calcium nitrate		<100	N9	02	52	U3	U3	C1	G1	R		45		1820
Caprolactam		<115	N10b	02		U3	U3		G1	R	25mg	69	268	1013
Carbolic acid →	Phenol													
Carbon disulphide	<5		N9i	01	52	U3	U3	C1	G1			-121	46	1261
Carbon tetrachloride	<5	<60	N9i	01	52	U3	U3	G	G1	C		-23	76	1592
Cataphoresis lacquer			N9	02	52	U3	U3	C1	G1					
Caustic potash →	Potassium hydroxide													
Caustic soda →	Sodium hydroxide													
Chlorobenzene	<5	<150	N9i	01	52	U3	U3	C2	G1	E	50	-46	132	1106
Citric acid			N6i	01		U1	A	C1	G1					
Copper(II)sulphate		<60	N6i	01		U1	U1		G1					
Crude oil, free of solids		<100	N6i	01		U1	A	C1	G					
Crude oil, sandy		<100	N10	02		U3	U3	C1	G1					
Cumene		<Kp	N9i	01	52	U3	U3		G1	A	50	-96	152	864
Dichloroethane 1.1	<5		N9i	01	52	U3	U3	C1	G1	E		-97	57	1175
Dichloroethane 1.2			N9i	01	52	U3	U3	C1	G1	C,E		-36	83	1260
Dichloromethane		<80	N13	02	53	U3	U3	C1	G1	C	100	-96	40	1325
Diesel fuel		<150	N6i	01		U1	A	C1	G				>200	880
Dimethylterephthalate		>150	N6bi	01		U3	U3		G1			141	288	1100
Electrophoresis varnish			N9	02	52	U3	U3	C1	G1					
Ethanal →	Acetaldehyde													
Ethanol		<Kp	N6i	01		U1	A	C1	G1	E	1000	-114	78	794
Ethyl alcohol →	Ethanol													
Ethylene dichloride →	Dichloroethane													
Ethylene glycol	<5	<100	N6i	01		U1	A	C1	G1			-10	>200	1120
	>5	<100	N9i	01	52	U3	U3	C1	G1			-10	>200	1120
Fatty alcohol		<100	N6i	01		U1	U1	C1	G1					
Fatty acid		<Kp	N6bi	01		U3	U3	C1	G1					
Formic acid	<30	<80	N9i	01	52	U3	U3	C1	G1	A	5			
Formolite	<40	<Kp	N9i	01	52	U3	U3	C1	G1	G				
Fuel oil / Fuel		<150	N6i	01		U1	A	C1	G				>155	860
Fuel oil, polluted		<150	N10	02		U3	U3	C1	G1					

Recommended applications

Liquid			Recommended mechanical seal							Liquid information				
(Explanations: page 12)	Concentration %	Temperature °C	Arrangement	Circulation	Auxiliary piping	Material: Slide ring	Material: Seal ring	Material: Gaskets	Material: Other parts	Danger notice	MAK-value	Melting point °C	Boiling point °C	Density kg/m³
Gas oil		<150	N6i	01		U1	A	C1	G				>200	
Glycol →	Ethylene glycol													
Heptane		<80	N6i	01		U1	A	C1	G	E	500	-90	98	681
Hexane		<50	N6i	01		U1	A	C1	G	E	50	-95	68	660
Hydrazine		<Kp	N13	02	53	U3	U3	C1	G1	C,G		2	113	1011
Isopentane →	Pentane													
Isopropyl alcohol →	Propan-2-ol													
Isopropyl benzole →	Cumenol													
Jet fuel		<100	N6i	01		U1	A	C1	G	E			>100	800
Kerosene / Kerosine		<100	N6i	01		U1	A	C1	G				>150	802
Lemon juice			N6i	01		U1	A	C1	G1					
Lime milk (CaOH-Susp.)	<20	20	N11f/N13	32/53	--/53	U1/U3	U1/U3	C1	G1					
Linseed oil		<60	N6i	01		U1	A	C1	G					
Lysol		<50	N6i	01		U1	A	C1	G1					
Magnesium hydroxide	<20	<40	N6i	01		U1	U1		G1					
Maize oil		<100	N6	02		U1	A	C1	G					930
Masut		<200	N6	02		U3	U3	C1	G1					
Methanol	<5	<60	N11	11		A	U1	C1	G1	G,E	200	-98	64	787
	>5		N9i	01	52	U3	U3	C1	G1					
Methyl alcohol →	Methanol													
Methylated spirit →	Ethanol													
Methylene ketone (Butane)		<Kp	N6i	01		U1	A		G	E	200	-86	80	805
Naphta		<Kp	N6	01		U1	A	C1	G				>30	
Naphtalene		<Kp	N9i	01	52	U3	U3	C1	G1			81	218	1250
Nickel bath <45 g/l NiCl		<60	N6	01		U1	U1	P	G1					
Nitric acid	<90	<60	N9	02	52	U3	U3	P	G1					
Nitrobenzene		<80	N9	02	52	U3	U3	G	G1	G	1		211	1198
Oil laquer		<40	N9	02	52	U3	U3	C1	G1					
Olive oil		<100	N6	01		U1	A	C1	G					920
Paraffine, Paraffine oil		<160	N6	01		U1	A	C1	G					
Pentane:														
Isopentane		<Kp	N11	11		A	U1	C1	G1	E	1000		27	
Neopentane		<Kp	N11	11		A	U1	C1	G1	E	1000		9	
n-Pentane		<Kp	N11	11		A	U1	C1	G1	E	1000		36	626
Perchloroethylene →	Tetrachloro ethylene													
Petrol, lead-free			N6i	01		U1	A	C1	G1	E				≈760
Petrol, leaded		<40	N6i	01		U1	A	C1	G	E				≈760
Petroleum, cleaned		<150	N6i	01		U1	A	C1	G					
Phenol		<Kp	N13	02	53	U3	U3	G	G1	G		33	182	1060
Phosphoric acid	<5	<20	N6	01		U1	U1	C1	G1					
	>5	<80	N9	01	52	U3	U3	C1	G1					
Phthalic anhydrid		<Kp	N6bi	01		U3	U3	C1	G1		5mg	131	295	1527
Potassium hydroxid	<20	<60	N10	02		U3	U3	C1	G1					
Propan-2-ol			N6	01		U1	A	C1	G	E		<82	800	
Propylene glycol	<5	<Kp	N6i	01		U1	A	C1	G1			-60	188	1038
	>5		N9i	01	52	U3	U3	C1	G1					
Propylene oxide	>5	<Kp	N9i	01	52	U3	U3	C1	G1	C,E		-112	35	859
PSA-Phthalic anhydride														
Rape oil		<60	N6i	01		U1	A	C1	G					
Skydrol		<70	N6i	01		U1	A	C1	G					
Sodium hydroxide	<20	<60	N6	02		U1	U1	C1	G1	A		<-25	<110	1219
	<50	<100	N9	02	52	U3	U3	C1	G1			<12	<150	1524
Soy oil		<100	N6i	01		U1	A	C1	G					920

Recommended applications

Liquid			Recommended mechanical seal							Liquid information				
						Material								
(Explanations: page 12)	Concentration %	Temperature °C	Arrangement	Circulation	Auxiliary piping	Slide ring	Seal ring	Gaskets	Other parts	Danger notice	MAK-value	Melting point °C	Boiling point °C	Density kg/m³
Spirit →	Ethanol													
Styrene	>5	<80	N9i	01	52	U3	U3	C1	G1	E	20	-33	146	909
Sulphuric acid	>95	<40	N9	02	52	U3	U3	C2	G1				300	1835
Synthetic-resin varnish			N9	02	52	U3	U3	C1	G1					
Tetrachloro ethylene		<60	N6i	01		U1	A	G	G		50	-23	121	1630
Tetrahydrofuran		<40	N9i	01	52	U3	U3		G1	E	200	-108	65	889
Thermal oils	For thermal oils with a vapour pressure below the atmospheric pressure at operating temperature, single mechanical seals with auxiliary stuffing box, series N10q, can be used. For vapour pressures above the atmospheric pressure, tandem-mechanical seals, series N9 / N13, with thermosiphon vessel, must be used. Vapour pressure values must be taken from the manufacturer's information sheets.													
		<350	N10/N9/ N13	02		U3	U3	G	G1	E				
Toluene	>5	<60	N9	02	52	U3	U3	C1	G1	E	100	-95	111	866
Trichloroethene		<60	N9i	01	52	U3	U3	G	G1	C	50	-73	87	1465
Vegetable oil		<150	N6	01		U1	A	C1	G					
Vinegar	<10	<60	N6i	01		U1	A	C1	G1					
Vinyl acetate		<60	N9i	01	52	U3	U3	C1	G1	E	10	-93	73	932
Vinylbenzene →	Styrene													
Water:														
Waste water, no solids		<80	N6	01		U1	A	C1	G1			0	100	1000
Waste water, polluted		<80	N10	02		U3	U3	C1	G1			0	100	1000
Hot water		<150	N11	11		A	U1	C1	G1			0	100	
Xylene		<60	N9i	01	52	U3	U3	C1	G1	E			>138	861
Zapon laquer			N9	02	52	U3	U3	C1	G1					
Zinc paint			N9	02	52	U3	U3	C1	G1					

Explanations:

Arrangement: Refer to arrangement drawings, page 4, 5, 6
Circulation: 01 = internal circulation; 02 = dead end; 11 = from discharge
Auxiliary piping: Thermosiphon vessel; Plan 52 = non-pressurized; Plan 53 = pressurized

Materials:
U1 = SiC shrink fitted
U3 = SiC elastically beared
A = Carbon antimony impregnated
G = Graphite
P = PTFE
G = Bellows 1.4571 (X2 CrNiMo 18.14.3), adapter 1.4571 (X6 CrNiMo 17.12.2)
G1 = Bellows 1.4571 (X2 CrNiMo 18.14.3), adapter 1.4462 (X2 CrNiMo 22.5.3)

Liquid information:
E = Liquid is easily ignited, flammable, explosive
C = Liquid is carcinogenic
A = Liquid is corrosive, attacks skin, eyes or mucous membrane
G = Liquid is hazardous to health

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