Pump Databook

SSP Pumps

Inside View

This databook has been produced as a quick reference guide to provide technical details for SSP rotary lobe pumps.

Main sections are as follows:

1. Principle of Operation
2. Basic Construction
3. Range Overview
4. Specification Options
5. Pump Sealing
6. Drives and Ancillaries
7. Pump Performance
8. Application Data
9. Dimensions
10. Technical Data

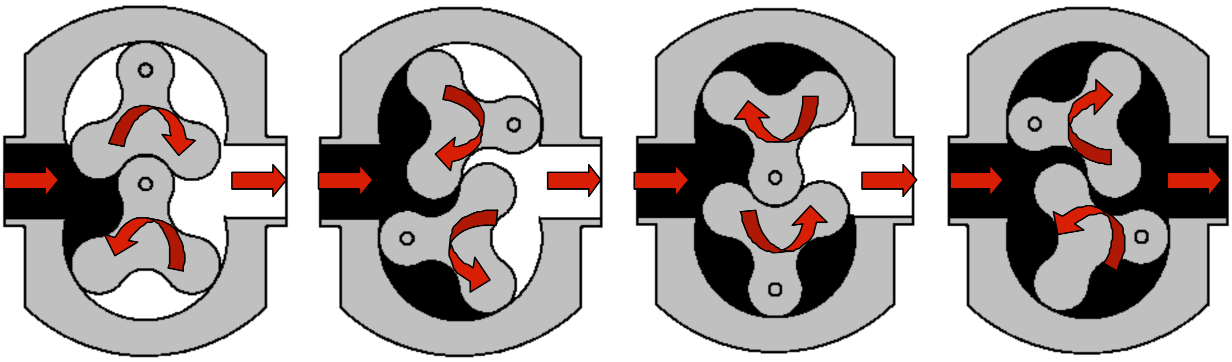
It should be noted we have intentionally not included for any information on ATEX within this databook, as this is an extensive subject matter which is still evolving and is covered by other documentation.

Contents

1.0 Principle of Operation

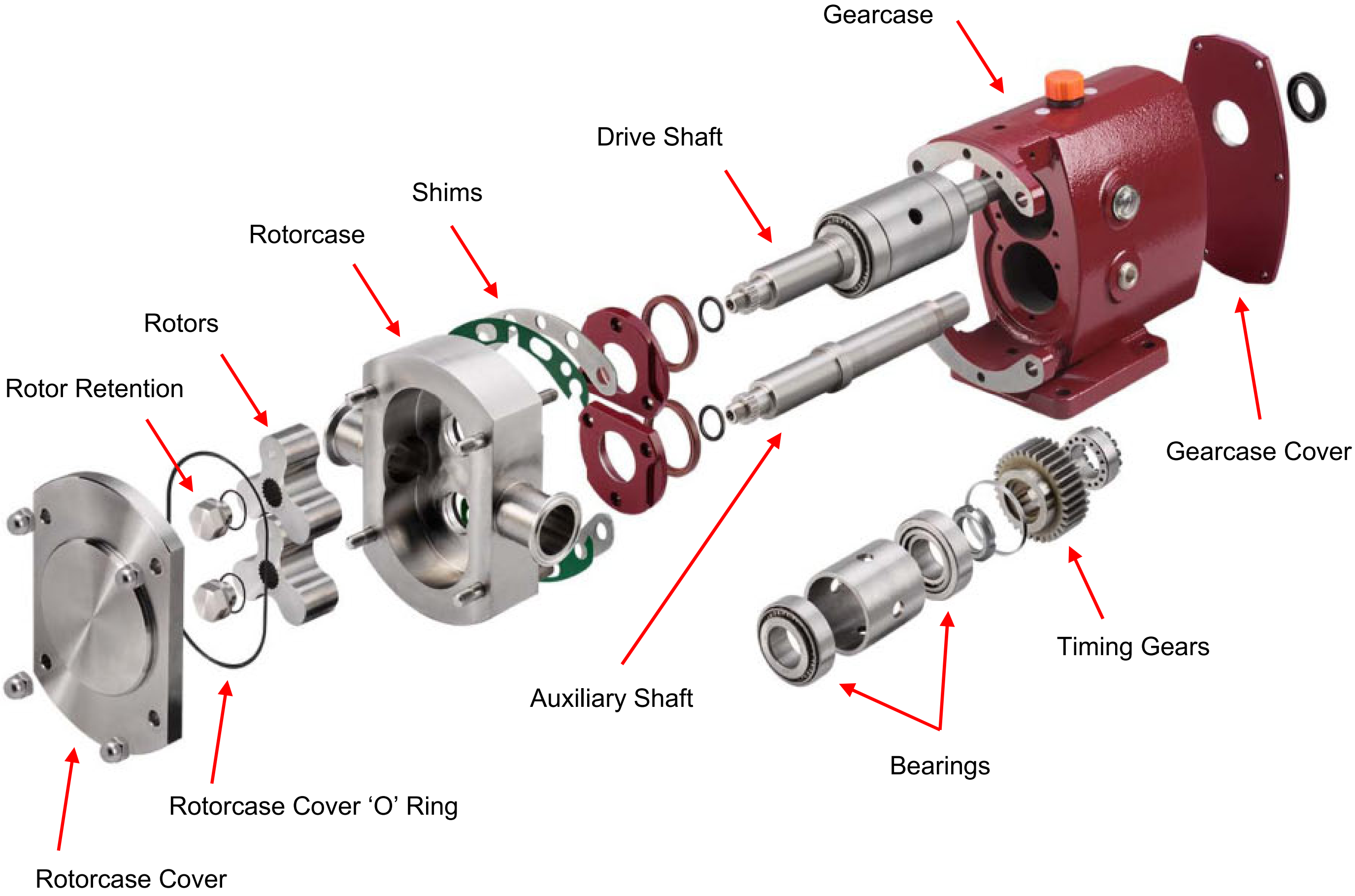
SSP ranges of Rotary Lobe pumps are of conventional design operating with no internal contacting parts in the pump head. The pumping principle is explained with reference to the diagram below, which shows the displacement of fluid from pump inlet to outlet. The rotors are driven by a gear train in the pump gearbox providing accurate synchronisation or timing of the rotors. The rotors contra-rotate within the pump head carrying fluid through the pump, in the cavities formed between the dwell of the rotor and the interior of the rotorcase.

In hydraulic terms, the motion of the counter rotating rotors creates a partial vacuum that allows atmospheric pressure or other external pressures to force fluid into the pump chamber. As the rotors rotate an expanding cavity is formed which is filled with fluid. As the rotors separate, each dwell forms a cavity. The meshing of the rotor causes a diminishing cavity with the fluid being displaced into the outlet port.



2.0 Basic Construction

Main Components of a typical SSP Rotary Lobe Pump



2.1 Materials

For SSP rotary lobe pump ranges the materials can be split into two main categories:

- Product Wetted Parts
  (i.e. Metallic and elastomeric parts in contact with the fluid being pumped).

- Non-product Wetted Parts
  (i.e. Metallic and elastomeric parts not in contact with the fluid being pumped).

Materials of Construction

Pump Component	S	X	L	D	A	G	N
Metallic Product Wetted Parts							
Rotorcase Cover							
316L Stainless Steel	◆	◆	◆	◇	◇	◇	◇
316 type Stainless Steel	◇	◇	◇	◇	◆	◇	◆
Mild Steel - Hardened	◇	◇	◇	◆	◇	◆	◇
Mild Steel - Tungsten Carbide Coated	◇	◇	◇	◈	◇	◈	◇
Mild Steel with Hardened Wear Plates	◇	◇	◇	◇	◇	◈[5]	◇
Rotor Retention							
Nuts							
316L Stainless Steel	◆	◇	◆	◇	◇	◇	◇
Retainers							
316L Stainless Steel	◇	◆	◇	◇	◇	◇	◇
Cap (Torque Locking Assembly Closure)							
316 type Stainless Steel	◇	◇	◇	◆	◆	◆	◇
Disc							
316 type Stainless Steel	◇	◇	◇	◇	◇	◇	◆
Rotors							
Tri-lobe							
316L Stainless Steel	◆	◇	◆	◇	◇	◇	◇
316 type Stainless Steel	◇	◇	◇	◇	◆	◇	◇
NBR Covered	◈[1]	◇	◇	◈[3]	◇	◇	◇
Ductile Iron	◇	◇	◇	◆	◇	◆	◇
Urethane Covered	◇	◇	◇	◈[3]	◇	◈	◇
Bi-lobe							
316L Stainless Steel	◈	◇	◇	◇	◇	◇	◇
Non-galling Alloy	◈	◇	◇	◇	◇	◇	◇
316 type Stainless Steel	◇	◇	◇	◈[4]	◇	◇	◇
Multi-lobe							
316L Stainless Steel	◇	◆	◇	◇	◇	◇	◇
Roloid							
316 type Stainless Steel - PTFE Impregnated	◇	◇	◇	◇	◇	◇	◆
316 type Stainless Steel	◇	◇	◇	◇	◇	◇	◈
Rotorcase							
316L Stainless Steel	◆	◆	◆	◇	◇	◇	◇
316 type Stainless Steel	◇	◇	◇	◇	◆	◇	◆
Ductile Iron	◇	◇	◇	◆	◇	◆	◇
Ductile Iron with Hardened Wear Plates	◇	◇	◇	◈	◇	◈	◇
Ductile Iron - Tungsten Carbide Coated with Hardened Wear Plates	◇	◇	◇	◈	◇	◈	◇
Shafts							
316L Stainless Steel	◆	◇	◇	◇	◇	◇	◇
316 type Stainless Steel	◇	◇	◇	◇	◆	◇	◆
Duplex	◆[2]	◆	◆	◇	◇	◇	◇
Surface Hardened Carbon Steel	◇	◇	◇	◆	◇	◇	◇
Medium Carbon Steel	◇	◇	◇	◇	◇	◆	◇
Elastomers							
NBR (Nitrile)	◆	◇	◇	◆	◆	◆	◆
EPDM (Ethylene Propylene)	◆	◆	◆	◆	◆	◆	◆
FPM (Fluorinated rubber) - alternatively known as Viton®	◆	◆	◆	◆	◆	◆	◆
PTFE (Polytetrafluoro Ethylene)	◆	◇	◇	◆	◆	◆	◆
MVQ (Silicone)	◇	◆	◇	◇	◇	◇	◇
Kalrez® (Perfluoroelastomer)	◆	◇	◇	◇	◇	◇	◇
Product Seals (see 5.0 Pump Sealing)							
Metallic Non-product Wetted Parts							
Gearcase							
Cast Iron	◆	◆	*see note*	◆	◆	◆	◆
Cast Iron - Electroless Nickel Plated	◈	◈		◇	◇	◇	◇
Timing Gears							
Hardened Steel	◆	◆	◆	◆	◆	◆	◆

Note: Series L has a electroless nickel plated cast iron bearing housing fitted with a 304 stainless steel cannister.

◆ = Standard
◈ = Option
◇ = Not Available

[1] = For 10 bar max pump models only
[2] = For high pressure pump models only
[3] = For 5 bar max pump models only
[4] = For 10 and 15 bar max pump models only
[5] = For A9 pump models only

2.2 Elastomer Limitations

Material	Temperature Limits Min °C	Temperature Limits Max °C	Comments
EPDM (Ethylene Propylene)	- 40	150	1. Resistant to most media used within the food industry. 2. Not suitable with organic and non-organic oils and fats.
FPM (Fluorinated Rubber)	- 20	200	1. Resistant to most chemicals and ozone. 2. Not suitable for fluids such as water, steam, lye, acid and alcohol's being pumped hot.
NBR (Nitrile)	- 40	100	1. Resistant to most hydrocarbons, e.g. oil and grease. 2. Is attacked by ozone.
PTFE (Polytetrafluoro Ethylene)	- 30	200	1. Resistant to most media. 2. Not elastic, tendency to compression set.
MVQ (Silicone)	- 50	230	1. Resistant to ozone, alcohol's, glycol's and most media used within the food industry. 2. Not suitable for steam, inorganic acids, mineral oils and most organic solvents.
Kalrez® (Perfluoroelastomer)	- 20	250	1. Resistant to almost all media.

2.3 Surface Finish

The surface finish of product wetted steel components has become a major factor in the food, pharmaceutical and biotechnology industries where hygiene and cleanability are of paramount importance. The 'standard' machined surface finish on stainless steel SSP rotary lobe pumps can be enhanced by Electropolishing and/or Mechanical (Hand) polishing.

Electropolishing
This is an electro-chemical process in which the stainless steel component is immersed into a chemical bath and subjected to an electrical current. A controlled amount of metal is removed from all surfaces evenly. The appearance is 'semi bright'.

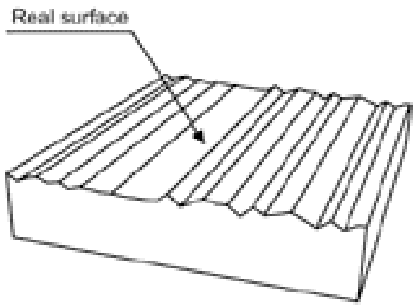
Mechanical (Hand)
This is required when it is necessary to improve the surface finish beyond that achieved by electropolishing only i.e. a 'mirror finish'. It typically involves:

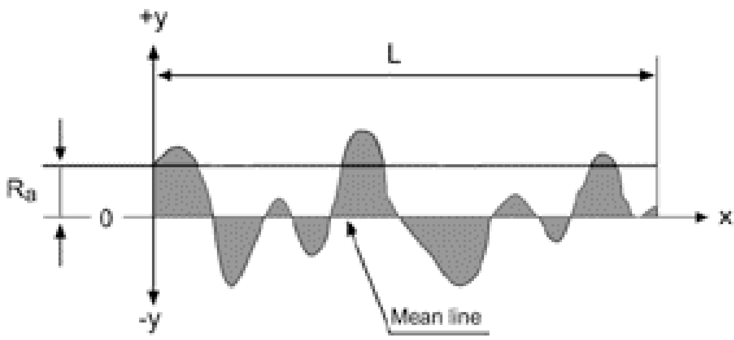
- Fine grinding using felt and compound.
- Brushing using bristle brushes and compound to remove any cutting marks left from grinding, and to reach any awkward areas.
- Polishing using mops and compound to obtain a mirror polished effect.

Surface Roughness
The most commonly used surface roughness measurement is Ra and is defined as 'the arithmetic mean of the absolute value of the deviation of the profile from the mean line'. Ra is measured in micron (μm). The surface roughness can alternatively be specified by a Grit value which specifies the grain size of the coating of the grinding tool used.

The approximate connection between Ra and Grit values is as follows:

Ra = 0.8 µm (32 Ra) ≈ 150 Grit
Ra = 1.6 µm (64 Ra) ≈ 100 Grit





For SSP Series L, S and X rotary lobe pumps, the surface roughness on product wetted parts such as rotors, rotorcase, rotor nuts/retainers and rotorcase covers is as follows:

Standard	-	0.8 Ra
Option (S and X only)		
Electropolishing	-	0.8 Ra
Mechanical (Hand)	-	0.5 Ra

3.0 Range Overview

Pump Series	Pumphead Material	Max. Flow Rate m^3/h	Max. Diff Pressure bar	Port Size mm
S	Stainless Steel	106	20	25 - 150
X	Stainless Steel	115	15	25 - 150
L	Stainless Steel	48	8	40 - 80
D	Ductile Iron	180	15	80 - 150
A	Stainless Steel	680	10	150 - 300
G	Ductile Iron	680	10	150 - 300
N	Stainless Steel	2.3	7	6 - 25
M	Stainless Steel	1.5	7	12 - 25

3.1 Series S

SSP Series S stainless steel rotary lobe pumps operate at the heart of process industries worldwide fulfilling a wide range of application requirements throughout Chemical, Food, Pharmaceutical and other related industries.

Handling from low to high viscosity pumped media the characteristic smooth, low shear pumping action is ideal for delicate media and where organic solids in suspension, creams, froths, gels, emulsions and mixtures are to be pumped.

Series S pumps conform to various standards and directives such as; USA 3A Sanitary Standard, EHEDG accreditation (European Hygienic Equipment Design Group) for the highest level of cleanability and ATEX certification where generally classified for use in potentially atmospheres under ATEX Directive 94/9/EC Group II, Categories 2 and 3.

In standard construction all metallic pumped media wetted components are manufactured from 316L stainless steel and pumps are fitted with tri-lobe rotors available in three temperature ratings, allowing the pump to be operated at maximum temperatures of 70°C, 130°C and 200°C for both process and CIP (Cleaning In Place).

The Series S pump has a robust cast iron gearbox with a universal design for models S1 to S4. This gives the flexibility of mounting pumps with the inlet and outlet ports in either a vertical or horizontal plane by changing the foot and its position. The Series S models S5 and S6 have a choice of two dedicated gearbox castings, which allows the inlet and outlet ports to be in either the vertical or horizontal plane.

Pump Model	**Inlet and Outlet Connections**		**Displacement**	**Differential Pressure**	**Maximum Speed**	**Weight** Bare Shaft Pump	
	Standard Port Size (international standards) mm	Enlarged Port Size (international standards) mm	litres/rev	bar	rev/min	Horizontal Porting (H) kg	Vertical Porting (V) kg
S1-0005-*08	25	-	0.053	8	1000	15	16
S1-0008-*05	25	40	0.085	5	1000	17	18
S2-0013-*10	25	40	0.128	10	1000	28	30
S2-0013-*15	25	40	0.128	15	1000	28	30
S2-0018-*07	40	50	0.181	7	1000	29	31
S2-0018-*10	40	50	0.181	10	1000	29	31
S3-0027-*10	40	50	0.266	10	1000	53	56
S3-0027-*15	40	50	0.266	15	1000	53	56
S3-0038-*07	50	65	0.384	7	1000	56	59
S3-0038-*10	50	65	0.384	10	1000	56	59
S4-0055-*10	50	65	0.554	10	1000	105	111
S4-0055-*20	50	65	0.554	20	1000	105	111
S4-0079-*07	65	80	0.79	7	1000	110	116
S4-0079-*15	65	80	0.79	15	1000	110	116
S5-0116-*10	65	80	1.16	10	600	152	152
S5-0116-*20	65	80	1.16	20	600	152	152
S5-0168-*07	80	100	1.68	7	600	160	160
S5-0168-*15	80	100	1.68	15	600	160	160
S6-0260-*10	100	100	2.60	10	500	260	260
S6-0260-*20	100	100	2.60	20	500	260	260
S6-0353-*07	100	150	3.53	7	500	265	265
S6-0353-*15	100	150	3.53	15	500	265	265

* = H (Horizontal Porting) or V (Vertical Porting)

3.2 Series X

SSP Series X stainless steel rotary lobe pumps provide the ultimate in clean pumping, complementing the SSP Series S pumps, which are used throughout industrial and clean processes worldwide.

Handling from low to high viscosity pumped media the characteristic smooth, low shear pumping action is ideal for gentle transfer of delicate and sensitive media.

Series X pumps conform to various standards and directives such as; USA 3A Sanitary Standard, EHEDG accreditation (European Hygienic Equipment Design Group) for the highest level of cleanability and ATEX certification where generally classified for use in potentially atmospheres under ATEX Directive 94/9/EC Group II, Categories 2 and 3.

In standard construction all metallic pumped media wetted components are manufactured from 316L stainless steel and pumps are fitted with four lobe rotors allowing the pump to be operated at a maximum temperature of 150°C for both process and CIP / SIP (Cleaning In Place / Sterilisation In Place).

A unique self-cleaning design rotor retention device incorporates a high integrity cup seal to fully isolate splines from the pumped media.

The Series X pump has a robust cast iron gearbox with a universal design for models X1 to X4. This gives the flexibility of mounting pumps with the inlet and outlet ports in either a vertical or horizontal plane by changing the foot and its position. The X5 and X6 models have dedicated gearbox castings, which also allows the inlet and outlet ports to be in either the vertical or horizontal plane. The X7 model has a dedicated gearbox casting allowing inlet and outlet ports in a vertical plane only.

Pump Model	**Inlet and Outlet Connections** Size (international standards) mm	**Displacement** litres/rev	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump	
					Horizontal Porting kg	Vertical Porting kg
X1-0005	25	0.05	6 / 12	1200	15	16
X1-0007	40	0.07	7	1200	16	17
X2-0013	40	0.128	5 / 15	1000	32	33
X2-0018	50	0.181	7	1000	33	34
X3-0027	50	0.266	5 / 15	1000	57	59
X3-0035	65	0.35	7	1000	59	61
X4-0046	50	0.46	5 / 15	1000	107	110
X4-0063	65	0.63	5 / 10	1000	113	116
X5-0082	65	0.82	15	600	155	155
X5-0115	80	1.15	10	600	165	165
X6-0140	80	1.40	15	500	278	278
X6-0190	100	1.90	10	500	290	290
X7-0250	100	2.50	15	500	-	340
X7-0380	150	3.80	10	500	-	362

3.3 Series L

SSP Series L stainless steel rotary lobe pumps provide the simple solution to many processes, fulfilling a wide range of application requirements throughout various industries worldwide.

Handling from low to high viscosity pumped media the characteristic smooth, low shear pumping action is ideal for delicate media and where organic solids in suspension, creams, froths, gels, emulsions and mixtures are to be pumped.

Series L pumps conform to the USA 3A Sanitary Standard and are EHEDG accredited (European Hygienic Equipment Design Group) for the highest level of cleanability.

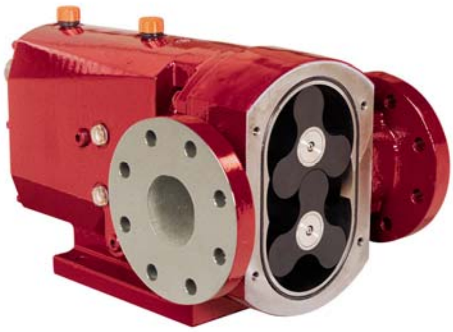
In standard construction all metallic pumped media wetted components are manufactured from 316L stainless steel and pumps are fitted with tri-lobe rotors allowing the pump to be operated at maximum temperatures of 130°C for both process and CIP (Cleaning In Place).

The Series L pump has a universal gearbox design which gives the flexibility of mounting pumps with the inlet and outlet ports in either a vertical or horizontal plane by simply changing the foot position. A stainless steel canister and electroless nickel plated bearing housing provides a clean, paint free corrosion resistant external finish.

Pump Model	**Inlet and Outlet Connections** Size (international standards) mm	**Displacement** litres/rev	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump kg
L2-0017	40	0.17	8	1000	21
L2-0021	40	0.21	8	1000	22
L3-0032	50	0.32	8	1000	34
L3-0040	50	0.40	8	1000	35
L4-0064	65	0.64	8	1000	60
L4-0082	80	0.82	8	1000	63

3.4 Series D

SSP Series D ductile iron rotary lobe pumps fulfil positive transfer duties throughout industry where the use of stainless steel for pumphead components is not essential, within application areas such as Petrochemicals, Chemical, Paper, Paints and Polymers, Petfood, Chocolate and Sugar.



Series D pumps also cover a wide span of sludge transfer duties throughout the environmental and industrial waste treatment processes. Transfer duties include Primary, Secondary and Humus Desludging, Thickener, Digester and Filterpress Feed and Tanker loading.

Series D pumps can be ATEX certified where generally classified for use in potentially atmospheres under ATEX Directive 94/9/EC Group II, Categories 2 and 3

In standard construction the pump casing is manufactured from ductile iron. Pumps are fitted with tri-lobe rotors manufactured from ductile iron (for non- sludge applications) or a metal insert covered with either NBR (which can be fitted with metal back plates for high fibre duties) or urethane, both giving long term wear resistance. The urethane rotors can be supplied slotted, providing grit channels to improve rotor life.

Pump Model	**Inlet and Outlet Connections** Size (international standards) mm	**Displacement** litres/rev	**Differential Pressure** bar	**Maximum Speed** rev/min	Sludge Applications rev/min	**Weight** Bare Shaft Pump kg
D4-0079-H15	80	0.79	15	750	-	110
D4-0095-H10	80	0.95	10	750	-	113
D4-0095-H05	80	0.95	5	500	350	113
D4-0140-H05	100	1.40	5	500	350	130
D5-0168-H15	100	1.68	15	600	-	170
D5-0200-H10	100	2.00	10	600	-	176
D5-0200-H05	100	2.00	5	500	350	176
D5-0290-H05	100 or 150	2.90	5	500	350	192
D6-0353-H15	150	3.53	15	500	-	281
D6-0420-H10	150	4.20	10	500	-	289
D6-0420-H05	150	4.20	5	500	350	289
D6-0600-H05	150	6.00	5	500	350	300

Note: Only Series D pump models rated at 5 bar differential pressure are suitable for sludge pumping.

3.5 Series A

SSP Series A rotary lobe pumps are designed for high volume fluid transfer duties and are amongst the world's largest models of this pump type. Pumps are engineered to order, customised to suit application requirements throughout Chemical, Food, Pharmaceutical and other related industries.

Series A pumps, manufactured from stainless steel, can handle from low to high viscosity pumped media and are ideal for delicate media and where organic solids in suspension, creams, froths, gels, emulsions and mixtures are to be pumped.

In standard construction all metallic pumped media wetted components are manufactured from 316 type stainless steel and pumps are fitted with tri-lobe rotors available in three temperature ratings, allowing the pump to be operated at maximum temperatures of 70°C, 130°C and 200°C for both process and CIP (Cleaning In Place).

Pump Model	**Inlet and Outlet Connections** Size (international standards) mm	**Displacement** litres/100 rev	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump kg
A7-0550-H07	150	550.0	7	750	307
A7-0550-H10	150	550.0	10	750	307
A8-0745-H07	150	745.0	7	650	590
A8-0745-H10	150	745.0	10	650	590
A8-1149-H03	200	1148.6	3.5	650	700
A8-1149-H07	200	1148.6	7	650	700
A9-1507-H10	250	1507.3	10	500	1362
A9-2270-H10	300	2270.0	10	500	1410

3.6 Series G

SSP Series G rotary lobe pumps are designed for high volume fluid transfer duties and are amongst the world's largest models of this pump type. Pumps are engineered to order, customised to suit application requirements throughout Waste Water Treatment and general industrial processes.

Series G pumps, manufactured from ductile iron, provide a good tolerance of suspended solids including fibrous matter and have proven ability in handling a full range of sludge thickness with rag and grit included.

In standard construction all metallic pumped media wetted components are manufactured from ductile iron. Pumps are fitted with tri-lobe rotors manufactured from ductile iron (for non-sludge applications) or a metal insert covered with urethane for long term wear resistance. The urethane rotors can be supplied slotted, providing grit channels to improve rotor life.

Pump Model	**Inlet and Outlet Connections** Size (international standards) mm	**Displacement** litres/100 rev	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump kg
G7-0550-H07	150	550.0	7	750	307
G7-0550-H10	150	550.0	10	750	307
G8-0745-H07	150	745.0	7	650	590
G8-0745-H10	150	745.0	10	650	590
G8-1149-H03	200	1148.6	3.5	650	700
G8-1149-H07	200	1148.6	7	650	700
G9-1507-H10	250	1507.3	10	500	1362
G9-2270-H10	300	2270.0	10	500	1410

3.7 Series N

SSP Series N stainless steel rotary lobe pumps have been designed for low volume fluid transfer duties within application areas such as laboratories, pilot plants, chemical processing, food processing, electroplating and film processing. The Series N pump, being small in size, facilitates installations where space is restricted.

The Series N pump is fitted with roloid gear rotors keyed to the shafts and held by retention discs enabling bi-directional pumping

In standard construction the rotors are precision ground from PTFE impregnated 316 type stainless steel for low friction flow. The rotors are suitable for operation at temperatures up to 100°C for both fluid pumped and CIP (Cleaning In Place). All other metallic pumped media components are manufactured from 316 type stainless steel.

Pump Model	**Inlet and Outlet Connections** Size mm	**Displacement** litres/100 rev	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump kg
N1-000S-H05	6	2.05	5	1000	10
N1-000S-H07	6	2.05	7	1000	10
N1-000L-H05	12 or 25	3.86	5	1000	10
N1-000L-H07	12 or 25	3.86	7	1000	10

3.8 Series M

SSP Series M stainless steel gear pumps have been designed for low volume fluid transfer duties for application areas such as filling machines, dosing and sampling, throughout Chemical, Food, Pharmaceutical and other related industries.

The gears manufactured from PTFE impregnated 316 type stainless steel are mounted between specially developed PTFE bearings, all fitted within the main pump body manufactured from 316 type stainless steel ensuring precision alignment.

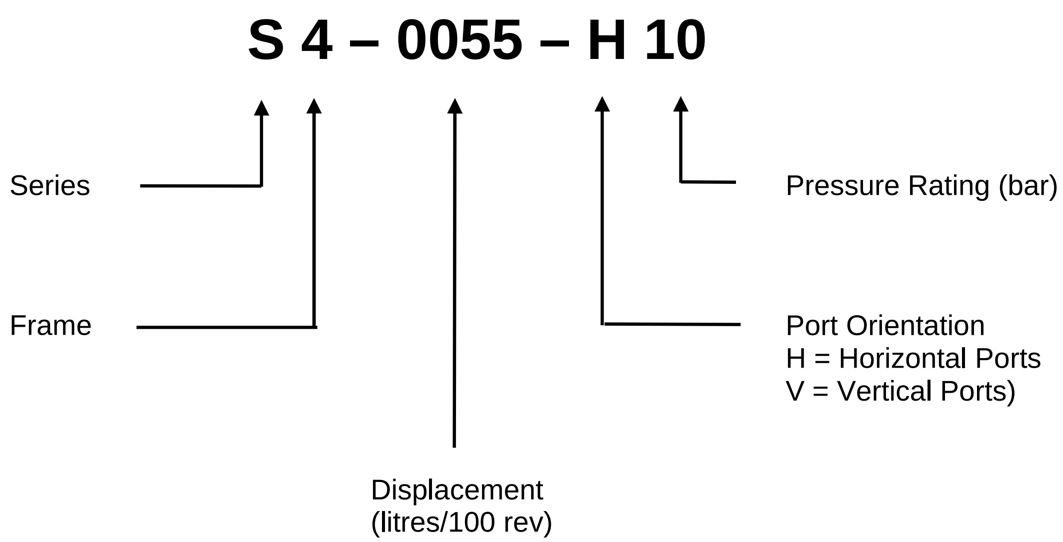
By releasing two hand nuts the three piece housing construction and all components can be easily dismantled. Shaft assemblies including mechanical seals can be withdrawn through the front of the pump. Standard pump build is suitable for temperatures up to 60°C with option of modified pump build for temperatures up to 100°C.

The pumps incorporate a location for mounting via a bracket to a frame size 71 or 80 flange motor, giving a freestanding unit.

Pump Model	**Inlet and Outlet Connections** Size mm	**Differential Pressure** bar	**Maximum Speed** rev/min	**Weight** Bare Shaft Pump kg
M2-000S-H07	25	7	1360	2
M2-000M-H07	25	7	1360	2.2
M2-000L-H04	25	4	1360	2.9

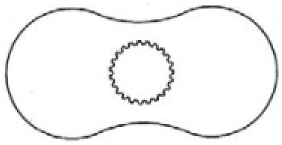
3.9 Pump Nomenclature *(not Series L)*

Example:

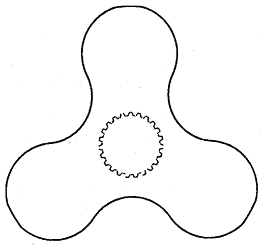


4.0 Pump Specification Options

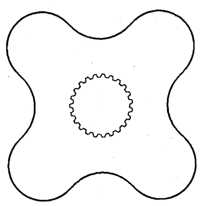
4.1 Rotor Form



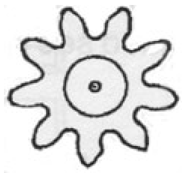
Bi-lobe



Tri-lobe



Multi-lobe



Roloid

Rotor Form	Material	Pump Series						
		S	X	L	D	A	G	N
Tri-lobe	Stainless Steel	✓	-	✓	-	✓	-	-
Tri-lobe	Ductile Iron	-	-	-	✓	-	✓	-
Tri-lobe	Rubber covered	✓	-	-	✓	-	-	-
Tri-lobe	Urethane covered	-	-	-	✓	-	✓	-
Bi-lobe	Stainless Steel	✓	-	-	✓	-	-	-
Bi-lobe	Non-galling alloy	✓	-	-	-	-	-	-
Multi-lobe	Stainless Steel	-	✓	-	-	-	-	-
Roloid	Stainless Steel	-	-	-	-	-	-	✓

Tri-lobe Rotors (Stainless Steel)
Most duties requiring the use of stainless steel rotary lobe pumps can be accomplished by pumps being fitted with stainless steel tri-lobe rotors. The tri-lobe rotor with its optimised profile and precision manufacture ensure interchangeability as well as smooth, high performance pumping action.

These are available on the Series S and A pump ranges with 3 temperature ratings:

- up to 70°C
- up to 130°C
- up to 200°C

and pressures up to 20 bar for Series S and up to 10 bar for Series A.

Also available on the Series L suitable for temperatures up to 130°C and pressures up to 8 bar.

Tri-lobe Rotors (Ductile Iron)
Series D and G pumps in standard construction have ductile iron tri-lobe rotors fitted for non-sludge applications.

These are available on the Series D and G pump ranges with 3 temperature ratings:

- up to 70°C
- up to 130°C
- up to 200°C

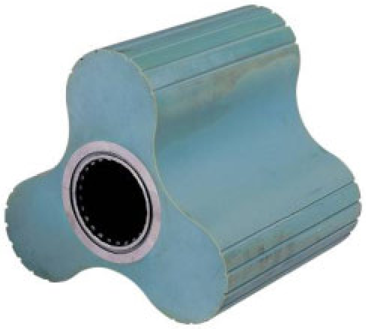
and pressures up to 15 bar for Series D and up to 10 bar for Series G.

Tri-lobe Rotors (Rubber Covered)
This rotor has a metallic insert (stainless steel for Series S and iron for Series D) covered in NBR rubber, and due to the resilience of the rubber coating these rotors have a slight interference fit with the pump rotorcase when initially fitted, but after a short running time wear to a tolerance level. This results in improved pump performance and suction lift capability over stainless steel and ductile iron tri-lobe rotors. For long term wear resistance these rotors can be fitted with metal back plates for high fibre duties on Series D pumps.

Rotors are suitable for continuous operation up to 70°C and intermittent operation up to 100°C, and pressures up to 7 bar (5 bar on sludge applications).

Tri-lobe Rotors (Urethane Covered)
This rotor has an iron insert covered in urethane that can be used on the Series D and G pump ranges in various sludge applications. The urethane covered rotors can be supplied slotted, providing grit channels to improve rotor life.

Rotors are suitable for continuous operation up to 70°C and pressures up to 3.5 bar.



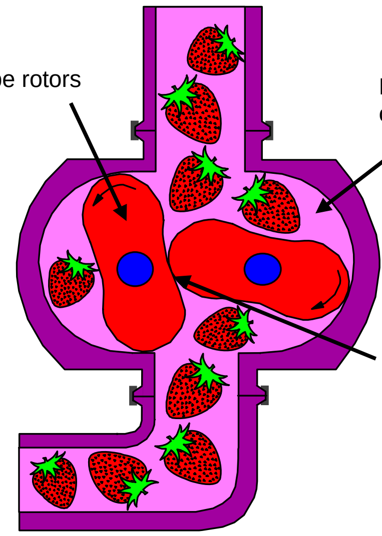
Slotted Urethane Rotor

Bi-lobe Rotors (Stainless Steel)
These rotors are generally used for handling delicate suspended solids in order to minimise any possible product damage. Typical applications are jam containing fruit pieces, sausage meat filling, petfood, soups and sauces containing solid matter. Other application areas include magma and massecuite pumping with Series D pumps.

These are available on the Series S and D pump ranges with 3 temperature ratings:

- up to 70°C
- up to 130°C
- up to 200°C

and pressures up to 20 bar for Series S and up to 15 bar for Series D.



Bi-lobe Rotors (Non-galling Alloy)
Manufactured from non-galling alloy these rotors have an advantage over stainless steel, as smaller clearances can be used, leading to increased volumetric efficiencies when pumping low viscosity media (i.e. < 20 cP for model S1 and < 50 cP for models S2 - S6 pumps).

These are available on the Series S pump range with 3 temperature ratings:

- up to 70°C
- up to 130°C
- up to 200°C

and pressures up to 20 bar.

It should be noted that the non-galling alloy rotors will contact the rotorcase and/or rotorcase cover at high pressure and/or high temperature. Whilst this contact is light, wear will take place thereby giving a small degree of shedding of material into the pumped media. When using non-galling alloy rotors consideration should be given to material compatibility as it is generally acknowledged that the non-galling alloys used in positive displacement pumps are not as resistive to corrosion as 316L stainless steel.

Multi-lobe Rotors
This rotor is manufactured from stainless steel and as the name suggests has many lobes. For the Series X pump range these rotors have 4 lobes and are designed to maximise efficiency, lower NPSH requirements, reduce shear and provide a smooth pumping action.

Rotors are suitable for temperatures up to 150°C and pressures up to 15 bar.

Roloid Rotors (Stainless Steel)
These rotors are often referred to as pumping gears as their form suggests. They are manufactured from stainless steel and impregnated with PTFE to reduce clearances, thereby increasing efficiency. Can also be made available from stainless steel without PTFE impregnation for applications where the use of PTFE is forbidden i.e. tobacco flavouring.

These are available on the Series N pump range with 2 temperature ratings:

- up to 70°C
- up to 100°C

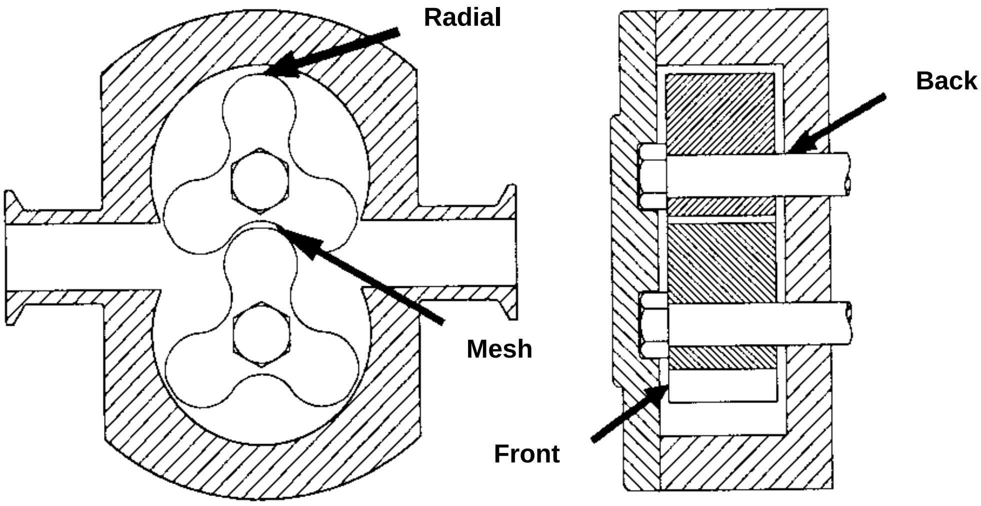
and pressures up to 7 bar.

4.2 Clearances

Within the pump head of SSP rotary lobe pumps there are clearances, which are the spaces between rotating components and between rotating and stationary components. Clearances are necessary to avoid rotor to rotor, rotor to rotorcase and rotor to rotorcase cover contact. The size of these clearances is related to the pressure and temperature of pump operation and rotor material.

The key clearances are as follows:

- Radial clearance (between rotor tip and rotorcase).
- Mesh clearance (between rotors).
- Front clearance (between front of rotor and rotorcase cover).
- Back clearance (between back of rotor and back face of rotorcase).

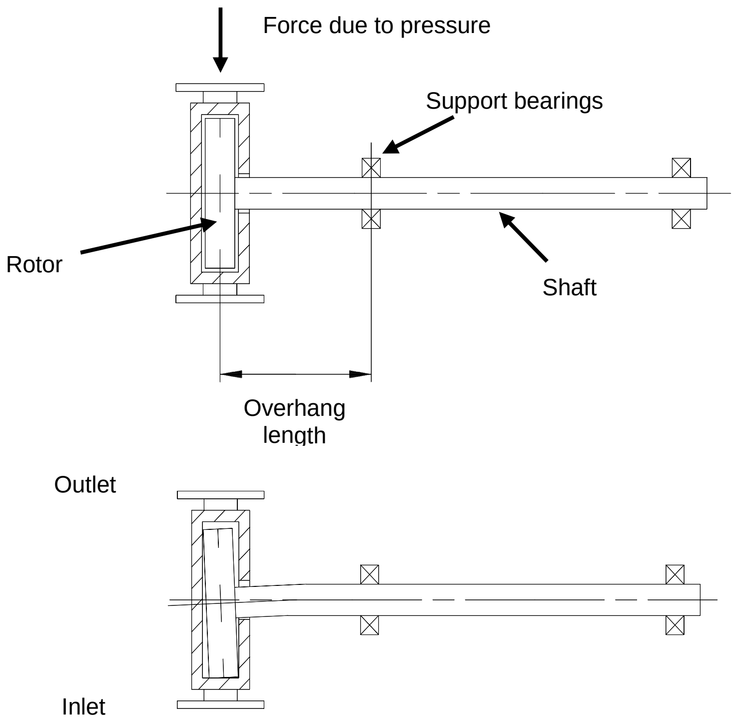


4.2.1 Pressure effect

The design concept of the rotary lobe pump is to have no contacting parts in the pumphead. This requires having the shaft support bearings to be mounted outside of the pumphead, which results in an overhung load, caused by the rotors fitted to the shafts as shown.

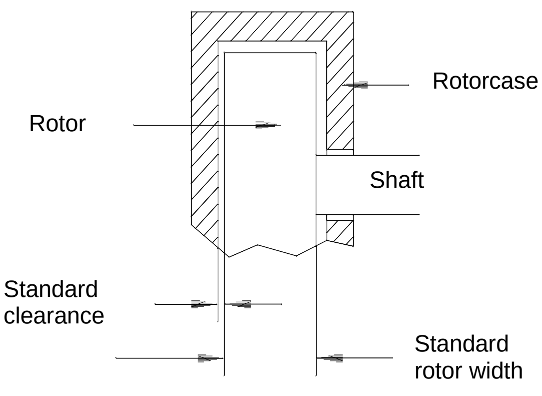
The effect of pressure on the rotors will cause shaft deflection, which could result in contact between rotors, rotorcase and rotorcase cover. To allow for this pressure effect, clearances are built into the pumphead between surfaces that may contact. For the Series S, L and D pump ranges there is only one pressure rating, which is the maximum differential pressure of the particular pump model. However, the Series X, A, G and N pump ranges have more than one pressure rating dependent upon pump model. The pressure effect is less significant on pumps fitted with rubber covered or non-galling alloy rotors.

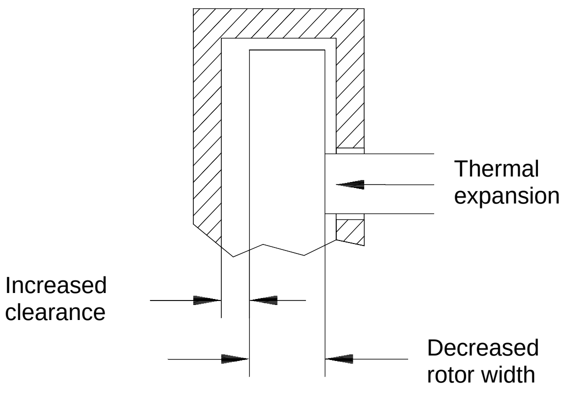
Should the pressure rating be exceeded it is likely that as product wetted parts of the Series S, X, L, A and N pump ranges are predominantly manufactured from stainless steel any contact between rotating and stationary parts would cause ‘galling’ and possible pump seizure.



4.2.2 Temperature effect

Temperature change can be caused by the fluid being pumped, pump mechanism, drive unit and/or the environment. Any CIP (Cleaning In Place) operation required should also be taken into consideration. Changes in temperature will cause expansion upon heating or contraction upon cooling, to the rotorcase and gearcase components. The most significant result is movement between shaft and gearcase/rotorcase allowing the rotors to move forward or backward in the rotorcase. With the rotors being allowed to move forward there will be a reduction to the front clearance. To compensate for this, the Series S, A, G and D pump ranges have increased clearances as shown below.





The clearance is exaggerated to show the temperature effect

Series S, A, G and D pumps are designed for three rotor temperature ratings:

- 70°C
- 130°C
- 200°C

For the Series X and L pump ranges, the design of the mechanical seal eliminates contact between the fluid being pumped and the shaft. This results in the shaft not being subjected to the full temperature variation and therefore only one temperature rating is necessary i.e. 150°C for Series X and 130°C for Series L.

It is imperative during any CIP (Cleaning In Place) operation that pumps are not subjected to rapid temperature changes i.e. hot to cold, as pump seizure can result from thermal shock.

4.3 Port Connections

SSP rotary lobe pumps are supplied with screwed male or flanged connections to all major standards as follows:

Standard Screwed Connection Standard	Pump Series						
	S	X	L	D	A	G	N
BSP	✓						✓
BSPT	✓						✓
DIN11851	✓	✓	✓				✓
DIN11864-1 Form A	✓	✓					
DS	✓						
ISS/IDF	✓	✓	✓				✓
NPT	✓						✓
Rdg	✓						
RJT	✓	✓	✓				✓
SMS	✓	✓	✓				✓
SMS FS	✓						
SRJT	✓						
Tri-clamp	✓	✓	✓				✓
Threaded bevel seat	✓						

Note:
1. Maximum differential pressure capability of the pump does not apply to the pressure rating of the selected port connection as stated below:
SMS - 10 bar (all sizes).
RJT - 10 bar (all sizes).
DIN11851 - 40 bar (25-40mm), 25 bar (50-100mm), 16 bar (150mm).
IDF/ISS - 16 bar (25-50mm), 10 bar (65-150mm) providing provision for support ring is made.
Tri-clamp (BS4525) - Pressure rating is dictated by the clamp band used. Refer to clamp band supplier.

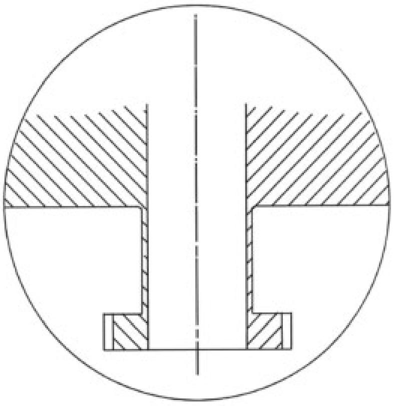
2. For DIN11851 and DIN11864-1 Form A ports, standard connections match BS4825 and enlarged connections match DIN11850.

3. For size 150mm on S6-0353 and X7-0380 pumps, only DIN11851, SRJT or Tri-clamp connections are available.

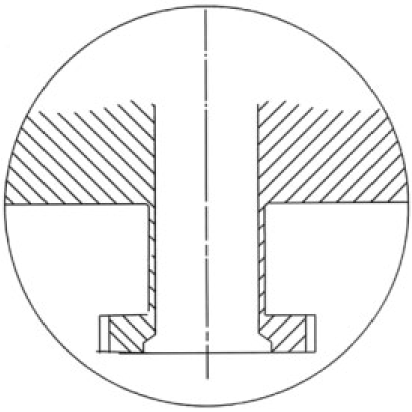
Flanged Connection Standard	Pump Series						
	S	X	L	D	A	G	N
ASA/ANSI 150RF	✓			✓	✓	✓	✓
ASA/ANSI 300RF	✓						
BS4504/DIN2533	✓			✓	✓	✓	✓
BS10E	✓			✓	✓	✓	✓
JIS10K	✓						

On Series D, A and G the pump casings are supplied with integral cast flanged inlet and outlet connections.

All models in the Series S, X and L pump ranges are supplied with full bore through porting, conforming to International Sanitary Standards BS4825. This provides effective CIP cleaning and maximises inlet and outlet port efficiency and NPSHr characteristics. The option of the enlarged port on the Series S pump range can be chosen for high viscosity applications.



Standard Port Design

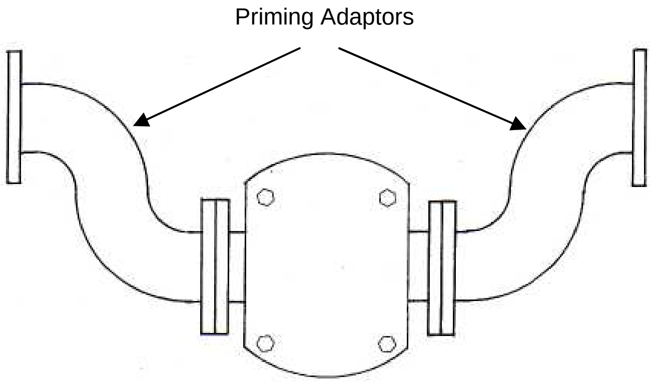


Enlarged Port Design

Flanges for vertically ported Series S pump models are not fitted directly to the discharge port. In this instance an elbow bend is included to which the flange is fitted.

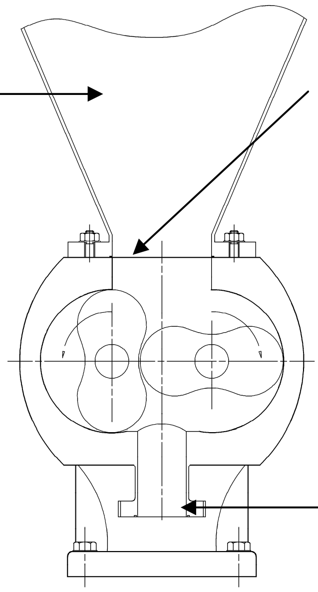
Priming Adaptors

For Series D pump models D4-0095-H05 and D4-0140-H05 suction lift adaptors are available, designed to assist priming on suction lift duties for sludge applications. These are bolted onto the pump inlet and outlet flanged connections.



4.4 Rectangular Inlets

For handling extremely viscous pumped media and/or large solids that would naturally bridge a smaller port, Series S rotary lobe pumps can be supplied with a rectangular inlet. Usually the pump will be in vertical port orientation to allow the pumped media to flow into the pumping chamber under gravity from a hopper mounted directly above or mounted with an adaptor to facilitate connection to large diameter pipework.

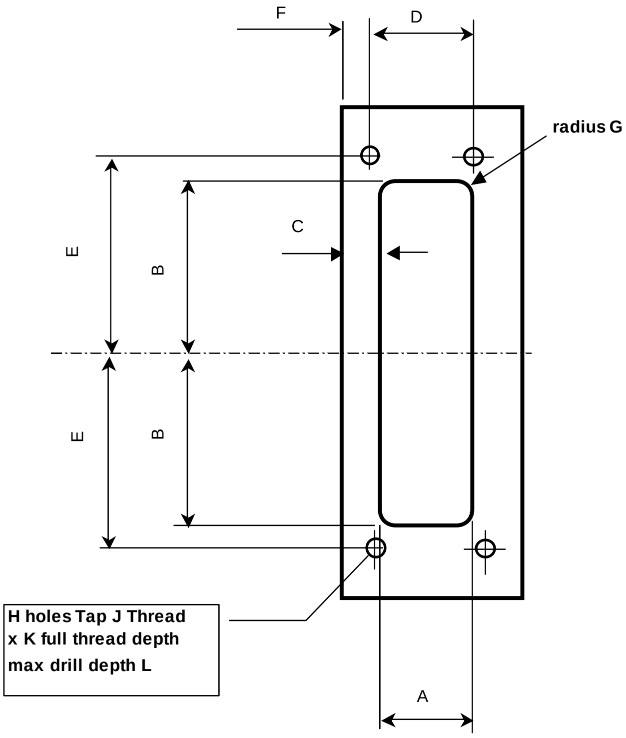


As can be seen from the table below there is a significant percentage area increase when using a rectangular inlet compared to a standard port connection, thereby increasing the pumps ability to handle highly viscous pumped media.

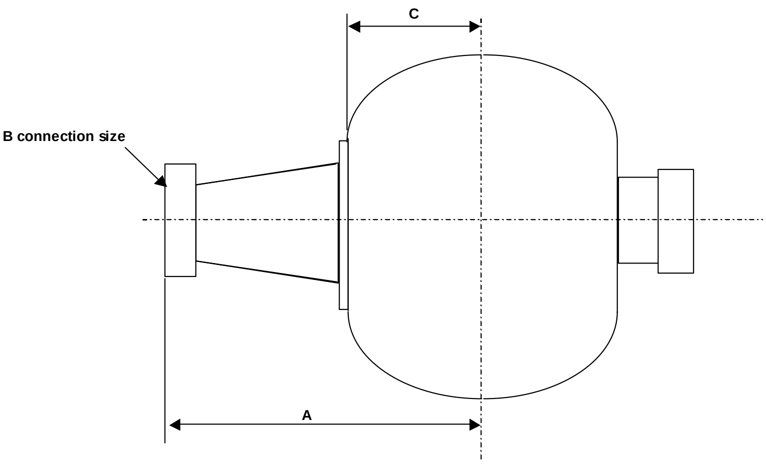
Pump Model	**Standard port area (mm^2)**	**Rectangular inlet area (mm^2)**	**% Area increase above standard port diameter**
S1-0005	387	660	171
S1-0008	387	1260	326
S2-0013	387	1216	314
S2-0018	957	1976	206
S3-0027	957	2112	221
S3-0038	1780	3360	189
S4-0055	1780	2688	151
S4-0079	2856	4320	151
S5-0116	2856	5032	176
S5-0168	4185	8160	195
S6-0260	7482	13888	186
S6-0353	7482	18240	244

Dimensions for Rectangular Inlet and standard Adaptor (mm)

Pump Model	A	B	C	D	E	F	G	H	J	K	L
S1-0005	11	30	5	-	50	10.5	5	2	M6	12	17
S1-0008	21	30	5	-	50	15.5	8	2	M6	12	17
S2-0013	16	38	6	16	45	6	8	4	M6	12	17
S2-0018	26	38	6	26	45	6	10	4	M6	12	17
S3-0027	22	48	8	20	60	9	10	4	M8	16	22
S3-0038	35	48	8	33	60	9	15	4	M8	16	22
S4-0055	28	48	10	30	72	9	10	4	M8	16	22
S4-0079	45	48	10	47	72	9	15	4	M8	16	22
S5-0116	37	68	14	41	90	12	15	4	M10	18	23
S5-0168	60	68	14	64	90	12	20	4	M10	18	23
S6-0260	62	95	18	78	98	10	20	4	M10	15	22
S6-0353	96	95	18	112	98	10	20	4	M10	15	22



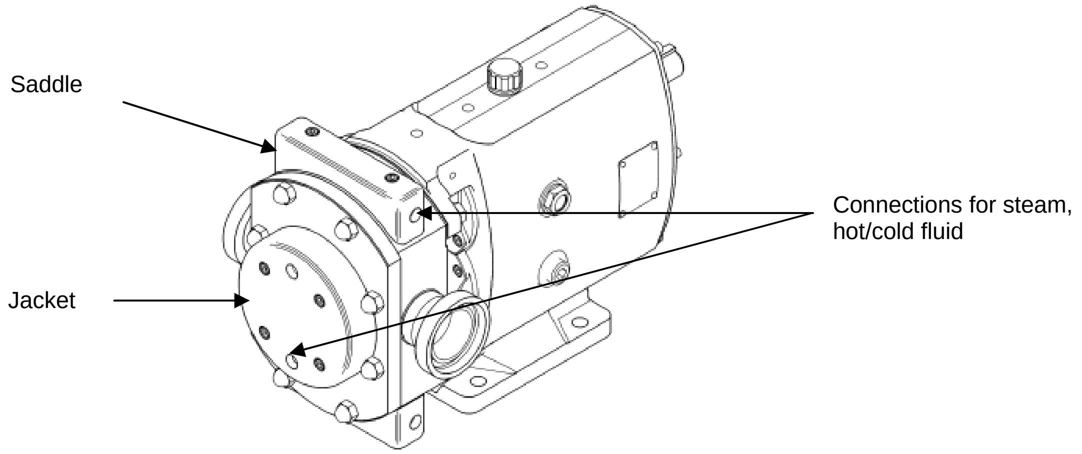
Rectangular to round adaptor
finished with screwed connection



Pump Model	A	B	C
S1-0005	150	40	52
S1-0008	150	50	52
S2-0013	171	50	65
S2-0018	171	80	65
S3-0027	193	80	80
S3-0038	193	80	80
S4-0055	218	100	100
S4-0079	218	100	100
S5-0116	300	100	112
S5-0168	300	150	112
S6-0260	320	150	130
S6-0353	320	150	130

4.5 Heating / Cooling Jackets and Saddles

SSP Series S, X and N pumps have the option of being fitted with heating/cooling devices. These are primarily used for heating the pumphead so as to maintain the pumped media viscosity and reduce risk of any crystallisation/solidification. They may also be used for cooling purposes.



Series S pumps can be fitted with jackets to the rotorcase cover and/or saddles to the rotorcase.
Series X and N pumps can be fitted with jackets to the rotorcase cover only.

The maximum pressure and temperature of heating/cooling fluid is 3.5 bar and 150°C respectively.
Heating/cooling jackets and saddles should be in operation approximately 15 minutes prior to pump start up and remain in operation 15 minutes after pump shut down.

Typical applications include:
- Adhesive
- Chocolate
- Gelatine
- Jam
- Resin
- Tar

Jacket /Saddle Connections

Jackets for all Series S, X and N pumps have 2 off 1/4 inch BSPT or NPT female connections with Series S pumps having the option of 3/8 inch or 1/2 inch female connections, either BSPT or NPT.

Saddles for Series S pump models S1 and S2 have 4 off 1/8 inch BSPT or NPT female connections with option of 1/4 inch female connections, either BSPT or NPT.

Saddles for Series S pump models S3 to S6 have 4 off 1/4 inch BSPT or NPT female connections with option of 3/8 inch female connections, either BSPT or NPT.

4.6 Pressure Relief Valves

SSP Series S pumps have the option of being fitted with pressure relief valves. These are supplied as an integral part of the pump and do not require any external pipework. The assembly replaces the standard rotorcase cover and is intended to protect the pump from over pressurisation. The valve will provide full pump protection for fluids having viscosities below 500 cP, above this figure our Technical Support should be consulted with regard to specific flow rates in relation to viscosity and differential pressures. The design is such that the valve mechanism is isolated from the pumped media.

As it is a mechanical device the relief valve does not operate instantaneously due to mechanical response time. The valve will begin to relieve at a pressure less than the fully open pressure. This 'accumulation' will vary depending upon the duty pressure, viscosity and pump speed. The accumulation tends to increase as pressure or pump speed decrease, and as viscosity increases. The valve is set to relieve at the required pressure by the correct choice of springs and can be adjusted on site to suit actual duty requirements.

The relief valve can be provided with the following options:

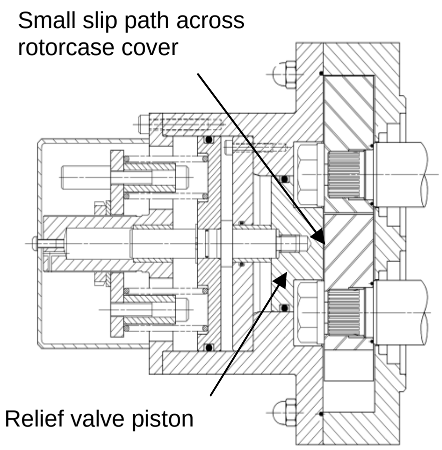
Automatic with Pneumatic Override - These valves may be pneumatically overridden for CIP conditions and/or remotely controlled if required. Air supply should be clean and dry at pressures of 4 - 8 bar.

Automatic with Manual Override - This valve has a lever to enable manual override for CIP or certain tank filling applications.

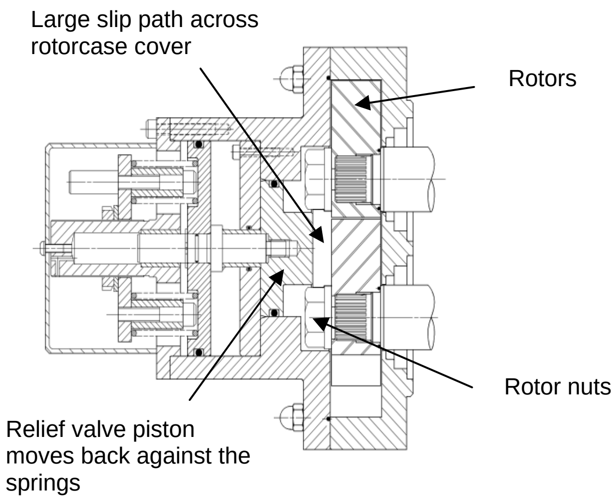
Valve Type	Pump Model	Normal Operating Pressure Range
Standard	S1-6	7-19 bar
Pneumatic override	S1-6	7-19 bar
Manual override	S1-3 S4-5 S6	19 bar 7-10 bar 7 bar

Pressure relief valves are only available for Series S pumps fitted with metal rotors.

Valve closed

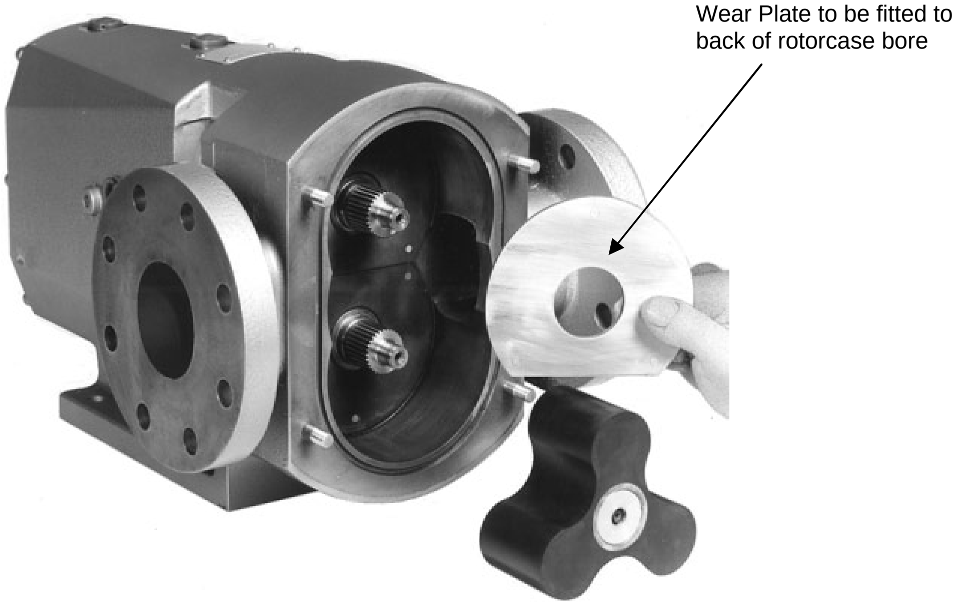


Valve open



4.7 Wear Plates

To increase abrasion resistance SSP Series D and G pumps have the option of being fitted with replaceable wear plates. These are manufactured from hardened steel and can be replaced in situ with minimal pump dismantling.



For all Series D pumps wear plates can be fitted to rotorcase only.

For all Series G pumps wear plates can be fitted to rotorcase and for G9 pump model wear plates can also be fitted to rotorcase cover.

4.8 Surface Coating

For particularly abrasive applications SSP Series D and G pumps can be supplied with rotorcase and rotorcase cover having a tungsten carbide coating that will increase wear resistance.

The hard coating material comprises of 25% Nickel Chrome and 75% Chrome Carbide and has a hardness of 70 HRC. This combined with a material coating thickness of 0.1/0.125 mm provides the resistance to withstand aggressive wear from pumped media such as calcium carbonate slurries, glass strands in solution, dye pigments, inks, sewage sludge containing grit particulates and other inorganic matter.

5.0 Pump Sealing

'A pump is only as good as its shaft seal'

A successful pump application largely depends upon the selection and application of suitable fluid sealing devices. Just as we know that there is no single pump that can embrace the diverse range of fluids and applications whilst meeting individual market requirements and legislations, the same can be said of fluid sealing devices. This is clearly illustrated by the large range of shaft seal arrangements, both mechanical and packed gland, that are available to the pump manufacturer.

Shaft sealing devices used in SSP rotary lobe pumps include:

- Mechanical Seals
  - Single externally mounted
  - Single externally mounted for external flush
  - Double 'back to back' with the inboard seal externally mounted for flush

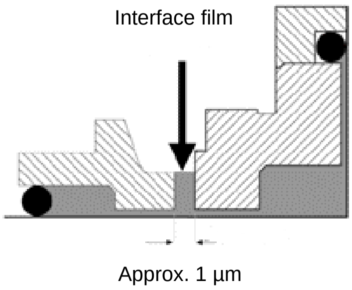
- Packed Glands
  - Both with and without lantern rings for flush

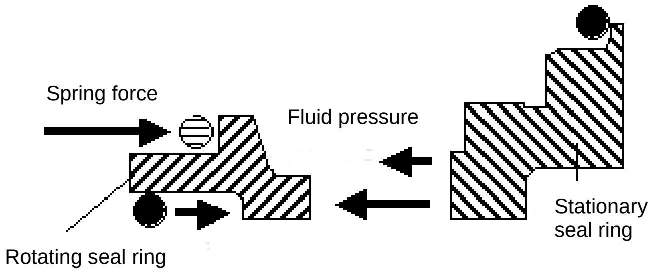
Pump Sealing Availability for SSP Rotary Lobe Pumps							
Mechanical Seal Type	**Pump Series**						
	S	**X**	**L**	**D**	**A**	**G**	**N**
R90 Single	✓			✓	✓	✓	
R90 Single Flushed	✓			✓	✓	✓	
R90 Double Flushed	✓			✓	✓	✓	
Hyclean Single	✓						
Hyclean Single Flushed	✓						
R00 Single		✓					
R00 Single Flushed		✓					
R00 Double Flushed		✓					
EasyFit Single			✓				
EasyFit Single Flushed			✓				
R80 Single							✓
Packed Gland	✓			✓	✓	✓	✓
Packed Gland Flushed	✓			✓	✓	✓	

Mechanical seals are designed for minimal leakage and typically consist of:

- A primary seal, comprising of stationary and rotary seal rings i.e. two flat faces, one rotating and one stationary, which support a fluid film, thus minimizing heat generation and subsequent mechanical damage.
- Two secondary seals, one for each of the stationary and rotary seal rings. These typically are 'o' rings.
- A method of preventing the stationary seal ring from rotating i.e. pins.
- A method of keeping the stationary and rotary seal rings together when they are not hydraulically loaded i.e. when the pump is stopped. This typically is a spring.
- A method of fixing and maintaining the working length. This typically is achieved by the seals physical position i.e. step on shaft or grub screws.

Principle of Mechanical Seal Operation
The function of the mechanical seal assembly is to combine the extreme primary seal face flatness and applied spring force. Once the pump is operational, hydraulic fluid forces combine with seal design to push the seal faces together. This reduces the fluid interface thickness to a minimum whilst increasing pressure drop, thereby minimising pumped fluid leakage.





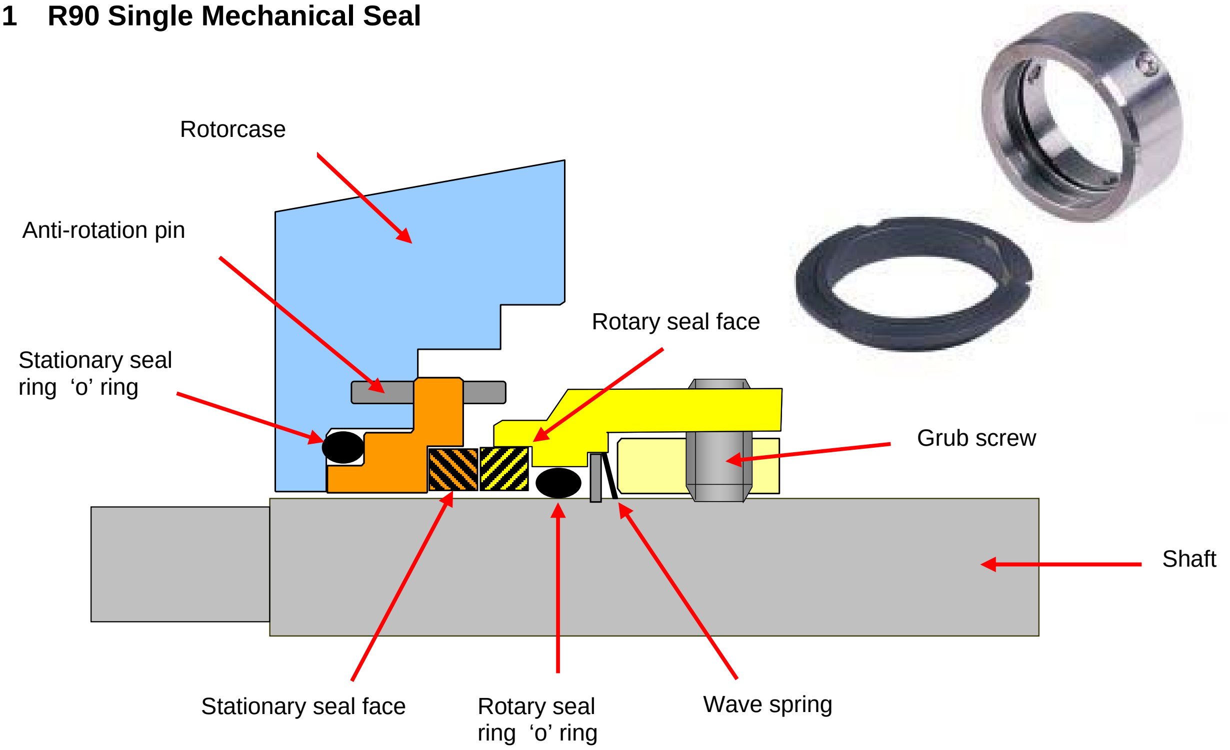
5.1 Single Mechanical Seal

This seal arrangement is generally used for fluids that do not solidify or crystallise in contact with the atmosphere and other non-hazardous duties. For satisfactory operation it is imperative the seal is not subjected to pressures exceeding the maximum rated pressure of the pump. Also the pump must not be allowed to run 'dry', thus avoiding damage to the seal faces, which may cause excessive seal leakage.

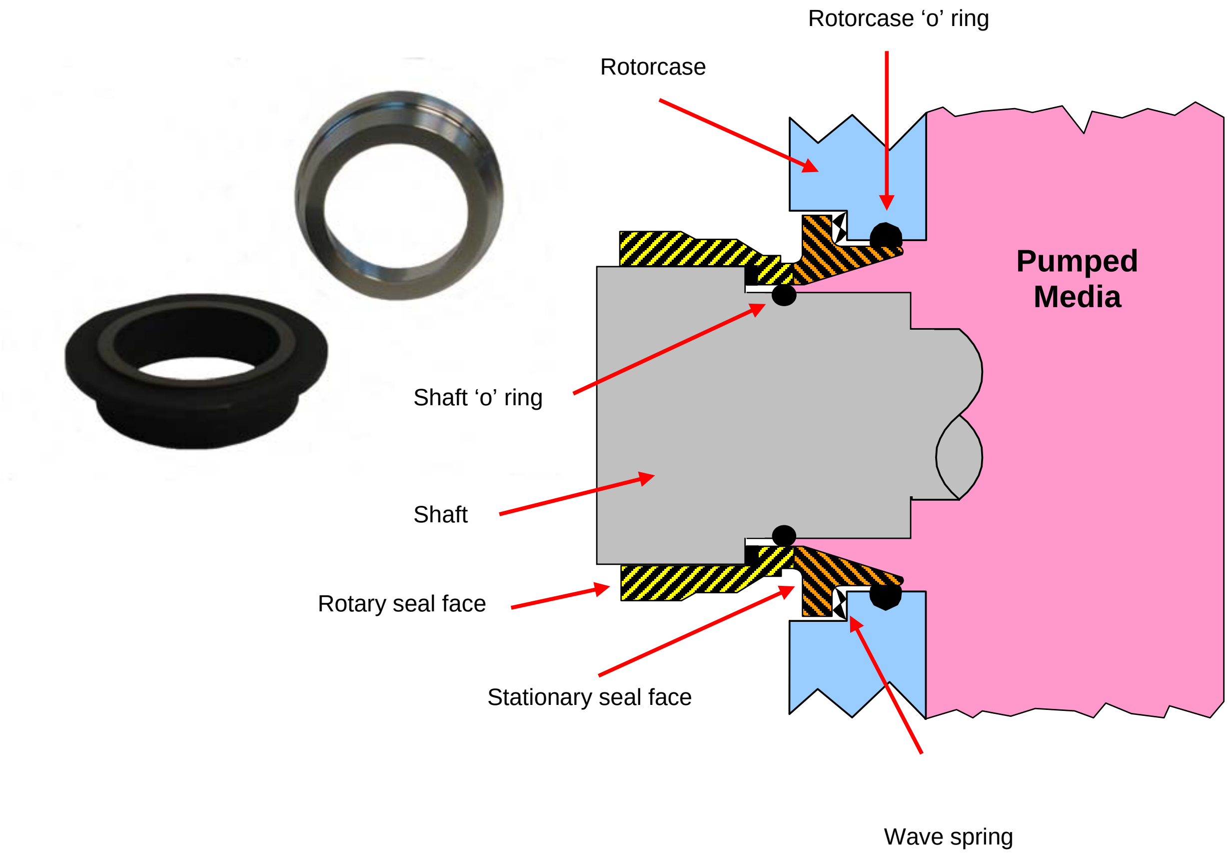
Typical applications are listed below, but full product/fluid and performance data must be referred to the seal supplier for verification.

- Alcohol
- Animal Fat
- Beer
- Dairy Creams
- Fish Oil
- Fruit Juice
- Liquid Egg
- Milk
- Shampoo
- Solvents
- Vegetable Oil
- Water
- Yoghurt

5.1.1 R90 Single Mechanical Seal

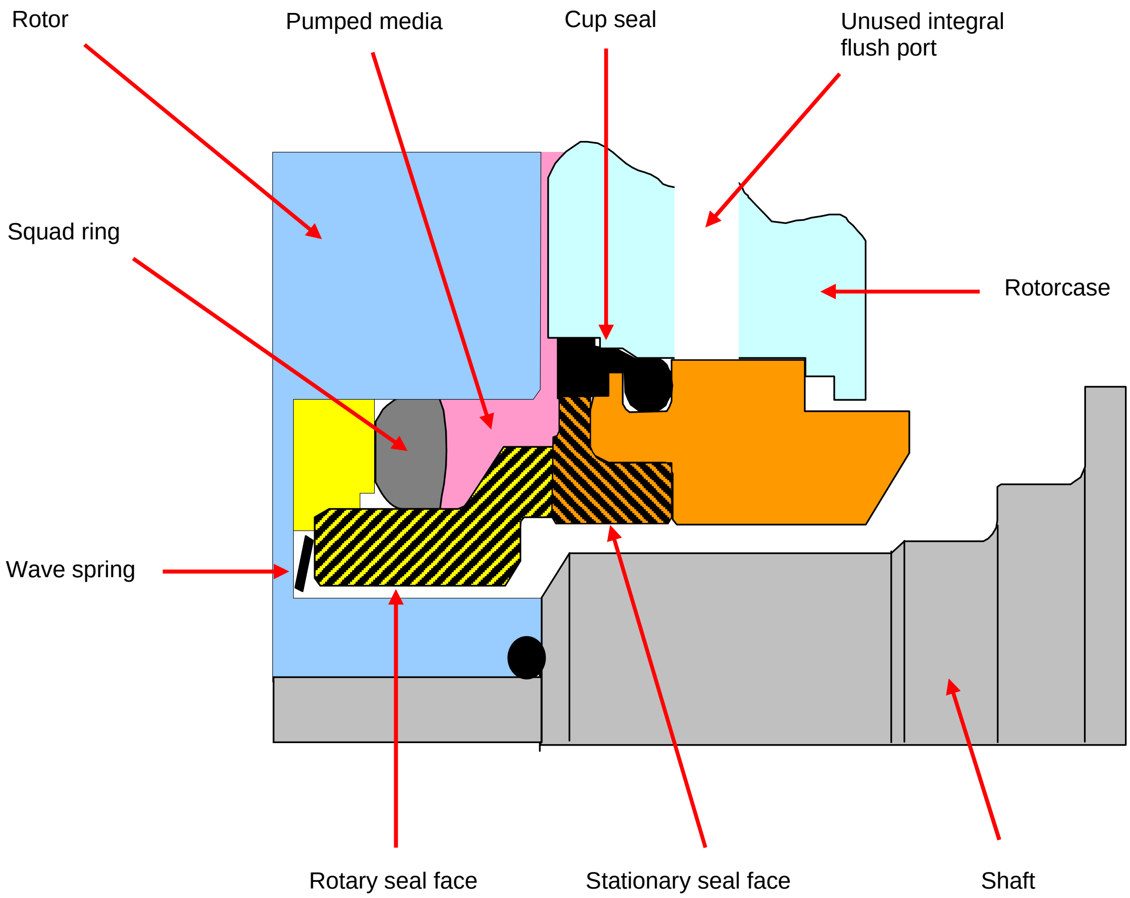


5.1.2 Hyclean Single Mechanical Seal



5.1.3 R00 Single Mechanical Seal

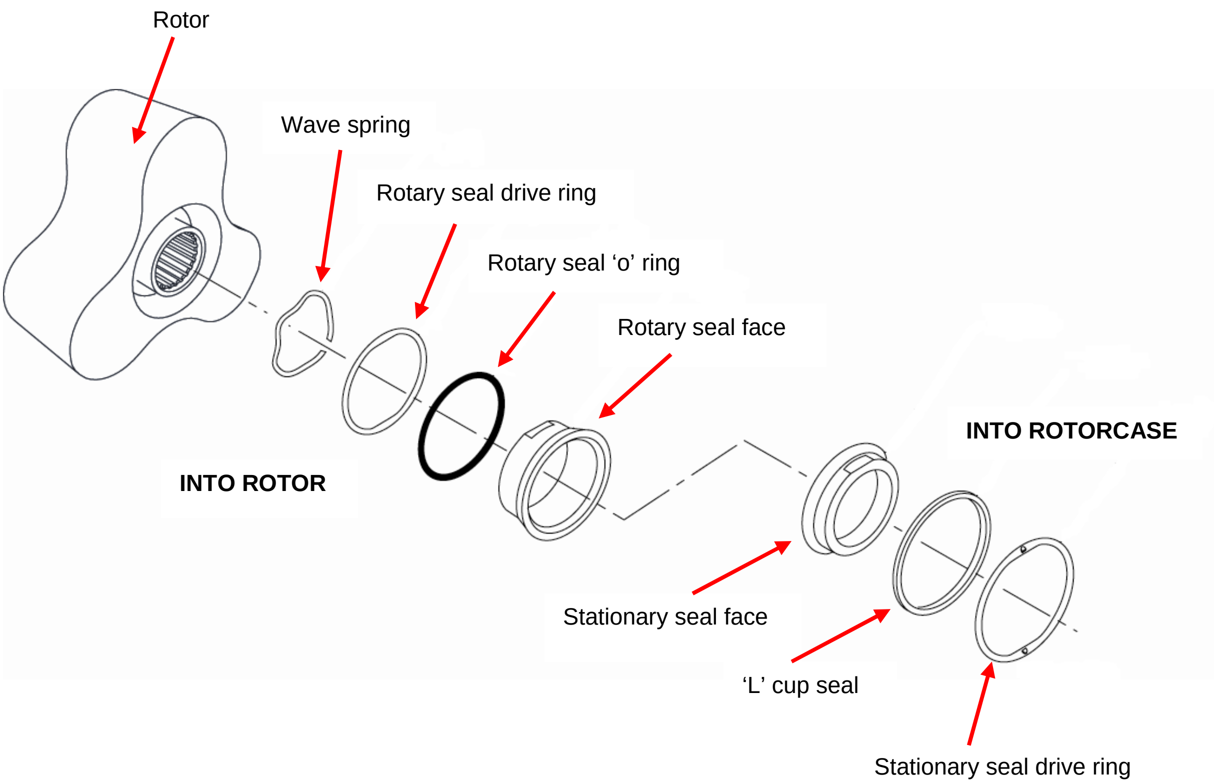
The R00 type mechanical seals are specifically designed for the Series X pump range. They are fully front loading seals and fully interchangeable without the need for additional housings or pump component changes.



5.1.4 EasyFit Single Mechanical Seal

The EasyFit type mechanical seals are specifically designed for the Series L pump range. They are fully front loading seals and fully interchangeable without the need for pipework disassembly.

Specialised seal setting of the mechanical seal is not required as the seal is dimensionally set on assembly. This feature further enhances fast and efficient on-site seal interchangeability.



5.2 Single Flushed Mechanical Seal

The definition of 'flush' is to provide a liquid barrier or support to the selected seal arrangement. This seal arrangement is generally used for any of the following conditions:

- Where the fluid being pumped can coagulate, solidify or crystallise when in contact with the atmosphere.

- When cooling of the seals is necessary dependent upon the fluid pumping temperature.

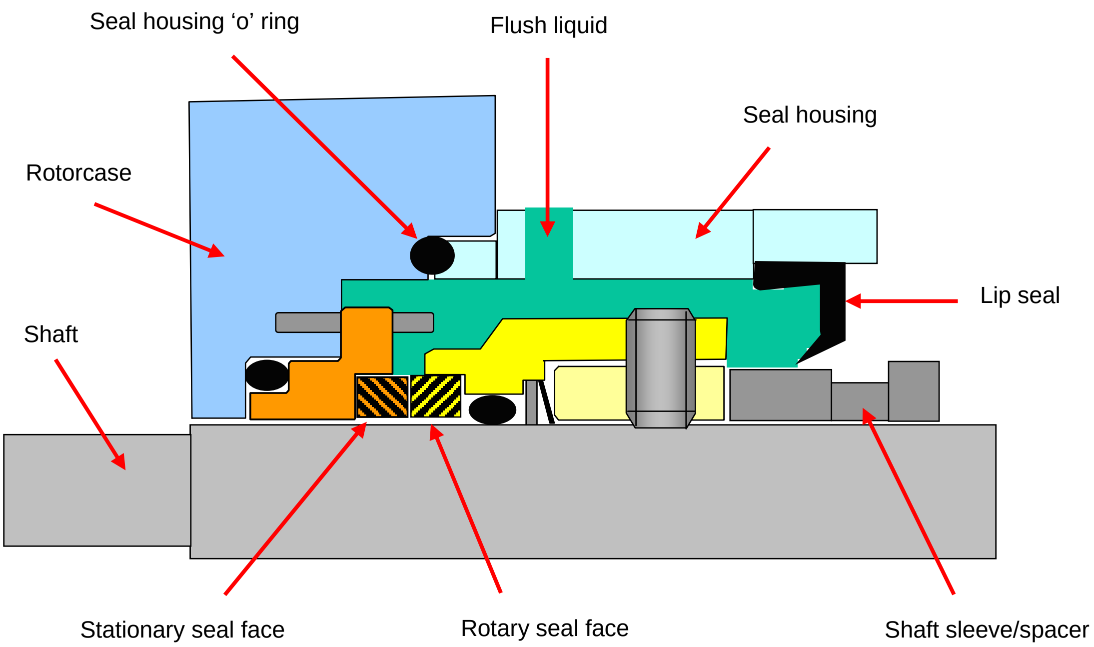
This seal arrangement requires the supply of liquid to the atmospheric side of the mechanical seal to flush the seal area. The characteristics of the fluid being pumped and the duty conditions will normally determine if a flush is necessary. When selecting a flushing liquid you must ensure that it is chemically compatible with the relevant materials of pump/seal construction and fully compatible with the fluid being pumped. Consideration should be given to any temperature limitations that may apply to the flushing liquid to ensure that hazards are not created (i.e. explosion, fire, etc). The flushing liquid is allowed to enter the seal housing at low pressure i.e. 0.5 bar max to act as a barrier.

This most basic flush system, sometimes referred to as quench, provides liquid to the atmosphere side of the mechanical seal thereby flushing away any product leakage. For the majority of pump models the flushed seal comprises the same stationary and rotating parts as the single seal, with the addition of a seal housing having a flushing connection and a lip seal.

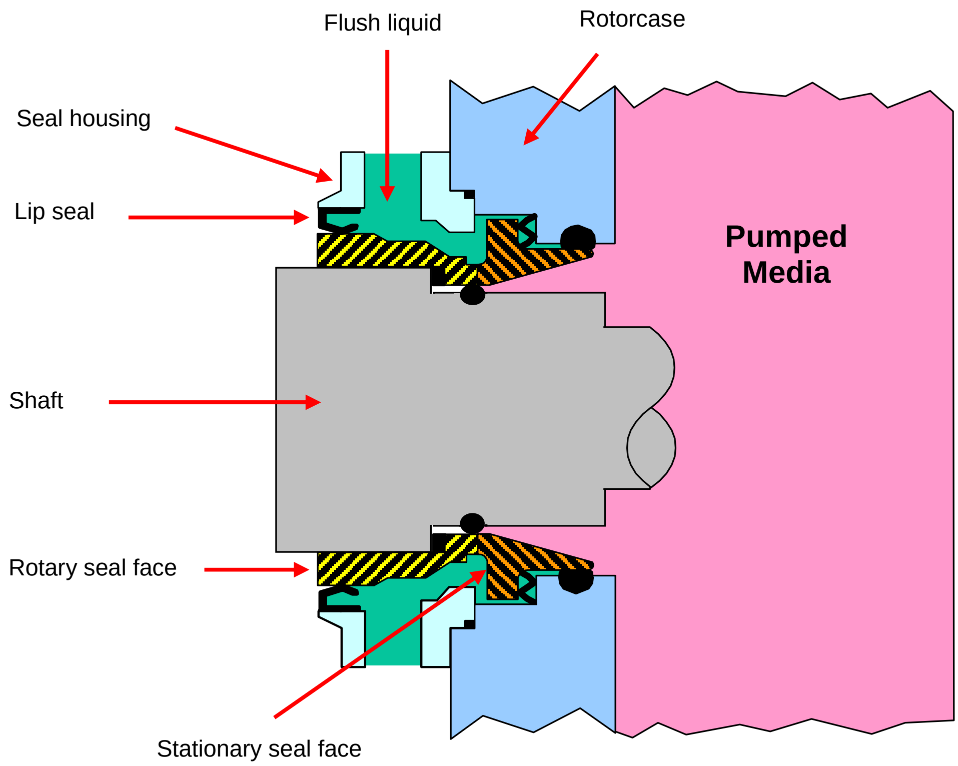
Typical applications are listed below, but full product/fluid and performance data must be referred to the seal supplier for verification.

- Adhesive
- Caramel
- Detergent
- Fruit Juice Concentrate
- Gelatine
- Jam
- Latex
- Paint
- Sugar Syrup
- Toothpaste
- Yeast

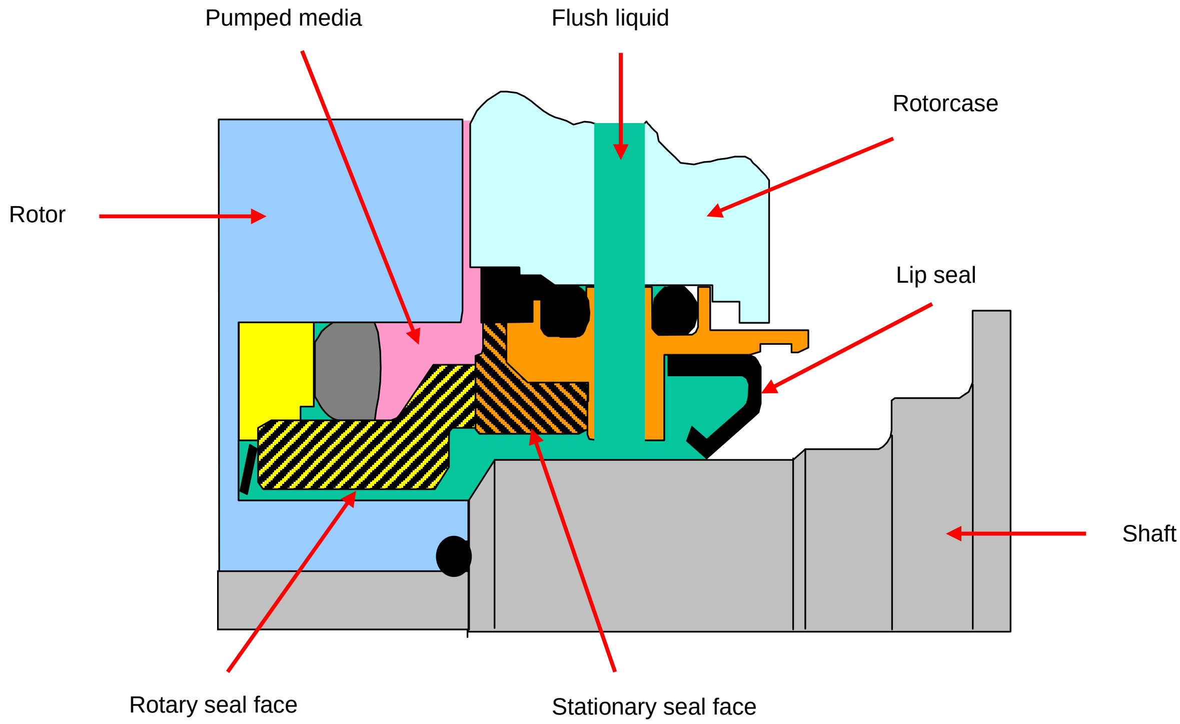
5.2.1 R90 Single Flushed Mechanical Seal



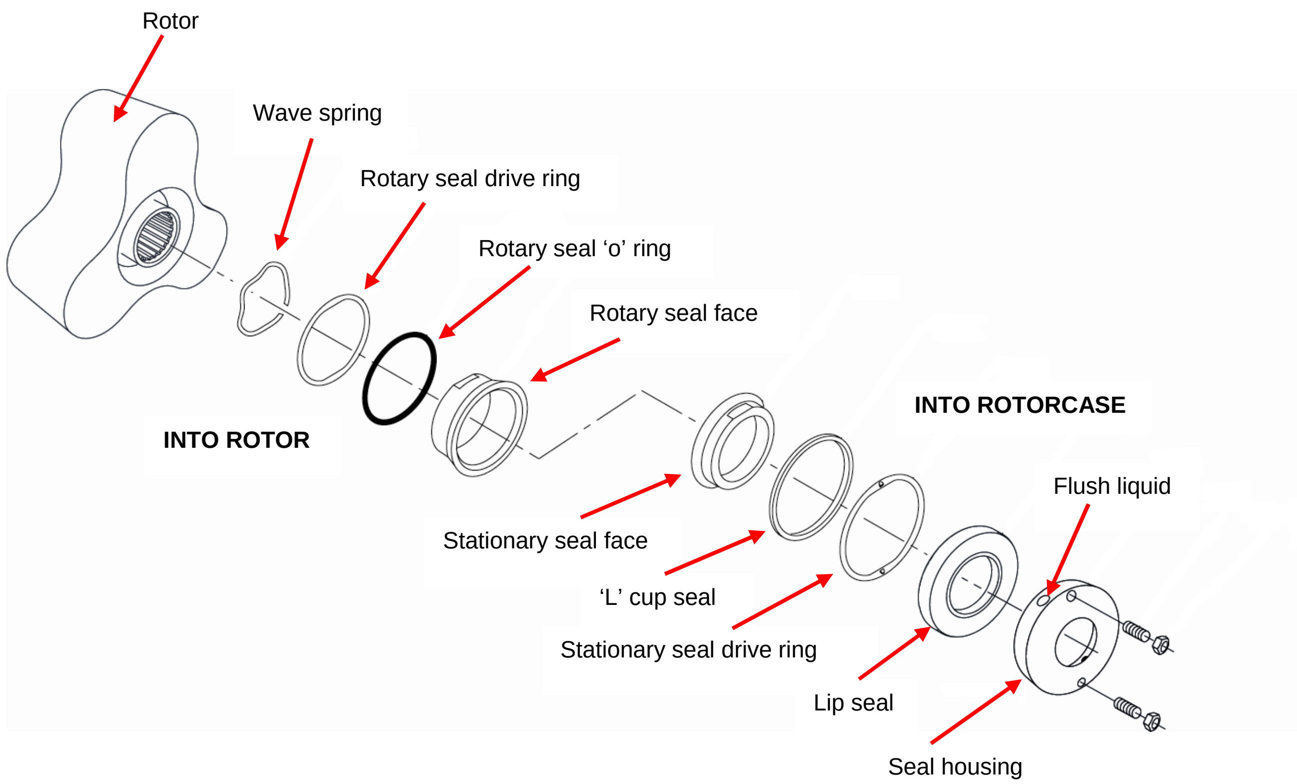
5.2.2 Hyclean Single Flushed Mechanical Seal



5.2.3 R00 Single Flushed Mechanical Seal



5.2.4 EasyFit Single Flushed Mechanical Seal



5.3 Double Flushed Mechanical Seal

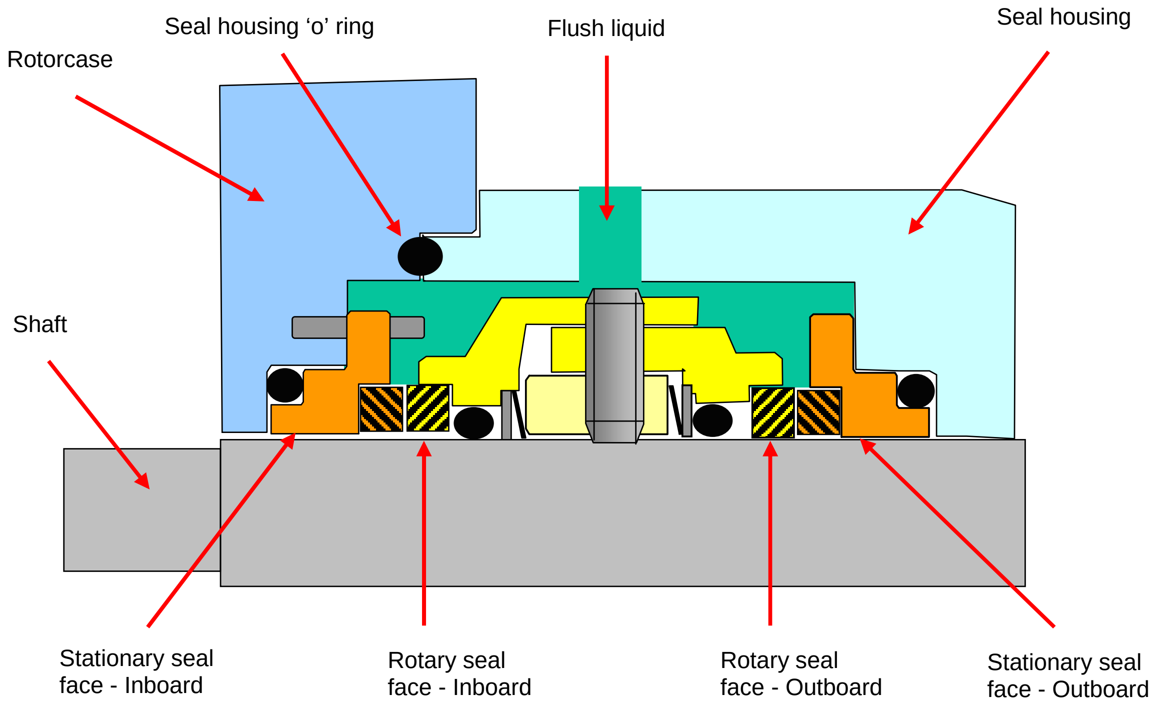
This seal arrangement is generally used with hostile media conditions i.e. high viscosity, fluid is hazardous or toxic. The double flushed seal used on SSP pump ranges is basically two single mechanical seals mounted 'back to back'. This seal generally comprises the same stationary and rotating parts as the single seal for the majority of pump models, with the addition of a seal housing having a flushing connection. A compatible flushing liquid is pressurised into the seal housing at a pressure of 1 bar minimum above the discharge pressure of the pump. This results in the interface film being the flushing liquid and not the pumped liquid. Special attention is required in selecting seal faces and elastomers.

The arrangement in contact with the pumped fluid is referred to as the 'inboard seal', and the seal employed for the flushing liquid is referred to as the 'outboard seal'.

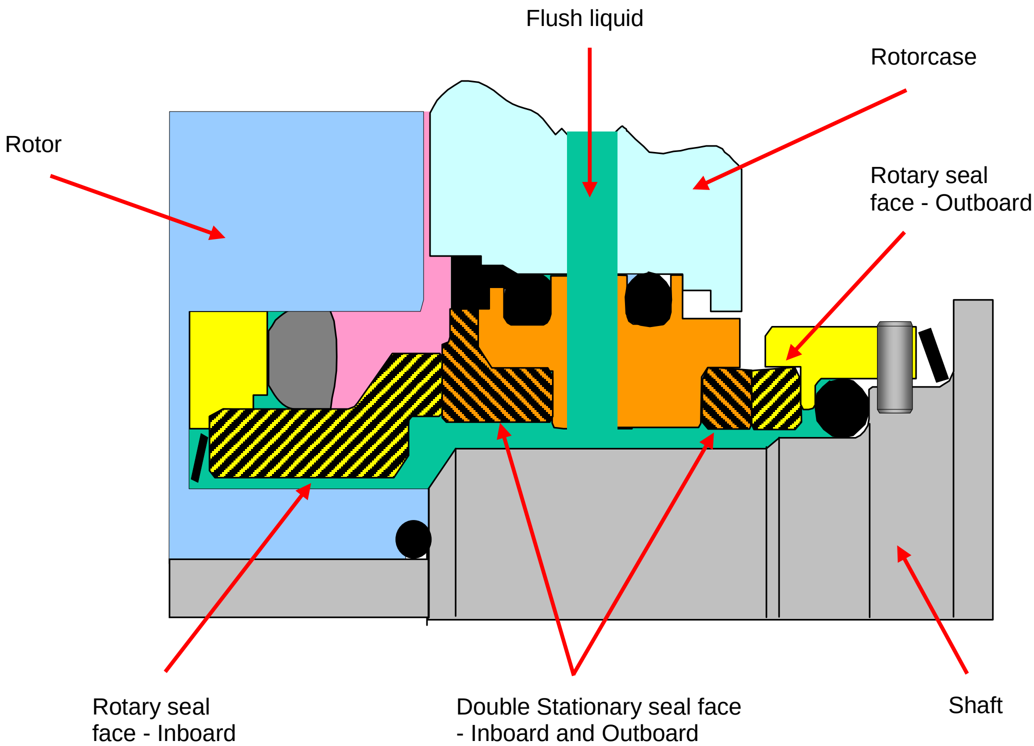
Typical applications are listed below, but full product/fluid and performance data must be referred to the seal supplier for verification.

- Abrasive Slurries
- Chocolate
- Glucose
- Hazardous Chemicals
- PVC Paste
- Photographic Emulsion
- Resin

5.3.1 R90 Double Flushed Mechanical Seal



5.3.2 R00 Double Flushed Mechanical Seal



5.4 Mechanical Seal Face / Elastomer Material Availability

Pump Series	Rotary Seal Face					Stationary Seal Face					Elastomer					
	Solid Carbon	Inserted Carbon	Stainless Steel	Silicon Carbide	Tungsten Carbide	Solid Carbon	Inserted Carbon	Stainless Steel	Silicon Carbide	Tungsten Carbide	NBR	EPDM	FPM	PTFE	MVQ	Kalrez®
S	◇	◇	◆	◆	◆	◆	◆	◇	◆	◆	◆	◆	◆	◆	◇	◆
X	◆	◇	◇	◆	◇	◇	◇	◆	◆	◇	◇	◆	◆	◇	◆	◇
L	◆	◇	◇	◆	◇	◇	◇	◆	◆	◇	◇	◆	◆	◇	◇	◇
D	◇	◇	◆	◆	◆	◆	◆	◇	◆	◆	◆	◆	◆	◆	◇	◇
A	◇	◇	◆	◆	◆	◆	◆	◇	◆	◆	◆	◆	◆	◆	◇	◇
G	◇	◇	◆	◆	◆	◆	◆	◇	◆	◆	◆	◆	◆	◆	◇	◇
N	◇	◇	◆	◇	◆	◆	◆	◇	◇	◆	◆	◆	◆	◆	◇	◇

◆ = Available ◇ = Not Available

5.5 Mechanical Seal Face / Operating Parameters

Viscosity	Seal Face Combination
up to 4999 cP	Solid Carbon v Stainless Steel Solid Carbon v Silicon Carbide Solid Carbon v Tungsten Carbide
up to 24999 cP	Inserted Carbon v Stainless Steel Inserted Carbon v Silicon Carbide Inserted Carbon v Tungsten Carbide
up to 149999 cP	Silicon Carbide v Silicon Carbide Tungsten Carbide v Tungsten Carbide
above 150000 cP	Consider Double Seals

Temperature	Seal Face Combination
up to 149°C	Solid Carbon v Stainless Steel Inserted Carbon v Stainless Steel Inserted Carbon v Silicon Carbide Inserted Carbon v Tungsten Carbide Silicon Carbide v Silicon Carbide Tungsten Carbide v Tungsten Carbide
above 150°C	Solid Carbon v Stainless Steel Inserted Carbon v Silicon Carbide Inserted Carbon v Tungsten Carbide

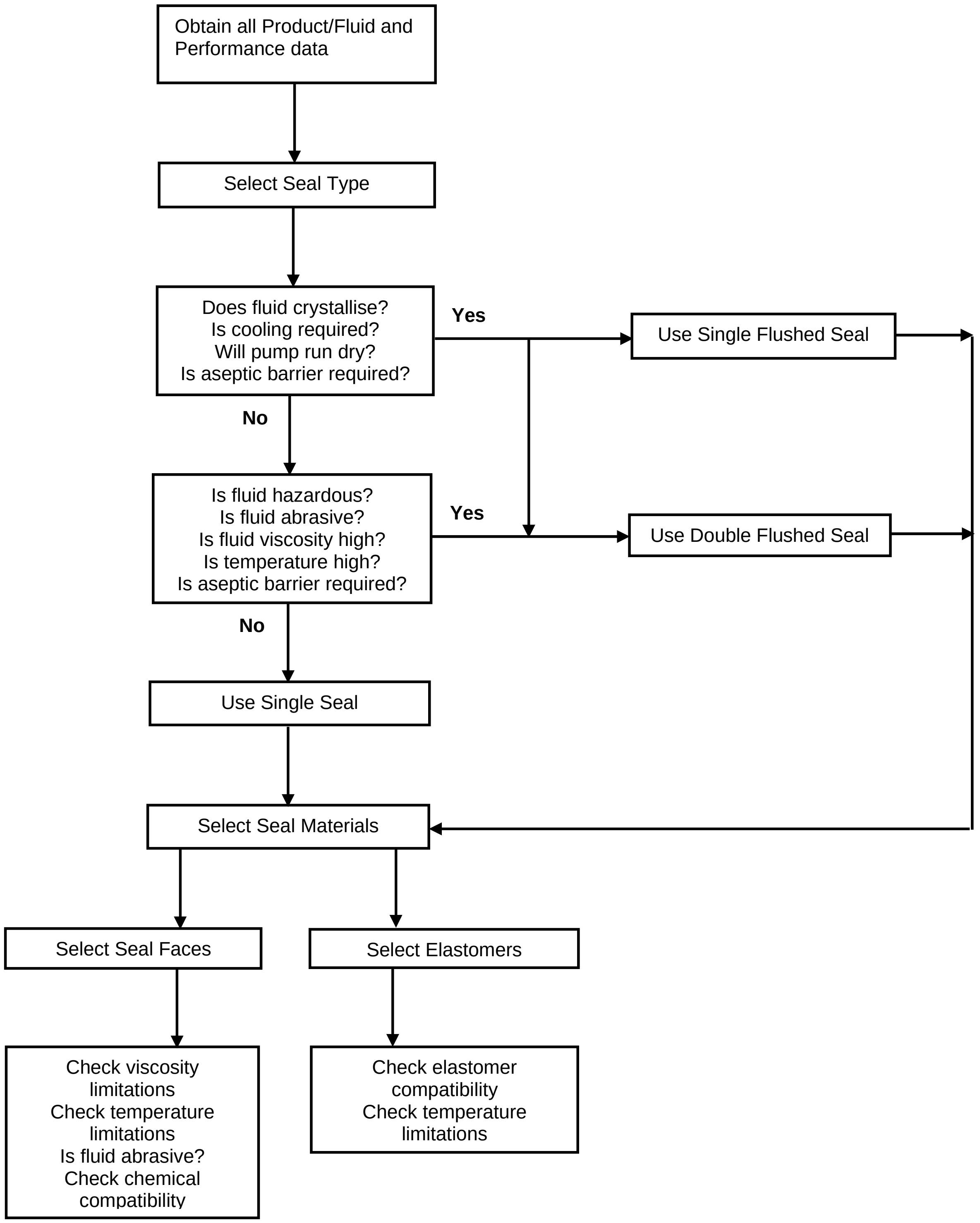
5.6 Seal Flush Connection Sizes

Frame	Pump Series						
	S	X	L	D	A	G	N
1	1/8	1/8					
2	1/8	1/8	1/8				
3	1/8	1/8	1/8				
4	1/4*	1/8	1/8	1/4*			
5	1/4	1/4		1/4			
6	1/4	1/4		1/4			
7		1/4			1/4	1/4	
8					1/4	1/4	
9					1/4	1/4	

Note: * = 1/8 for Packed Gland Flushed.
All connections are inch BSPT or NPT female.

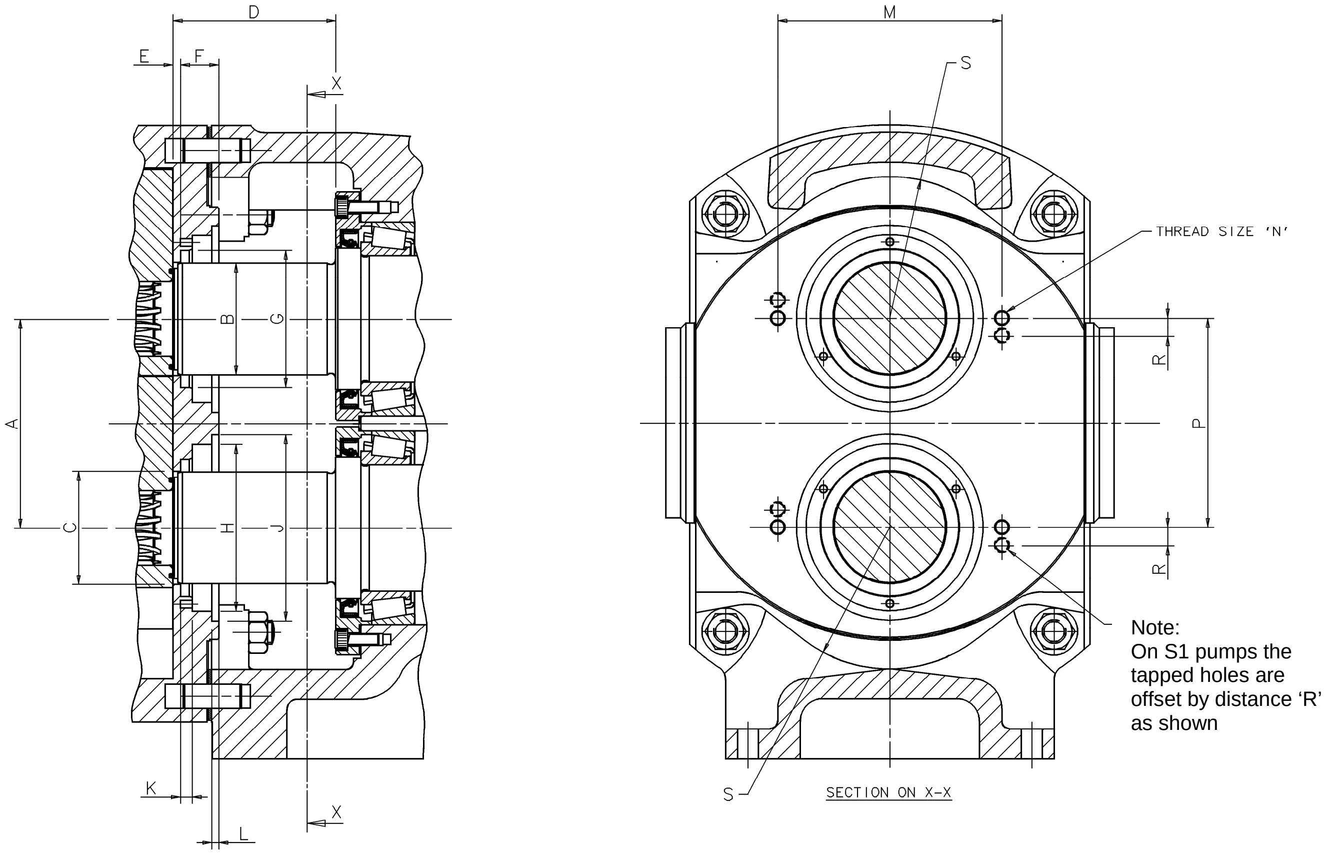
5.7 Mechanical Seal Selection Process

The illustration below describes the mechanical seal selection process with relevant questions to be answered. This should be used for guidance purposes only, as actual seal selections should be verified by the seal suppliers.



5.8 Mechanical Seal Space Availability

To ascertain if a particular proprietary mechanical seal will fit into a Series S pump, see below space availability drawing and dimensions.



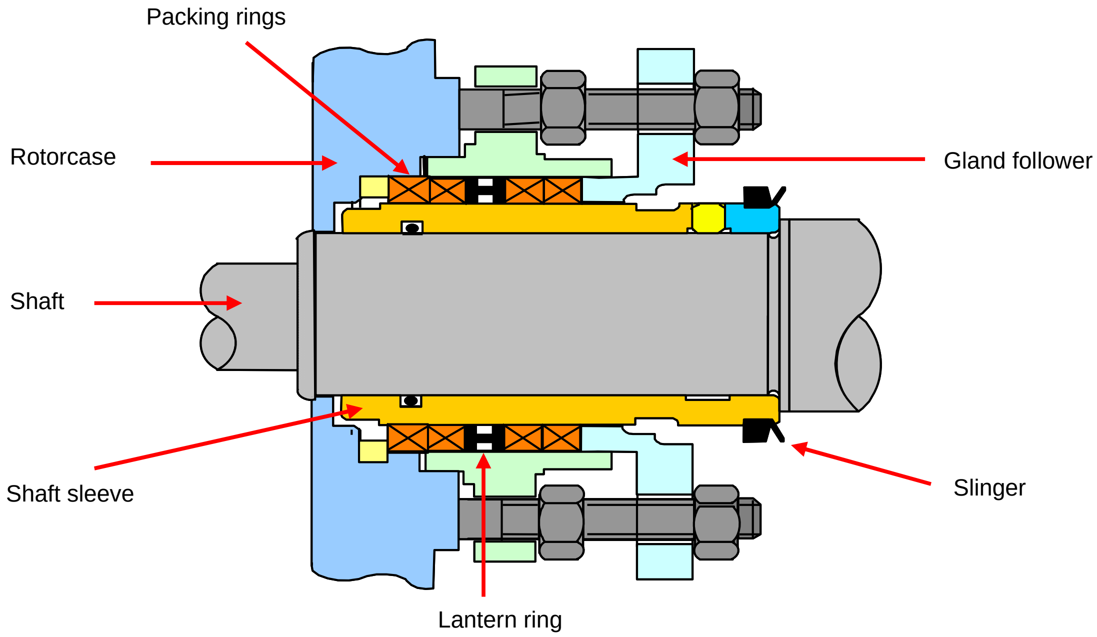
All dimensions in mm

Pump	A Centres	B dia. Shaft	C dia.	D	E	F	G dia.	H dia.	J dia.	K	L	M Centres	N Thread	P Centres	R	S Radius
S1	45	20	21	55	3	9	30	50	-	6.5	-	78.5	M6	45	7	38
S2	60	30	31	65	3	20	41	53	59	6.5	5	80	M8	60	-	50
S3	75	35	36	72	4	18.5	47	61	69	7	5	96	M8	75	-	57
S4	96	45	46	82	4	21	58	73	85	7	5.5	110	M10	96	-	66
S5	120	55	57	90	5	20	69.5	88	100	7.5	4.5	130	M10	120	-	81
S6	140	75	76	108	5	25.5	92	112	125	7.5	4.5	150	M10	140	-	95

5.9 Packed Gland

This is a simple, low cost, and easy to maintain controlled leakage sealing arrangement. These are specified for many ‘dirty’ applications, but when possible, should always be avoided for sanitary duties, as they are less hygienic than mechanical seals.

The grade of packing used depends on the product being handled and operating conditions. When packed glands are specified, using polyamide or PTFE packings will satisfy the majority of duties. Provided the liquid being sealed contains no abrasive particles or does not crystallise, gland packings will function satisfactorily on plain stainless steel shafts or renewable stainless steel shaft sleeves. In instances of moderately abrasive fluids, such as brine solutions being handled, the pumps should be fitted with hard coated shaft sleeves, which may be easily replaced when worn. Pumps provided with a packed gland seal are normally fitted with rubber slingers mounted between the gland followers and the gearcase front lip seals. The slingers will reduce the possibility of the product contacting the gearcase lip seals, thereby overcoming any undesirable operating conditions that could arise in this area. When correctly assembled and adjusted, a slight loss of product should occur so as to lubricate the packing and shaft or sleeve, if fitted.



5.10 Packed Gland Flushed

With fluids containing very abrasive particles or fluids that will coagulate, solidify or crystallise in contact with the atmosphere, a packed gland with lantern ring may be used. In such circumstances a compatible liquid is supplied to the chamber formed by the lantern ring at a pressure of at least 1 bar above the pump pressure. The function of this liquid is to prevent, or at least inhibit, the entry of abrasives into the very small clearances between the shaft and packing. In the case of liquids which coagulate, solidify or crystallise in contact with the atmosphere the flushing liquid acts as a dilutant and barrier in the gland area preventing the pumped fluid from coming in contact with the atmosphere.

A disadvantage with this seal arrangement is that the flushing liquid will pass into the product causing a relatively small degree of dilution/contamination, which cannot always be accepted.

In common with all packed gland assemblies slight leakage must occur but in this instance it will basically be a loss of flushing liquid as opposed to product being pumped.

5.11 Accumulator Grease Feed System (Chocolate Sealing)

For chocolate applications the tried and tested sealing solution over many years is the Double R90 mechanical seal having tungsten carbide faces with FPM ‘o’ rings both inboard and outboard, and a barrier fluid of food compatible (FDA approved) grease provided by an Accumulator Grease Feed System.

This simple solution pressurises both seal chambers with FDA approved grease which lubricates the shaft seals ensuring they maintain their sealing integrity by having only a grease interface film.

This system can only be fitted on SSP Series S and D pump ranges.

How it works
The system consists of a nitrogen charged diaphragm accumulator feeding grease to the seals via stainless steel tubes at a pressure higher than the pump operational differential pressure. A pressure gauge is fitted to a manifold block mounted directly below the accumulator to register and set the grease pressure in the system. At the rear of the manifold block is an isolating valve used for controlled de-pressurising of the grease system. A grease nipple is used for priming the system and adjusting system pressure when in operation.

Pressure Settings

- Accumulator Gas Pressure = Pump Duty Pressure (bar) x 0.75
- Grease Charge Pressure = Pump Duty Pressure (bar) + 4 bar
- Pressure Switch (if fitted) = Pump Duty Pressure (bar) + 1 bar

6.0 Drives and Ancillaries

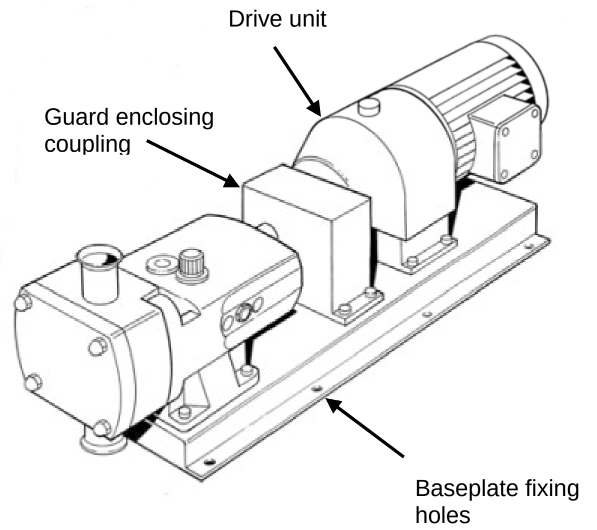
SSP Rotary Lobe pumps can be supplied bare shaft (without drive) or mounted on a baseplate with drive such as electric motor, air motor, and diesel or petrol engine dependent upon customer requirements and services available - electric motors being the most commonly used method of drive. Rotary Lobe pumps generally operate at low to medium speeds i.e. 25 to 650 rev/min, and therefore some form of speed reduction is required from normal AC motor synchronous speeds of 1500, 1000 and 750 rev/min for 50 Hz (1800, 1200 and 900 rev/min for 60 Hz). This is generally achieved by using a geared electric motor direct coupled to the pump drive shaft via a flexible coupling.

Fixed Speed

When exact flow is not critical a fixed speed drive is generally used. The integral geared electric motor is the most commonly used type of fixed speed drive, which is a compact low cost unit and easy to install. Complete ranges of drive speeds are available from the different manufacturers and usually one can be found within a few rev/min of the required speed.

Variable Speed

To handle changing duty conditions or a number of different duties, it may be necessary to use a variable speed drive or frequency converter to obtain correct pump duty speeds. There are many types of mechanical and hydraulic variable speed drives available in a wide range of speeds, which are well suited to rotary lobe pump characteristics by offering the ability to adjust the pump speed to control flow and adjust for system conditions. The frequency converter allows the operator to change the frequency of the electric motor, thereby changing pump speed and controlling flow.



Baseplates

The SSP 'standard' is a pressed mild steel or 304 stainless steel design which is required to be bolted to the floor. For larger drive units, the underside of the baseplate is re-inforced with steel ribbing.

The mild steel baseplate is supplied painted to suit customer requirements and the stainless steel has a satin polish finish.

In some application areas such as dairy or brewing it is normal practice to hose down pump units and floorings - in these circumstances ball feet can be fitted to baseplates, which can be a fixed or variable height, to raise baseplate above floor level. Baseplates can also be designed to meet specific customer standards when required.

Guards

All rotating machinery should be adequately guarded and when pumps are supplied complete with a drive, a guard is fitted over the flexible coupling which links the pump drive shaft to the output shaft of the selected driver. The selection of guard material is important relative to its working environment. Non-sparking material such as brass is used with flameproof/explosion proof motors in hazardous areas. For non-hazardous applications mild steel or stainless steel is generally used.

6.1 Motors

6.1.1 Output Power

The output power is always lower than the rated electrical power due to various losses in the motor. The ratio of output power to rated electrical power is known as the motor efficiency. The table below shows output power that is specified in standard ratings.

Frequency	Output Power - kW							
50 Hz	0.37	0.55	0.75	1.1	1.5	2.2	3	4
60 Hz	0.43	0.63	0.86	1.27	1.75	2.5	3.5	4.6
50 Hz	5.5	7.5	11	15	18.5	22	30	37
60 Hz	6.3	8.6	12.7	17.5	21	25	35	42

6.1.2 Rated Speed

The rated speed of a motor is always lower than the synchronous speed due to motor slip. The connection between synchronous speed, rated speed, frequency and poles is shown in the table below:

No. Poles	2	4	6	8
No. Pairs of poles	1	2	3	4
Synchronous speed at 50 Hz - rev/min	3000	1500	1000	750
Rated speed at 50 Hz - rev/min	2880	1440	960	720
Synchronous speed at 60 Hz - rev/min	3600	1800	1200	900
Rated speed at 60 Hz - rev/min	3460	1720	1150	860

6.1.3 Voltage

Standard motors for use on 3 phase 50 or 60 Hz can be wound for any single voltage as follows:

- Up to 3 kW - 230 to 400 volts
- 4 kW and over - 400 to 690 volts

Euronorm motors supplied at 400 volts will generally operate satisfactorily with voltage variations of ± 10% from the rated voltage.

6.1.4 Cooling

Motor cooling is specified by letters IC (International Cooling) in accordance with standards. The most common being IC411 shown as follows:

- IC411 - Totally Enclosed Fan Ventilated (TEFV) – motor cooled by an external mounted fan.
- IC410 - Totally Enclosed Non Ventilated (TENV) – self cooling, no external mounted fan.
- IC418 - Totally Enclosed Air Over Motor (TEAOM) – motor cooled by airstream.
- IC416 - Totally Enclosed Forced Cooled (TEFC) – motor cooled by an independent fan.

6.1.5 Insulation and Thermal Rating
Standard motors will operate satisfactorily in an ambient temperature range of - 20°C to + 40°C (class B temperature rise) and at altitudes up to 1000 metres above sea level.

Motors supplied with class F insulation system with only class B temperature rise (80°C) ensure an exceptional margin of safety and longer life even in abnormal operating conditions such as withstanding ambient temperatures up to 55°C or 10% overload or adverse supply systems. Motors operating in ambient temperatures higher than 55°C will have class H insulation. Some derating of the motor may be necessary for high ambient temperatures and high altitude.

6.1.6 Protection
The degree of motor protection is specified by means of the letters IP (International Protection) in accordance with standards. These state the method of determining degrees of ingress protection for both dust and water. The letters IP are followed by two digits, the first of which specifies the protection against contact and ingress of foreign bodies and the second digit specifies the protection against water. Table showing degrees of protection is shown below:

Designation	**1st Digit:** **Protection against contact and ingress of foreign bodies**	**2nd Digit:** **Protection against water**
IP44	Protection against contact with live or moving parts by tools, wires or other objects of thickness greater than 1 mm. Protection against the ingress of solid foreign bodies with a diameter greater than 1 mm.	Water splashed against the motor from any direction shall have no harmful effect.
IP54	Complete protection against contact with live or moving parts inside the enclosure. Protection against harmful deposits of dust. The ingress of dust is not totally prevented, but dust cannot enter in an amount sufficient to interfere with satisfactory operation of the machine.	Water splashed against the motor from any direction shall have no harmful effect.
IP55		Water projected by a nozzle against the motor from any direction shall have no harmful effect.
IP56		Motor protected against conditions on a ship's deck or powerful water jets.
IP65	No ingress of dust.	Water projected by a nozzle against the motor from any direction shall have no harmful effect.

6.1.7 Tropic Proof Treatment
Motors operating in tropical climates are invariably subjected to hot, humid and wet conditions, which will produce considerable amounts of condensation on internal surfaces. Condensation occurs when the surface temperature of the motor is lower than the dew-point temperature of the ambient air. To overcome this motors can be supplied with special tropic proof treatment. Failure to include this treatment and the resulting corrosion can cause irreparable damage to stator windings and moving parts.

6.1.8 Anti-Condensation Heaters
Where the motor is to be left standing for long periods of time in damp conditions it is recommended that anti-condensation heaters are fitted and energised to prevent condensation forming in the motor enclosure. These heaters are normally 110 volts or 220 volts.

6.1.9 Thermistors
To protect the motor windings from overload due to high temperature, motors can be fitted with thermistors, which are temperature-dependent semi-conductor devices embedded in the motor windings. Where motors can be allowed to operate at slow speed, i.e. being used with a frequency converter, it is normal to fit thermistors to prevent the motor from overloading or to insufficient cooling from the motor fan.

6.1.10 Motors for Hazardous Environments

The degree of hazard varies from extreme too rare. Hazardous areas are classified into three Zones as follows:

- Zone 0, in which an explosive gas-air mixture is continuously present or present for long periods – No motors may be used in this zone.
- Zone 1, in which an explosive gas-air mixture is likely to occur in normal operation.
- Zone 2, in which an explosive gas-air mixture is not likely to occur in normal operation and if it occurs it will only be present for a short time.

By implication, an area that is not classified Zone 0, 1 or 2 is deemed to be a non-hazardous or safe area.

To ensure equipment can be safely used in hazardous areas, its gas group must be known and its temperature class must be compared with the spontaneous ignition temperature of the gas mixtures concerned.

Temperature Class	Ignition Temperature for Gas/Vapour	Max. Permitted Temperature of Electrical Equipment
T1	up to 450°C	450°C
T2	300 to 450°C	300°C
T3	200 to 300°C	200°C
T4	135 to 200°C	135°C
T5	100 to 135°C	100°C
T6	85 to 100°C	85°C

Group I	-	Equipment for coal mines susceptible to methane gas.
Group II	-	Equipment for explosive atmospheres other than mines i.e. surface industries. Group II is subdivided A, B or C, according to the severity of the environment, IIC being the highest rating. A motor from one of the higher categories can also be used in a lower category.

Flameproof Enclosure - EEx d and EEx de

These motors are designated for operation in Zone 1 hazardous areas. The motor enclosure is designed in such a way that no internal explosion can be transmitted to the explosive atmosphere surrounding the machine. The enclosure will withstand, without damage, any pressure levels caused by an internal explosion.

The temperature of the motor’s external enclosure should not exceed the self-ignition temperature of the explosive atmosphere of the installation area during operation. No motor device outside the flameproof area shall be a potential source of sparks, arcs or dangerous overheating.

Variants combining two types of protection usually combine ‘d’ and ‘e’ types of protection. The most commonly used and recognised by the CENELEC European Standards is the EEx de variant. The motor is designed with an EEx d flameproof enclosure, while the terminal box features an EEx e increased safety protection. Such design combines the superior safety degree of the ‘d’ type of protection with the less stringent electrical connection requirements of increased safety motors.

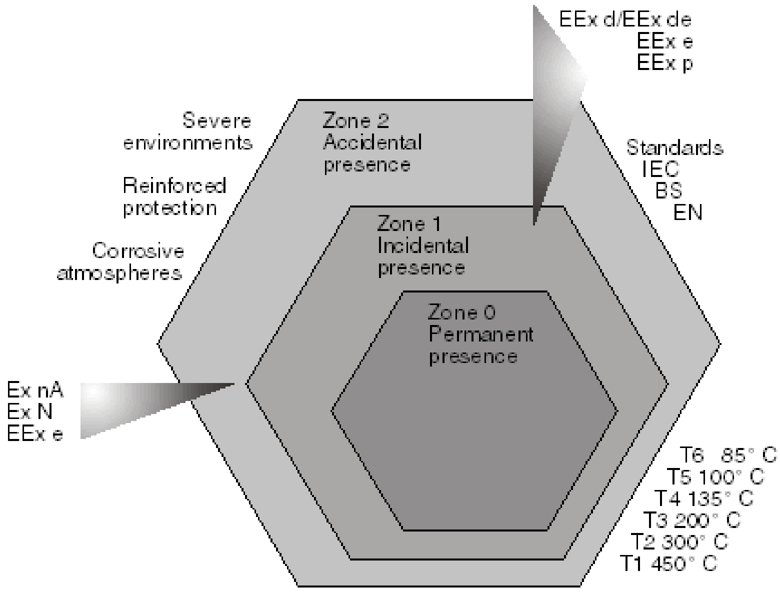
Increased Safety Design - EEx e

The design of this motor type prevents the occurrence of sparks, arcs or hot spots in service, which could reach the self-ignition temperature of the surrounding, potentially explosive atmosphere, in all inner and outer parts of the machine.

Non-Sparking Design – EEx nA, Ex nA, Ex N
These motors are designated for operation in Zone 2 hazardous areas. The motor construction is similar to standard TEFV motors, but with special attention to eliminate production of sparks, arcs or dangerous surface temperatures.

The British Standard is the type Ex N version. The marking according to standard EN 50021 is EEx nA, where EEx n = European standard for Ex product with protection 'n', A = for non-sparking equipment.

The classification parameters of motors for hazardous areas can be summarised as below:



Environment	Group	Gas
Mines	I	Methane
Explosive atmospheres	IIA	Propane
Other than mines	IIB	Ethane
IIC	Hydrogen	

6.1.11 Speed Control
The effective speed control of AC electric motors has long been regarded as an adaptable and economical means of reducing costs and saving energy. Speed control can be multi-speed, variable voltage or frequency converter.

- **Multi-Speed**
  Pole Change (Tapped or Dahlander)
  These have a single winding and two speeds in a ratio of 2:1 and can be supplied for constant torque or variable torque applications.

- **PAM (Pole Amplitude Modulation)**
  Similar to above except that pole variations can be 4/6 or 6/8.

- **Dual Wound**
  Motors have two separate windings and can be supplied for any two speed combinations.

  A combination of dual and pole change windings can give 3 or 4 speeds from one design.

- **Variable Voltage**
  This form of speed control requires greater derating than for converter drives and is best suited to 4 pole machines of 2:1 speed reduction with close matching of motor output to absorbed pump load. These motors are of special design – standard motors being unsuitable.

- **Frequency Converter**
  The use of a frequency converter will allow speed control of a standard AC motor by adjusting the frequency, although some derating may be necessary. Basic frequency converters will permit operation over a typical speed range of 20:1.

  When using a frequency converter, the motor ratings must take into account the following:

  - Increased heating due to the harmonic content of the inverter waveforms.

  - Reduced cooling arising from motor speed reduction.

  - The power or torque requirements throughout the entire speed range.

  - Other limiting factors such as maximum motor speeds, ambient temperature, altitude etc.

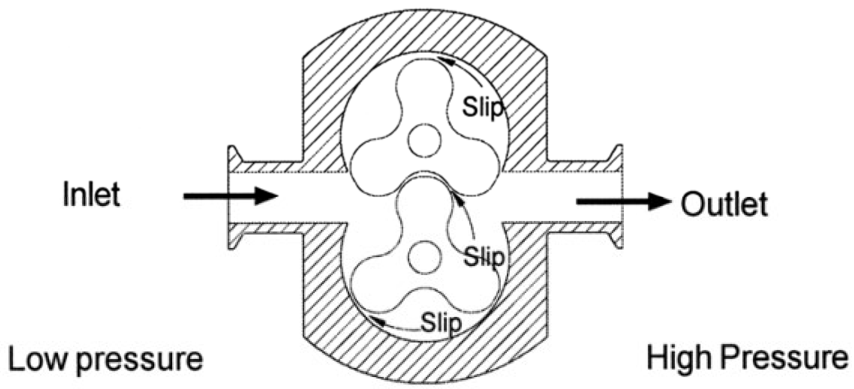
  For rotary lobe pumps using constant torque loads, the level of derating will depend on the speed range required.

  As well as motors being remotely controlled by frequency converters, electric motors can be made available with the frequency converter already fitted to the motor. These arrangements are generally available for motors up to 7.5 kW and have the advantage of not using any shielded motor cables, as there are no extra connections between the frequency converter and motor. Also providing room in a switch cabinet will not be necessary.

7.0 Pump Performance

7.1 Slip

Slip is defined as the fluid lost by leakage through the pump clearances. The direction of slip will be from the high pressure to the low pressure side of the pump i.e from pump outlet to pump inlet. The amount of slip is dependent upon several factors.

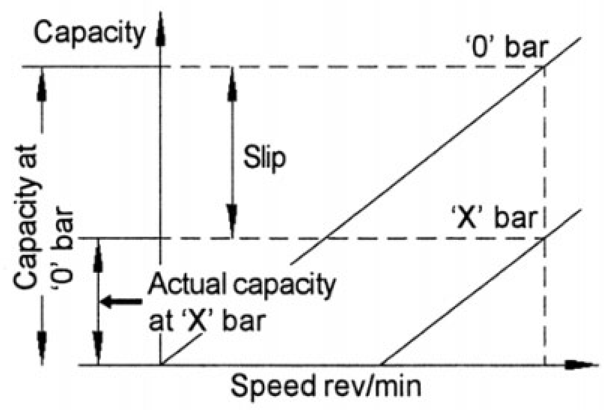


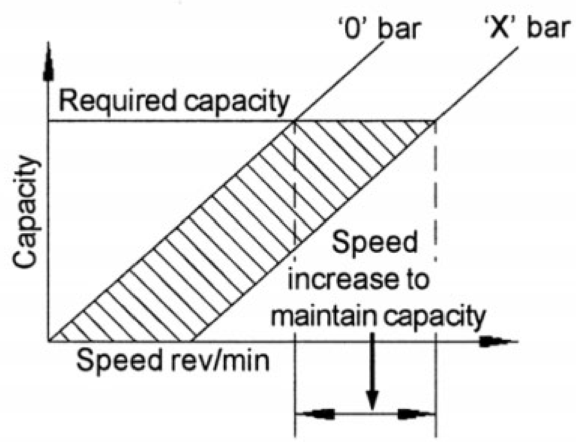
7.1.1 Clearance Effect

Increased clearances will result in greater slip. The size and shape of the rotor will be a factor in determining the amount of slip.

7.1.2 Pressure Effect

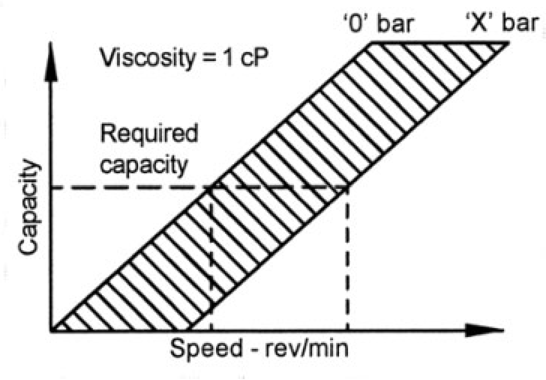
The amount of slip will increase as pressure increases which is shown below. For a given pump speed the amount of slip can be seen as the capacity at 'zero' bar less the capacity at 'X' bar. To overcome this amount of slip it will be necessary to increase the pump speed to maintain the capacity required.

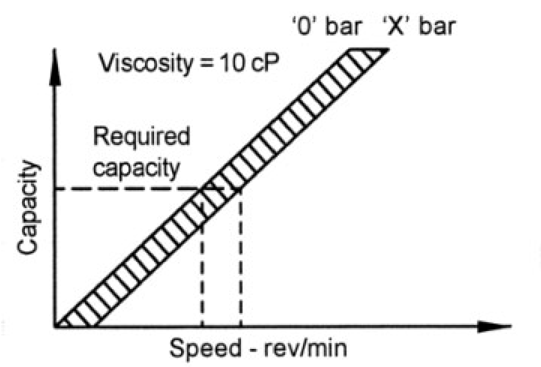


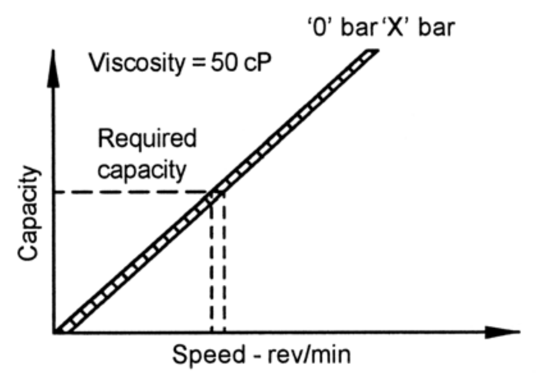


7.1.3 Viscosity Effect

The amount of slip will decrease as fluid viscosity increases. The effect of viscosity on slip is shown below. The pressure lines will continue to move towards the 'zero' pressure line as the viscosity increases.



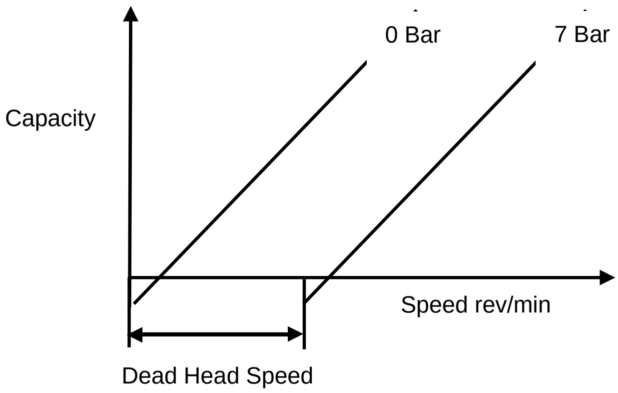




7.1.4 Pump Speed Effect

Slip is independent of pump speed. This factor must be taken into consideration when operating pumps at low speeds with low viscosity fluids. For example, the amount of slip at 400 rev/min pump speed will be the same as the amount of slip at 200 rev/min pump speed providing pressure is constant.

The pump speed required to overcome slip is known as the 'dead head speed'. It is important to note that flow will be positive after overcoming the dead head speed.



In summary, the effects of different parameters on slip are as follows:

- Slip increases with pressure
- Slip increases with clearances
- Slip decreases with viscosity

7.2 Initial Suction Line Sizing

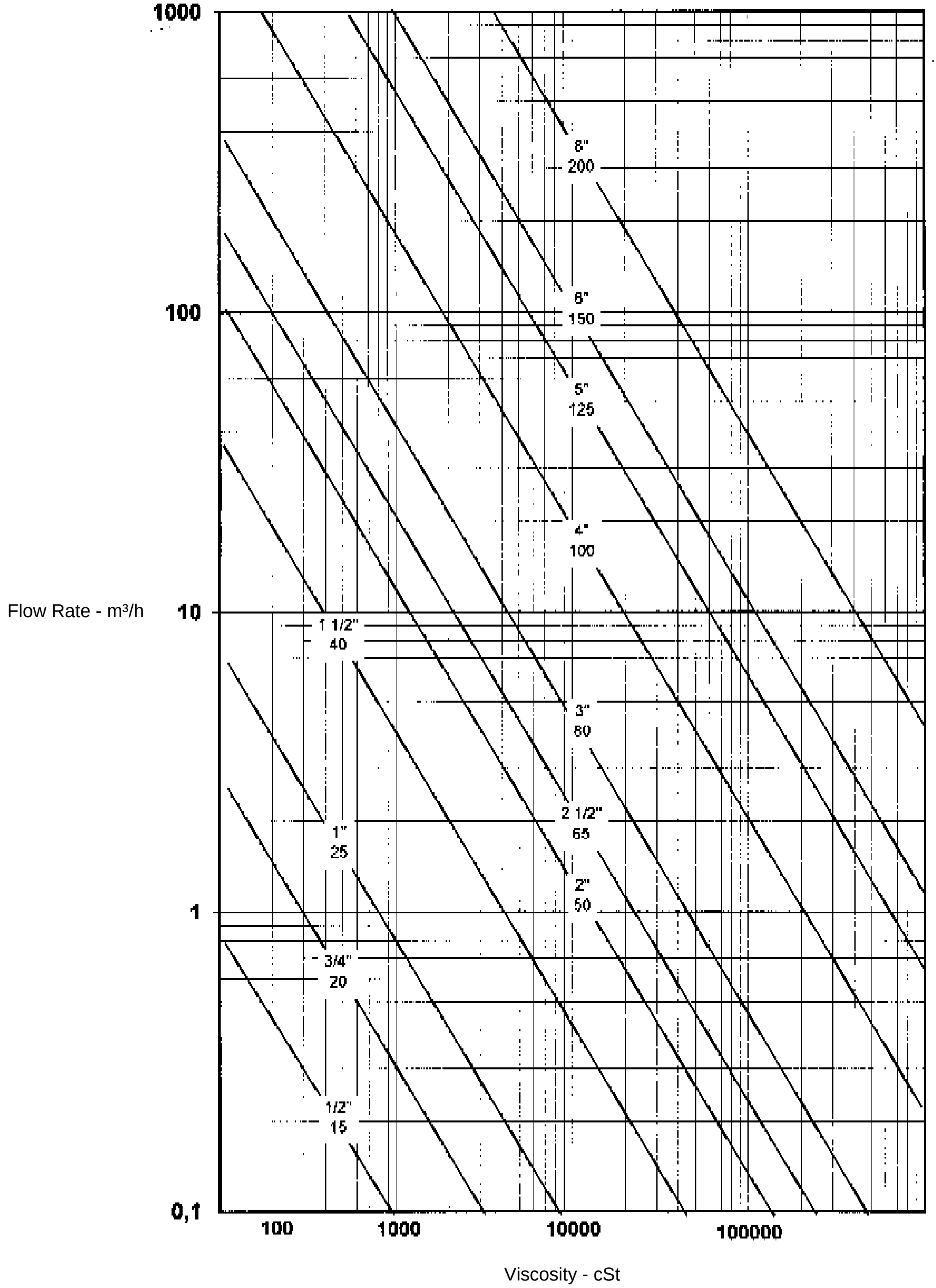
For guidance purposes only on high viscosity duties, the suction line can be initially sized using the initial suction line sizing curve where the relationship between viscosity and flow rate provides an indication of pipe sizing.

For example, for a flow rate of 10 m^3/h on a fluid with viscosity 900 cSt, a pump with 40 mm (*1½ in*) diameter suction line would be initially selected.

It is important to note this is only an approximate guide and care should be taken not to exceed the pump's viscosity/speed limit.

In general terms it is common to find the recommendation for the inlet pipe size to be the same diameter as the pump inlet connection.

Initial Suction Line Sizing Curve



7.3 Performance Curve

SSP rotary lobe pumps can be sized from published performance curves or a pump selection program. Due to pumphead clearances previously described, different performance curves are used for the various temperature ratings for rotors i.e. 70°C, 130°C and 200°C. The SX pump range has only 150°C rotor temperature rating. For convenience viscosity units are stated as cSt.

7.3.1 How to use the Performance Curve

The performance curve consists of four different curves:

- Capacity as a function of speed, related to pressure and viscosity.
- Power as a function of speed, related to pressure and viscosity of 1 cSt.
- Power as a function of viscosity greater than 1 cSt.
- Speed as a function of viscosity.

The curves are based on water at 20°C but are shown with calculated viscosity correction data. Example shown refers to the Series S pump range but the same sizing procedure is also used for other pump ranges.

Example:

Product/Fluid Data:

Fluid to be pumped	-	Vegetable Oil
Viscosity	-	100 cSt
SG	-	0.95
Pumping temperature	-	30°C

Performance Data:

Capacity	-	3.6 m^3/h
Total Pressure	-	8 bar

The optimum is to size the smallest pump possible as hydraulic conditions dictate. However other factors such as fluid behaviour, solids etc. should be considered.

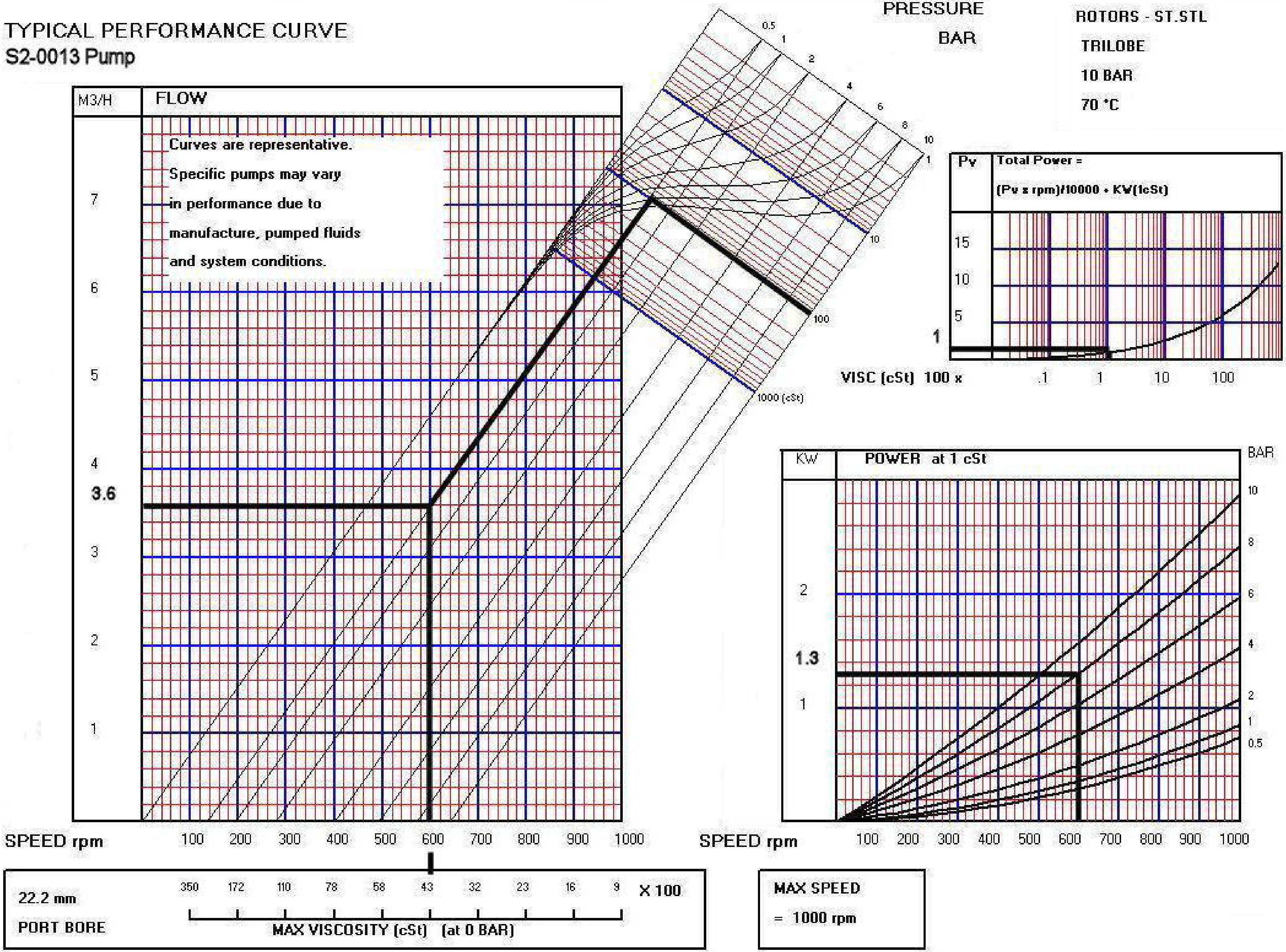
Step 1 - Find Appropriate Curve

Locate a curve for the required pump model that covers the performance data. Due to the large number of curves available it is not practical to include all performance curves in this databook. Curves can be obtained on request. However, the sizing process is as follows:

From the initial suction line sizing curve, a pump with a size 25 mm (1 in) inlet connection would be required. Although the smallest pump models S1-0005 and S1-0008 have 25 mm (1 in) pump inlet connections, the flow rate required would exceed the pumps speed limit on the performance curve.

For this particular example, we therefore need to select a performance curve for the pump model S2-0013 with 70°C rotor clearances, being the next appropriate pump size.

TYPICAL PERFORMANCE CURVE
S2-0013 Pump



Step 2 - Find Viscosity and Pressure
Begin with viscosity and find the intersection point with duty pressure.
From example - 100 cSt and 8 bar

Step 3 - Find Flow Rate
Move diagonally downward and find intersection with required flow rate.
From example - 3.6 m^3/h

Step 4 - Find Speed
Move vertically downward to determine necessary pump speed.
From example - 600 rev/min

Step 5 - Viscosity/Port Size Check
Move vertically downward and check that maximum viscosity rating has not been exceeded against relevant inlet size.
From example - maximum viscosity rating 4300 cSt

Step 6 - Find Power
The power required by a pump is the summation of the hydraulic power and various losses that occur in the pump and pumping system. Viscosity has a marked effect on pump energy losses. The losses being due to the energy required in effecting viscous shear in the pump clearances. Viscous power is the power loss due to viscous fluid friction within the pump (Pv factor).

Typically curves are used in conjuction with equation as follows:

$$\text{Total Required Power (kW)} = \frac{\text{Pv x Pump speed (rev/min)}}{10000} + \text{Hydraulic power at 1 cSt (kW)}$$

where Pv = Power/viscosity factor

From example:

- At speed 600 rev/min the hydraulic power at 1 cSt is 1.3 kW,
- At viscosity 100 cSt the Pv factor is 1.0

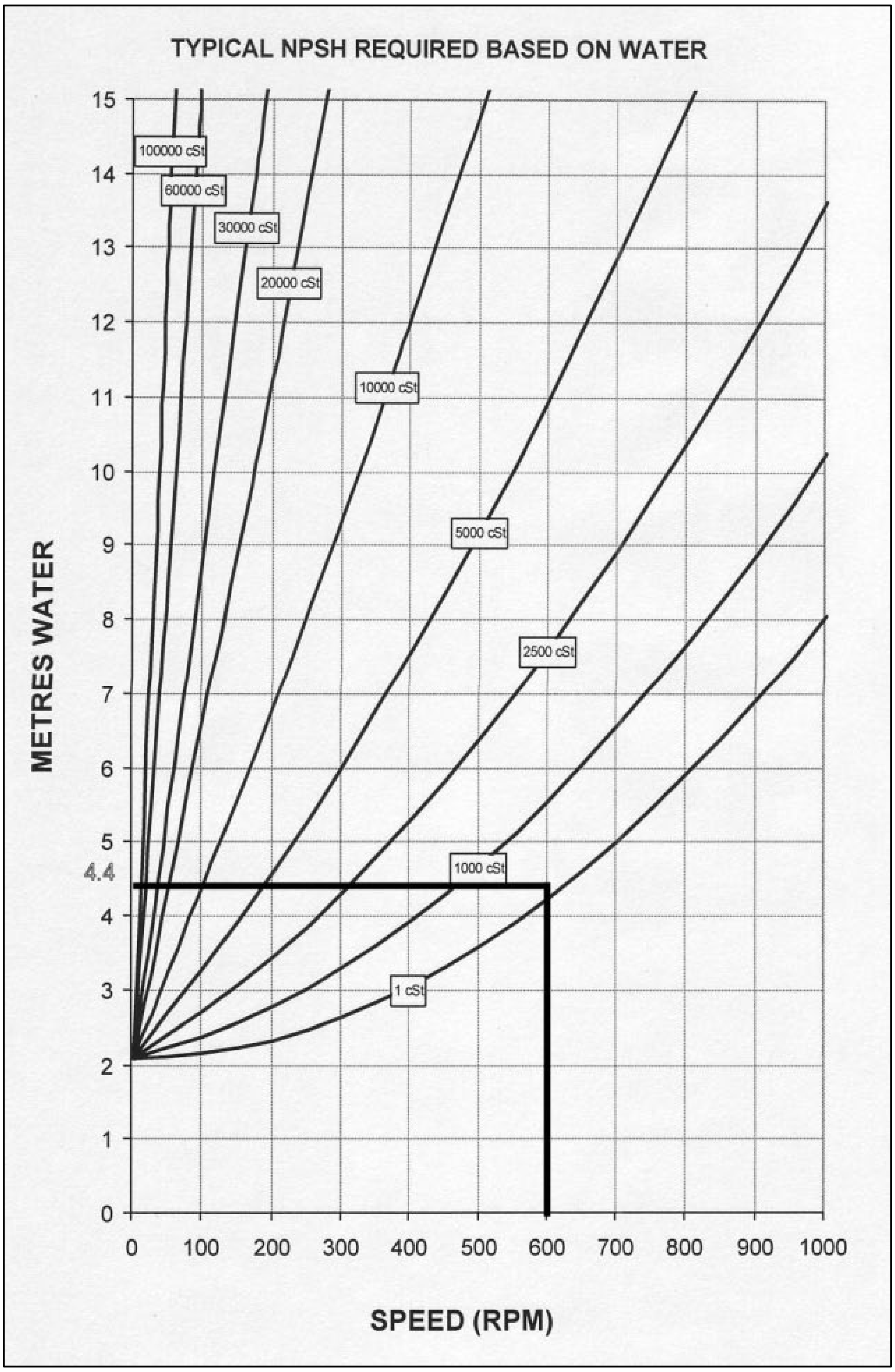
$$\text{Total Required Power (kW)} = \frac{\text{Pv x Pump speed (rev/min)}}{10000} + \text{Hydraulic power at 1 cSt (kW)}$$

$$= \frac{1.0 \ \text{x} \ 600}{10000} + 1.3$$

$$= 1.36 \text{ kW}$$

It should be noted, this is the power needed at the pump shaft and the appropriate motor power must be selected, which in this instance would be 1.5 kW being the nearest motor output power above the required power.

Step 7 - Find NPSHr
NPSHr can be found by looking at the appropriate NPSH pump curve, which is a function of speed and expressed in metres water column (mwc).



From example – at speed 600 rev/min the NPSHr is 4.4 mwc.

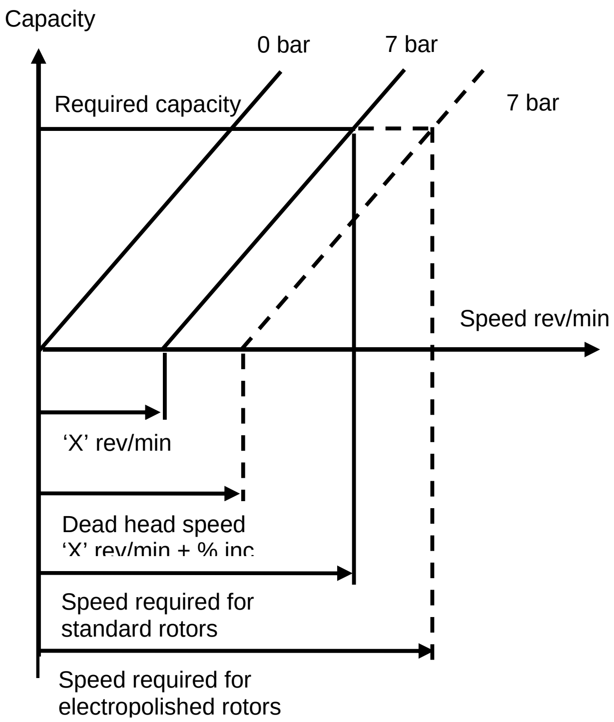
7.4 Pumps with Electropolished Surface Finish

For Series X pumps, performance will be affected by mechanical and electro polish surface finish to the pumphead internals. For sizing purposes a 20% increase on the 'dead head speed' should be applied to the standard performance curve and interpolated accordingly.

For Series S pumps, the performance is unaffected and therefore standard performance curves should be used.

7.4.1 How to Interpolate Performance Curve

'X' rev/min represents the 'dead head speed' for standard multi-lobe rotors to which a percentage increase is applied. Pump speed for electropolished multi-lobe rotors is found accordingly.



7.5 Guidelines for Solids Handling

SSP Pumps have the ability to handle solids, which in this context are particles whose dimensions exceed the rotor clearances.

The following criteria should be considered when deciding the pumps ability to handle large solids in suspension:

		Optimum Conditions
• Solids form	-	Spherical
• Solids physical properties i.e. hardness, resilience, shear strength	-	Soft, yet possess resilience and shear strength
• Solids surface finish	-	Smooth
• Fluid/solids proportion	-	Proportion of solids to fluid is small
• Relationship of fluid/solid SG	-	Equal
• Flow velocity (pump speed)	-	Maintained such that solids in suspension are not damaged
• Rotor form	-	Bi-lobe
• Port size	-	Large as possible

The table below shows the maximum spherical solids size that can be satisfactory handled without product degradation, providing optimum conditions are met.

Series L Model	**Tri-lobe Rotors**		**Series S Model**	**Bi-lobe Rotors**		**Tri-lobe Rotors**		**Series X Model**	**Multi-lobe Rotors**	
	mm	***in***		**mm**	***in***	**mm**	***in***		**mm**	***in***
			S1-0005	8	*0.31*	6	*0.24*	X1-0005	7	*0.28*
			S1-0008	8	*0.31*	6	*0.24*	X1-0007	7	*0.28*
L2-0017	8	*0.31*	S2-0013	8	*0.31*	6	*0.24*	X2-0013	10	*0.39*
L2-0021	8	*0.31*	S2-0018	13	*0.51*	9	*0.34*	X2-0018	10	*0.39*
L3-0032	10	*0.39*	S3-0027	13	*0.51*	9	*0.34*	X3-0027	13	*0.51*
L3-0040	10	*0.39*	S3-0038	16	*0.63*	11	*0.44*	X3-0035	13	*0.51*
L4-0064	12	*0.47*	S4-0055	16	*0.63*	11	*0.44*	X4-0046	16	*0.63*
L4-0082	12	*0.47*	S4-0079	22	*0.88*	15	*0.59*	X4-0063	16	*0.63*
			S5-0116	22	*0.88*	15	*0.59*	X5-0082	19	*0.75*
			S5-0168	27	*1.06*	18	*0.72*	X5-0115	19	*0.75*
			S6-0260	27	*1.06*	18	*0.72*	X6-0140	25	*0.98*
			S6-0353	37	*1.47*	24	*0.94*	X6-0190	25	*0.98*
								X7-0250	28	*1.1*
								X7-0380	28	*1.1*

7.6 Guidelines for Pumping Shear Sensitive Media

Special attention needs to be made to pumping shear sensitive media such as yeast and yoghurt where the cell structure needs to remain intact. Excess pump speed can irreversibly damage the cell structure, therefore pump speeds need to be kept relatively low.

7.7 Guidelines for Pumping Sludge

SSP Series D and G rotary lobe pumps are ideally suited for sludge handling but due to the sludge's thickness and abrasive nature, special considerations for pump sizing should be noted as follows:

Selection Criteria	Sludge Type - Solids Content: Raw or Primary Sludge			Digested Sludge			Activated, Humus or Water Treatment Sludge		
	1 - 3%	**4 - 6%**	**7 - 10%**	**1 - 3%**	**4 - 6%**	**7 - 10%**	**1 - 3%**	**4 - 6%**	**7 - 10%**
Viscosity (cP)									
Applicable in pump	50 - 100	100 - 300	300 - 500	10	50	300	10	50	300
Pressure (bar)									
Max. Differential	3.5	3.5	3.5	3.5	3.5	3.5	5	4.5	4
Pump Speeds (rev/min)									
Max. Recommended Speed	280	250	200	250	250	220	450	400	350
Min. Speed for flooded suction	150	150	150	150	150	150	150	150	150
Min. Speed for 1 - 2 m suction lift	180	180	180	180	180	180	180	180	180
Min. Speed for 2 - 3 m suction lift	220	220	NR	220	220	NR	220	220	NR
Power									
Factor	1.5	1.5 - 2	2 - 2.5	1	1.5	2	1	1.5	2

NR = Not Recommended

Notes:

1. Do not use both maximum speed and maximum pressure simultaneously.
2. Smallest pump suitable for Digested sludge applications is D5 model.
3. Thickened sludge (generally considered as > 7%) may contain polymer and coagulants. Inclusion of these additives can result in the sludge becoming gelatinous and adopting a psuedoplastic characteristic which may adversely affect inlet conditions to the pump. In such conditions particular attention should be given to NPSH availability.
4. Water treatment sludge applications may demand the use of product wetted materials other than cast/ductile iron.
5. The power factor is a multiplier that should be applied to the frictional head loss. The result of this calculation should then be used to calculate the power absorbed.

8.0 Application Data

As a recognised market leader in pumping technology SSP has been at the forefront of supplying rotary lobe pumps to various industries for over 50 years. The following table shows a general guide as to which SSP pump ranges can be used in various application areas:

Application Area	Pump Series					
	S	X	L	D	A	G
Beverage	✓		✓			
Chemical	✓	✓	✓	✓	✓	✓
Confectionery	✓		✓	✓		
Dairy	✓	✓	✓			
Pharmaceutical	✓	✓				
Prepared Foods	✓	✓	✓			
Pulp & Paper	✓			✓	✓	✓
Soaps & Detergents	✓	✓	✓		✓	
Sugar	✓			✓		✓
Waste Treatment				✓		✓

8.1 Beverage Industry

Typical Pumped Media

- Beer
- Carbonated Soft Drinks
- Coffee Liquor
- Fruit Juice Concentrates
- Milk Drinks
- Sugar Solutions
- Wine
- Yeast Slurries

Applications

- Bottling
- Fermentation
- Filling
- Filtration
- Mixing
- Pasteurisation
- Tanker Loading
- Transfer

The SSP Advantage:

- ***Hygienic construction***
  - Non-contacting pumphead design with all metallic pumped media wetted components manufactured in 316L stainless steel.
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***High volumetric efficiency***
  - Maximised efficiency achieved with optimum pumphead geometry by maintaining high accuracy and repeatability of component part manufacture.
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive cultured media, such as yeast slurries.
- ***CIP/SIP ability***
  - Temperatures up to 200ºC

8.2 Chemical Industry

Typical Pumped Media
- Acids
- Adhesives
- Detergents
- Horticultural Products
- Paints
- Petrochemicals
- Photographic Solutions
- Plastics / Resins
- Printing Inks
- Solvents

Applications
- Dosing
- Filling
- Storage
- Tanker Loading
- Transfer

The SSP Advantage:
- ***ATEX Certified***
  - Series S, X and D pumps can be ATEX Certified where generally classified for use in potentially explosive atmospheres under ATEX Directive 94/9/EC Group II, Categories 2 and 3.
- ***Special Materials***
  - For those particularly aggressive applications that demand pumps to be manufactured in materials other than 316L and duplex stainless steel, SSP can supply in Uranus B6 (904L), and nickel alloys such as HASTELLOY® and others.
- ***EHEDG accreditation***
  - Series S, X and L pumps are EHEDG accredited for the highest level of cleanability.
- ***Material traceability***
  - EN 10204 3.1 Material traceability for the stainless steel product wetted parts on Series S and X.

8.3 Confectionery Industry

Typical Pumped Media
- Biscuit Cream
- Caramel
- Chocolate
- Cocoa Butter
- Cocoa Mass
- Condensed Milk
- Fat
- Fondant
- Glucose
- High-Boiled Sugar Syrup
- Jellies

Application
- Crystallisation
- Enrobing
- Mixing
- Rework
- Storage
- Transfer

The SSP Advantage:
- ***Hygienic construction***
  - Non-contacting pumphead design with all metallic pumped media wetted components manufactured in 316L stainless steel.
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Ability to pump abrasive media***
  - Non-contacting pumphead design enhances the pump's ability to handle abrasive crystalline slurries, whilst minimising product damage.
- ***CIP/SIP ability***
  - Temperatures up to 200ºC

8.4 Dairy Industry

Typical Pumped Media
- Butter
- Cheese
- Cream
- Egg
- Ice Cream
- Milk
- Quarg
- Whey
- Yoghurt

Application
- Homogenisation
- Pasteurisation
- Processing
- Reception
- Separation
- Storage
- Tanker Loading

The SSP Advantage:
- ***Hygienic construction***
  - Non-contacting pumphead design with all metallic pumped media wetted components manufactured in 316L stainless steel.
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive cultured media, such as yoghurt.
- ***CIP/SIP ability***
  - Temperatures up to 200ºC
- ***EHEDG accreditation***
  - Series S, X and L pumps are EHEDG accredited for the highest level of cleanability.
- ***USA 3-A sanitary standard conformity***

8.5 Pharmaceutical Industry

Typical Pumped Media
- Blood
- Cell Cultures
- Enzymes
- Ointments
- Protein Solutions
- Syrups

Application
- Dosing
- Fermentation
- Filling
- Injection
- Processing
- Sterilisation
- Transfer
- Ultra-filtration

The SSP Advantage:
- ***Hygienic construction***
  - Non-contacting pumphead design with all metallic pumped media wetted components manufactured in 316L stainless steel.
- ***CIP/SIP ability***
  - Temperatures up to 200ºC
- ***Electropolishing***
  - Product wetted components can be electropolished to 0.5 (20 Ra).
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive media, such as cell cultures.
- ***EN 10204 2.1 and 3.1 Certification and Material Traceability***
- ***EHEDG accreditation***
  - Series S and X pumps are EHEDG accredited for the highest level of cleanability.
- ***ATEX Certified***
  - Series S and X pumps can be ATEX Certified where generally classified for use in potentially explosive atmospheres under ATEX Directive 94/9/EC Group II, Categories 2 and 3.
- ***FDA compliance for all product wetted parts***

8.6 Prepared Foods Industry

Typical Pumped Media
- Additives
- Baby Food
- Edible Oils
- Fruit Puree
- Meat Chunks
- Jam
- Petfood
- Sauces
- Soups
- Toppings

Application
- Batch Cooking
- Continuous Cooking
- Filling
- Processing
- Storage
- Thickening
- Transfer

The SSP Advantage:
- ***Hygienic construction***
  - Non-contacting pumphead design with all metallic pumped media wetted components manufactured in 316L stainless steel.
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive media.
- ***CIP/SIP ability***
  - Temperatures up to 200ºC
- ***EHEDG accreditation***
  - Series S, X and L pumps are EHEDG accredited for the highest level of cleanability.
- ***FDA compliance for all product wetted parts***

8.7 Pulp and Paper Industry

Typical Pumped Media
- Alum
- Anti-foaming Agents
- Black Liquor
- Calcium Carbonate
- Carboxy Methyl Cellulose (CMC)
- China Clay Slurries
- Dyes
- Latex
- Rosin
- Starch
- Tall Oil
- TiO2

Application
- Chemical Dosing
- Coating Feed
- Coating Recovery
- Sizing
- Transfer
- Separation
- Transfer

The SSP Advantage:
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive media, such as latex and starch based coatings.
- ***Ability to pump abrasive media***
  - Non-contacting pumphead design ensures that abrasive particles do not cause excessive wear.
- ***Indefinite dry running capability***
  - Avoids pump components shedding into the pumped media.
- ***Compact design***
  - Occupies considerably less floor space than other pump technologies.

8.8 Soap and Detergents Industry

Typical Pumped Media
- Dishwash Liquid
- Dodecyl Benzene Sulphonic Acid
- Fabric Conditioner
- Fatty Acid
- Lye
- Neat Soap
- Sodium Lauryl Ether Sulphate
- Surfactants

Application
- Blending
- Drying
- Mixing
- Recovery
- Separation
- Transfer

The SSP Advantage:
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low shear pumping***
  - Minimal damage to extremely shear sensitive media.
- ***Ability to pump abrasive media***
  - Non-contacting pumphead design ensures that abrasive particles do not cause excessive wear.
- ***Indefinite dry running capability***
  - Avoids pump components shedding into the pumped media.
- ***Compact design***
  - Occupies considerably less floor space than other pump technologies.

8.9 Sugar Industry

Typical Pumped Media
- Glucose
- High / Low Green Syrup
- Liquid Sugar
- Magma
- Massecuite
- Molasses
- Sugar Syrup
- Thick Juice
- Treacle

Application
- Carbonation
- Crystallisation
- Evaporation
- Recovery
- Separation
- Storage
- Tanker Loading

The SSP Advantage:
- ***Ability to pump abrasive media***
  - Non-contacting pumphead design enhances the pump’s ability to handle abrasive crystalline slurries, whilst minimising product damage.
- ***Cost effective easy maintenance***
  - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low energy consumption***
  - Lower power requirements than other pump technologies.
- ***Compact design***
  - Occupies considerably less floor space than other pump technologies.

8.10 Waste Treatment Industry

Typical Pumped Media
- Primary Sludge
- Digested Sludge
- Humus Sludge
- Raw Sewage
- Abattoir Waste
- Poultry Waste
- Other Industrial Waste

Application
- Primary De-sludging
- Secondary De-sludging
- Humus De-sludging
- Thickener Feed
- Digester Feed
- Filterpress Feed
- Tanker Loading

The SSP Advantage:
- ***Cost effective easy maintenance***
    - Low running and maintenance costs and easy access to pumphead minimising downtime, results in a reduced lifecycle cost.
- ***Low energy consumption***
    - Lower power requirements than other pump technologies.
- ***Compact design***
    - Occupies considerably less floor space than other pump technologies.
- ***Abrasion resistance***
    - Pumphead and rotors can be supplied with a tungsten carbide coating to increase wear resistance. Also pump casings can be supplied with hardened, replaceable wear plates that can be replaced in-situ with minimal pump dismantling.

8.11 General Applications Guide

The table shown below gives a general guide as to the SSP pump series required to suit the application:

General Requirements	Pump Series					
	S	X	L	A	G	D
Pumped Media						
Max. Viscosity - cP	1000000	1000000	1000000	1000000	1000000	1000000
Max. Pumping Temperature	200°C *(392°F)*	150°C *(302°F)*	130°C *(266°F)*	200°C *(392°F)*	200°C *(392°F)*	200°C *(392°F)*
Min. Pumping Temperature	-20°C *(-4°F)*	-20°C *(-4°F)*	-20°C *(-4°F)*	-20°C *(-4°F)*	-20°C *(-4°F)*	-20°C *(-4°F)*
Ability to pump abrasive products	✗	✗	✗	✗	✓	✓
Ability to pump fluids containing air or gases	✓	✓	✓	✓	✓	✓
Abilty to pump solids in suspension	✓	✓	✓	✓	✓	✓
CIP capability	✓	✓	✓	✓	✗	✗
Dry running capability (when fitted with flushed mechanical seals)	✓	✓	✓	✓	✓	✓
Self draining capability	✓	✓	✓	✗	✗	✗
Compliance with International Standards and Directives						
USA 3-A	✓	✓	✓	✗	✗	✗
EHEDG	✓	✓	✓	✗	✗	✗
ATEX	✓	✓	✗	✗	✗	✓
EN10204 2.2	✓	✓	✓	✓	✓	✓
EN10204 3.1	✓	✓	✗	✗	✗	✗
FDA	✓	✓	✓	✗	✗	✗

Application Guide

Listed below are fluids commonly pumped.

Notes:
1. The elastomer compatibilty is for guidance purposes only as this maybe affected by temperature.
2. The fluid viscous behaviour type shown relates to general terms - in some instances Pseudoplastic fluids can have Thixotropic tendencies.
(†) = Fluid can become Dilatant at high concentration and high shear rate.
(‡) = If low concentration, this can be Newtonian.
3. ($) = Seal selection dependent upon temperature and concentration.
4. Where single seal is shown, it is on the proviso that pump is cleaned out after each use.

Viscosity applicable in pump
low = <50 cP
med = 50 - 1000 cP
high = >1000 cP

Pump Speed
very low = < 50 rpm
low = 50 - 100 rpm
med = 100 - 350 rpm
high = >350 - max rpm pump speed (system conditions permitting i.e. NPSHa etc)

Pumped Media	Viscous Behaviour Type	Viscosity	Speed	Pump Series	Sealing	Elastomer Compatibility			
						NBR	EPDM	FPM	PTFE
ACETIC ACID	Newtonian	low	high	S, A	($)		✓		✓
ACETONE	Newtonian	low	high	S, X, L, D	Single		✓		✓
ADHESIVE - SOLVENT BASED	Pseudoplastic	high	med	S, A	Single Flush				✓
ADHESIVE - WATER BASED	Pseudoplastic	med	med	S, L, A	Single Flush		✓		✓
ALKYD RESIN	Pseudoplastic	high	med	S, L, D	Single Flush			✓	✓
ALUMINIUM SULPHATE	Pseudoplastic	low	high	S, A	Single Flush	✓	✓	✓	✓
AMMONIUM HYDROXIDE	Newtonian	low	high	S, A	($)		✓		✓
ANIMAL FAT	Newtonian	low	high	S, L	Single			✓	✓
ANTIFOAM	Pseudoplastic	high	med	S, A	Single		✓	✓	
BABY BATH	Pseudoplastic	med	med	S, X, L	Single			✓	✓
BABY LOTION	Pseudoplastic	med	med	S, X, L	Single			✓	✓
BABY OIL	Newtonian	low	high	S, X, L	Single			✓	✓
BATH FOAM	Pseudoplastic	med	med	S, X, L	Single			✓	✓
BATTER	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
BEER	Newtonian	low	high	S, L	Single		✓	✓	✓
BENTONITE SUSPENSION	Pseudoplastic (†)	med	med	S, L, A	Single Flush	✓	✓	✓	✓
BISCUIT CREAM	Pseudoplastic	high	med	S, L	Single Flush			✓	✓
BISULPHITE	Newtonian	low	high	S, L	Single Flush	✓	✓	✓	✓
BITUMEN	Pseudoplastic	high	very low	D, G	Double	✓		✓	✓
BLACK LIQUOR	Newtonian	med	med	S, A, D, G	Single Flush			✓	✓
BLACK LIQUOR SOAP	Pseudoplastic	med	med	S, A, D, G	Single Flush			✓	✓
BLEACH	Newtonian	low	high	S, L, A	($)		✓	✓	✓
BLOOD	Newtonian	low	med	S, X	Single		✓	✓	✓
BODY LOTION	Pseudoplastic	med	med	S, X, L	Single			✓	✓
BODY SCRUB	Pseudoplastic	med	low	S, X, L	Single Flush			✓	✓
BRAKE FLUID	Newtonian	low	high	S, L, D, A, G	Single				
BRINE	Newtonian	low	high	S, L	Single	✓	✓	✓	✓
BUTTER	Pseudoplastic	high	very low	S	Single		✓	✓	✓
CALCIUM CARBONATE SLURRY	Pseudoplastic	high	med	S, A	Single	✓	✓	✓	✓
CARAMEL - COLOURING	Newtonian	low	high	S, L	Single		✓	✓	✓
CARAMEL - TOFFEE	Pseudoplastic	high	low	S, L	Single Flush		✓	✓	✓
CARBONATION SLURRY	Newtonian	med	med	D, G	Single Flush		✓	✓	✓
CASTOR OIL	Newtonian	low	high	S, L	Single	✓		✓	✓
CELLULOSE ACETATE DOPE	Pseudoplastic	high	low	S, A	Single Flush				✓
CELLULOSE SUSPENSION	Pseudoplastic	low	med	S, A	Single Flush	✓	✓	✓	✓
CERAMIC SLIP	Pseudoplastic (†)	med	med	S, D, G	Double	✓	✓	✓	✓
CHEESE	Pseudoplastic	high	med	S	Single Flush		✓	✓	✓
CHEWING GUM	Pseudoplastic	high	med	S, L	Single Flush				✓
CHINA CLAY SLURRY	Pseudoplastic (†)	med	low	S, A	Double	✓	✓	✓	✓
CHOCOLATE	Pseudoplastic	high	low	D	Double			✓	✓
CHROMIC ACID	Newtonian	low	high	S, A	Double			✓	✓
CHUTNEY	Pseudoplastic	med	med	S, L	Single Flush		✓	✓	✓
CITRIC ACID	Newtonian	low	high	S, L	Single	✓	✓	✓	✓
COAL TAR	Newtonian	med	med	S, L	Single Flush			✓	✓
COCOA BUTTER	Newtonian	med	med	S, L	Single			✓	✓
COCOA LIQUOR	Pseudoplastic	high	med	S	Double			✓	✓
COCONUT CREAM	Pseudoplastic	med	med	S, X, L	Single			✓	✓
COLLAGEN GEL	Pseudoplastic	high	low	S, X, L	Single Flush		✓	✓	✓
CONDENSED MILK	Pseudoplastic	high	med	S, L	Single Flush		✓	✓	✓
CORN SYRUP	Newtonian	med	med	S, L	Single Flush	✓	✓	✓	✓
COSMETIC CREAM	Pseudoplastic	med	med	S, X, L	Single Flush			✓	✓
COUGH SYRUP	Pseudoplastic	med	med	S, X, L	Single Flush		✓	✓	✓
CRUDE OIL	Pseudoplastic	med	med	D, G	Single Flush			✓	✓
CUSTARD	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
DAIRY CREAM	Pseudoplastic	low	med	S, L	Single		✓	✓	✓
DETERGENT - AMPHOTERIC	Newtonian	med	med	S, X, L, A	Single Flush			✓	✓
DETERGENT - ANIONIC	Pseudoplastic (‡)	med	med	S, X, L, A	Single Flush	✓	✓	✓	✓
DETERGENT - CATIONIC	Newtonian	med	med	S, X, L, A	Single Flush			✓	✓
DETERGENT - NONIONIC	Newtonian	med	med	S, X, L, A	Single Flush		✓	✓	✓
DIESEL OIL	Newtonian	low	high	S, L	Single	✓		✓	✓
DISHWASH LIQUIDS	Pseudoplastic (‡)	med	med	S, X, L, A	Single			✓	✓
DODECYL BENZENE SULPHONIC ACID	Newtonian	high	med	S, X, L, A	Single Flush			✓	✓
DYE	Newtonian	low	high	S, L, A, G	Single		✓	✓	✓
EGG	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
ETHANOL	Newtonian	low	high	S, X, L, D	Single	✓	✓		✓
ETHYLENE GLYCOL	Newtonian	low	high	S, L, A	Single	✓	✓	✓	✓
FABRIC CONDITIONER	Pseudoplastic	low	high	S, X, L	Single			✓	✓
FATS	Newtonian	low	high	S, L	Single			✓	✓
FATTY ACID	Newtonian	low	high	S, L	Single			✓	✓
FERRIC CHLORIDE	Newtonian	low	med	S, A	($)	✓	✓	✓	✓
FERTILISER	Pseudoplastic	low	high	S, L	Single Flush	✓	✓	✓	✓
FILTER AID	Pseudoplastic	med	med	S, L, A	Single Flush	✓	✓	✓	✓
FININGS	Pseudoplastic	low	high	S, L	Single		✓	✓	✓
FIRE FIGHTING FOAM	Pseudoplastic	low	med	S, L, A	Single			✓	✓
FISH OIL	Newtonian	low	high	S, L	Single			✓	✓
FONDANT	Pseudoplastic	high	very low	S, L	Single Flush		✓	✓	✓
FORMIC ACID	Newtonian	low	high	S, A	($)		✓		✓
FROMAGE FRAIS	Pseudoplastic	low	med	S, L	Single		✓	✓	✓
FRUCTOSE	Newtonian	high	med	S, L	Single Flush		✓	✓	✓
FRUIT JUICE CONCENTRATE	Pseudoplastic	high	med	S, L	Single Flush		✓	✓	✓
FRUIT PUREE	Pseudoplastic	med	med	S, L	Single		✓	✓	✓

Application Guide

Listed below are fluids commonly pumped.

Notes:
1. The elastomer compatibilty is for guidance purposes only as this maybe affected by temperature.
2. The fluid viscous behaviour type shown relates to general terms - in some instances Pseudoplastic fluids can have Thixotropic tendencies.
(†) = Fluid can become Dilatant at high concentration and high shear rate.
(‡) = If low concentration, this can be Newtonian.
3. ($) = Seal selection dependent upon temperature and concentration.
4. Where single seal is shown, it is on the proviso that pump is cleaned out after each use.

Viscosity applicable in pump
low = <50 cP
med = 50 - 1000 cP
high = >1000 cP

Pump Speed
very low = < 50 rpm
low = 50 - 100 rpm
med = 100 - 350 rpm
high = >350 - max rpm pump speed (system conditions permitting i.e. NPSHa etc)

Pumped Media	Viscous Behaviour Type	Viscosity	Speed	Pump Series	Sealing	Elastomer Compatibility			
						NBR	EPDM	FPM	PTFE
FUDGE	Pseudoplastic	high	very low	S, L	Single Flush		✓	✓	✓
GELATINE	Pseudoplastic	med	med	S, L	Single Flush		✓	✓	✓
GLUCOSE	Newtonian	high	med	S	Single Flush		✓	✓	✓
GLYCERINE	Newtonian	med	med	S, L	Single Flush	✓	✓	✓	✓
GOLDEN SYRUP	Newtonian	high	med	S	Single Flush		✓	✓	✓
GREASE	Pseudoplastic	med	med	S, L	Single	✓		✓	✓
GYPSUM SLURRY	Pseudoplastic	med	very low	S, D, G	Double	✓	✓	✓	✓
HAIR CONDITIONER	Pseudoplastic	med	med	S, X, L	Single			✓	✓
HAIR GEL	Pseudoplastic	med	med	S, X, L	Single			✓	✓
HAND CLEANSER	Pseudoplastic	med	med	S, L	Single			✓	✓
HIGH GREEN SYRUP	Newtonian	high	med	S, D, G	Single Flush		✓	✓	✓
HONEY	Pseudoplastic	high	med	S, L	Single Flush		✓	✓	✓
HYDROCHLORIC ACID	Newtonian	low	high	S, A	Double			✓	✓
HYDROGEN PEROXIDE	Newtonian	low	med	S, A	($)			✓	✓
ICE CREAM MIX	Pseudoplastic	low	med	S, L	Single		✓	✓	✓
INK - PRINTING	Pseudoplastic	high	med	S, A, D, G	Double			✓	✓
INK - WATER BASED	Newtonian	med	high	S, L, A	Single Flush		✓	✓	✓
INVERT SUGAR SYRUP	Newtonian	med	med	S, L	Single Flush		✓	✓	✓
ISOBUTYL ALCOHOL	Newtonian	low	high	S, X, L, D	Single		✓	✓	✓
ISOCYANATE	Newtonian	low	med	S, A	Double				✓
ISOPROPANOL	Newtonian	low	high	S, X, L, D	($)		✓	✓	✓
JAM	Pseudoplastic	med	med	S, L	Single Flush		✓	✓	✓
JELLIES	Pseudoplastic	med	med	S, L	Single Flush			✓	✓
KEROSENE	Newtonian	low	high	S, L	Single	✓		✓	✓
LACTIC ACID	Newtonian	low	high	S, L	Single Flush			✓	✓
LACTOSE	Newtonian	med	med	S, L	Single Flush		✓	✓	✓
LANOLIN	Newtonian	low	high	S, L	Single			✓	✓
LATEX	Pseudoplastic	high	low	S, A	Single Flush		✓		✓
LECITHIN	Newtonian	high	med	S, L	Single			✓	✓
LIPSTICK	Pseudoplastic	med	med	S, X, L	Single			✓	✓
LIQUORICE	Pseudoplastic	high	low	S, L	Single Flush			✓	✓
LOW GREEN SYRUP	Newtonian	med	med	S, D. G	Single Flush		✓	✓	✓
LUBRICATING OIL	Newtonian	med	high	S, L, A	Single			✓	
LYE	Newtonian	low	med	S, L, A	Single Flush		✓		✓
MAGMA	Pseudoplastic	high	low	D, G	Single Flush		✓	✓	✓
MAIZE STARCH SLURRY	Pseudoplastic	med	med	S, L	Single	✓	✓	✓	✓
MALT EXTRACT	Pseudoplastic	high	low	S, L	Single Flush		✓	✓	✓
MANGANESE NITRATE	Newtonian	low	high	S, L, A	Single Flush			✓	✓
MASCARA	Pseudoplastic	med	med	S, X, L	Single Flush			✓	✓
MASHED POTATO	Pseudoplastic	high	low	S, L	Single		✓	✓	✓
MASSECUITE	Pseudoplastic	high	low	D, G	Single Flush		✓	✓	✓
MAYONNAISE	Pseudoplastic	med	med	S, L	Single				✓
MEAT PASTE	Pseudoplastic	high	very low	S, L	Single Flush		✓	✓	✓
METHANOL	Newtonian	low	high	S, X, L, D	Single Flush	✓	✓		✓
METHYL ETHYL KETONE SOLVENT	Newtonian	low	high	S, X, L, D	Single Flush		✓		✓
METHYLATED SPIRIT	Newtonian	low	high	S, X, L, D	Single	✓	✓		✓
METHYLENE CHLORIDE	Newtonian	low	high	S, A	Double			✓	✓
MILK	Newtonian	low	high	S, L	Single		✓	✓	✓
MINCEMEAT	Pseudoplastic	high	very low	S, L	Single		✓	✓	✓
MINERAL OIL	Newtonian	low	high	S, L	Single	✓		✓	✓
MOLASSES	Newtonian	high	low	D, G	Single Flush		✓	✓	✓
MUSTARD	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
NEAT SOAP	Pseudoplastic	med	med	S, L, A	Single Flush		✓		✓
NIGRE	Pseudoplastic	low	med	S, L, A	Single Flush		✓		✓
NITRIC ACID	Newtonian	low	high	S, A	($)			✓	✓
NON-IONIC SURFACTANT (SYNPERONIC)	Newtonian	med	med	S, X, L	Single Flush		✓	✓	✓
PAINTS - SOLVENT BASED	Pseudoplastic	high	med	S, A, D, G	Single Flush				✓
PAINTS - WATER BASED	Pseudoplastic	low	med	S, L, A	Single Flush	✓	✓	✓	✓
PAPER COATING - CLAY	Pseudoplastic (†)	med	med	S, A	Single Flush		✓		✓
PAPER COATING - PIGMENT	Pseudoplastic (†)	med	med	S, A	Single Flush	✓	✓	✓	✓
PAPER COATING - STARCH	Pseudoplastic	med	med	S, A	Single Flush	✓	✓	✓	✓
PEANUT BUTTER	Pseudoplastic	med	med	S, L	Single Flush			✓	✓
PERACETIC ACID	Newtonian	low	high	S	Double				✓
PETFOOD	Pseudoplastic	high	low	S, L	Single		✓	✓	✓
PETROLEUM	Newtonian	low	high	S, L	Single	✓		✓	✓
PHOSPHORIC ACID	Newtonian	low	high	S, A	($)		✓		✓
PHOTOGRAPHIC EMULSION	Pseudoplastic	low	med	S, X	Double		✓	✓	✓
PLASTISOL	Newtonian	med	med	S, L, A	Single Flush		✓		✓
POLYETHYLENE GLYCOL	Newtonian	low	high	S, X, L, D	Single		✓	✓	✓
POLYOL	Pseudoplastic	high	med	S, L, A	Single Flush			✓	✓
POLYPROPYLENE GLYCOL	Newtonian	low	high	S, L	Single	✓	✓	✓	✓
POLYVINYL ACETATE	Pseudoplastic	high	med	S, A	Double		✓	✓	✓
POLYVINYL ALCOHOL	Pseudoplastic	med	med	S, L, A	Single Flush		✓	✓	✓
POLYVINYL PYRROLIDONE	Pseudoplastic	med	med	S, X, L	Single Flush	✓	✓	✓	✓
POTASSIUM HYDROXIDE	Newtonian	low	med	S, L, A	($)		✓		✓
PROPIONIC ACID	Newtonian	low	high	S, A	Double				✓
PROPYLENE GLYCOL	Newtonian	low	high	S, L	Single	✓	✓	✓	✓
PVC PASTE	Pseudoplastic	high	med	S, L, A	Single Flush			✓	✓
QUARG	Pseudoplastic	med	med	S	Single		✓	✓	✓
RESIN	Newtonian	high	med	S, D	Double			✓	✓
RUBBER SOLUTION	Pseudoplastic	med	med	S, A	Single Flush				✓

Application Guide

Listed below are fluids commonly pumped.

Notes:
1. The elastomer compatibilty is for guidance purposes only as this maybe affected by temperature.
2. The fluid viscous behaviour type shown relates to general terms - in some instances Pseudoplastic fluids can have Thixotropic tendencies.
(†) = Fluid can become Dilatant at high concentration and high shear rate.
(‡) = If low concentration, this can be Newtonian.
3. ($) = Seal selection dependent upon temperature and concentration.
4. Where single seal is shown, it is on the proviso that pump is cleaned out after each use.

Viscosity applicable in pump
low = <50 cP
med = 50 - 1000 cP
high = >1000 cP

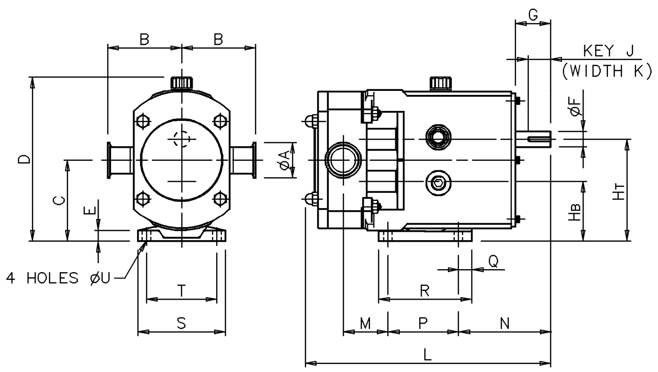
Pump Speed
very low = < 50 rpm
low = 50 - 100 rpm
med = 100 - 350 rpm
high = >350 - max rpm pump speed (system conditions permitting i.e. NPSHa etc)

Pumped Media	Viscous Behaviour Type	Viscosity	Speed	Pump Series	Sealing	Elastomer Compatibility			
						NBR	EPDM	FPM	PTFE
SAUCE - CONFECTIONERY	Pseudoplastic	low	med	S, L	Single Flush			✓	✓
SAUCE - VEGETABLE	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
SAUSAGE MEAT	Pseudoplastic	high	very low	S, L	Single		✓	✓	✓
SHAMPOO	Pseudoplastic	med	med	S, X, L	Single			✓	✓
SHAVING CREAM	Pseudoplastic	med	med	S, X, L	Single			✓	✓
SILICONE OIL	Newtonian	high	low	S, L, A	Single	✓	✓	✓	✓
SLUDGE - DIGESTED 1 to 3%	Pseudoplastic	low	med	D, G	Single	✓	✓	✓	✓
SLUDGE - DIGESTED 4 to 6%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SLUDGE - DIGESTED 7 to 10%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SLUDGE - HUMUS 1 to 3%	Pseudoplastic	low	high	D, G	Single	✓	✓	✓	✓
SLUDGE - HUMUS 4 to 6%	Pseudoplastic	low	high	D, G	Single	✓	✓	✓	✓
SLUDGE - HUMUS 7 to 10%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SLUDGE - PRIMARY 1 to 3%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SLUDGE - PRIMARY 4 to 6%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SLUDGE - PRIMARY 7 to 10%	Pseudoplastic	med	med	D, G	Single	✓	✓	✓	✓
SODIUM ALKYL ETHER SULPHATE 70%	Pseudoplastic	med	med	S, X, L, A	Single Flush			✓	
SODIUM HYDROXIDE	Newtonian	low	med	S, L, A	Single Flush		✓		✓
SODIUM LAURYL ETHER SULPHATE 27%	Pseudoplastic	low	med	S, X, L, A	Single			✓	
SODIUM LAURYL ETHER SULPHATE 70%	Pseudoplastic	med	med	S, X, L, A	Single Flush			✓	
SODIUM SILICATE	Newtonian	high	med	S, L, A	Single Flush		✓	✓	✓
SODIUM POLYACRYLATE (NARLEX)	Newtonian	med	med	S,X, L	Single Flush		✓	✓	
SORBIC ACID	Newtonian	low	high	S, L	Single Flush				✓
SORBITOL	Newtonian	med	med	S, L	Single	✓	✓	✓	✓
STARCH	Pseudoplastic	med	med	S, A	($)		✓	✓	✓
STEARIC ACID	Pseudoplastic	med	high	S, L, A	Single			✓	✓
SUGAR PULP - BEET	Pseudoplastic	high	low	D, G	Single Flush		✓	✓	✓
SUGAR PULP - CANE	Pseudoplastic	high	low	D, G	Single Flush		✓	✓	✓
SUGAR SYRUP	Newtonian	med	med	S, L	Single Flush		✓	✓	✓
SULPHONIC ACID	Newtonian	med	med	S, X, L, A	Single Flush			✓	✓
SULPHURIC ACID	Newtonian	low	high	S, A	Double			✓	✓
TALL OIL	Newtonian	med	med	S, A	Single Flush			✓	✓
TALLOW	Newtonian	low	high	S, L	Single			✓	✓
THICK JUICE	Newtonian	med	med	S, D, G	Single Flush		✓	✓	✓
TITANIUM DIOXIDE	Pseudoplastic (†)	low	med	S, A	Double	✓	✓	✓	✓
TOBACCO FLAVOURING	Newtonian	low	high	S, L	Single		✓		
TOLUENE	Newtonian	low	high	S, X, L, D	Single Flush			✓	✓
TOMATO KETCHUP	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
TOMATO PUREE	Pseudoplastic	med	med	S, L	Single		✓	✓	✓
TOOTHPASTE	Pseudoplastic	high	med	S, X, L	Single Flush			✓	✓
TREACLE	Newtonian	high	med	S	Single Flush		✓	✓	✓
TRI-ETHANOLAMINE	Newtonian	med	high	S, X, D	Single				✓
TRUB	Pseudoplastic	med	high	S, L	Single Flush	✓	✓	✓	✓
UREA	Newtonian	low	high	S, D	Double		✓	✓	✓
VARNISH	Newtonian	med	med	S, A	Double				✓
VASELINE	Pseudoplastic	med	med	S, L	Single	✓		✓	✓
VEGETABLE GUM	Pseudoplastic	med	med	S, L	Single Flush		✓	✓	✓
VEGETABLE OIL	Newtonian	low	high	S, L	Single			✓	✓
VISCOSE	Pseudoplastic	high	low	S, L, D	Single			✓	✓
WATER	Newtonian	low	high	S, L	Single	✓	✓	✓	✓
WAX	Newtonian	low	med	S, L, A	Single Flush			✓	✓
WHEY	Newtonian	low	med	S, L	Single		✓	✓	✓
WHITE SPIRIT	Newtonian	low	high	S, L	Single			✓	✓
WINE	Newtonian	low	high	S, L	Single		✓	✓	✓
WORT	Newtonian	low	high	S, L	Single		✓	✓	✓
XYLENE	Newtonian	low	high	S, X, L, D	Single			✓	✓
YEAST	Pseudoplastic	low	high	S, L	Single		✓	✓	✓
YOGHURT	Pseudoplastic	low	med	S, L	Single		✓	✓	✓

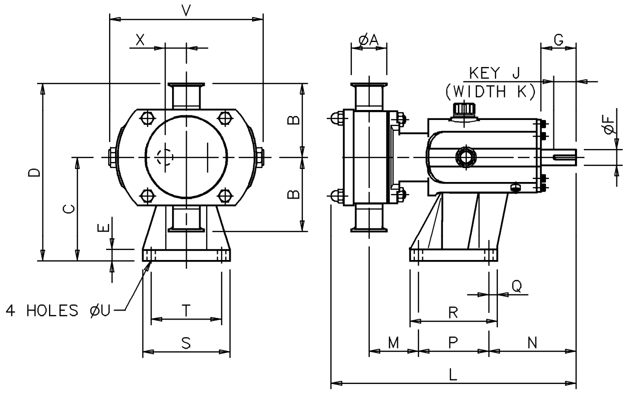
9.0 Dimensions

9.1 Series S Bareshaft Pump

Horizontally Ported Pump



Vertically Ported Pump



Vertically ported
All dimensions in mm

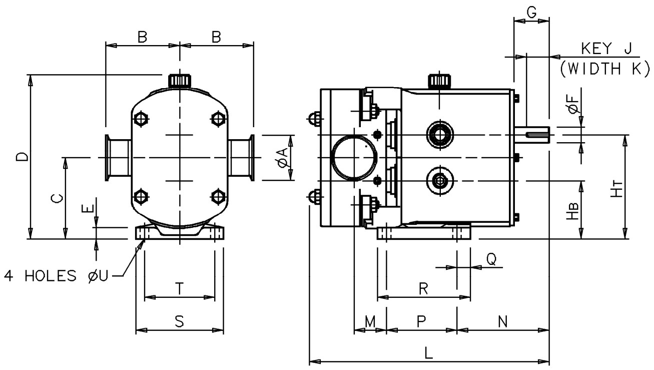
Pump Model	A Standard Port	A Enlarged Port	B	C	D	E	F	G	J	K	L	M	N	P	Q	R	S	T	U	V	X
S1-0005-V08	25	-	95	113	208	15	16	40	30	5	285	49	117	80	22	114	104	80	10	179	22.5
S1-0008-V05	25	40	95	113	208	15	16	40	30	5	295	55	117	80	22	114	104	80	10	179	22.5
S2-0013-V10 or V15	25	40	105	147	252	15	22	50	32	6	339	67	124	100	12	124	124	100	12	219	30
S2-0018-V07 or V10	40	50	105	147	252	15	22	50	32	6	348	70	124	100	12	124	124	100	12	219	30
S3-0027-V10 or V15	40	50	125	175	300	22	28	61	40	8	437	67.5	161	155	15	185	155	125	14	253	37.5
S3-0038-V07 or V10	50	65	125	175	300	22	28	61	40	8	450	72	161	155	15	185	155	125	14	253	37.5
S4-0055-V10 or V20	50	65	150	213	363	25	38	80	63	10	541	78	197	200	17	234	184	150	14	307	48
S4-0079-V07 or V15	65	80	150	213	363	25	38	80	63	10	558	87	197	200	17	234	184	150	14	307	48
S5-0116-V10 or V20	65	80	175	256.5	431.5	30	45	110	70	14	627	91.5	264	200	20	240	220	180	14	345	60
S5-0168-V07 or V15	80	100	175	256.5	431.5	30	45	110	70	14	650	103	264	200	20	240	220	180	14	345	60
S6-0260-V10 or V20	100	100	190	295	485	30	48	110	70	14	748	124	267	260	20	300	250	210	14	400	70
S6-0353-V07 or V15	100	150	190	295	485	30	48	110	70	14	777	139	267	260	20	300	250	210	14	400	70

Horizontally ported
All dimensions in mm

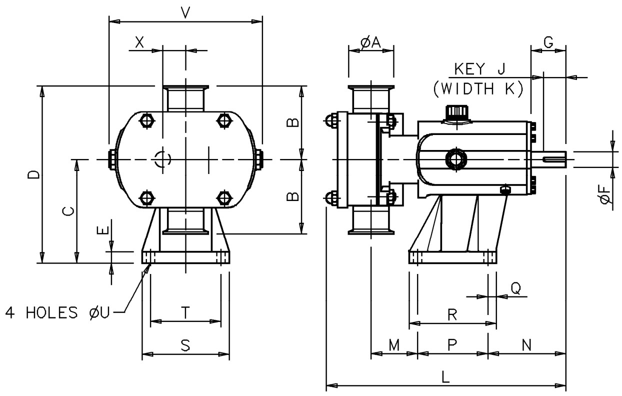
Pump Model	A Standard Port	A Enlarged Port	B	C	D	E	F	G	HB	HT	J	K	L	M	N	P	Q	R	S	T	U
S1-0005-H08	25	-	95	90.5	189	10	16	40	68	113	30	5	285	42	124	80	10	100	100	80	10
S1-0008-H05	25	40	95	90.5	189	10	16	40	68	113	30	5	295	48	124	80	10	100	100	80	10
S2-0013-H10 or H15	25	40	105	115	233	15	22	50	85	145	32	6	339	60	131	100	19	132	124	100	12
S2-0018-H07 or H10	40	50	105	115	233	15	22	50	85	145	32	6	348	63	131	100	19	132	124	100	12
S3-0027-H10 or H15	40	50	125	137.5	273	18	28	61	100	175	40	8	437	82.5	176	125	30	181	154	125	14
S3-0038-H07 or H10	50	65	125	137.5	273	18	28	61	100	175	40	8	450	87	176	125	30	181	154	125	14
S4-0055-H10 or H20	50	65	150	163	325	20	38	80	115	211	63	10	541	101	224	150	35	202	184	150	14
S4-0079-H07 or H15	65	80	150	163	325	20	38	80	115	211	63	10	558	110	224	150	35	202	184	150	14
S5-0116-H10 or H20	65	80	175	195	376	20	45	110	135	255	70	14	627	97	279	180	35	275	210	180	14
S5-0168-H07 or H15	80	100	175	195	376	20	45	110	135	255	70	14	650	108	279	180	35	275	210	180	14
S6-0260-H10 or H20	100	100	190	225	429	20	48	110	155	295	70	14	748	124.5	266	260	40	370	220	190	14
S6-0353-H07 or H15	100	150	190	225	429	20	48	110	155	295	70	14	777	140	266	260	40	370	220	190	14

9.2 Series X Bareshaft Pump

Horizontally Ported Pump



Vertically Ported Pump



Vertically ported
All dimensions in mm

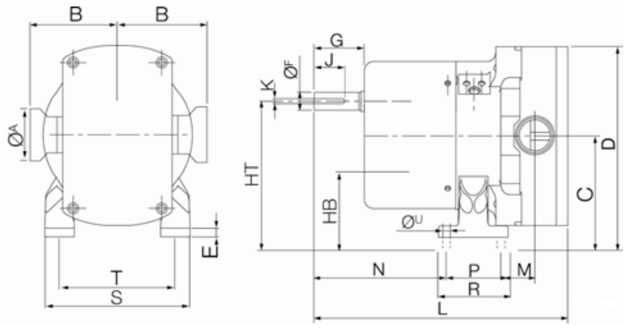
Pump Model	A	B	C	D	E	F	G	J	K	L	M	N	P	Q	R	S	T	U	V	X
X1-0005	25	95	113	208	15	16	40	30	5	281	53	100	80	22	114	104	80	10	174	23.5
X1-0007	40	95	113	208	15	16	40	30	5	294	60	100	80	22	114	104	80	10	174	23.5
X2-0013	40	105	147	252	15	22	50	32	6	325	59	111	100	12	124	124	100	12	213	32.5
X2-0018	50	105	147	252	15	22	50	32	6	341	66	111	100	12	124	124	100	12	213	32.5
X3-0027	50	125	175	300	22	28	61	40	8	431	71	142	155	15	185	155	125	14	246	37.5
X3-0035	65	125	175	300	22	28	61	40	8	447	77	142	155	15	185	155	125	14	246	37.5
X4-0046	50	150	213	363	25	38	80	63	10	514	74	174	200	17	234	184	150	14	301	49.5
X4-0063	65	150	213	363	25	38	80	63	10	533	81	174	200	17	234	184	150	14	301	49.5
X5-0082	65	175	257	432	30	45	110	70	14	599	61	264	200	20	240	220	180	14	344	60
X5-0115	80	175	257	432	30	45	110	70	14	626	81	264	200	20	240	220	180	14	344	60
X6-0140	80	190	295	485	30	48	110	70	14	687	77	267	260	20	300	250	210	14	400	70
X6-0190	100	190	295	485	30	48	110	70	14	715	89	267	260	20	300	250	210	14	400	70
X7-0250	100	205	365	570	30	60	110	90	18	763	94	288	280	25	330	290	240	18	475	81.5
X7-0380	150	205	365	570	30	60	110	90	18	817	121	288	280	25	330	290	240	18	475	81.5

Horizontally ported
All dimensions in mm

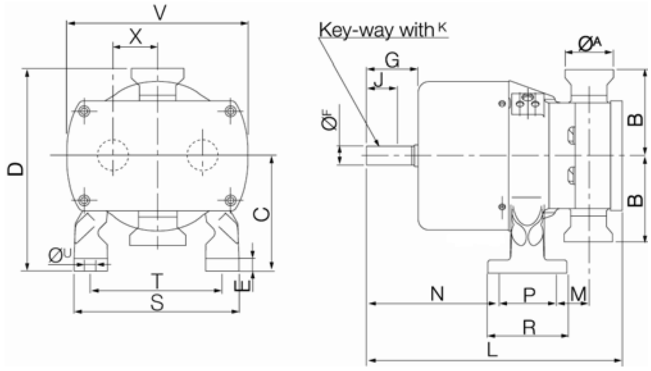
Pump Model	A	B	C	D	E	F	G	HB	HT	J	K	L	M	N	P	Q	R	S	T	U
X1-0005	25	95	90.5	189	10	16	40	67	114	30	5	281	29	124	80	10	100	100	80	10
X1-0007	40	95	90.5	189	10	16	40	67	114	30	5	294	36	124	80	10	100	100	80	10
X2-0013	40	105	115	233	15	22	50	82.5	148	32	6	325	39	131	100	19	132	124	100	12
X2-0018	50	105	115	233	15	22	50	82.5	148	32	6	341	46	131	100	19	132	124	100	12
X3-0027	50	125	138	272	18	28	60	100	175	40	8	431	68	175	125	30	181	154	125	14
X3-0035	65	125	138	272	18	28	60	100	175	40	8	447	74	175	125	30	181	154	125	14
X4-0046	50	150	163	325	20	38	80	114	213	63	10	514	74	225	150	35	202	184	150	14
X4-0063	65	150	163	325	20	38	80	114	213	63	10	533	81	225	150	35	202	184	150	14
X5-0082	65	175	195	376	20	45	110	135	255	70	14	599	46	279	180	35	275	210	180	14
X5-0115	80	175	195	376	20	45	110	135	255	70	14	626	66	279	180	35	275	210	180	14
X6-0140	80	190	225	429	20	48	110	155	295	70	14	687	78	266	260	40	370	220	190	14
X6-0190	100	190	225	429	20	48	110	155	295	70	14	715	90	266	260	40	370	220	190	14

9.3 Series L Bareshaft Pump

Horizontally Ported Pump



Vertically Ported Pump



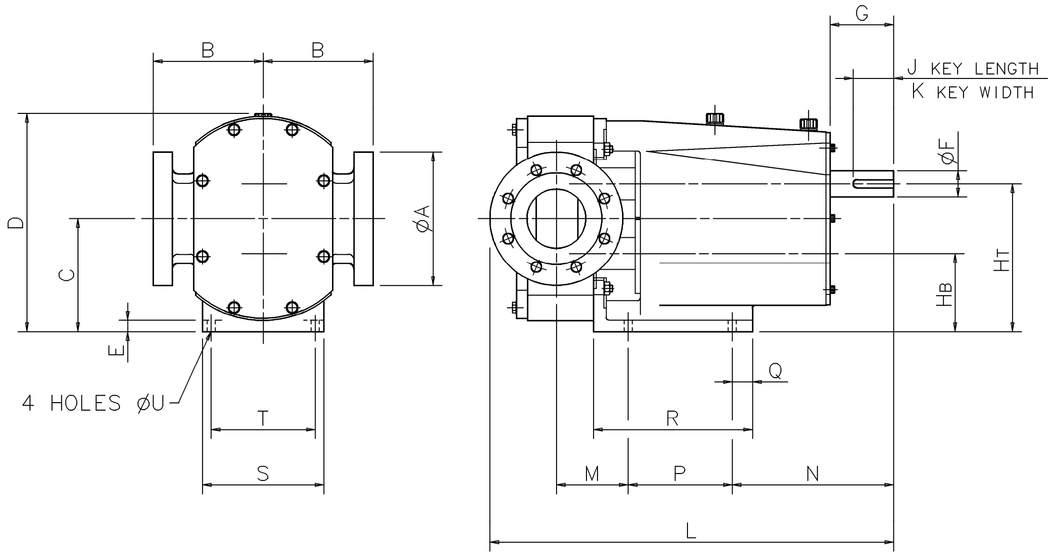
Vertically ported
All dimensions in mm

Pump Model	A	B	C	D	E	F	G	J	K	L	M	N	P	R	S	T	U	V	X
L2 - 0017	40	96	120	216	15	20	50	32	6	275	35	139	60	90	162	124	12	191	36
L2 - 0021	40	96	120	216	15	20	50	32	6	286	44	139	60	90	162	124	12	191	36
L3 - 0032	50	120	136	256	15	24	50	40	8	304	35	157	64	95	192	150	12	230	44
L3 - 0040	50	120	136	256	15	24	50	40	8	316	47	157	64	95	192	150	12	230	44
L4 - 0064	65	130	159	289	20	30	55	40	8	370	51	161	100	145	235	180	14	270	53
L4 - 0082	80	138	159	297	20	30	55	40	8	386	60	161	100	145	235	180	14	270	53

Horizontally ported
All dimensions in mm

Pump Model	A	B	C	D	E	F	G	HB	HT	J	K	L	M	N	P	R	S	T	U
L2 - 0017	40	96	120	216	15	20	50	84	156	32	6	275	35	139	60	90	162	124	12
L2 - 0021	40	96	120	216	15	20	50	84	156	32	6	286	44	139	60	90	162	124	12
L3 - 0032	50	120	136	251	15	24	50	92	180	40	8	304	35	157	64	95	192	150	12
L3 - 0040	50	120	136	251	15	24	50	92	180	40	8	316	47	157	64	95	192	150	12
L4 - 0064	65	130	159	294	20	30	55	106	212	40	8	370	51	161	100	145	235	180	14
L4 - 0082	80	138	159	294	20	30	55	106	212	40	8	386	60	161	100	145	235	180	14

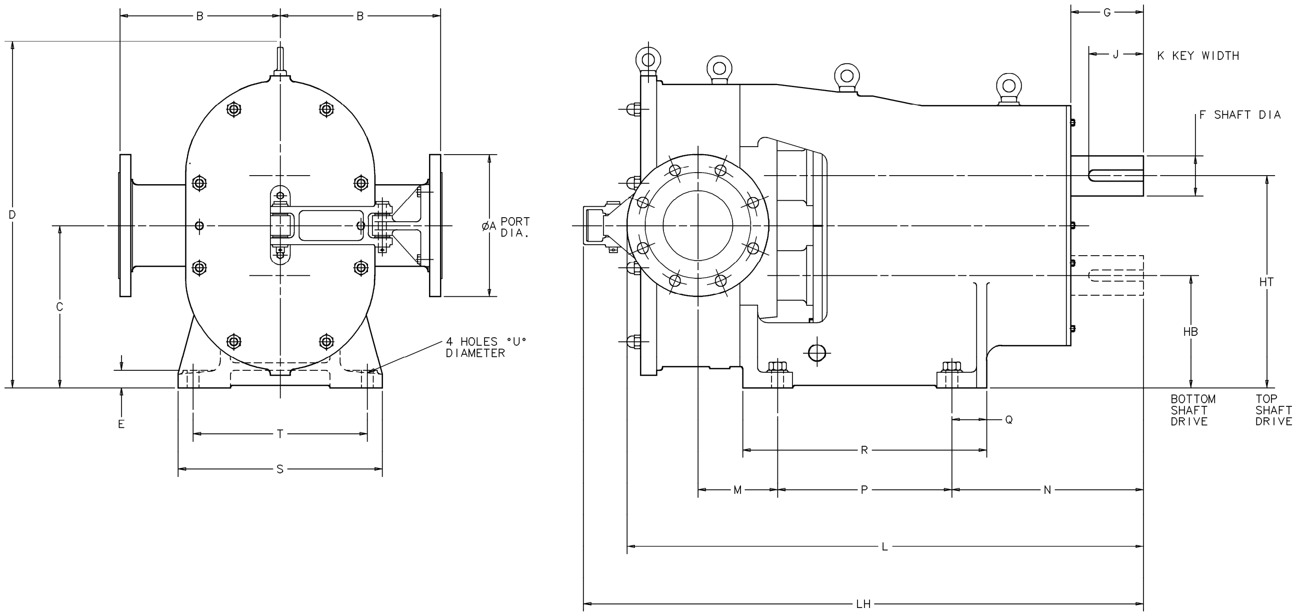
9.4 Series D Bareshaft Pump



All dimensions in mm

Pump Model	A	B	C	D	E	F	G	HB	HT	J	K	L	M	N	P	Q	R	S	T	U
D4-0079-H15	80	170	163	307	20	38	80	115	211	63	10	593	118	225	150	35	255	184	150	14
D4-0095-H10	80	170	163	307	20	38	80	115	211	63	10	597	122	225	150	35	255	184	150	14
D4-0095-H05	80	170	163	307	20	38	80	115	211	63	10	597	122	225	150	35	255	184	150	14
D4-0140-H05	100	170	163	307	20	38	80	115	211	63	10	628	138	225	150	35	255	184	150	14
D5-0168-H15	100	190	195	371	20	45	110	135	255	70	14	692	118	279	180	35	275	210	180	14
D5-0200-H10	100	190	195	371	20	45	110	135	255	70	14	699	125	279	180	35	275	210	180	14
D5-0200-H05	100	190	195	371	20	45	110	135	255	70	14	699	125	279	180	35	275	210	180	14
D5-0290-H05	100	190	195	371	20	45	110	135	255	70	14	719	145	279	180	35	275	210	180	14
D5-0290-H05	150	190	195	371	20	45	110	135	255	70	14	747	145	279	180	35	275	210	180	14
D6-0353-H15	150	225	225	429	20	48	110	155	295	70	14	822	153	266	260	40	370	220	190	14
D6-0420-H10	150	225	225	429	20	48	110	155	295	70	14	832	163	266	260	40	370	220	190	14
D6-0420-H05	150	225	225	429	20	48	110	155	295	70	14	832	163	266	260	40	370	220	190	14
D6-0600-H05	150	225	225	429	20	48	110	155	295	70	14	857	188	266	260	40	370	220	190	14

9.5 Series A and G Bareshaft Pump



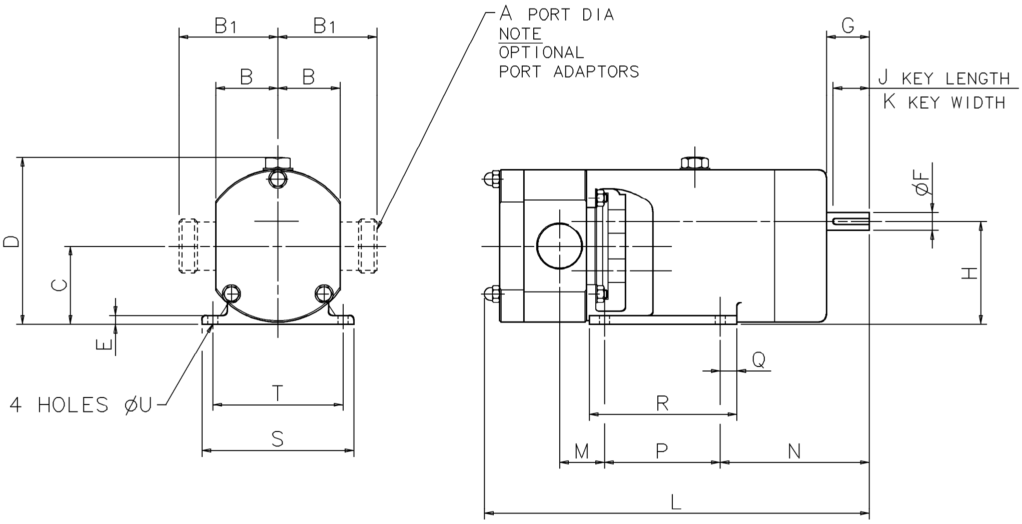
Series A
All dimensions in mm

Pump Model	A	B	C	D	E	F	G	HB	HT	J	K	L	LH	M	N	P	Q	R	S	T	U
A7-0550-H07	150	225	276	588	22	55	110	190	362.5	90	16	850	915	127	225	350	20	390	224	180	18
A7-0550-H10	150	225	276	588	22	55	110	190	362.5	90	16	850	915	127	225	350	20	390	224	180	18
A8-0745-H10	150	325	325	682	35	80	146	225	425	110	22	1038	1125	160	385	350	70	490	410	350	24
A8-1149-H03	200	325	325	682	35	80	146	225	425	110	22	1107	1202	200	385	350	70	490	410	350	24
A8-1149-H07	200	325	325	682	35	80	146	225	425	110	22	1107	1202	200	385	350	70	490	410	350	24
A9-1507-H10	250	400	450	850	35	120	165	325	575	140	32	1536	1578	196	367	750	35	820	350	280	28
A9-2270-H10	300	400	450	850	35	120	165	325	575	140	32	1608	1663	246	367	750	35	820	350	280	28

Series G
All dimensions in mm

Pump Model	A	B	C	D	E	F	G	HB	HT	J	K	L	LH	M	N	P	Q	R	S	T	U
G7-0550-H07	150	225	276	588	22	55	110	190	362.5	90	16	850	915	127	225	350	20	390	224	180	18
G7-0550-H10	150	225	276	588	22	55	110	190	362.5	90	16	850	915	127	225	350	20	390	224	180	18
G8-0745-H10	150	325	325	682	35	80	146	225	425	110	22	1038	1125	160	385	350	70	490	410	350	24
G8-1149-H03	200	325	325	682	35	80	146	225	425	110	22	1107	1202	200	385	350	70	490	410	350	24
G8-1149-H07	200	325	325	682	35	80	146	225	425	110	22	1107	1202	200	385	350	70	490	410	350	24
G9-1507-H10	250	400	450	850	35	120	165	325	575	140	32	1536	1578	196	367	750	35	820	350	280	28
G9-2270-H10	300	400	450	850	35	120	165	325	575	140	32	1608	1663	246	367	750	35	820	350	280	28

9.6 Series N Bareshaft Pump

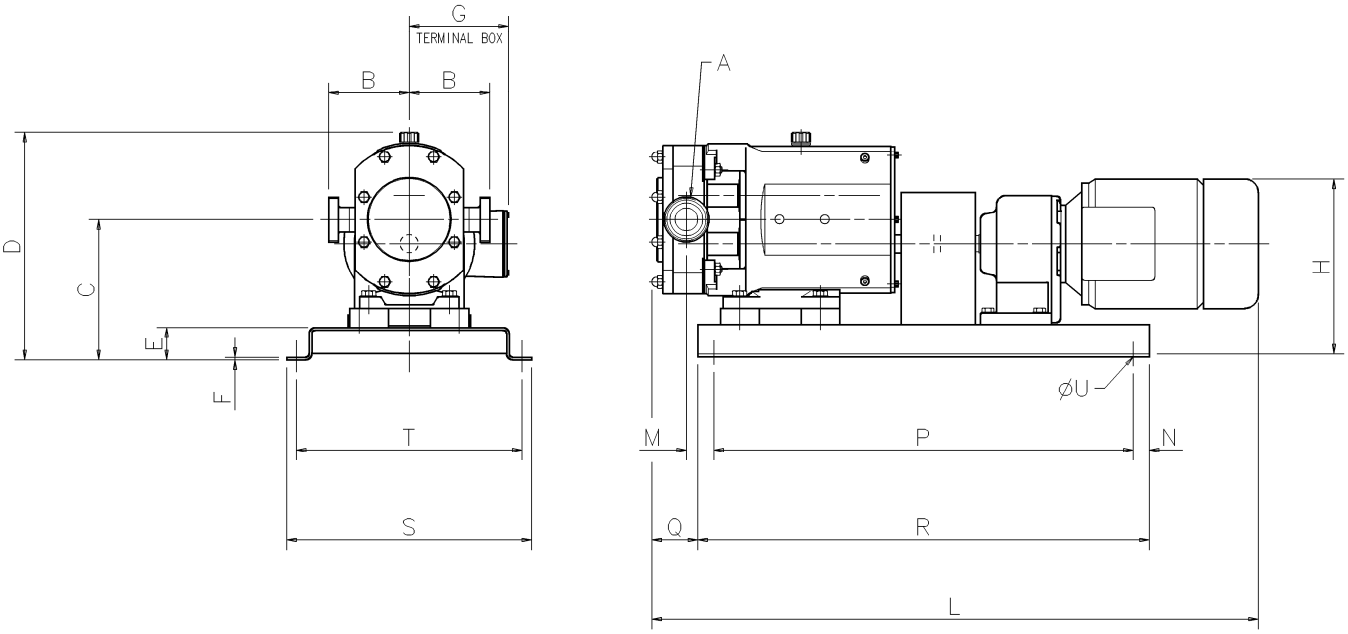


All dimensions in mm

Pump Model	A	B	B1	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U
N1-000S-H05	6	42	-	54	115	6.5	12	30	71	25	4	250	25	103	80	11	102	105	90	7
N1-000S-H07	6	42	-	54	115	6.5	12	30	71	25	4	250	25	103	80	11	102	105	90	7
N1-000L-H05	12 or 25	42	68	54	115	6.5	12	30	71	25	4	266	31	103	80	11	102	105	90	7
N1-000L-H07	12 or 25	42	68	54	115	6.5	12	30	71	25	4	266	31	103	80	11	102	105	90	7

9.7 Series S Horizontally Ported (H) Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.

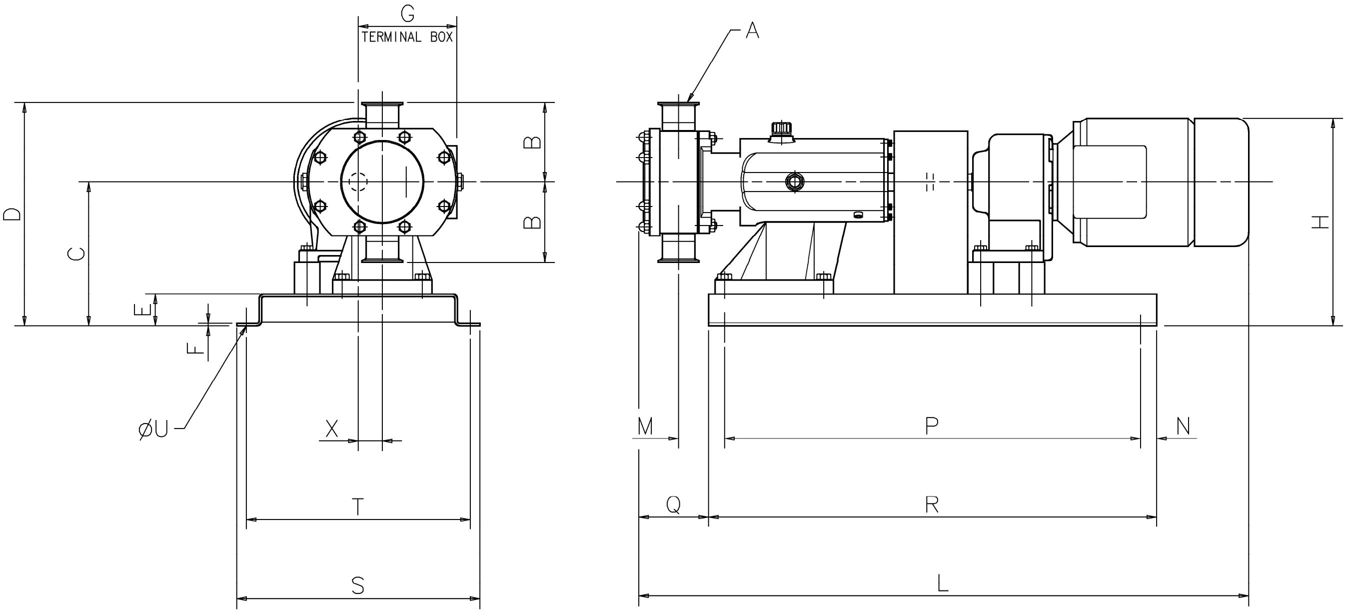


Horizontally ported (H)
All dimensions in mm

Pump Model	Motor Power kW	A		B	C		D		E	F	G max	H max	L		M	N	P	Q	R	S	T	U
		Std Port	Enl Port		min	max	min	max					min	max								
	0.37										120	236	658	740								
S1-0005-H08	0.55	25	-		140.5		239				140	246	675	758	27							
	0.75			95					50	4	140	246	675	758		25	500	41	550	290	260	11 x 4
	0.37										120	236	668	750								
S1-0008-H05	0.55	25	40		140.5		239				140	246	685	768	33							
	0.75										140	246	685	768								
	0.55					182		300			140	263	729	812								
S2-0013-H10 or H15	0.75	25	40			182		300			140	263	729	812	40			63				
	1.1			105	165	170	283	288	50	4	150	288	771	856		25	550		600	330	300	11 x 4
	0.75					182		300			140	263	738	821								
S2-0018-H07 or H10	1.1	40	50			182		300			150	288	780	865	43			72				
	1.5					170		288			150	288	780	865								
	1.1					212.5		348			150	303	869	954								
S3-0027-H10 or H15	1.5	40	50			212.5		348			150	303	869	954	42.5			71				
	2.2			125	187.5	212.5	323	348	50	4	160	312	914	999		25	650		700	380	350	11 x 4
	1.5					212.5		348			150	303	882	967								
S3-0038-H07 or H10	2.2	50	65			212.5		348			160	303	927	1012	47			84				
	3					217.5		353			160	312	927	1012								
	3					228		390			160	327	1018	1103								
S4-0055-H10 or H20	4	50	65			228		390			167	339	1069	1192	51			87				
	5.5			150	213	238	375	400	50	5	194	394	1190	1332		30	790		850	400	370	14 x 4
	4					228		390			167	339	1086	1209								
S4-0079-H07 or H15	5.5	65	80			238		400			194	394	1207	1349	60			104				
	7.5					238		400			194	394	1207	1349								
	5.5					285		466			194	392	1276	1418								
S5-0116-H10 or H20	7.5	65	80			285		466			194	392	1276	1418	127			98				
	11			175	245	290	426	471	50	5	226	439	1357	1561		100	800		1000	420	390	14 x 4
	5.5					285		466			194	392	1299	1441								
S5-0168-H07 or H15	7.5	80	100			285		466			194	392	1299	1441	138			121				
	11					290		471			226	439	1380	1584								
	5.5					295		499			194	412	1397	1539								
S6-0260-H10 or H20	7.5	100	100			295		499			194	412	1397	1539	144.5			142				
	11			190	275	300	479	504	50	8 ms, 5 ss	226	459	1478	1682		100	1000		1200	650	570	22 x 6
	7.5					295		499			194	412	1426	1568								
S6-0353-H07 or H15	11	100	150			300		504			226	459	1507	1711	160			171				
	15					300		504			226	459	1507	1711								

9.8 Series S Vertically Ported (V) Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.

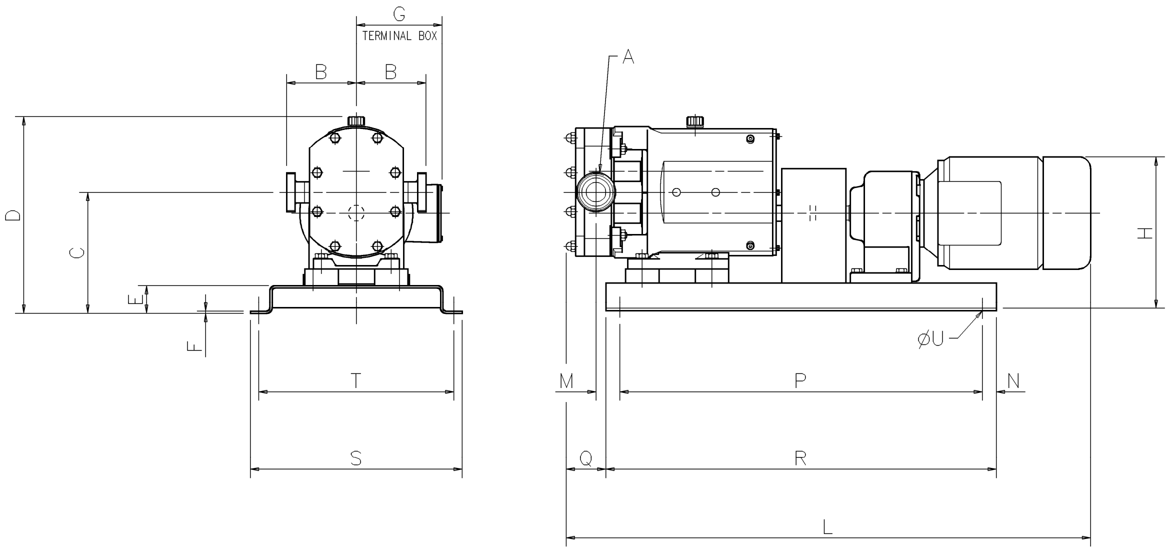


Vertically ported (V)
All dimensions in mm

Pump Model	Motor Power kW	A Std Port	A Enl Port	B	C	D	E	F	G max	H max	L min	L max	M	N	P	Q	R	S	T	U	X
S1-0005-V08	0.37	25	-	95	163	258	50	5	120	281	658	740	59	25	500	73	550	290	260	11 x 4	22.5
	0.55								140	291	675	758									
	0.75								140	291	675	758									
S1-0008-V05	0.37	25	40						120	281	668	750	65			83					
	0.55								140	291	685	768									
	0.75								140	291	685	768									
S2-0013-V10 or V15	0.55	25	40	105	197	302	50	5	140	325	729	812	120	25	550	93	600	330	300	14 x 4	30
	0.75								140	325	729	812									
	1.1								150	350	771	856									
S2-0018-V07 or V10	0.75	40	50						140	325	738	821	123			102					
	1.1								150	350	780	865									
	1.5								150	350	780	865									
S3-0027-V10 or V15	1.1	40	50	125	225	350	50	5	150	378	869	954	67.5	25	650	96	700	380	350	11 x 4	37.5
	1.5								150	378	869	954									
	2.2								160	387	914	999									
S3-0038-V07 or V10	1.5	50	65						150	378	882	967	72			109					
	2.2								160	387	927	1012									
	3								160	387	927	1012									
S4-0055-V10 or V20	3	50	65	150	263	413	50	5	160	425	1018	1103	81	30	790	117	850	400	370	14 x 4	48
	4								167	437	1069	1192									
	5.5								194	470	1190	1332									
S4-0079-V07 or V15	4	65	80						167	437	1086	1209	90			134					
	5.5								194	470	1207	1349									
	7.5								194	470	1207	1349									
S5-0116-V10 or V20	5.5	65	80	175	306.5	481.5	50	5	194	514	1276	1418	166.5	100	800	138	1000	420	390	14 x 4	60
	7.5								194	514	1276	1418									
	11								226	561	1357	1561									
S5-0168-V07 or V15	5.5	80	100						194	514	1299	1441	178			161					
	7.5								194	514	1299	1441									
	11								226	561	1380	1584									
S6-0260-V10 or V20	5.5	100	100	190	345	535	50	8 ms, 5 ss	194	552	1397	1539	194	100	1000	191	1200	650	570	22 x 6	70
	7.5								194	552	1397	1539									
	11								226	599	1478	1682									
S6-0353-V07 or V15	7.5	100	150						194	552	1426	1568	209			220					
	11								226	599	1507	1711									
	15								226	599	1507	1711									

9.9 Series X Horizontally Ported Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.

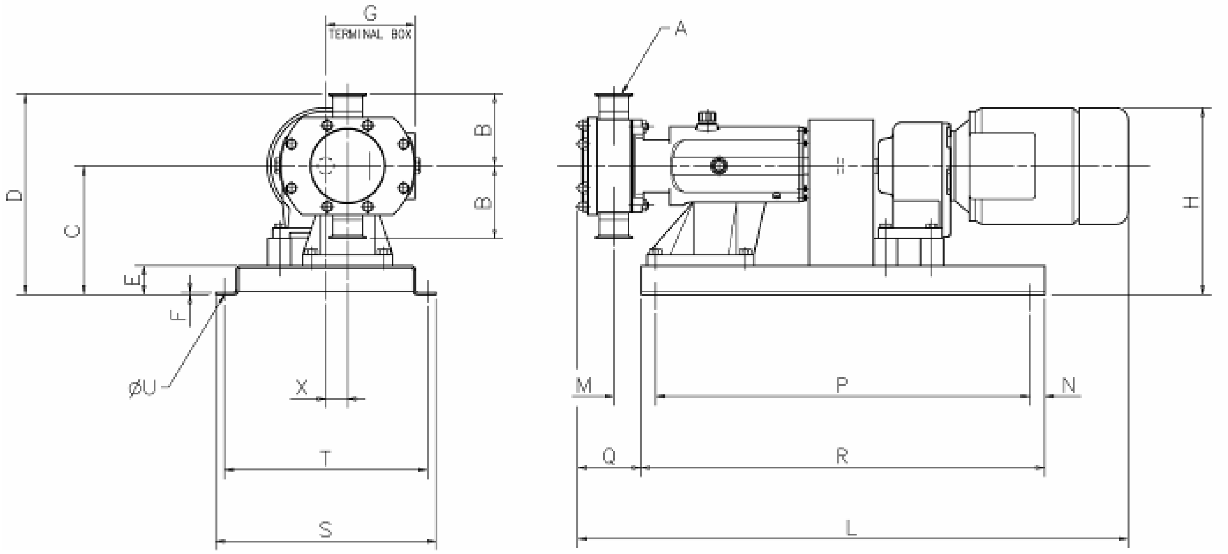


Horizontally ported
All dimensions in mm

Pump Model	Motor Power kW	A Port Dia.	B	C min	C max	D min	D max	E	F	G max	H max	L min	L max	M	N	P	Q	R	S	T	U
	0.37									120	236	654	736								
X1-0005	0.55	25		140.5		239				140	246	671	754	34			57				
	0.75									140	246	671	754								
	0.37		95					50	4	120	236	667	749		25	500		550	290	260	11 x 4
X1-0007	0.55	40		140.5		239				140	246	684	767	41			70				
	0.75									140	246	684	767								
	0.55				182		300			140	263	715	798								
X2-0013	0.75	40			182		300			140	263	715	798	39			69				
	1.1				170		288			150	288	757	842								
	0.75		105	165	182	283	300	50	4	140	263	731	814		25	550		600	330	300	11 x 4
X2-0018	1.1	50			182		300			150	288	773	858	46			85				
	1.5				170		288			150	288	773	858								
	1.1				212.5		348			150	303	863	948								
X3-0027	1.5	50			212.5		348			150	303	863	948	63			101				
	2.2				212.5		348			160	312	908	993								
	1.5		125	187.5	212.5	323	348	50	4	150	303	879	964		25	650		700	380	350	11 x 4
X3-0035	2.2	65			212.5		348			160	303	924	1009	69			117				
	3				217.5		353			160	312	924	1009								
	3				228		390			160	327	991	1076								
X4-0046	4	50			228		390			167	339	1042	1165	54			89				
	5.5				238		400			194	394	1163	1305								
	4		150	213	228	375	390	50	5	167	339	1061	1184		30	790		850	400	370	14 x 4
X4-0063	5.5	65			238		400			194	394	1182	1324	61			108				
	7.5				238		400			194	394	1182	1324								
	5.5				285		466			194	392	1248	1390								
X5-0082	7.5	65			285		466			194	392	1248	1390	76			70				
	11				290		471			226	439	1329	1533								
	5.5		175	245	285	426	466	50	5	194	392	1275	1417		100	800		1000	420	390	14 x 4
X5-0115	7.5	80			285		466			194	392	1275	1417	96			97				
	11				290		471			226	439	1356	1560								
	5.5				295		499			194	412	1336	1478								
X6-0140	7.5	80			295		499			194	412	1336	1478	98			81				
	11				300		504			226	459	1417	1621								
	7.5		190	275	295	479	499	50	5	194	412	1364	1506		100	1000		1200	650	570	22 x 6
X6-0190	11	100			300		504			226	459	1445	1649	110			109				
	15				300		504			226	459	1445	1649								

9.10 Series X Vertically Ported Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.

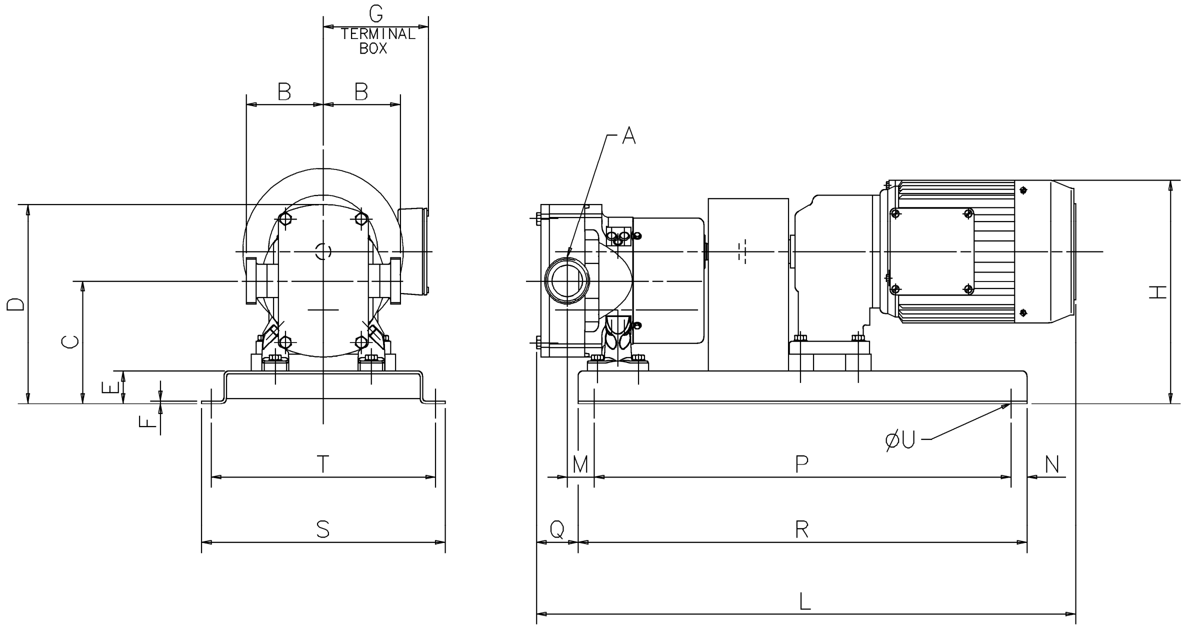


Vertically ported
All dimensions in mm

Pump Model	Motor Power kW	A Port Dia.	B	C	D	E	F	G max	H max	L min	L max	M	N	P	Q	R	S	T	U	X
X1-0005	0.37	25	95	163	258	50	4	120	281	654	736	63	25	500	86	550	290	260	11 x 4	23.5
	0.55							140	291	671	754									
	0.75							140	291	671	754									
X1-0007	0.37	40						120	281	667	749	70			99					
	0.55							140	291	684	767									
	0.75							140	291	684	767									
X2-0013	0.55	40	105	197	302	50	4	140	325	715	798	62	25	550	92	600	330	300	11 x 4	32.5
	0.75							140	325	715	798									
	1.1							150	350	757	842									
X2-0018	0.75	50						140	325	731	814	69			108					
	1.1							150	350	773	858									
	1.5							150	350	773	858									
X3-0027	1.1	50	125	225	350	50	4	150	378	863	948	76	25	650	114	700	380	350	11 x 4	37.5
	1.5							150	378	863	948									
	2.2							160	387	908	993									
X3-0035	1.5	65						150	378	879	964	82			130					
	2.2							160	387	924	1009									
	3							160	387	924	1009									
X4-0046	3	50	150	263	413	50	5	160	425	991	1076	79	30	790	114	850	400	370	14 x 4	49.5
	4							167	437	1042	1165									
	5.5							194	470	1163	1305									
X4-0063	4	65						167	437	1061	1184	86			133					
	5.5							194	470	1182	1324									
	7.5							194	470	1182	1324									
X5-0082	5.5	65	175	306.5	481.5	50	5	194	514	1248	1390	136	100	800	110	1000	420	390	14 x 4	60
	7.5							194	514	1248	1390									
	11							226	561	1329	1533									
X5-0115	5.5	80						194	514	1275	1417	156			137					
	7.5							194	514	1275	1417									
	11							226	561	1356	1560									
X6-0140	5.5	80	190	345	535	50	5	194	552	1336	1478	147	100	1000	130	1200	650	570	22 x 6	70
	7.5							194	552	1336	1478									
	11							226	599	1417	1621									
X6-0190	7.5	100						194	552	1364	1506	159			158					
	11							226	599	1445	1649									
	15							226	599	1445	1649									
X7-0250	5.5	100	205	415	620	50	5	194	552	1412	1554	164	100	1100	165	1300	750	670	22 x 6	81.5
	7.5							194	552	1412	1554									
	11							226	599	1493	1697									
X7-0380	7.5	150						194	552	1466	1608	191			219					
	11							226	599	1547	1751									
	15							226	599	1547	1751									

9.11 Series L Horizontally Ported Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.

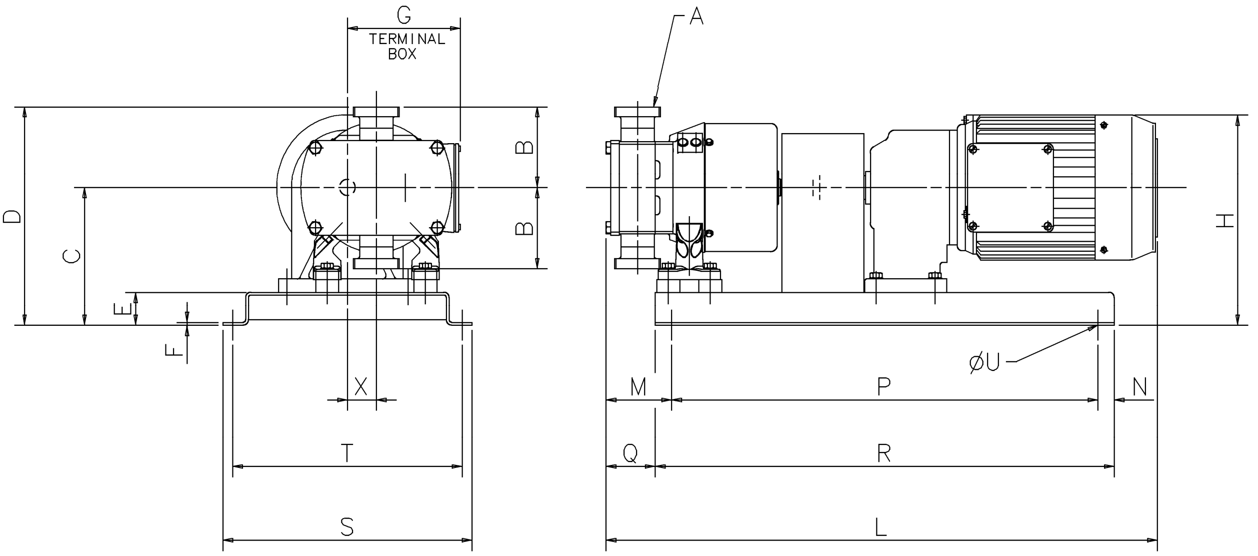


All dimensions in mm

<table>
<tr><th rowspan="2">Pump Model</th><th rowspan="2">Motor Power kW</th><th rowspan="2">A Port Dia.</th><th rowspan="2">B</th><th colspan="2">C</th><th colspan="2">D</th><th rowspan="2">E</th><th rowspan="2">F</th><th rowspan="2">G max</th><th rowspan="2">H max</th><th colspan="2">L</th><th rowspan="2">M</th><th rowspan="2">N</th><th rowspan="2">P</th><th rowspan="2">Q</th><th rowspan="2">R</th><th rowspan="2">S</th><th rowspan="2">T</th><th rowspan="2">U</th></tr>
<tr><th>min</th><th>max</th><th>min</th><th>max</th><th>min</th><th>max</th></tr>
<tr><td>L2-0017</td><td>0.55
0.75
1.1</td><td>40</td><td>96</td><td rowspan="2">170</td><td rowspan="2">190</td><td rowspan="2">266</td><td rowspan="2">286</td><td rowspan="2">50</td><td rowspan="2">4</td><td>140
145
145</td><td rowspan="2">270</td><td>665
665
707</td><td>748
748
792</td><td>35</td><td>25</td><td rowspan="2">550</td><td>51</td><td rowspan="2">600</td><td rowspan="2">330</td><td rowspan="2">300</td><td rowspan="2">11 x 4</td></tr>
<tr><td>L2-0021</td><td>0.75
1.1
1.5</td><td>40</td><td>96</td><td>145
145
154</td><td>676
718
718</td><td>759
803
803</td><td>44</td><td>25</td><td>62</td></tr>
<tr><td>L3-0032</td><td>1.1
1.5
2.2</td><td>50</td><td>120</td><td rowspan="2">186</td><td rowspan="2">224</td><td rowspan="2">301</td><td rowspan="2">339</td><td rowspan="2">50</td><td rowspan="2">4</td><td>145
154
166</td><td rowspan="2">313</td><td>736
736
781</td><td>821
821
866</td><td>30</td><td>25</td><td rowspan="2">650</td><td>53</td><td rowspan="2">700</td><td rowspan="2">380</td><td rowspan="2">350</td><td rowspan="2">11 x 4</td></tr>
<tr><td>L3-0040</td><td>1.5
2.2
3</td><td>50</td><td>120</td><td>154
166
166</td><td>748
793
793</td><td>833
878
878</td><td>42</td><td>25</td><td>65</td></tr>
<tr><td>L4-0064</td><td>3
4
5.5</td><td>65</td><td>130</td><td rowspan="2">209</td><td rowspan="2">258</td><td rowspan="2">344</td><td rowspan="2">393</td><td rowspan="2">50</td><td rowspan="2">4</td><td>166
166
194</td><td rowspan="2">370</td><td>847
898
1019</td><td>932
1021
1161</td><td>46</td><td>25</td><td rowspan="2">700</td><td>79</td><td rowspan="2">750</td><td rowspan="2">400</td><td rowspan="2">370</td><td rowspan="2">11 x 4</td></tr>
<tr><td>L4-0082</td><td>4
5.5
7.5</td><td>80</td><td>138</td><td>166
194
204</td><td>914
1035
1035</td><td>1037
1177
1177</td><td>55</td><td>25</td><td>95</td></tr>
</table>

9.12 Series L Vertically Ported Motorised Pump

Typical arrangement drawing with pump direct coupled to standard TEFV geared electric motor with speed range 200 - 600 rev/min. For other speeds and pump model/motor power options please refer to our Technical Support. All dimensions given are typical to be used for guidance purposes only.



All dimensions in mm

Pump Model	Motor Power kW	A Port Dia.	B	C min	C max	D min	D max	E	F	G max	H max	L min	L max	M	N	P	Q	R	S	T	U	X
L2-0017	0.55 0.75 1.1	40	96	170	205	266	301	50	4	140 145 145	270	665 665 707	748 748 792	42	25	550	58	600	330	300	11 x 4	26
L2-0021	0.75 1.1 1.5	40	96							145 145 154		676 718 718	759 803 803	51	25		69					
L3-0032	1.1 1.5 2.2	50	120	186	227	306	347	50	4	145 154 166	313	736 736 781	821 821 866	40	25	650	63	700	380	350	11 x 4	31
L3-0040	1.5 2.2 3	50	120							154 166 166		748 793 793	833 878 878	53	25		75					
L4-0064	3 4 5.5	65	130	209	225	339	363	50	4	166 166 194	370	847 898 1019	932 1021 1161	51	25	700	84	750	450	420	11 x 4	37
L4-0082	4 5.5 7.5	80	138							166 194 204		914 1035 1035	1037 1177 1177	60	25		100					

10.0 Technical Data

10.1 Useful Formulas

Product		
Viscosity	$\nu = \frac{\mu}{\rho}$ or $\nu = \frac{\mu}{SG}$ or $\mu = \nu \times SG$	where: ν = Kinematic viscosity (mm²/s) μ = Absolute viscosity (mPa.s) ρ = Fluid density (kg/m³) where: ν = Kinematic viscosity (cSt) μ = Absolute viscosity (cP) SG = Specific gravity 1 Poise = 100 cP 1 Stoke = 100 cSt
Flow		
Velocity	$V = \frac{Q}{A}$ or $V = \frac{Q \times 353.6}{D^2}$ or $V = \frac{Q \times 0.409}{D^2}$ or $V = \frac{Q \times 0.489}{D^2}$	where: V = velocity (m/s) Q = capacity (m³/s) A = tube area (m²) where: V = velocity (m/s) Q = capacity (m³/h) D = tube diameter (mm) where: V = velocity (ft/s) Q = capacity (US gall/min) D = tube diameter (in) where: v = velocity (ft/s) Q = capacity (UK gall/min) D = tube diameter (in)

Flow		
Reynolds number (ratio of inertia forces to viscous forces)	$Re = \frac{D \times V \times \rho}{\mu}$	where: D = tube diameter (m) V = velocity (m/s) ρ = density (kg/m³) μ = absolute viscosity (Pa.s)
	or	
	$Re = \frac{D \times V \times \rho}{\mu}$	where: D = tube diameter (mm) V = velocity (m/s) ρ = density (kg/m³) μ = absolute viscosity (cP)
	or	
	$Re = \frac{21230 \times Q}{D \times \mu}$	where: D = tube diameter (mm) Q = capacity (l/min) μ = absolute viscosity (cP)
	or	
	$Re = \frac{3162 \times Q}{D \times \nu}$	where: D = tube diameter (in) Q = capacity (US gall/min) ν = kinematic viscosity (cSt)
	or	
	$Re = \frac{3800 \times Q}{D \times \nu}$	where: D = tube diameter (in) Q = capacity (UK gall/min) ν = kinematic viscosity (cSt)
Pressure / Head		
Pressure (total force per unit area exerted by a fluid)	$P = \frac{F}{A}$	where: F = Force A = Area
Static Pressure/Head (relationship between pressure and elevation)	$P = \rho \times g \times h$	where: P = pressure/head (Pa) ρ = fluid density (kg/m³) g = acceleration due to gravity (m/s²) h = height of fluid (m)
	or	
	$P = \frac{h \times SG}{10}$	where: P = pressure/head (bar) h = height of fluid (m)
	or	
	$P = \frac{h \times SG}{2.31}$	where: P = pressure/head (psi) h = height of fluid (ft)
Total head	H = Ht – (± Hs)	where: Ht = total discharge head Hs = total suction head

Pressure / Head		
Total discharge head	Ht = ht + hft + Pt	where: ht = static discharge head hft = pressure drop in discharge line Pt > 0 for pressure Pt < 0 for vacuum Pt = 0 for open tank
Total suction head	Ht = hs – hfs + (± Ps)	where: hs = static suction head > 0 for flooded suction < 0 for suction lift hfs = pressure drop in suction line Ps > 0 for pressure Ps < 0 for vacuum Ps = 0 for open tank
Friction loss (Miller equation)	$Pf = \frac{fD \times L \times \rho \times V^2}{d \times 2}$ or $Pf = \frac{5 \times SG \times fD \times L \times V^2}{d}$ or $Pf = \frac{0.0823 \times SG \times fD \times L \times V^2}{d}$	where: Pf = friction loss (Pa) fD = friction factor (Darcy) L = tube length (m) V = velocity (m/s) ρ = fluid density (kg/m³) D = tube diameter (m) where: Pf = friction loss (bar) f = friction factor L = tube length (m) V = velocity (m/s) SG = specific gravity D = tube diameter (mm) where: Pf = friction loss (psi) f = friction factor L = tube length (ft) V = velocity (ft/s) SG = specific gravity D = tube diameter (in)
Darcy friction factor	$fD = \frac{64}{Re}$	where: fD = friction factor Re = Reynolds number
NPSHa (Net Positive Suction Head available)	NPSHa = Pa ± hs – hfs – Pvp (+ hs for flooded suction) (– hs for suction lift)	where: Pa = pressure absolute above fluid level (bar) hs = static suction head (m) hfs = pressure drop in suction line (m) Pvp = vapour pressure (bar a) or Pa = pressure absolute above fluid level (psi) hs = static suction head (ft) hfs = pressure drop in suction line (ft) Pvp = vapour pressure (psia)

Power		
Hydraulic power (theoretical energy required)	Power (W) = $Q \times H \times \rho \times g$ or Power (kW) = $\frac{Q \times H}{k}$ or Power (hp) = $\frac{Q \times H}{k}$ or Power (hp) = $\frac{Q \times H}{k}$	where: Q = capacity (m^3/s) H = total head (m) ρ = fluid density (kg/m^3) g = acceleration due to gravity (m/s^2) where: Q = capacity (l/min) H = total head (bar) k = 600 where: Q = capacity (US gall /min) H = total head (psi) k = 1715 where: Q = capacity (UK gall /min) H = total head (psi) k = 1428
Required power (power needed at the pump shaft)	$\frac{\text{Hydraulic power}}{\text{Efficiency (100\% = 1.0)}}$	
Torque		
Torque	Torque (Nm) = $\frac{\text{Required power (kW)} \times 9550}{\text{Pump speed (rev/min)}}$ or Torque (Kgfm) = $\frac{\text{Required power (kW)} \times 974}{\text{Pump speed (rev/min)}}$ or Torque (ftlb) = $\frac{\text{Required power (hp)} \times 5250}{\text{Pump speed (rev/min)}}$	

Efficiency		
Hydraulic efficiency (η_h)	$\frac{\text{Pump head loss (m)}}{\text{Total head (m)}} \times 100\%$	
Mechanical efficiency (η_m)	$1 - \frac{\text{Pump mechanical losses}}{\text{Required power}} \times 100\%$	
Volumetric efficiency	$\eta_v = \frac{Q}{q} \times 100\%$	where: η_v = volumetric efficiency Q = pump capacity q = pump displacement
Pump efficiency (η_p)	$\frac{\text{Water horse power}}{\text{Required power}} \times 100\%$ or $\eta_p = \frac{Q \times H \times \rho \times g}{\omega \times T}$	where: η_p = pump efficiency Q = capacity (m^3/s) H = total head/pressure (m) ρ = fluid density (kg/m^3) g = acceleration due to gravity (m/s^2) ω = shaft angular velocity (rad/s) T = shaft torque (Nm)
Overall efficiency (η_{oa})	$\frac{\text{Water horse power}}{\text{Drive power}} \times 100\%$	
Pump Speed		
Pump speed	$n = \frac{Q \times 100}{q \times \eta_v \times 60}$ or $n = \frac{Q \times 100}{q \times \eta_v}$ or $n = \frac{Q \times 100}{q \times \eta_v}$	where: n = pump speed (rev/min) Q = capacity (m^3/h) q = pump displacement (m^3/100 rev) η_v = vol. efficiency (100% = 1.0) where: n = pump speed (rev/min) Q = capacity (US gall/min) q = pump displacement (US gall/100 rev) η_v = vol. efficiency (100% = 1.0) where: n = pump speed (rev/min) Q = capacity (UK gall/min) q = pump displacement (UK gall/100 rev) η_v = vol. efficiency (100% = 1.0)

10.2 Conversion Tables

Length

mm	m	cm	in	ft	yd
1.0	0.001	0.10	0.0394	0.0033	0.0011
1000	**1.0**	100	39.370	3.2808	1.0936
10	0.01	**1.0**	0.3937	0.0328	0.1094
25.4	0.0254	2.540	**1.0**	0.0833	0.0278
304.8	0.3048	30.48	12	**1.0**	0.3333
914.4	0.9144	91.441	36	3.0	**1.0**

Volume

m^3	cm^3	l	in^3	ft^3	UK gall.	US gall.
1.0	100×10^4	1000	61024	35.315	220.0	264.0
10×10^7	**1.0**	10×10^{-4}	0.0610	3.53×10^{-5}	22×10^{-5}	26.4×10^{-5}
0.0010	1000	**1.0**	61.026	0.0353	0.22	0.2642
1.64×10^{-5}	16.387	0.0164	**1.0**	58×10^{-5}	0.0036	0.0043
0.0283	28317	28.317	1728	**1.0**	6.2288	7.4805
0.0045	4546.1	4.546	277.42	0.1605	**1.0**	1.201
37.88×10^{-4}	3785.4	3.7853	231.0	0.1337	0.8327	**1.0**

Volumetric Capacity

m^3/h	l/min	hl/h	UK gall/min	US gall/min	ft^3/h	ft^3/s	m^3/s
1.0	16.667	10.0	3.6667	4.3999	35.315	9.81×10^{-3}	2.78×10^{-4}
0.060	**1.0**	0.60	0.22	0.2642	2.1189	5.88×10^{-4}	1.67×10^{-5}
0.10	1.6667	**1.0**	0.3667	0.4399	3.5315	9.81×10^{-4}	2.78×10^{-5}
0.2727	4.546	2.7270	**1.0**	1.201	9.6326	2.67×10^{-3}	7.57×10^{-5}
0.2273	3.785	2.2732	0.8326	**1.0**	8.0208	2.23×10^{-3}	6.31×10^{-5}
0.0283	0.4719	0.2832	0.1038	0.1247	**1.0**	2.78×10^{-4}	7.86×10^{-6}
101.94	1699	1019.4	373.73	448.83	3600	**1.0**	0.0283
3600	6×10^4	36000	13200	15838	127208	35.315	**1.0**

Mass Capacity

kg/s	kg/h	lb/h	UK ton/hr	t/d (tonne/day)	t/h (tonne/hr)	lb/s
1.0	3600	7936.6	3.5431	86.40	3.6	2.2046
2.78×10^{-4}	**1.0**	2.2046	98.4×10^{-5}	0.024	0.001	6.12×10^{-4}
1.26×10^{-4}	0.4536	**1.0**	44.6×10^{-5}	0.0109	4.54×10^{-4}	2.78×10^{-4}
0.2822	1016.1	2240	**1.0**	24.385	1.0160	0.6222
11.57×10^{-3}	41.667	91.859	0.0410	**1.0**	0.0417	0.0255
0.2778	100	2201.8	0.9842	24	**1.0**	0.6116
0.4536	1632.9	3600	1.6071	39.190	1.6350	**1.0**

Pressure / Head

bar	kg/cm^2	lb/in^2	atm	ft (water)	m (water)	mm Hg	in Hg	kPa
1.0	1.0197	14.504	0.9869	33.455	10.197	750.06	29.530	100
0.9807	**1.0**	14.223	0.9878	32.808	10	735.56	28.959	98.07
0.0689	0.0703	**1.0**	0.0609	2.3067	0.7031	51.715	2.036	6.89
1.0133	1.0332	14.696	**1.0**	33.889	10.332	760.0	29.921	101.3
0.0299	0.0305	0.4335	0.0295	**1.0**	0.3048	22.420	0.8827	2.99
0.0981	0.10	1.422	0.0968	3.2808	**1.0**	73.356	2.896	9.81
13.3×10^{-4}	0.0014	0.0193	13.2×10^{-4}	0.0446	0.0136	**1.0**	0.0394	0.133
0.0339	0.0345	0.4912	0.0334	1.1329	0.3453	25.40	**1.0**	3.39
1.0×10^{-5}	10.2×10^{-6}	14.5×10^{-5}	9.87×10^{-6}	3.34×10^{-4}	10.2×10^{-5}	75.0×10^{-4}	29.5×10^{-5}	**1.0**

Force

kN	kgf	lbf
1.0	101.97	224.81
9.81×10^{-3}	**1.0**	2.2046
44.5×10^{-4}	0.4536	**1.0**

Torque

Nm	kgfm	lbft	lbin
1.0	0.102	0.7376	8.8508
9.8067	**1.0**	7.2330	86.796
1.3558	0.1383	**1.0**	12.0
0.113	0.0115	0.0833	**1.0**

Power

W	kgfm/s	ft lbf/s	hp	kW
1.0	0.102	0.7376	1.34×10^{-3}	1000
9.8067	**1.0**	7.2330	0.0132	9806.7
1.3558	0.1383	**1.0**	1.82×10^{-3}	1355.8
745.70	76.040	550.0	**1.0**	74.6×10^{-4}
0.001	10.2×10^{-5}	73.8×10^{-5}	13.4×10^{-7}	**1.0**

Density

kg/m^3	g/cm^3	lb/in^3	lb/ft^3
1.0	10^{-3}	36.127×10^{-6}	62.428×10^{-3}
10^3	**1.0**	36.127×10^{-3}	62.428
27.680×10^3	27.680	**1.0**	1.728×10^3
16.019	16.019×10^{-3}	0.5787×10^{-3}	**1.0**

Viscosity

When S.G. = 1.0		When S.G. is other than 1.0		Viscosity Units									
Read Directly Across		Find cst, then mutiply cSt x SG = cP	Find cSt, then mutiply Stoke x SG = Poise										
cP	Poise	cSt	Stoke	Saybolt Universal SSU	Seconds Engler	Redwood Standard #1	Ford #3	Ford #4	Zahn #1	Zahn #2	Zahn #3	Zahn #4	Zahn #5
1	0.01	1	0.01	31	54	29							
2	0.02	2	0.02	34	57	32							
4	0.04	4	0.04	38	61	36							
7	0.07	7	0.07	47	75	44	8						
10	0.10	10	0.10	60	94	52	9	5	30	16			
15	0.15	15	0.15	80	125	63	10	8	34	17			
20	0.20	20	0.20	100	170	86	12	10	37	18			
25	0.25	25	0.25	130	190	112	15	12	41	19			
30	0.30	30	0.30	160	210	138	19	14	44	20			
40	0.40	40	0.40	210	300	181	25	18	52	22			
50	0.50	50	0.50	260	350	225	29	22	60	24			
60	0.60	60	0.60	320	450	270	33	25	68	27			
70	0.70	70	0.70	370	525	314	36	28	72	30			
80	0.80	80	0.80	430	600	364	41	31	81	34			
90	0.90	90	0.90	480	875	405	45	32	88	37	10		
100	1.0	100	1.0	530	750	445	50	34		41	12	10	
120	1.2	120	1.2	580	900	492	58	41		49	14	11	
140	1.4	140	1.4	690	1050	585	66	45		58	16	13	
160	1.6	160	1.6	790	1200	670	72	50		66	18	14	
180	1.8	180	1.8	900	1350	762	81	54		74	20	16	
200	2.0	200	2.0	1000	1500	817	90	58		82	23	17	10
220	2.2	220	2.2	1100	1650	933	98	62		88	25	18	11
240	2.4	240	2.4	1200	1800	1020	106	65			27	20	12
260	2.6	260	2.6	1280	1950	1085	115	68			30	21	13
280	2.8	280	2.8	1380	2100	1170	122	70			32	22	14
300	3.0	300	3.0	1475	2250	1250	130	74			34	24	15
320	3.2	320	3.2	1530	2400	1295	136	89			36	25	16
340	3.4	340	3.4	1630	2550	1380	142	95			39	26	17
360	3.6	360	3.6	1730	2700	1465	150	100			41	27	18
380	3.8	380	3.8	1850	2850	1570	160	106			43	29	19
400	4.0	400	4.0	1950	3000	1650	170	112			46	30	20
420	4.2	420	4.2	2050	3150	1740	180	118			48	32	21
440	4.4	440	4.4	2160	3300	1830	188	124			50	33	22
460	4.6	460	4.6	2270	3450	1925	200	130			52	34	23
480	4.8	480	4.8	2380	3600	2020	210	137			54	36	24
500	5.0	500	5.0	2480	3750	2100	218	143			58	38	25
550	5.5	550	5.5	2660	4125	2255	230	153			64	40	27
600	6.0	600	6.0	2900	4500	2460	250	170			68	45	30
700	7.0	700	7.0	3380	5250	2860	295	194			76	51	35
800	8.0	800	8.0	3880	6000	3290	340	223				57	40
900	9.0	900	9.0	4300	8750	3640	365	247				63	45
1000	10	1000	10	4600	7500	3900	390	264				69	49

When S.G. = 1.0		When S.G. is other than 1.0		Viscosity Units									
Read Directly Across		Find cst, then mutiply cSt x SG = cP	Find cSt, then mutiply Stoke x SG = Poise										
cP	Poise	cSt	Stoke	Saybolt Universal SSU	Seconds Engler	Redwood Standard #1	Ford #3	Ford #4	Zahn #1	Zahn #2	Zahn #3	Zahn #4	Zahn #5
1100	11	1100	11	5200	8250	4410	445	299				77	55
1200	12	1200	12	5620	9000	4680	480	323					59
1300	13	1300	13	6100	9750	5160	520	350					64
1400	14	1400	14	6480	10350	5490	550	372					70
1500	15	1500	15	7000	11100	5940	595	400					75
1600	16	1600	16	7500	11850	6350	635	430					80
1700	17	1700	17	8000	12600	6780	680	460					85
1800	18	1800	18	8500	13300	7200	720	490					91
1900	19	1900	19	9000	13900	7620	760	520					96
2000	20	2000	20	9400	14600	7950	800	540					
2100	21	2100	21	9850	15300	8350	835	565					
2200	22	2200	22	10300	16100	8730	875	592					
2300	23	2300	23	10750	16800	9110	910	617					
2400	24	2400	24	11200	17500	9500	950	645					
2500	25	2500	25	11600	18250	9830	985	676					
3000	30	3000	30	14500	21800	12300	1230	833					
3500	35	3500	35	16500	25200	14000	1400	950					
4000	40	4000	40	18500	28800	15650	1570	1060					
4500	45	4500	45	21000	32400	17800		1175					
5000	50	5000	50	23500	36000	19900		1350					
5500	55	5500	55	26000	39600			1495					
6000	60	6000	60	28000	43100			1605					
6500	65	6500	65	30000	46000			1720					
7000	70	7000	70	32500	49600			1870					
7500	75	7500	75	35000	53200			2010					
8000	80	8000	80	37000	56800			2120					
8500	85	8500	85	39500	60300			2270					
9000	90	9000	90	41080	63900			2350					
9500	95	9500	95	43000	67400			2470					
10000	100	10000	100	46500	71000			2670					
15000	150	15000	150	69400	106000								
20000	200	20000	200	92500	140000								
30000	300	30000	300	138500	210000								
40000	400	40000	400	185000	276000								
50000	500	50000	500	231000	345000								
60000	600	60000	600	277500	414000								
70000	700	70000	700	323500	484000								
80000	800	80000	800	370000	550000								
90000	900	90000	900	415500	620000								
100000	1000	100000	1000	462000	689000								
125000	1250	125000	1250	578000	850000								
150000	1500	150000	1500	694000									
175000	1750	175000	1750	810000									
200000	2000	200000	2000	925000									

Temperature

minus 459.4 - 0			0 - 49			50 - 100			100 - 490			500 - 1000		
°C	to	°F	°C	to	°F	°C	to	°F	°C	to	°F	°C	to	°F
-273	-459		-17.8	0	32	10.0	50	122.0	38	100	212	260	500	932
-268	-450		-17.2	1	33.8	10.6	51	123.8	43	110	230	266	510	950
-262	-440		-16.7	2	35.6	11.1	52	125.6	49	120	248	271	520	968
-257	-430		-16.1	3	37.4	11.7	53	127.4	54	130	266	277	530	986
-251	-420		-15.6	4	39.2	12.2	54	129.2	60	140	284	282	540	1004
-246	-410		-15.0	5	41.0	12.8	55	131.0	66	150	302	288	550	1022
-240	-400		-14.4	6	42.8	13.3	56	132.8	71	160	320	293	560	1040
-234	-390		-13.9	7	44.6	13.9	57	134.6	77	170	338	299	570	1058
-229	-380		-13.3	8	46.4	14.4	58	136.4	82	180	356	304	580	1076
-223	-370		-12.8	9	48.2	15.0	59	138.2	88	190	374	310	590	1094
-218	-360		-12.2	10	50.0	15.6	60	140.0	93	200	392	316	600	1112
-212	-350		-11.7	11	51.8	16.1	61	141.8	99	210	410	321	610	1130
-207	-340		-11.1	12	53.6	16.7	62	143.6	100	212	413.6	327	620	1148
-201	-330		-10.6	13	55.4	17.2	63	145.4	104	220	428	332	630	1166
-196	-320		-10.0	14	57.2	17.8	64	147.2	110	230	446	338	640	1184
-190	-310		-9.4	15	59.0	18.3	65	149.0	116	240	464	343	650	1202
-184	-300		-8.9	16	60.8	18.9	66	150.8	121	250	482	349	660	1220
-179	-290		-8.3	17	62.6	19.4	67	152.6	127	260	500	354	670	1238
-173	-280		-7.8	18	64.4	20.0	68	154.4	132	270	518	360	680	1256
-169	-273	-459.4	-7.2	19	66.2	20.6	69	156.2	138	280	536	366	690	1274
-168	-270	-454	-6.7	20	68.0	21.1	70	158.0	143	290	554	371	700	1292
-162	-260	-436	-6.1	21	69.8	21.7	71	159.8	149	300	572	377	710	1310
-157	-250	-418	-5.6	22	71.6	22.2	72	161.6	154	310	590	382	720	1328
-151	-240	-400	-5.0	23	73.4	22.8	73	163.4	160	320	608	388	730	1346
-146	-230	-382	-4.4	24	75.2	23.3	74	165.2	166	330	626	393	740	1364
-140	-220	-364	-3.9	25	77.0	23.9	75	167.0	171	340	644	399	750	1382
-134	-210	-346	-3.3	26	78.8	24.4	76	168.8	177	350	662	404	760	1400
-129	-200	-328	-2.8	27	80.6	25.0	77	170.6	182	360	680	410	770	1418
-123	-190	-310	-2.2	28	82.4	25.6	78	172.4	188	370	698	416	780	1436
-118	-180	-292	-1.7	29	84.2	26.1	79	174.2	193	380	716	421	790	1454
-112	-170	-274	-1.1	30	86.0	26.7	80	176.0	199	390	734	427	800	1472
-107	-160	-256	-0.6	31	87.8	27.2	81	177.8	204	400	752	432	810	1490
-101	-150	-238	0.0	32	89.6	27.8	82	179.6	210	410	770	438	820	1508
-96	-140	-220	0.6	33	91.4	28.3	83	181.4	216	420	788	443	830	1526
-90	-130	-202	1.1	34	93.2	28.9	84	183.2	221	430	806	449	840	1544
-84	-120	-184	1.7	35	95.0	29.4	85	185.0	227	440	824	454	850	1562
-79	-110	-166	2.2	36	96.8	30.0	86	186.8	232	450	842	460	860	1580
-73	-100	-148	2.8	37	98.6	30.6	87	188.6	238	460	860	466	870	1598
-68	-90	-130	3.3	38	100.4	31.1	88	190.4	243	470	878	471	880	1616
-62	-80	-112	3.9	39	102.2	31.7	89	192.2	249	480	896	477	890	1634
-57	-70	-94	4.4	40	104.0	32.2	90	194.0	254	490	914	482	900	1652
-51	-60	-76	5.0	41	105.8	32.8	91	195.8				488	910	1670
-46	-50	-58	5.6	42	107.6	33.3	92	197.6				493	920	1688
-40	-40	-40	6.1	43	109.4	33.9	93	199.4				499	930	1706
-34	-30	-22	6.7	44	111.2	34.4	94	201.2				504	940	1724
-29	-20	-4	7.2	45	113.0	35.0	95	203.0				510	950	1742
-23	-10	14	7.8	46	114.8	35.6	96	204.8				516	960	1760
-17.8	0	32	8.3	47	116.6	36.1	97	206.6				521	970	1778
			8.9	48	118.4	36.7	98	208.4				527	980	1796
			9.4	49	120.2	37.2	99	210.2				532	990	1814
						37.8	100	212.0				538	1000	1832

Locate temperature in middle column. If in °C read the °F equivalent in the right hand column. If in °F read °C equivalent in the left hand column

°C = (°F - 32) x 0.5556
°F = (°C x 1.8) + 32

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