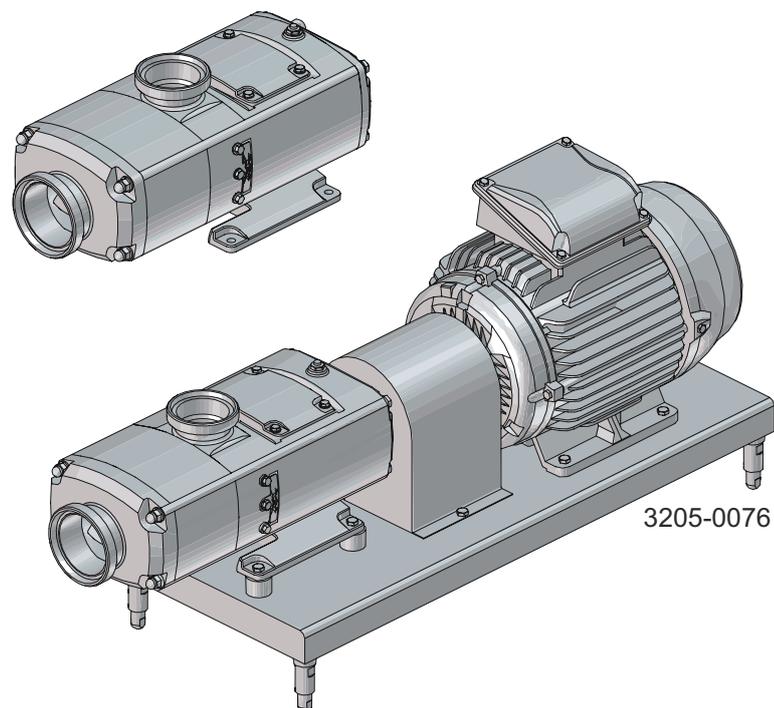


Twin Screw Pumps

Guidelines to successful applications



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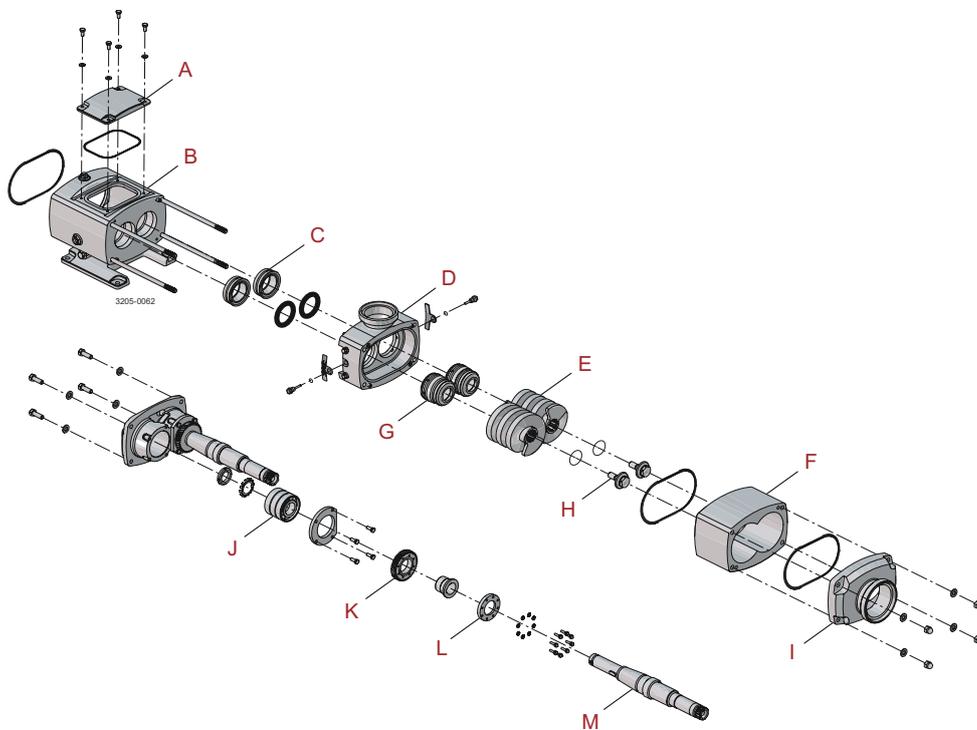
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1 General

This document has been produced to support pump users at all levels, providing guidelines as to the correct selection and successful application of Alfa Laval Twin Screw Pumps.

1.1 Basic Pump Construction

- A. Gear cover
- B. Gearbox
- C. Needle bearing
- D. Seal housing
- E. Feed screws
- F. Pump casing
- G. Seals
- H. Feed screw nuts
- I. Front cover
- J. Ball bearings
- K. Timing gear
- L. Clamp plate
- M. Auxiliary shaft



1.2 Required Sizing Data

To provide an optimised twin-screw selection for customer, the following conditions are required for ALL intended duties:

- Pumped media
- Solids present (% of solids, sizes) - if applicable
- Pumping temperature
- Viscosity
- Specific Gravity
- Flow rate
- Differential pressure
- Twin Screw pump to be used for CIP duty (Yes / No)

Yes	No	No (No-Bypass)
CIP conditions required for pump selection	Application is for process only	CIP conditions required for pump selection
Flow / Pressure / Temperature	By-pass required for CIP flow	Flow / Pressure / Temperature

Knowledge of any CIP usage is vital with regards to pump motor selection and pump operation - see 1.4 and 1.6

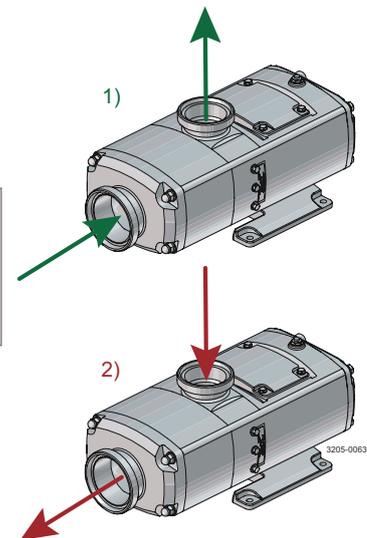
1.2.1 Additional data required for optimised sizing

Pump

- Port orientation
 - Inlet Front / Outlet Top (Option 1 - default)
 - Inlet Top / Outlet Front (Option 2)
- Port size, front cover & seal housing

NOTE

15 % reduction on pump pressure rating with inlet — Top
20 % reduction on pump pressure rating with inlet — Top (OSx8 only)



Motor

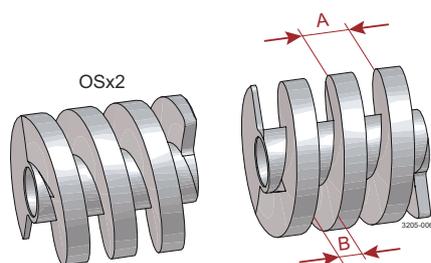
- MEPs requirement (destination country)
- Motor drive standard (IEC or NEMA)
- Electrical supply
- Ingress Protection (IP rating / NEMA equivalent)

1.3 General Selection Guidelines

1.3.1 Screw pitches

Deciding on the perfect screw pitch is the key to successful operation of the twin screw pump.

- OSx8 screw size = Highest displacement / Lowest rated pressure
- OSx7 screw size = Higher displacement / Lower rated pressure
- OSx6 screw size = High displacement / Low rated pressure
- OSx4 screw size = Intermediate flow rate / pressure
- OSx2 screw size = Lowest flow rate / Highest rated pressure



Pitch	OS1x	OS2x	OS3x	OS4x	Pressure limit (water)	# Closed chambers
A	mm (inch)				bar (psi)	B
OSx2	14 (0.55)	26 (1.02)	33 (1.30)	45 (1.77)	16 (232)	3
OSx4	23 (0.91)	35 (1.38)	46 (1.81)	62 (2.44)	12 (174)	2
OSx6	35 (1.38)	52 (2.05)	67 (2.64)	91 (3.58)	8 (116)	1
OSx7		31 * 2 (1.22 * 2)	40 * 2 (1.57 * 2)		6 (87)	2
OSx8		65 (2.56)	85 (3.35)		5.5 (80)	1

For twin screw selection, the default pump choice should be the **largest screw pitch option on smallest pump available** based on flow capacity against pressure.

For example, OS26 before OS24 or OS22 depending on the duty pressure (OS26 limited to 8 bar / 116 psi, OS24 limited to 12 bar / 174 psi etc).

This is set to allow the smallest operating speed range due to displacement, optimising motor selection and process flexibility. This also benefits the presence of solids and allowing for largest handling on select pump series - see 1.3.5 Maximum particle size for table reference.

1.3.1.1 Extended screw pitches

Keeping to the principle of the **largest screw pitch option on smallest pump available** based on flow capacity against pressure. The introduction of the "Double Feed" / OSx7 and "Extended" / OSx8 pitch screw options allows for more selection optimisation to the models applicable.

Continuing with the modular platform, the added displacement of these two screws on existing gearboxes means increased flow capacity at the expense of a lower differential pressure limit - limiting their use to applications where pressures do not exceed 5.5 bar.

When deciding on which extended pitch is the correct choice for selection, the following guidelines should be considered.

The Double Feed Screw / OSx7 pitch

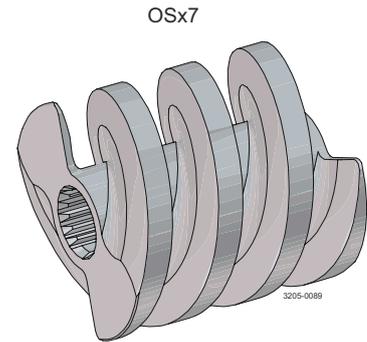
This screw has two windings, the chamber size is 1/4 of the pitch compared to 1/2 as other pitch screws.

Used for high volume applications on media where viscosity range: 1-2000 cP.

Very low pulsation level and good suction + NPSHr performance compared to OSx6 and OSx8.

Due to the increased surface area with double windings, not suitable for shear-sensitive media where product integrity is paramount - added surface area would also result in higher power consumption due to increased friction.

Solids handling is less than ideal with greater potential for particles to get "squeezed" between the flanks at inlet.



The Extended Screw / OSx8 pitch

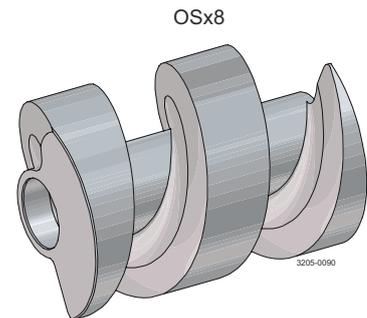
This screw is a longer version of the OSx6 pitch with same chamber size.

The new, initial choice on screw pitch selection, where duty allows.

Great for handling sensitive shear media and equipped with the largest solids handling capacity.

Excellent on highly viscous media but due to large pitch and overhang, operational speeds are kept to a maximum of 2000 rpm, regardless of being used for process or CIP.

Highest NPSHr value among the screw pitch options and lowest suction performance.



1.3.2 NPSH considerations

For satisfactory pump operation, the condition at the inlet of a pump is critical.

It is critical NPSHa is greater than the NPSH requirement by the pump. The value of NPSHa in the system is dependent upon the characteristic of the fluid being pumped, inlet piping, vapour pressure, the location of the suction vessel, and the pressure applied to the fluid in the suction vessel.

It is important to note, it is the design of the system that sets the inlet condition and **not the pump**.

Applications in systems where there is a low NPSHa, consideration should be given for the smallest pitch screw which has the best NPSHr performance.

For example, OS 2x series

OS22 = smallest pitch option / lowest NPSHr

OS28 = largest pitch option / highest NPSHr

1.3.3 Maximum permissible speeds

Maximum permissible speeds relative to viscosity:

Speed Limits

Viscosity	Max Process Speed / Max CIP Inter Speeds														
	OS1x		OS2x		OS3x**		OS4x**		**OSx7						
cP	rpm														
1	2800	/	3300	2500	/	3300	2200	/	3000	1800	/	2800	See respective model size for speed limitation		
10	2800	/	3300	2500	/	3300	2200	/	3000	1800	/	2500			
100	2800	/	3300	2500	/	3300	2200	/	3000	1800	/	2500			
250	2800	/	2930	2500	/	2930	2200	/	2930	1800	/	2500	2070	/	2070
500	2135	/	2135	2135	/	2135	2135	/	2135	1800	/	2135	1510	/	1510
1000	1570	/	1570	1570	/	1570	1570	/	1570	1570	/	1570	1110	/	1110
5000	815	/	815	815	/	815	815	/	815	815	/	815	575	/	575
10000	635	/	635	635	/	635	635	/	635	635	/	635	450	/	450
50000	395	/	395	395	/	395	395	/	395	395	/	395	280	/	280
75000	360	/	360	360	/	360	360	/	360	360	/	360	255	/	255
100000	340	/	340	340	/	340	340	/	340	340	/	340	240	/	240

NOTE

The maximum process and CIP intermittent speeds on a OSx8 pitch with 1cP, regardless of model size, is limited to 2000 rpm.

1.3.4 Viscosity

With low viscosity applications (<50 cP), consider the lower pitch models with increased number of chambers for improved efficiency performance to reduce the amount of “slip” closed chamber >1.

However, for any shear sensitive products, consideration should be noted regarding speed / capacity when increasing the quantity of closed chambers. The smaller pitch option (i.e. OSx2 or OSx4) leads to reduced capacity and therefore will require higher operating speeds to match larger pitch displacement.

NOTE

High viscosity media does not require any consideration with respect to pump chamber (pitch option) except for the OSx7, where the double feed thread limits the viscosity - recommendation use of OSx7 option with media values to 2000 cP.

1.3.5 Maximum particle size

Alfa Laval Twin Screw pumps have the ability to handle solids.

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

Optimum Conditions:

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

Maximum Solids Handling mm (inch)							
OS1x		OS2x		OS3x		OS4x	
OS12	6 (0.24)	OS22	12 (0.47)	OS32	16 (0.63)	OS42	21 (0.82)
OS14	11 (0.43)	OS24	16 (0.63)	OS34	21 (0.82)	OS44	29 (1.14)
OS16	17 (0.67)	OS26	24 (0.94)	OS36	32 (1.26)	OS46	43 (1.69)
		OS27	15 (0.59)	OS37	20 (0.78)		
		OS28	32 (1.26)	OS38	42 (1.65)		

1.3.6 Abrasion considerations

Care should be taken when handling abrasive media, i.e. some products such as inks have very fine particles, whilst other products such as sugar slurries, can contain much larger particles which can lead to excessive pump wear.

To combat this issue, consideration needs to be given to pumping speed, temperature and differential pressure.

Wear from abrasion can be decreased by operating pumps at a lower speed range. Alfa Laval recommends an absolute operational limit of 600 rpm on any media that could be considered "abrasive".

Depending upon the abrasion level of the product; consideration should be given to include for the additional hardened screw option having increased surface hardness to improve wear resistance.

Alfa Laval Twin Screw pump has hardened casing as standard.

Surface hardness measurement - typically 1092 HV0.05 with diffusion depth of 25.5 µm.

1.3.7 Priming

The Alfa Laval Twin Screw pump may be classed as "Self-priming". The pump must contain a minimum liquid volume to seal the clearances for initial prime forming a liquid ring. This allows evacuation of any entrained air/ gas within pumped media in concentrations up to 60%.

Please contact Alfa Laval Technical Support for further details on priming/suction lift.

1.3.8 Reverse Operation

The Alfa Laval Twin Screw pump may be operated in reverse operation to that originally intended but the following differential pressure limitations must be taken into consideration.

Pump Configuration	Flow Direction	OSx2	OSx4 barg (psi)	OSx6	OSx7	OSx8	Limiting Factors
Standard	Standard (Front-In/Top-Out)	16 (232)	12 (174)	8 (116)	6 (87)	5.5 (80)	None
Standard	Reversed (Front-Out/Top-In)	6 (87)	5.5 (80)	3.5 (50)	2.5 (36)	2 (29)	Reduced Bearing Life Reduced Clearance
Bearings Reversed Only	Reversed (Front-Out/Top-In)	7.5 (108)	5.5 (80)	3.5 (50)	3.5 (50)	3.0 (43)	Reduced Clearance
Pump Casing Reversed Only	Reversed (Front-Out/Top-In)	6 (87)	6 (87)	6 (87)	4 (58)	3 (43)	Reduced Bearing Life
Bearings & Pump Casing Reversed	Reversed (Front-Out/Top-In)	13.5 (195)	10 (145)	6.5 (94)	5 (72)	4 (58)	Reduced Lever Ratio

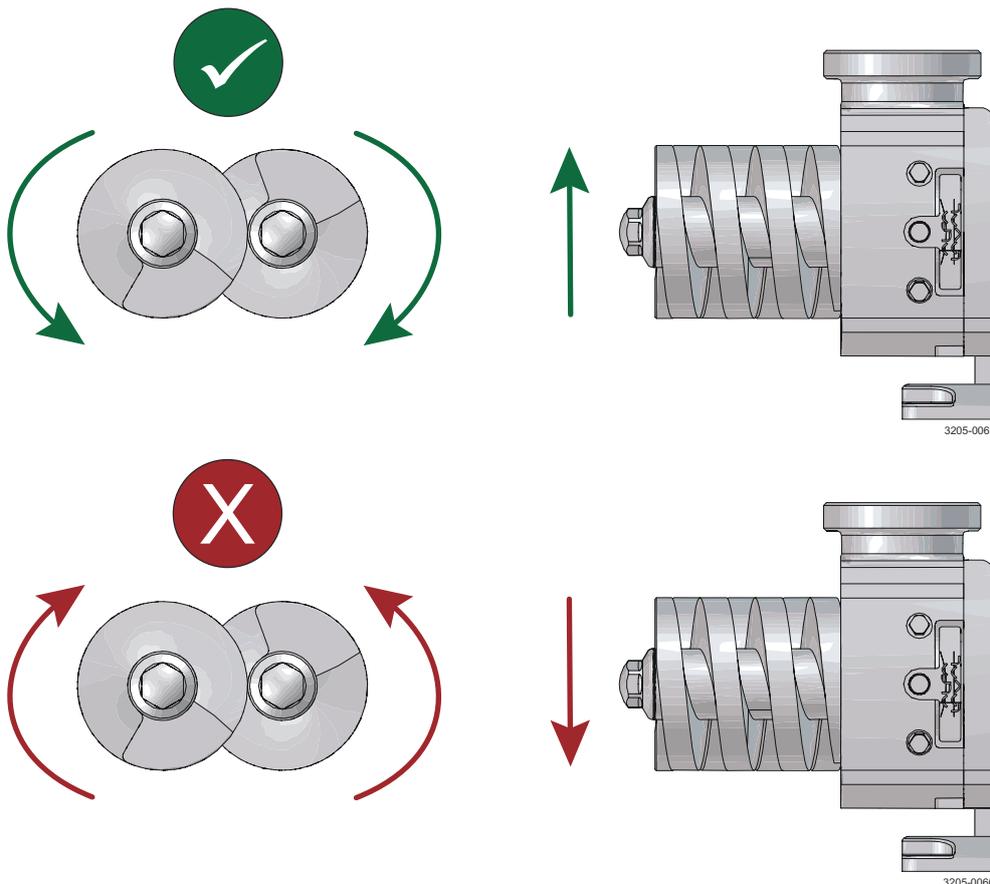
1.4 CIP & SIP Process

1.4.1 CIP

Alfa Laval Twin Screw pumps are designed for performing both process and CIP duties. Increased operating speeds allow for the twin screw to match typical centrifugal pump operating speeds.

If the CIP system pressure is > 1bar / 14.5 psi the **Alfa Laval Twin Screw pump must either run at a speed to match CIP flow to prevent turbining or a suitable by-pass arrangement installed.**

Turbining - reversal of screws against intended direction, which can lead to shaft deflection and potential damage of the pump via contact between screws and casing.



If the pump runs slowly with the flow, the inlet pressure must be <1 bar / 14.5 psi to avoid a negative differential pressure to avoid turbining.

For example, inlet pressure higher than outlet pressure.

1.4.2 SIP Sterilisation

In addition to or alternative to CIP cleaning, sterilisation in place scenarios (SIP) may be employed,

- a) Steam sterilisation (the steam runs through the pump with the pump stationary)
- b) Hot water sterilisation (the pump is in operation)

Should the user operate the pump during steam sterilisation, damage will be caused to the shaft seal due to possible dry running. To avoid this, slow rotation with shafts is possible (<100 rpm) if fitted with single flushed seal or double seal.

Recommendation to keep pump stationary during Steam-In-Place process.

1.4.3 Thermal shock

In general, no pump should be subjected to sudden extremes of temperature as components within both the pump and system can be damaged by thermal expansion/contraction.

The Alfa Laval Twin Screw pump allows temperature changes of up to 70°C differential (diff. 158°F) without risk of thermal shock. If more than 70°C / 158°F differential is required, the pump should be stationary and brought up or down to temperature < 70°C / 158°F differential, allowing the pump head to stabilise before operating the pump.

For example:

Process temperature - 25°C / 77°F	Process Temperature - 15°C / 60°F
CIP temperature - 85°C / 185°F	CIP Temperature - 90°C / 194°F
Differential - 60°C / 145°F	Differential - 75°C / 167°F

For second example, the pump would need to be stationary until the temperature differential was within 70°C / 158°F (being cooled or heated.)

1.4.4 Operating Temperature Limitations

For the Alfa Laval Twin Screw pump, temperature limitation is defined by the continuous operation (process) and the intermittent operation (CIP)

Maximum continuous operation temperature - 100°C / 212°F

Maximum intermittent operation temperature - 150°C / 302°F

Note: for continuous operation temperatures exceeding 100°C / 212°F, please contact Alfa Laval Technical Support.

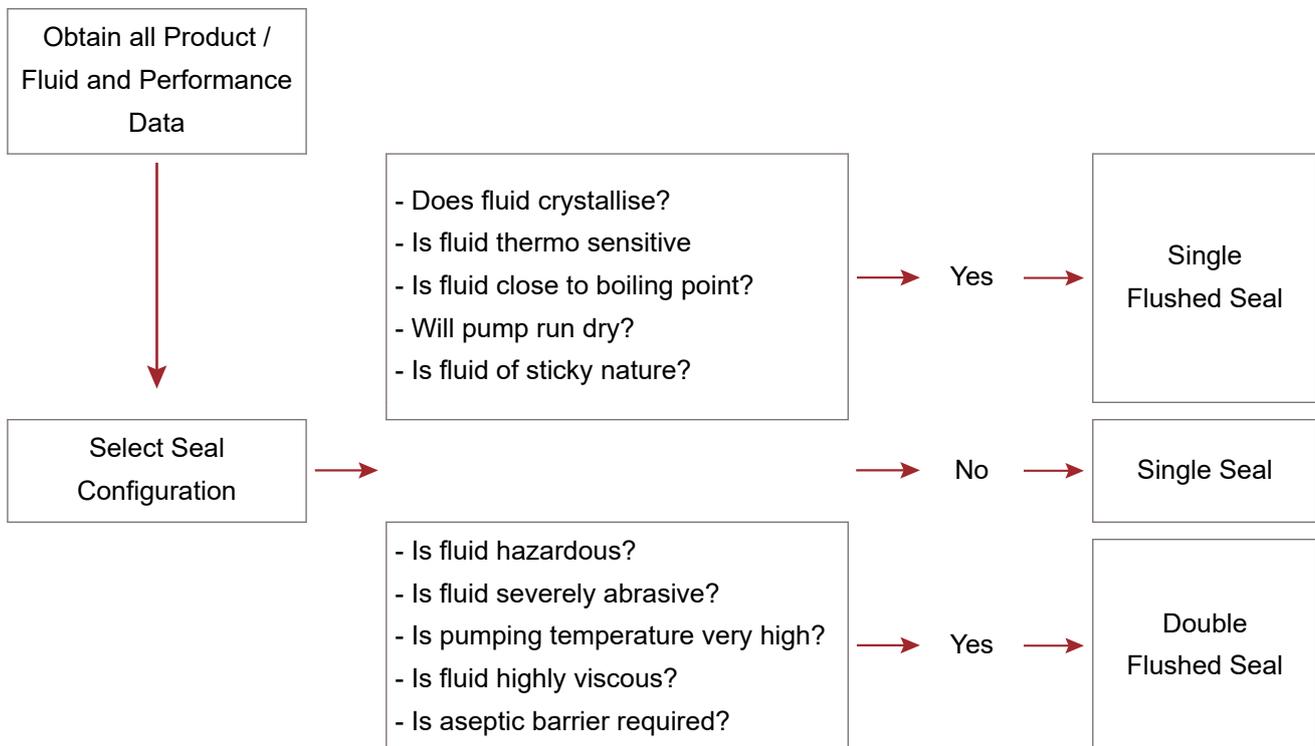
1.5 General Mechanical Seal Selection

The Alfa Laval Twin Screw Pump comes equipped with a cartridge style mechanical seal. The truly front loading, self-setting design allows very easy installation.

The cartridge can be refurbished by replacing all sealing faces and elastomers by use of service kit, providing increased flexibility and reduced down-time.

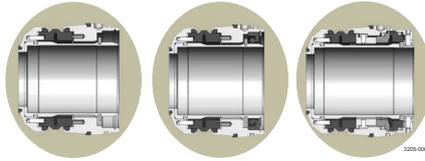
When configuring for the correct seal selection, It is best to understand the pumping media's characteristic. Is it abrasive? Does it have good lubrication qualities? Does media require protection from oxidation?

See below flow diagram for guideline to which sealing arrangement is best suited to pumping requirements.



The default selection in Anytime is Single Flush with SiC/SiC faces.

This is due to the pump primarily used on both Process and CIP duties, as between cycles there may be the possibility for temporary dry running.



Single

Single Flush

Double

	Rotary	Stationary
Standard	Silicon carbide	Silicon carbide
Option	Silicon carbide	Carbon

Elastomer Material	Temperature Range	General Notes
EPDM →	Minus 40° C to 150° C max. Minus 40° F to 302° F max.	→ Resistant to steam and most food product — not resistant to organic and non-organic oils and fats.
FPM, →	Minus 20° C to 200° C max. Minus 4° F to 392° F max.	→ Resistant to most chemicals — not suitable for fluids such as water, steam, lye, and acid.
FFPM →	Minus 20° C to 250° C max. Minus 4° F to 482° F max.	→ Resistant to almost all product.

1.6 Motors

The Alfa Laval Twin Screw Pump can operate at a wide speed range from 0 - 3300 rpm (depending on model).

To cover this wide range, the designated motor unit must be suited to cover all intended duties.

1.6.1 Motor Sizing Values

Values to consider when sizing for a motor

Shaft power (kW / HP)
Speed (rpm)
Torque (Nm / (lb.ft))

These 3 values have direct correlation that can be seen by below formulae

Metric units

Power, speed and torque:

$$M = P * 9550 / n$$

where:

P = Power (kW)

M = Torque (Nm)

n = Speed (rpm)

Re-arrange for torque:

$$M = P * 9550 / n$$

This arrangement shows how speed and power impacts on torque:

P = Power (kW)

M = Torque (Nm)

n = Speed (rpm)

Imperial US units

Power, speed and torque

$$M = P * 5252 / n$$

where:

P = Power (hp)

M = Torque (lb.ft)

n = Speed (rpm)

Re-arrange for torque

$$M = P * 5252 / n$$

This arrangement shows how speed and power impacts on torque:

P = Power (hp)

M = Torque (lb.ft)

n = Speed (rpm)

1.6.2 Torque

The main consideration for selecting an electric motor is **torque** - not power.

Running a motor over the rated torque output will cause increased current flow which in most cases will cause the inverter safety features to stop the motor but could lead to permanent damage to the motor windings due to over-heating.

Alfa Laval Twin Screw pumps are designed to operate over large speed ranges, therefore consideration needs to be made to the impact the variable speeds have on the torque output of the motor and the varying power requirements of the pump at the different duty point to ensure sufficient motor power and torque is available over the full speed range.

1.6.3 Speed / Frequency

Frequency correlates directly to the motor speed and normally using a variable frequency drive or inverter.

- Decreasing frequency = Decreasing speed
- Increasing frequency = Increasing speed

The most common supply frequencies are 50 Hz or 60 Hz

	4-pole	6-pole	8-pole
50 Hz	1500 rpm	1000 rpm	750 rpm
25 Hz	750 rpm	500 rpm	375 rpm
10 Hz	300 rpm	200 rpm	150 rpm

	4-pole	6-pole	8-pole
60 Hz	1800 rpm	1200 rpm	900 rpm
30 Hz	800 rpm	600 rpm	450 rpm
10 Hz	360 rpm	240 rpm	180 rpm

The Twin Screw Pump can be configured with direct drive electric motor and geared electric motor.

Pump for Process + CIP = **Direct drive motor via frequency inverter**

Pump for process only = **Geared electric motor.**

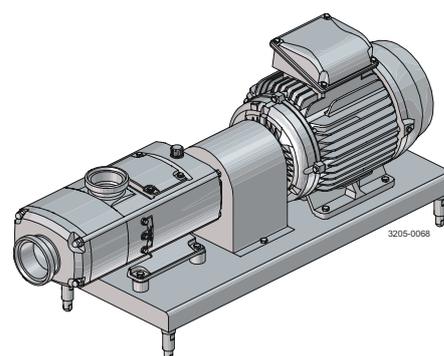
Note: high speed process applications (> 650 rpm) consider direct drive.

Minimum / Maximum frequency range on motors

Default - Self-cooled motors (TEFC) = 10 -120 Hz

Option - Forced blower cooled motors (TEBC) = 5 - 120 Hz

TEBC also known as Forced Fan Ventilation.



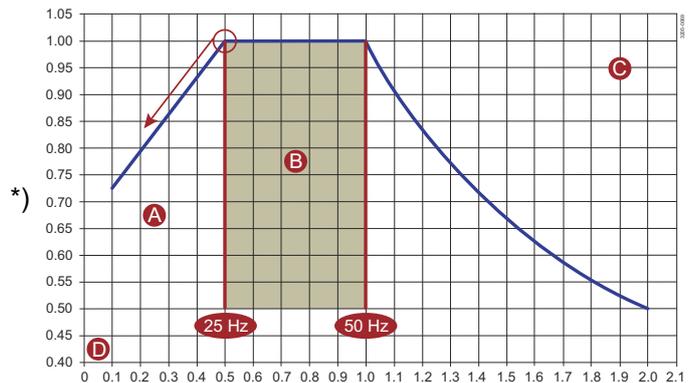
- All motors supplied with Alfa Laval Twin Screw pumps are suitable for frequency inverter use.
- Standard motor offering insulation class F / Temperature rise B (80 Degree Kelvin).
- All applications involving operating speeds under 5Hz, please contact Alfa Laval Technical Support.

1.6.4 Torque / Frequency

An electric motor in theory, will generate constant torque when frequency is reduced below rated value (50/60Hz); This is handled by a Variable Frequency Drive (VFD) also known as an Inverter.

However, physical factors can affect the torque output of the motor when speed is decreased preventing constant torque. For example, in self-cooled motors the torque output decreases as the motor speed reduces. This is caused by the reduced fan speed leading to reduced motor cooling causing an increase in motor temperature and therefore reduced power/torque rated output.

Torque de-rating for self cooling motors



A. Slower the speed. The greater the torque de-rates.

B. Constant Torque Range (No de-rating)

C. Constant flux. Constant V/f. 50 Hz Supply

D. NOTE: 1.0 represents 100 %. Frequency output: 50 or 60 Hz. 0,5 would represent 50 %; 25 or 30 Hz.

[f/f_n] — Operating frequency (p.u.)

*) [T_R] — Torque derating factor (p.u.)

Above shows the relationship of torque to frequency.

With a self-cooled (TEFC) motor on a supply frequency of 50Hz, there is a constant torque between 50 - 25 Hz (50% or 2:1) meaning no de-rating in torque output. Below 25 Hz, the torque output is de-rated due to the slower running speed of the integrated fan, in order to dissipate the additional heat generated.

This torque de-rating is automatically programmed into Anytime.

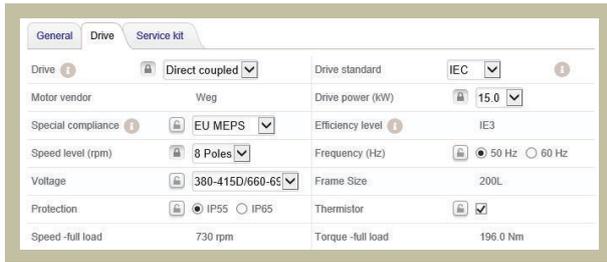
Example: Why size to torque - (Metric Units)

Using a duty where pump requires:

Process : 201 - 460 rpm / power abs: 4.8 - 9.1 kW.

CIP : 1173 rpm / power abs: 10.5 kW.

An 11 kW or 15 kW motor should be sufficient to duty when maximum power is 10.5kW?



Answer:

Not when using torque as the primary value.

With a 15 kW 8-pole,

Torque full-load = 196 Nm

Not sufficient?

Suitable motor needs minimum of 226.2 Nm.

Motor Torque must be higher than Operating Torque at all duty points.

Larger motor size is required to cover FULL duty conditions.

Torque calculation				
Duty	Speed	Frequency	Absorbed Power	Operating torque
Duty 1 – min.	201 rpm	14 Hz	4.8 kW	226.2 Nm
Duty 1 – max.	460 rpm	31 Hz	9.1 kW	188.2 Nm
Duty CIP – max.	1.173 rpm	80 Hz	10.5 kW	85.3 Nm

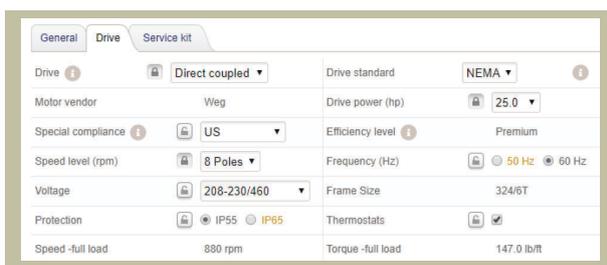
Example: Why size to torque - (US Units)

Using a duty where pump requires:

Process : 201 - 460 rpm / power abs: 6.4 - 12.2 HP.

CIP : 1173 rpm / power abs: 14 HP.

An 20 HP or 25 HP motor should be sufficient to duty when maximum power is 14 HP?



Answer:

Not when using torque as the primary value.

With a 25 HP 8-pole,

Torque full-load = 147 lb.ft

Not sufficient?

Suitable motor needs minimum of 167 lb.ft

Motor Torque must be higher than Operating Torque at all duty points.

Larger motor size is required to cover FULL duty conditions.

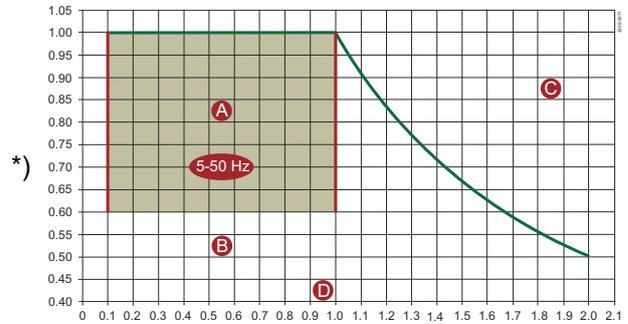
Torque calculation				
Duty	Speed	Frequency	Absorbed Power	Operating torque
Duty 1 – min.	201 rpm	14 Hz	6.4 HP	167 lb.ft
Duty 1 – max.	460 rpm	31 Hz	12.2 HP	138.8 lb.ft
Duty CIP – max.	1.173 rpm	80 Hz	14 HP	62.9 lb.ft

To counter torque de-rating at reduced speeds, the following two options can be considered.

1. Forced blower cooled motors (TEBC) are equipped with a separate fan driven by a separate motor thereby ensuring 100% airflow regardless of motor running speed and no de-rating is required due to increase motor temperature.

This results in 100% torque decreasing to 5Hz ; see below graph -

Torque de-rating for TEBC motors



A. Constant Torque Range (No de-rating)

B. Here we can see full torque from 1.0 (50/60 Hz) down to 0.1 with forced ventilation keeping the motor cool.

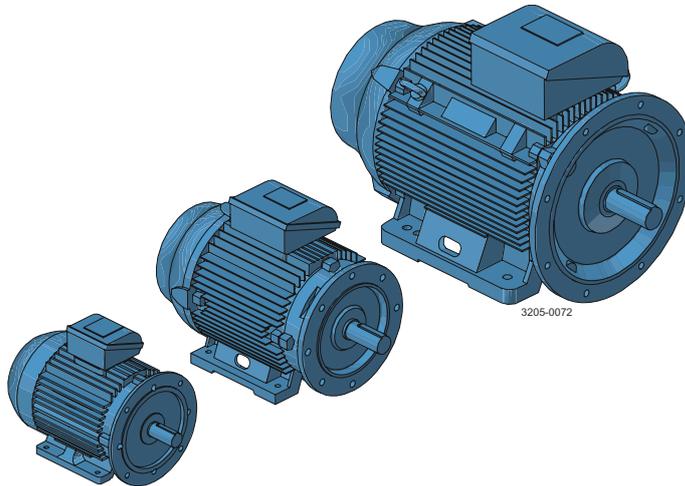
C. Forced ventilation. 50 Hz Supply

D. NOTE: 1.0 represents 100 %. Frequency output: 50 or 60 Hz.

TEBC units can also be used to help optimise motor selections where duty points are below the 2:1 motor turn-down and requires a larger motor to meet torque requirements after de-rating.

2. Increased motor size

Increasing motor size is the alternative solution. With this, the motor is operated at a reduced load. Therefore, there is less power loss and an additional increased thermal reserve due to increased size of the motor.



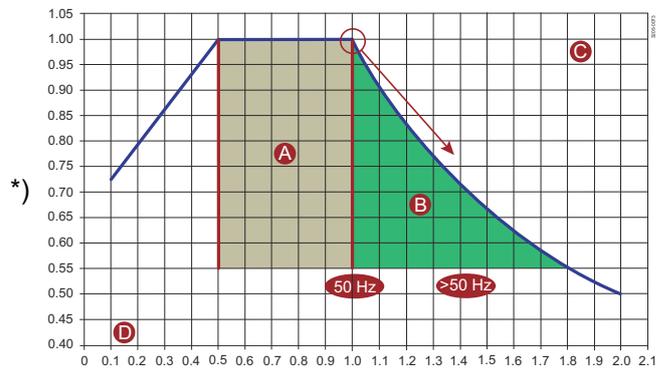
Due to the intended use of the Alfa Laval Twin Screw Pump operating for both process and CIP, consideration is required when the chosen motor could operate above the set supply frequency (50 or 60 Hz) to meet the required CIP duty speed.

Above the nominal frequency the available torque reduces, as the voltage is no longer increasing at higher frequencies the magnetic flux reduces. This range is known as the field weakening range.

A further increase in frequency in the field weakening range therefore results in a torque reduction. See graph below -

- A. Constant Torque
- B. Torque de-rating
- B. Here we can see full torque from 1.0 (50/60 Hz) down to 0.1 with forced ventilation keeping the motor cool.
- C. Forced flux. Constant V/f. 50 Hz Supply
- D. **NOTE:** 1.0 represents 100 %. Frequency output: 50 or 60 Hz. 0.5 would represent 50%; 25 or 30 Hz.

Torque de-rating for self cooling motors



[f/fn] — Operating frequency (p.u.)
 *) [TR] — Torque derating factor (p.u.)

In applications where running speed will be above supply frequency (50/60Hz), motor torque will automatically be de-rated due to limitation available power/voltage.

Motor changes from constant torque to constant power, therefore as speed increases, available torque reduces.

The torque reduces according to the relationship- $M_{AB} / M_{NOM} = F_{NOM} / F_{AB}$

M= Torque

F = Frequency

Example - Frequency at 70Hz

$$M_{70Hz} = \frac{F_{NOM}}{F_{AB}} * M_{NOM} = \frac{50 \text{ Hz}}{70 \text{ Hz}} * M_{NOM} \Rightarrow 71\% * M_{NOM}$$

Anytime has taken the varying torque de-rating on all selectable motors to ensure only the correct motor options can be chosen for required duty/duties.

2 Application Examples

It should be noted that the information given in this section is for guidance purposes only.

2.1 Dairy

Pumped Media	Viscous Behaviour	Viscosity cP (in-pump)	Max. Speed rpm	Sealing	Additional Comments
Milk	Newtonian	5 - 15	< 2000	Single ¹	
Sweetened Condensed Milk	Pseudoplastic	20 - 500	< 900	Single Flush	
Evaporated Milk	Newtonian	10 - 50	< 1100	Single ¹	
Drinking Yoghurt	Pseudoplastic	1 - 10	< 1300	Single ¹	
Stirred Yoghurt	Pseudoplastic	20 - 150	< 1100	Single ¹	
Yoghurt (thick)	Pseudoplastic	50 - 500	< 900	Single ¹	"Gentle" handling < 500 rpm
Yoghurt with Pieces	Pseudoplastic	5 - 50	< 900	Single ¹	"Gentle" handling < 500 rpm
Cream Butter Fat 40-48%	Pseudoplastic	20 - 120	< 900	Single ¹	
Cream BF 15-25%	Pseudoplastic	5 - 15	< 1200	Single ¹	
Cream Cheese	Pseudoplastic	400 - 3000	< 650	Single Flush	Does not flow readily
Cold Butter	Pseudoplastic	300 - 5000	< 500	Single ¹	Needs force feeding. Temperature dependent.
Anhydrous Milk Fat (AMF)	Pseudoplastic	5 - 300	< 650	Single ¹	
Whey Concentrate	Pseudoplastic	500 - 2000	< 650	Single Flush	Does not flow readily
Quark BF 10 - 40%	Pseudoplastic	20 - 800	< 700	Single Flush	
Skyr	Pseudoplastic	80 - 900	< 650	Single ¹	
Lactose Slurry	Pseudoplastic	300 - 750	< 600	Single Flush	Keep product stirred whilst pumping
Whey Permeate	Pseudoplastic	500 - 1000	< 600	Single Flush	High Lactose Content (84% +/- 3%)
Egg White	Pseudoplastic	10 - 30	< 1100	Single ¹	
Egg Yolk	Pseudoplastic	30 - 500	< 650	Single ¹	
Salted Egg Yolk	Pseudoplastic	75 - 650	< 550	Single Flush	
Curds & Whey	Pseudoplastic	30 - 150	< 600	Single ¹	Thixotropic tendencies

¹ Where single seal is shown, it is on proviso that pump is suitably flooded between cycles to ensure no potential dry-running; if not, Single Flushed seal recommended.

2.2 Beverages

Pumped Media	Viscous Behaviour	Viscosity cP (in-pump)	Max. Speed rpm	Sealing	Additional Comments
Brewer's Yeast	Pseudoplastic	100 - 5000	< 650	Single ¹	"Live" Yeast instead of "Dead"
Carbonated Soft drinks	Newtonian	1 - 4	< 1500	Single ¹	A positive suction pressure must be present
Beverage Syrups	Pseudoplastic	50 - 750	< 1200	Single Flush	
Fruit Juice	Pseudoplastic	< 10	< 2000	Single Flush	
Fruit Juice with Pulp	Pseudoplastic	< 10	< 900	Single Flush	
Fruit Juice Concentrate	Pseudoplastic	200 - 1500	< 1000	Single Flush	
Wine	Newtonian	1	< 1500	Single ¹	
Beer	Newtonian	1	< 2000	Single ¹	
Coconut Water	Newtonian	1 - 5	< 2000	Single ¹	

¹ Where single seal is shown, it is on proviso that pump is suitably flooded between cycles to ensure no potential dry-running; if not, Single Flushed seal recommended.

2.3 Sugar Solutions

Pumped Media	Viscous Behaviour	Viscosity cP (in-pump)	Max. Speed rpm	Sealing	Additional Comments
Sugar Syrup Brix 60 -75%	Newtonian	40 - 650	< 750	Single Flush	Temperature dependent (Values assumed 40 - 60°C) Consideration for hardened screws
Glucose	Newtonian	350 - 4500	< 850	Single Flush	Temperature dependent (Values assumed 55 - 70°C) Consideration for hardened screws
Invert Sugar Syrup 77% Brix	Newtonian	100 - 800	< 1000	Single Flush	Temperature dependent (Values assumed 40 - 50°C)
Liquid Sugar	Newtonian	800 - 5000	< 1100	Single Flush	Temperature dependent (Values assumed 30 - 50°C)

2.4 Prepared foods

Pumped Media	Viscous Behaviour	Viscosity cP (in-pump)	Max. Speed rpm	Sealing	Additional Comments
Fruit Purees	Pseudoplastic	20 - 850	< 800 <500 (solids)	Single Flush	If hard solids present, Consideration for hardened screws
Fruit Preparation	Pseudoplastic	20 - 750	< 800 <500 (solids)	Single Flush	If hard solids present, Consideration for hardened screws
Baby Food	Pseudoplastic	250 - 1200	< 500	Single ¹	
Meat, Mince Emulsion	Pseudoplastic	500 - 20000	< 400	Double Seal	Almost non-flowing. Hardened screws if bones or cartilage is present
Tomato Sauce	Pseudoplastic	5 - 50	< 800	Single Flush	Sugar
Ketchup	Pseudoplastic	20 - 500	< 500	Single Flush	Salt, sugar, vinegar con. % dependent. Consideration for hardened screws
Mayonnaise	Pseudoplastic/ Thixotropic	25 - 100	< 600	Single ¹	Slower speeds to ensure stable emulsion
Edible Oil	Newtonian	10 - 100	< 2000	Single ¹	
Pet Food	Pseudoplastic	30 - 1400	< 750	Single Flush	Solids size dependent
Jam	Pseudoplastic	100 - 500	< 700	Single Flush	
Soups (Various)	Pseudoplastic	10 - 200	< 700	Single Flush	Solids size. % dependent
Gelatine	Newtonian	200 - 1000	< 750	Single Flush	Slight pseudoplastic tendencies
Honey	Newtonian	150 - 1000	< 850	Single Flush	
Peanut Butter	Pseudoplastic	100 - 3000	< 750 <500 (solids)	Single Flush	
Soy Bean Protein Solution	Pseudoplastic	1 - 15	< 1150	Single Flush	

¹ Where single seal is shown, it is on proviso that pump is suitably flooded between cycles to ensure no potential dry-running; if not, Single Flushed seal recommended.

2.5 Personal / Homecare

Pumped Media	Viscous Behaviour	Viscosity cP (in-pump)	Max. Speeds rpm	Sealing	Additional Comments
Sodium Lauryl Sulphate 27% (SLES)	Pseudoplastic	100 – 350	< 1050	Single ¹	Single Flush preferable
Sodium Lauryl Sulphate 70% (SLES)	Pseudoplastic	100 – 500	< 850	Single ¹	Single Flush preferable
Cocamidopropyl betaine (CAPB)	Newtonian	10 – 100	< 600	Single Flush	Slight shear-thinning properties. Not be allowed to settle in pump. Needs frequent clean.
Linear-Alkylbenzene Sulfonic Acid (LABSA)	Newtonian	250 – 1000	< 800	Single Flush	Temperature dependent Values assumed 30 - 50°C
Fatty acid	Newtonian	5 – 1000	< 1200	Single ¹	Consideration for heating jacket to maintain temperature.
Liquid Soap	Pseudoplastic	20 – 300	< 1050	Single ¹	
Detergents (various)	Newtonian/ Pseudoplastic	50 – 500	< 1050	Single ¹	Single Flush preferable. Dependent on contents / concentration.
Hair Gel	Pseudoplastic	90 – 400	< 850	Single ¹	Temperature dependent Values assumed 10 - 20°C
Toothpaste (Gel)	Pseudoplastic	400 – 4000	< 500	Single Flush	Almost non-flowing. If abrasive silica or micro-beads present; consideration for hardened screws.
Toothpaste (Chalk)	Pseudoplastic	1000 – 6000	< 400	Single Flush	Almost non-flowing. Consideration for hardened screws.

¹ Where single seal is shown, it is on proviso that pump is suitably flooded between cycles to ensure no potential dry-running; if not, Single Flushed seal recommended.