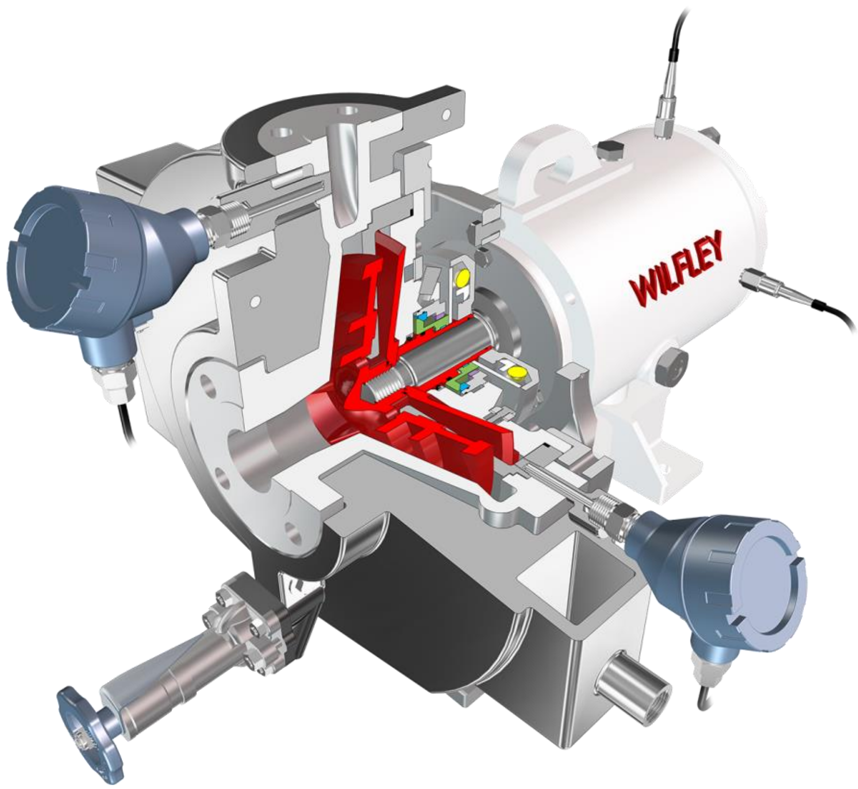
MODEL A7 & A9

Chemical Process Pump



Application Guide – A7 & A9
A2552

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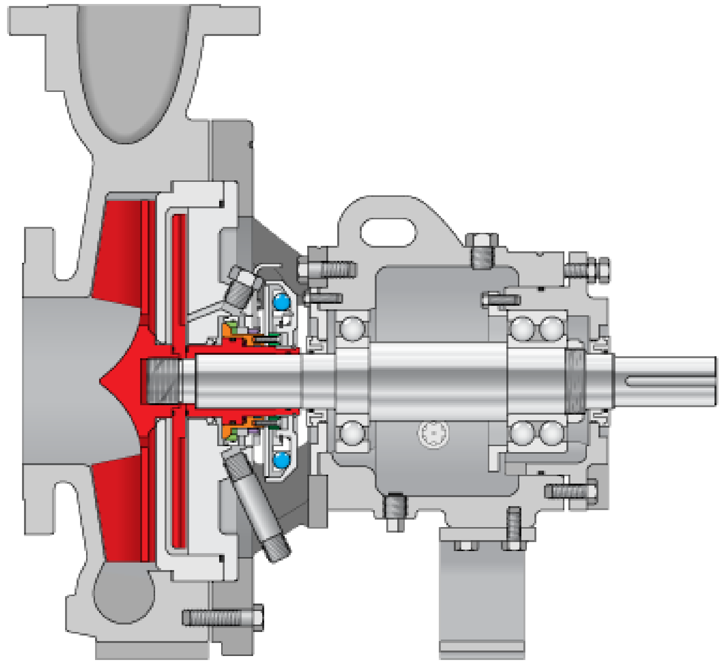
Wilfley A7 & A9 Chemical Pump



The Wilfley model A7/A9 is a heavy duty, chemical process pump designed to meet or exceed ASME B73.1 specification. The ANSI standard sizes offered allow a selection from a broad range of flow capacities and discharge heads. With impeller sizes from 6-inch to 19-inch nominal diameters suited for up to 3600rpm applications, there is a pump for a wide range of conditions. The A7/A9 centrifugal pump is an end suction overhung pump with a semi open or enclosed impeller designed for use in the process and chemical industry. The A9 is an evolution of the A7 pump line with features that improve the reliability and robustness. The two pumps are similar overall although they do differ in seal options and durability.

The heavy-duty construction of these pumps provides a longer service life in many demanding applications where competitors' pumps simply do not hold up. Beware, pump selection must be carefully accomplished to ensure success. In broad terms this means attention to details and proper review of:

- Hydraulic conditions.
- Mechanical loads imposed by hydraulic rating, pumpage and environment.
- Sealing the pumpage where the shaft penetrates the casing.
- Corrosion and erosion resistance.
- Operating conditions.

Although not comprehensive, this guide was issued to aid in some of the more common yet technical and application specific concerns regarding A7/A9 pump selection. The content of this manual should serve to supplement the A7/A9 Installation, Operation, and Maintenance manual (IOM A2550).

This manual assumes that the reader has a fair knowledge regarding pump selections and performance curves. It is meant to provide additional detail useful when application specific questions arise, such as operating pressure, materials of construction, or seal offerings.

CENTRIFUGAL PUMP BASICS

Proper selection and application of pumping technology can greatly improve the reliability of a pumping system. The process requirements should be determined before selecting a pump system.

Be aware that centrifugal pumps are not suited for high viscosity liquids (greater than 65 centistokes). As the viscosity of pumped liquids increases, centrifugal pumps lose efficiency, produce less head, and have lower capacity. Pumped liquids with viscosities greater than 45 cS can cause severe inefficiencies in centrifugal pumps. For applications such as this, careful consideration should be put forth in the pump selection.

Due to the inherent nature of a centrifugal pump, the head developed by a centrifugal pump is limited by the impeller size or speed of operation. Typically, centrifugal pumps are not self-priming and they have limited ability to pump fluids containing vapors. Please take care in proper pump selection. If you are unsure about some of these factors when selecting the A7/A9 pump, please contact your Wilfley representative to assist with the proper unit for the job.

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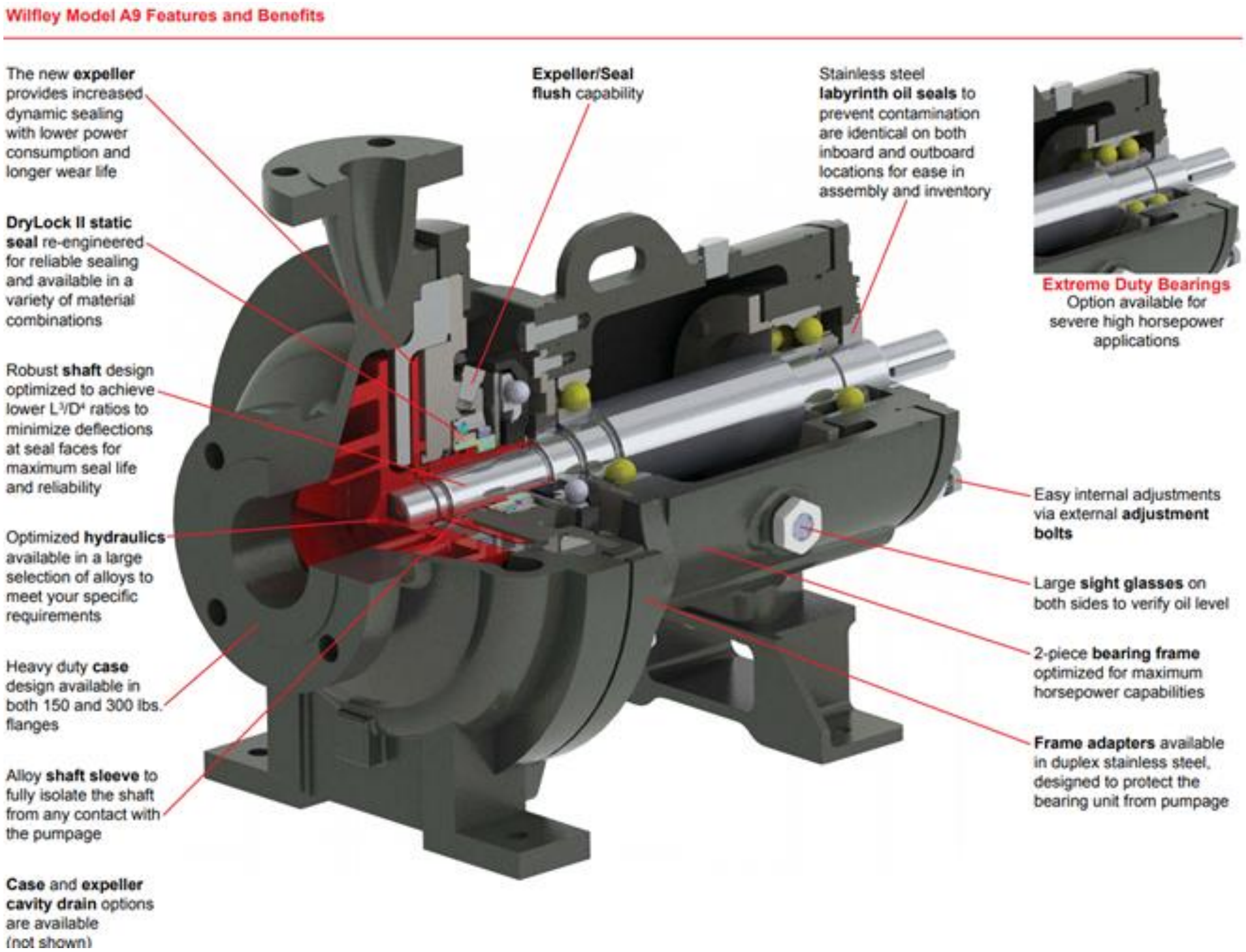
SPECIAL FEATURES OFFERED

Although there is no true "standard" configuration A7 / A9 pump, there are several common features that are sold on almost every pump as well as more unique special options and configurations. Generally, the fewest special options selected will allow for the most economical pump in the shortest lead time. Certain special features are pre-engineered and available with no impact on delivery. However, special variations may be included as "engineered" options that will require extra cost and increased lead time for delivery. See the charts below for some less common offerings.



Standard Specifications
Oil-lubricated bearings
2-Piece frame (Ductile Iron)
Oil Level sight glasses
4340/4140 HT Shaft
O-Ring material: VITON
Wet end without auxiliary connections
150# raised-faced flanges, ANSI
Impeller with balance holes

Pump Frame Options
Extreme duty bearings (Frame 2, 3 & 4)
Stainless steel shaft
Protective coated shaft (P.T.F.E. , Ni)
Vibration monitoring
C Frame Adapter
SS or PTFE Coated hardware

Seal Options
Drylock Seal
Solidlock Seal
Single Mechanical Seal
Double Mechanical Seal
Backup Seals
Compression Packing

Wet end options	Materials
Suction & discharge pressure ports	Ductile Iron
Case drain port	304/316 Stainless
Discharge thermowell	Stainless CD4Mcu
Expeller thermowell port	WCD4 Duplex
High temperature modifications	Max 5
Steam Jacketing (Casing & Seal housing)	Alloy 20
Flat faced flanges	Alloy C & C Max
150 or 300# flanges	High Nickel Alloy
DIN flanges	Alloy B
Seal flush connections	Alloy G
Flush plan components	
Impeller Balance Holes	
Impeller lock	
Vortex/Recessed Impeller	
Low flow high head hydraulics	
Seal Housing Drip lip	

Gaskets & O-ring Options
Viton™(FKM)
Kalrez®
EPR/EPDM
TEFLON™(PTFE) encapsulated
AFLAS® (TFE/P)

Lubrication Options
Grease lubrication
Constant level oiler
Cooling Provisions (high temperature)
Oil mist configuration

Subbase Options
Overhead platforms
Fabricated baseplate
Polycrete baseplate
Bent plate baseplate
Special fabrications
Stainless steel construction

For ENGINEERED SPECIALS, contact Denver Sales and Engineering. 5870 E. 56th Avenue, Commerce City, CO 80022 USA • Toll Free: 1-800-525-9930 • Phone: +1 (303) 779-1777 • www.wilfley.com • pumps@wilfley.com

PUMP SELECTION

Proper pump selection requires a knowledge of the intended conditions of service as well as some parameters related to material compatibility. The appropriate engineer should be able to assist in identifying the proper pump for your process fluid. There are several variables and inputs that these experts will be able to consider when identifying the proper pump for the job. Below is a list of different details that must be known before there is confidence that the pump selection truly is correct for the application in question.

- Material of construction (pH of fluid)
- Shaft seal type
- Piping size
- Operating Conditions (Speed, head, flow, efficiency)
- Future capacity increases
- Material specific gravity and viscosity
- Dynamic seal Maximum Intake Head considerations
- Casing pressure limitations
- Motor selection and sizing (frequency, number of poles, HP, frame size)
- Drive controller
- Accessory Items (sub-base, couplings, guards)
- Fluid operating temperatures
- Cavitation concerns (Vapor pressure & boiling points)
- Min. safe continuous Flow: Radial and Axial loads
- Operating and lifecycle costs
- Solids percentage and associated component wear
- Number of operation stages
- Condition monitoring
- Power limits of Frame, shaft deflection
- Losses due to operation altitude

While this guide is not intended to cover every facet of the selection or application specific criteria of the model A7/A9, it is intended to provide additional detail relevant to those looking for additional technical data.

MATERIALS OF CONSTRUCTION

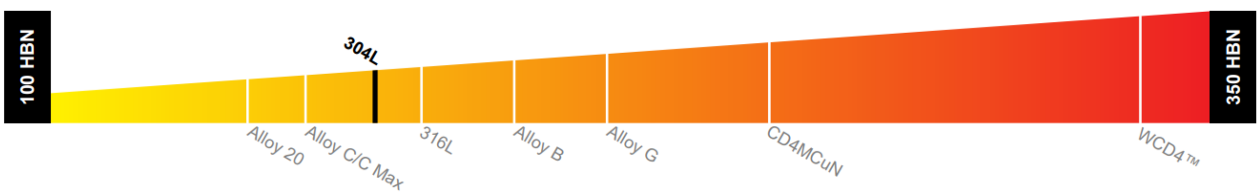
A wide range of materials are offered for the A7/A9 family of pumps. The selection of these materials is application specific and should be scrutinized by an expert to ensure the proper specifications of a pump. Consideration should be given to chemical compatibility and corrosion resistance, pressure limitations, operating temperatures, abrasion and wear, as well as the corresponding costs and lead time considerations.

BASIC MATERIAL PROPERTIES

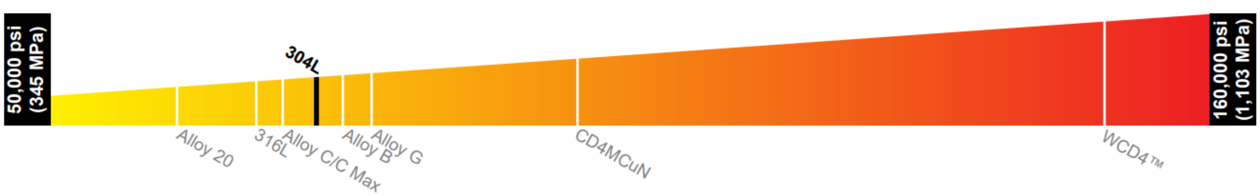
MATERIAL NAME	ASTM SPECIFICATION	TENSILE STRENGTH ksi (MPa)	YIELD POINT ksi (MPa)	ELONGATION (%)	HARDNESS (BRINELL)
Ductile Iron	A395	60 (410)	40 (275)	18	160
304/304L Stainless	A744, Gr. CF-3	75 (517)	30 (206)	35	170
316/316L Stainless	A744,Gr. CF8M	70 (483)	30 (206)	30	180
Alloy 20	A744,Gr. CN7M	62 (427)	25 (172)	40*	140
CD4MCuN	A890, Gr. 1B	100 (690)	70 (483)	15	250
Wilfley WCD4™	A890, Gr. 1B (Modified)	164 (1130)	113 (779)	16	345
Maxalloy 5	A532 Class III, Type A	80 (550)	--	--	615
Alloy B	A494 N7M (Modified)	76 (524)	40 (275)	20	200
Alloy C / C Max	A494 CW2M	72 (138)	40 (275)	20	155
Alloy G	A494 CX2MW	80 (550)	45 (310)	30	210

* Wilfley A20 has better elongation than ASTM requirement.

Average Hardness



Minimum Tensile Strength



MAXIMUM ALLOWABLE WORKING PRESSURES/ TEMPERATURE

Maximum allowable working pressures are based on material composition and flange limitations. Below is relevant information regarding maximum working pressures for A7/A9 pumps at 100° Fahrenheit (38° C). Pump discharge plus intake head must not exceed these pressures! Note this table is for Class 150 Flanges.

Pressure	US Customary	Metric
Ductile Iron	290 psi	20.00 bar
304 & 316 Stainless	275 psi	19.00 bar
304L & 316L	230 psi	15.90 bar
Alloy 20	230 psi	15.90 bar
CD4MCuN	290 psi	20.00 bar
Wilfley WCD4™	300 psi	20.70 bar
Maxalloy 5	167 psi	11.50 bar
Alloy C	275 psi	19.00 bar

The associated temperature limits reduce the maximum allowable working pressure. Outright temperature limitations are show below based on material.

Temperature	US Customary	Metric
Ductile Iron	400° F	200° C
304 & 316 Stainless	280° F	138° C
304L & 316L	280° F	138° C
Alloy 20	280° F	138° C
CD4MCuN	400° F	200° C
Wilfley WCD4™	400° F	200° C
Maxalloy 5	100° F	38° C
Alloy C	100° F	38° C

Review the flange pressure vs temperature limitations below shown for a few different materials. Contact your Wilfley regional rep for additional assistance in selecting the proper material of construction. Select applications may exceed the temperature limits above, but only after a thorough analysis by a qualified Wilfley representative for each individual application.

Note that cases and seal housings are hydrostatically tested at conditions above the maximum allowable working pressure for integrity. These pressures are based upon the flange rating of the case and the material of construction.

MINIMUM TEMPERATURES

Minimum temperatures for A7 /A9 pumps are usually dictated by process fluid as well as lubrication reliability. The most adverse effects of cold climate are icing and process fluid freezing, which may result in various detrimental phenomena such as additional weight loads, physical obstruction, change of material properties, freezing expansion damage, and electrical components failures. Cold climate effects on centrifugal pump design and operation must be carefully assessed before installation since any carry over work may drastically impair project execution. Heaters are recommended when minimum ambient temperatures are below 40°F (4°C) as freezing temperatures are usually detrimental to centrifugal pumps.

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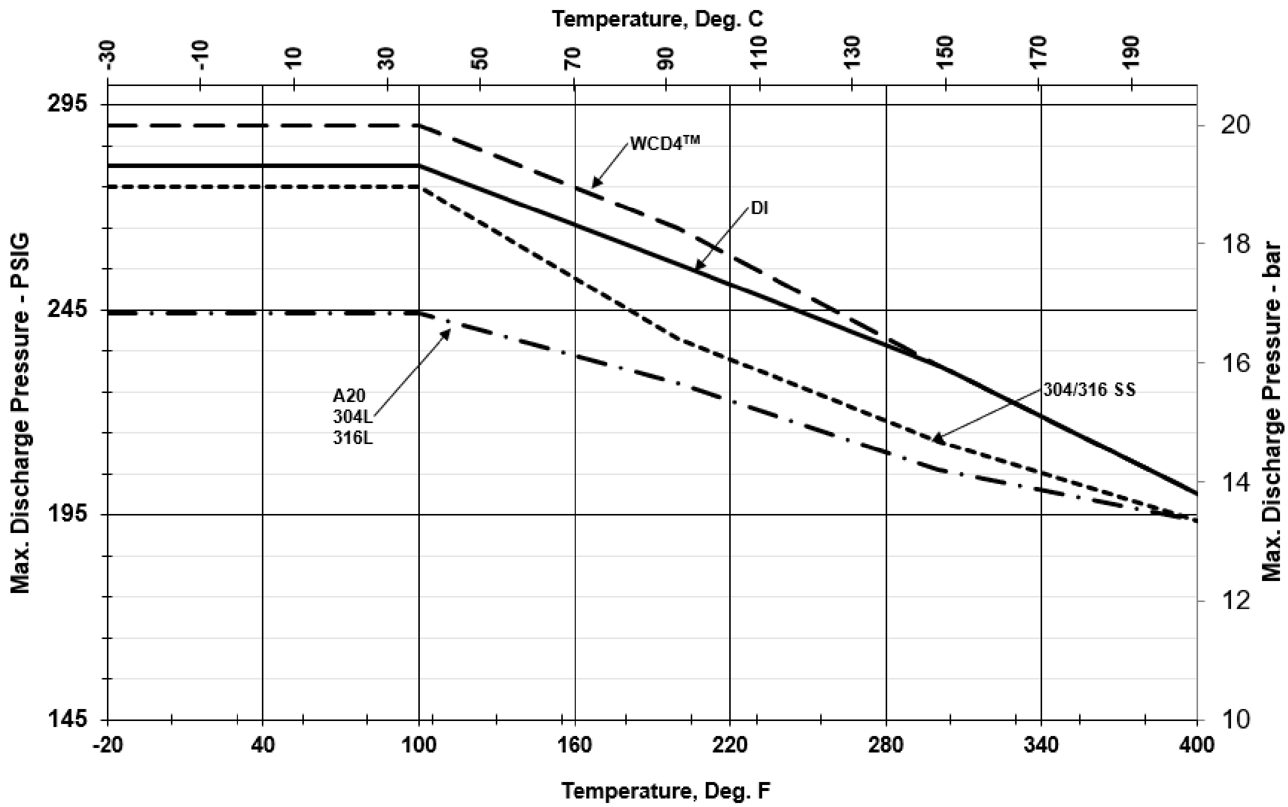
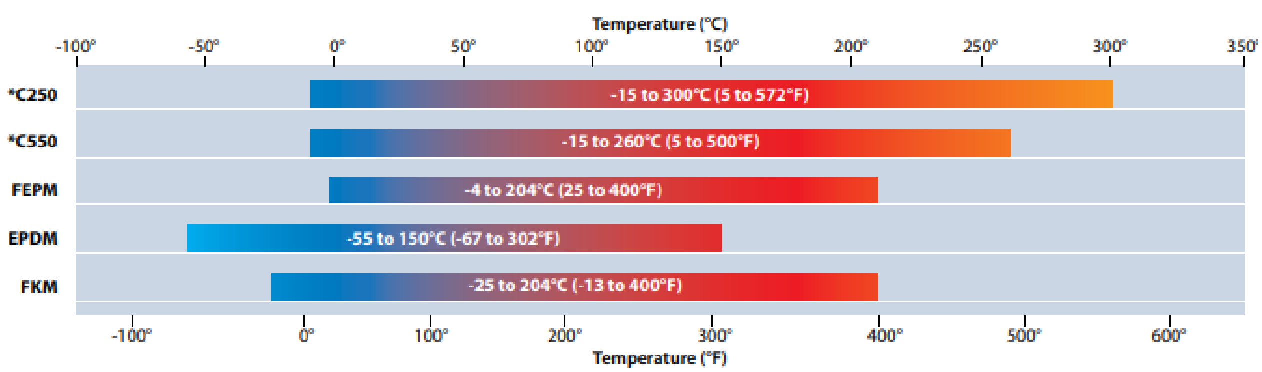
CLASS 150 FLANGES: PRESSURE –TEMPERATURE RATINGS



TEMPERATURE LIMITS OF ELASTOMERS



Material of Construction	pH Range
Ductile Iron	6 – 9
304 & 316 Stainless	3 – 10
304L & 316L	4 – 10
Alloy 20	2 - 10
CD4MCuN	2 – 13.5
Wilfley WCD4™	2 – 13.5
Maxalloy 2	4.5 – 12

pH VALUES

Alloy C	2 – 12

The pH values should only be used as a guide with weak aqueous solutions. For more corrosive solutions, temperature and chemical composition should be carefully evaluated in the material selection.

The pH of a liquid is an indication of its corrosive qualities, either acidic or alkaline. It is a measure of the hydrogen or hydroxide ion concentration in gram equivalents per liter. The scale of pH values is from zero (acidic) to 14 (basic), with 7 as a neutral point. The table below outlines materials of construction usually recommended for pumps handling liquids of known pH value.

CHEMICAL COMPATIBILITY

Wilfley recommends referencing Iso-corrosion diagrams for different materials as a guide in the selection of materials. The corrosion rates may vary widely with temperature, concentration, and the presence of trace elements or abrasive solids. For more information, it is highly recommended to review chemical compatibility charts for elastomers and gaskets of each individual application to ensure intended functionality of parts.

SOLIDS HANDLING GUIDELINES

The A7/A9 chemical and process pump is designed for what are considered clean liquids. It may also pump liquids with dissolved solids, though wear of internal components will increase if those solids are abrasive. Refer to Hydraulic Institute ANSI 12.1-12.6 for additional detail on pumping solids. The A7/A9 may pump solids outlined in the HI standard as Class I and Class II.

Although some solids can be tolerated, pumping abrasive particles is not suggested with these pumps, especially at motor speeds above 1750 RPM. Solids should be limited to no more than 40% by volume fine solids. The cleaner the fluid, the smaller the particles and the lower the operating speed, the less wear will occur.

CORRECTION OF PUMP PERFORMANCE FOR VISCOUS LIQUID

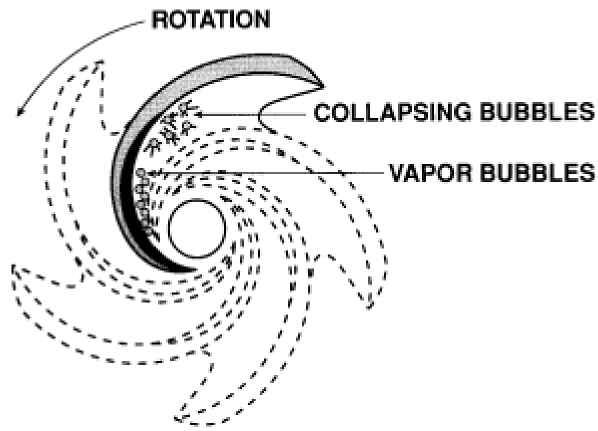
Viscosity is a measurement of a fluid’s resistance to flow, or in order words, the ability of said fluid to be pumped. The pump performance is negatively affected when handling viscous liquids**.**
A marked increase in brake horsepower, a reduction in head and some reduction in capacity occur with moderate and high viscosities.

The Hydraulic Institute provides correction curves for determining the performance of a pump handling a viscous liquid when its performance on water is known. Said charts are to be used only within the scales shown. Do not extrapolate. Use only when adequate NPSH is available in order to avoid cavitation. For non-uniform liquids (slurries, gels), the characteristic of the liquid may produce varying results. An increase in viscosity will dramatically reduce the pump efficiency. Because of this, the net result will result in a marked increase in brake horsepower when compared with a less viscous fluid at the same pumping condition. Always be aware of the considerations of viscous materials with centrifugal pumps. Too viscous and the pump will be efficiency impaired or may not pump at all.

VAPOR PRESSURE

The vapor pressure of a liquid is the absolute pressure at which the liquid vaporizes or converts into a gas at a specific temperature. Normally, the units are expressed in pounds per square inch absolute (psia). The vapor pressure of a liquid increases with its temperature. For this reason, the temperature should be specified for a declared vapor pressure.

CAVITATION

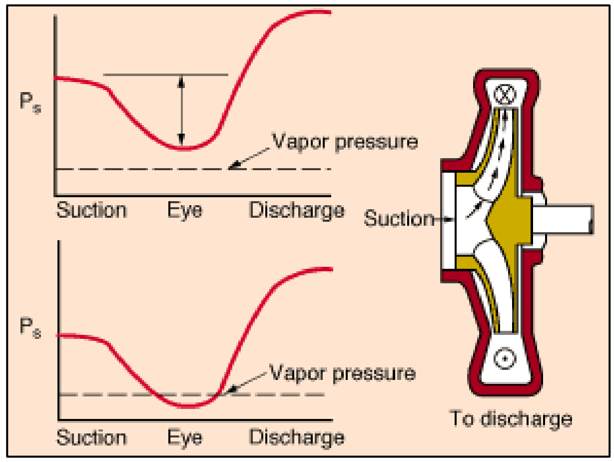


Cavitation occurs when pressure inside the impeller drops below the vapor pressure of the solution being pumped. Vapor bubbles form which collapse as the bubbles move through the impeller and pressure increases. This will result in damage as well as a decrease in pump performance, generally identified by noise and vibration. If the pump operates under cavitating conditions for enough time, the following can occur:

- Pitting marks on the impeller blades and on the internal volute casing wall of the pump.
- Premature bearing failure.
- Premature mechanical seal failure.

These problems may occur because of:

- A reduction of pressure at the suction nozzle.
- Shaft breakage and other fatigue failures in the pump.
- An increase of the temperature of the pumped liquid.
- An increase in the velocity or flow of the fluid.
- Separation and reduction of the flow due to a change in the viscosity of the liquid.
- Undesirable flow conditions caused by obstructions or sharp elbows in the suction piping.
- The pump is inadequate for the system.

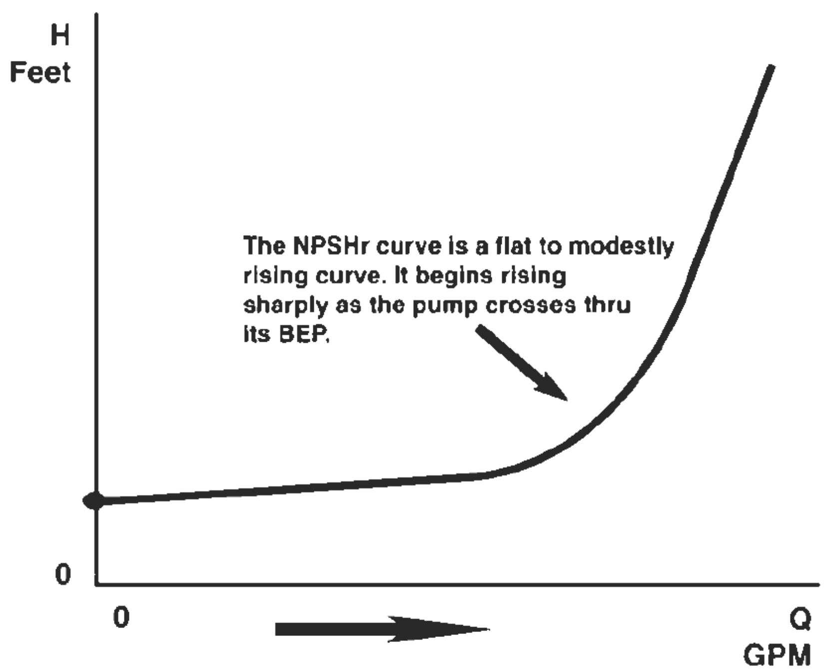


Proper selection for a pump should include sizing and analysis regarding vapor pressure, the potential for cavitation and NPSH requirements for each application.

NPSH$_A$ Sizing

Net Positive Suction Head Available -- NPSH$_A$ the measure of the energy in a liquid above the vapor pressure. It is used to determine the likelihood that a fluid will vaporize in the pump, which is an important parameter to consider.

Inadequate NPSH$_A$ can result in severe vibrations, premature wear, deterioration of the Total Dynamic Head (TDH) and possibly a damage to the pump. NPSH$_A$ must be accurately determined and a proper margin should be maintained to ensure good reliable operation. Inadequate NPSHa establishes favorable conditions for cavitation in the pump. If the pressure in the eye of the impeller falls below the vapor pressure of the fluid, then cavitation an begin and damage may result.



$NPSH_R$

Since optimum reliability and life will be achieved when little or no cavitation is present, an operating safety margin must be applied to such that the NPSH used is less than $NPSH_A$. NPSH – Required ($NPSH_R$) is determined in accordance with Hydraulic Institute standards. It is the point where the TDH has decreased 3% from normal. As a rule, a margin of 3 feet (1 meter) is usually adequate. The $NPSH_R$ is typically shown on the pump curves.

If the $NPSH_R > NPSH_A$ consider the following:

* Decrease speed
* Use larger size pump

EFFICIENCY

Generally, it is best to aim for the highest pumping efficiency of a pump when selecting and sizing a unit. This will reduce overall operating costs as far as energy consumption. But be aware unit costs may be related to seal usage and replacement such as if a mechanical seal must be exchanged on a regular basis.

VIBRATION

Allowable values for pump vibration shall be in accordance with Hydraulic institute ANSI/HI 9.6.4 standard. Pumps operating far from BEP will have higher vibrations due to radial and or axial loading. Pumps operating at higher speed will also be prone to more vibrations.

SEAL CONFIGURATIONS

Sealing is traditionally most troublesome for pumps, but it also happens to be the area where problems unique to each application exist. Wilfley offers pumping problems that the big guys do not always want to solve. One of those areas is the selection of the seal which the A7/A9 pump has received special attention. The A7/A9 family of pumps offers several seal options to solve the most challenging problems regards to centrifugal pump sealing.

Wilfley A7/A9 pumps can be equipped with a variety of seals including the Solidlock® seal, DryLock® seal, a full range of mechanical seal accommodations as well as compression packing. For different sizes of the A7/A9 pump, there may be Drylock seal designations (i.e. Drylock II). Be aware they are similar in design, but small improvements were made for reliability, performance, and fit.

SEAL INFORMATION CHART

Seal Name	Seal Type	Runs Dry	Solids	Crystallizing liquids	Vapors	High Temp.
Solidlock® Seal	Dynamic	Yes	Yes	Yes	No	No
DryLock® Seal	Dynamic	Yes	No	No	No	Yes
Mechanical Seal (Tapered)	Mechanical	No	No*	No	Yes	Yes
Mechanical Seal (Straight Bore)	Mechanical	No	No*	No	Yes	Yes
Compression Packing	Mechanical	No	Yes	No	No	No

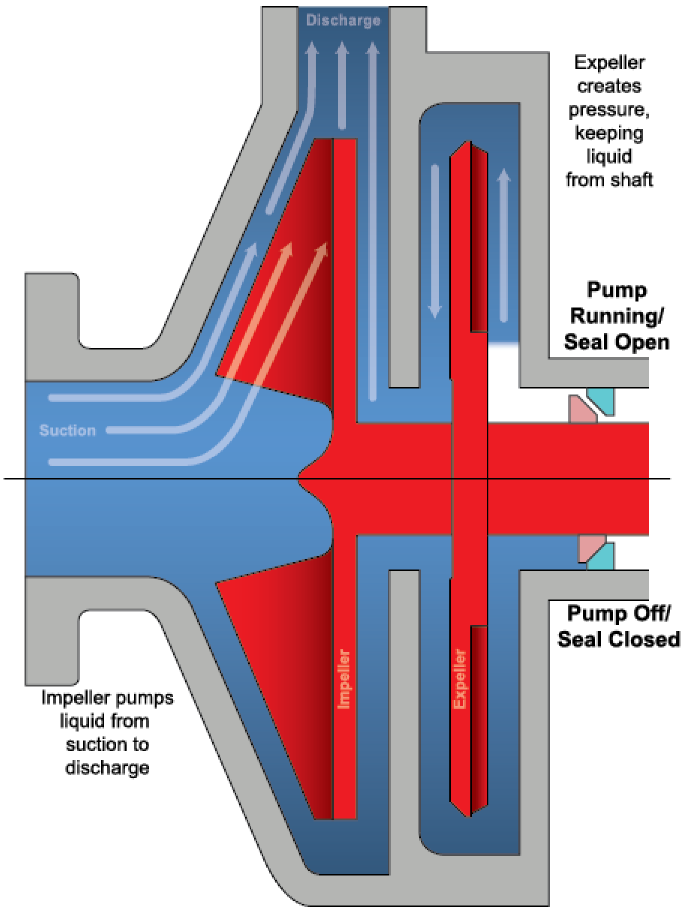
***Per Mechanical Seal Manufacturer's Recommendations**

For further information regarding seal specific questions, or when one type of seal may be advantageous, please contact the Wilfley sales and application team for assistance.

SEAL CAVITY

The integrity of any centrifugal pump seal depends on the conditions of the environment. Generally, all seals follow the idea that the cleaner and better controlled the fluid is within the seal cavity, the more reliable performance will result.

DYNAMIC SEAL - Function



The Wilfley dynamic seal is an effective solution to some problems of the centrifugal pump. This concept has it roots back to the early 1900's where the earlier Wilfley pumps were created.

The dynamic seal is quite simple in nature. When the pump is not operating, fluid is captured by the machanical closure of two seal faces. When operating, the dynamic secondary expeller sends fluid away from the seal faces. During operation, the seal faces separate and there is no physical surface on surface contact.

The secondary expeller holds the fluid in position during operating. It will also operate without issue if the tank level runs dry as no seal faces will touch or burn up, such as with traditional mechanical seals.

The dynamic seal technology is favorable to compression packing as there is no required flush water to dilute the system or packing glad/shaft sleeve that will wear out. This simplifies maintenance for certain applications and provides a drastic reduction in leakage.

Both Drylock and Solidlock seals used on the A7/A9 family of pumps use the secondary expeller in addition to a dynamic moving seal where the seal faces move back and force between shut off position and operating position.

Suction pressure and Dynamic seals

Dynamic seals have one criterion that must be reviewed before proper pump selection. The suction pressure must not exceed the expeller capability or leakage could occur. For additional detail, see the Air Ingress section of this guide. If the pump is leaking while running, the pumpage will damage the seal faces. Leakage may not be evident immediately but eventually the liquid will get between the seal faces and lead to seal failure. **Check suction pressure limits at all operating speeds.**

The pump operating speed must always be above the recommended minimum speed; otherwise, the seal faces will remain in contact (closed position) and they will overheat and be damaged. **Applications using Variable Frequency Drives should be evaluated with care to be sure that this will not occur at any speed.**

Dynamic Seal Flushing

The seal surfaces must be kept free of deposits of solids to maintain the functionality. There are access ports allowing the expeller cavity to be flushed and drained, along with a seal flush and seal drain port to empty the contents of the cavity during maintenance.

In some applications, this requires washing the expeller cavity before shutting down and before pump start-up. In these applications, crystallization or particulate build up may cause operational and reliability concerns. Since small differences can affect these applications in unpredicted ways, it is recommended that the seal flush connection be incorporated and available if later needed. High-pressure flushing of the system must be avoided. If high-pressure steam or liquid is employed for cleaning the system (especially for solids handling services), it is possible to damage the lip of the stationary seal through bending or cracking.

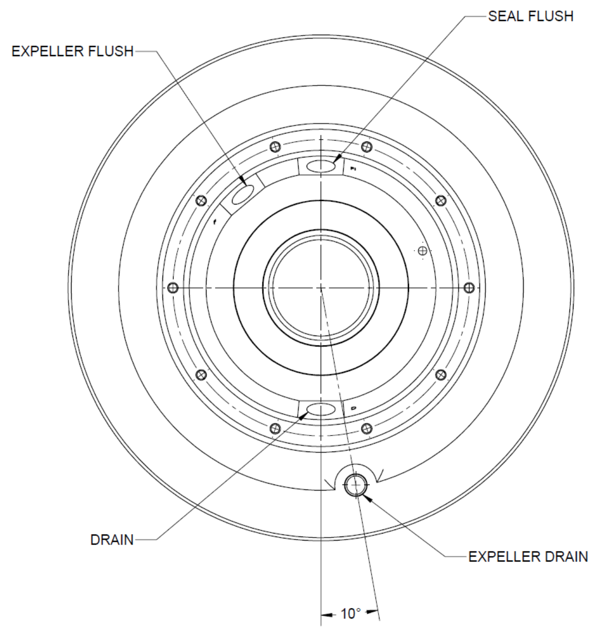


Figure - The back side of the seal housing

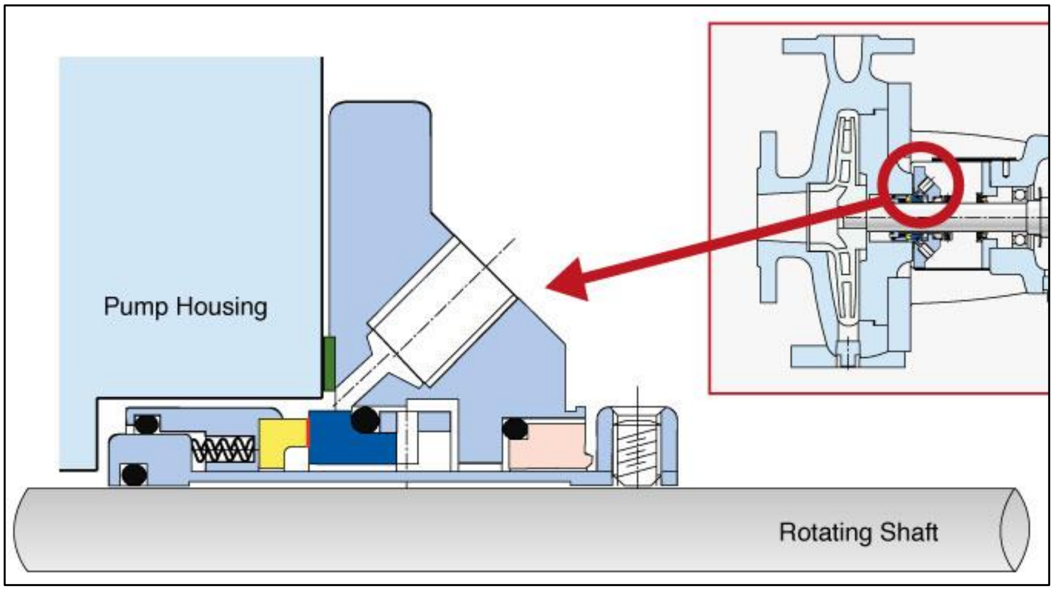
Information about the pumped fluid and past issues experienced on the production line is extremely important in determining if expeller flush is required. Some liquids pump very well within a given range of temperatures but sometimes contact with the atmosphere produces drastic changes in the pumping characteristics such as higher viscosities, crystallization, or settling. Washing improves seal mobility, but reduced life should be expected under the following adverse conditions:

- Liquids with settling solids, more than 15% by weight. The settling solids may become entrapped and break the lip of the stationary seal, thereby damaging the seal surface.
- Caustics, brines, crystallizing solutions.

These are applications that must be carefully analyzed, sometimes requiring intermittent flushing even during operation for continued reliable performance.

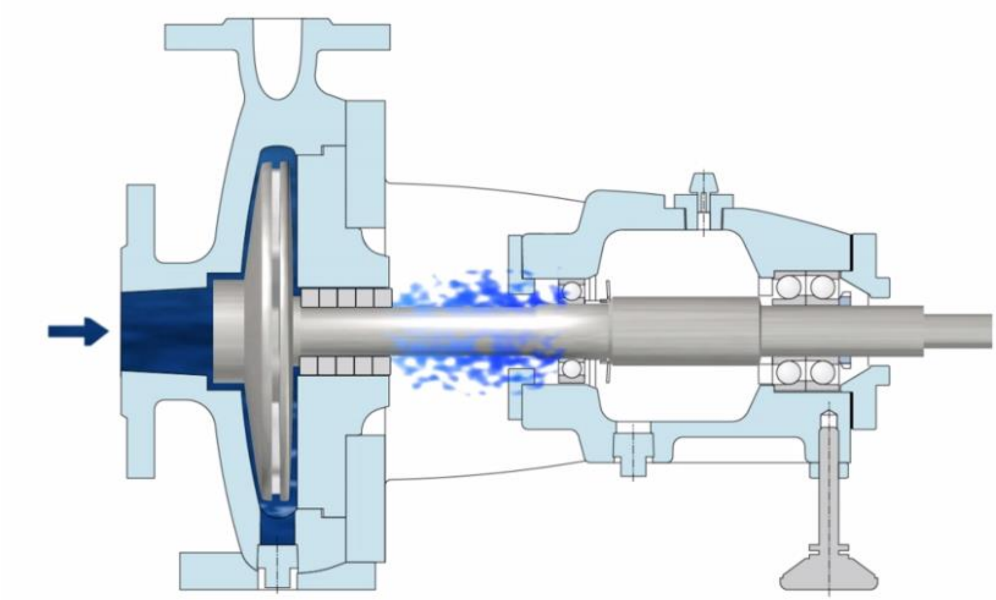
MECHANICAL SEAL - Function

Centrifugal pumps may be sealed with a what is known as a mechanical. These units are produced by seal manufacturers and usually involve a cartridge assembly that may be installed onto standardized shaft sizes. For proper operation, fluid is required at the seal faces for reliability and performance. Usually this is accomplished by what are known as Flush plans. Generally, mechanical seals are reliable. The A7/A9 series of pumps can accommodate a variety of seals manufactured by different vendors, including double mechanical seals. Often, mechanical seals require a flush water source.



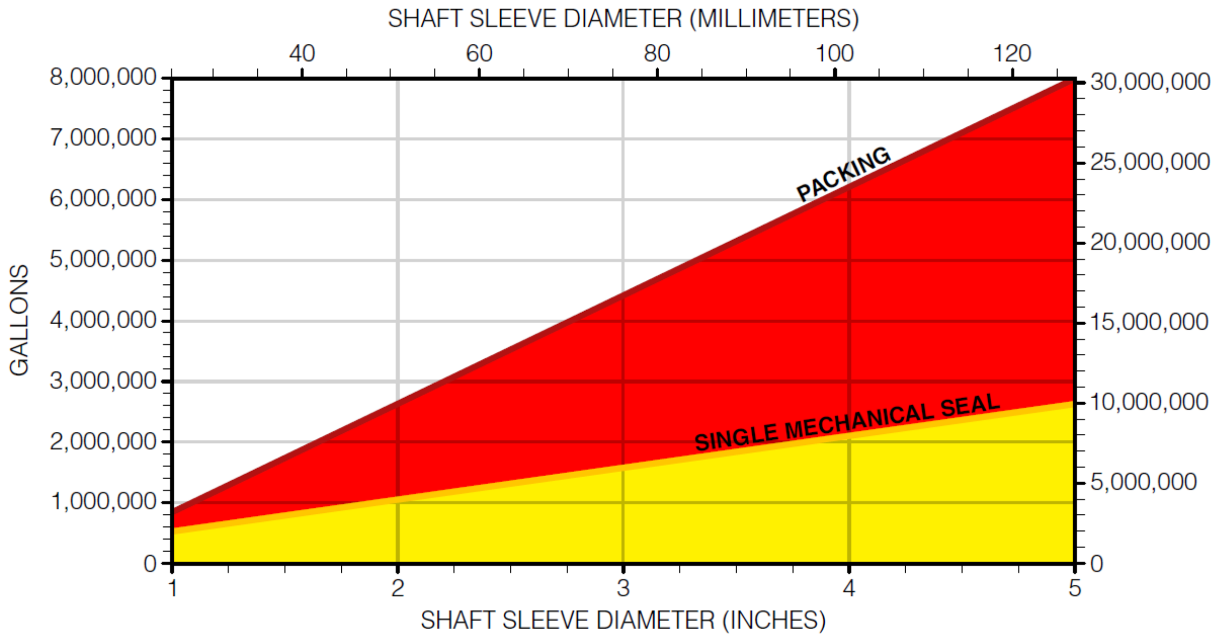
COMPRESSION PACKING - Function

The oldest seal in the industry is the compression packing seal. It utilizes an amount of packing rings stuffed together inline to form a tight squeeze on the pump shaft or shaft sleeve. This may wear the rotating parts over time and cause power losses due to friction. Flushing water is required, and this means an excess amount of water is used when operating a packing seal. Low cost and misalignment tolerance may be conditions where a compression packing seal is selected. Usually this is more in a slurry application than a chemical pump application.

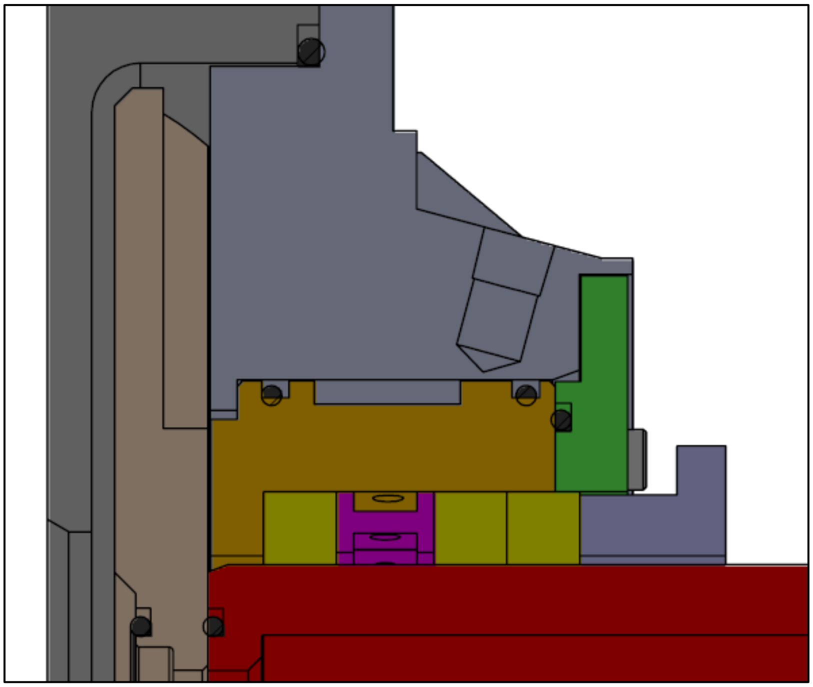


FLUSH WATER CONSUMPTION - Annual

Based on a pump running for 24 hours a day, 365 days a year, flushing water consumption may be estimated. Solution contains 10-20% fine solids by weight. Mechanical seal flush rate data based on 1 USGPM per inch of shaft sleeve diameter. Packing data is based on a "full flush" configuration with 60% of the flush water entering the process.

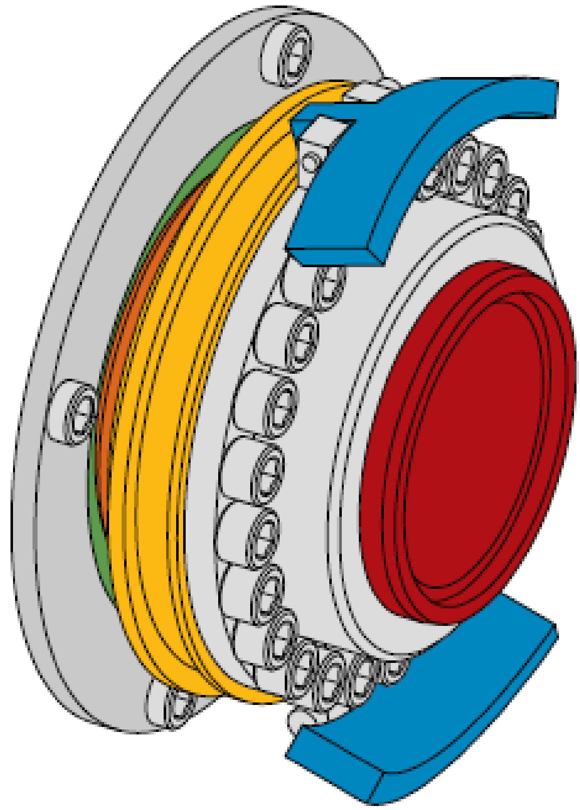


The A7/A9 may be used with expeller seal and packing backup. When used in this configuration, the goal would be to reduce pressure to reach packing rings and generally reduce the required flushing pressure. This is required because as a rule of thumb, flushing pressure should be approximately 15psig above fluid pressure. This configuration is especially useful for larger pumps where the fluid pressure and associated flushing pressures may be extremely high.



Expeller with Packing

SOLIDLOCK® SEAL – DETAIL



Product Description

For applications with abrasives and some degree of solids or particulates that tend to crystalize, the Solidlock seal is an excellent solution. The two seal faces operate as a dynamic seal in tandem with the expeller.

Upon start up, centrifugal forces act upon governor weights to open physically separate the seal faces during rotation. This means there is no seal drag during operation, no wear or rubbing of parts or seal faces. At shut down, isolated springs force the seal faces to close prior to the transition of dynamic sealing to static sealing. The soft stationary seal face will flex outwards against the hard rotary seal face to eliminate leakage of internal pressure.

No flushing plan is required and the Solidlock seal may operate dry without issue, such as if a tank level is dropped accidentally. The cartridge design allows the units to be installed easily and quickly, offering installation in many Wilfley pump families.

The life of the seal is dependent upon the correct placement of the seal based on suction pressure, pump speed and characteristics of the pumping liquid. With the correct selection of materials, the unit will be able to accommodate up to 400 degrees Fahrenheit applications.

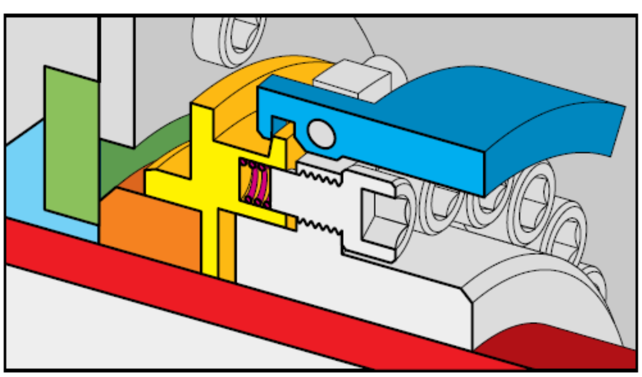
Since chemical processes are all unique, the construction material for the SolidLock® components should be reviewed for compatibility with the pumped liquid:

Material of Construction – Stainless Steel

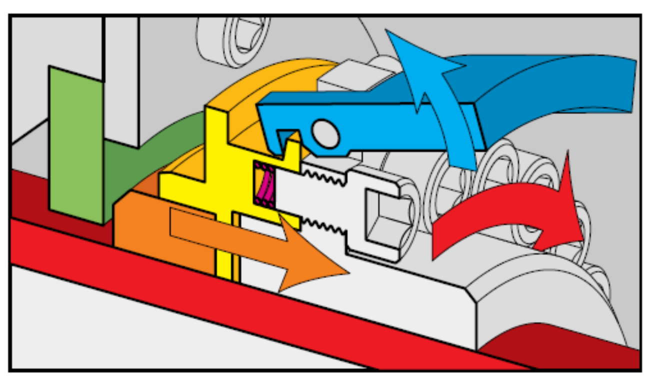
Rotary seal – WCD4® (Wilfley Proprietary CD4MCu)

Stationary seal face – Fluoroelastomer FKM(Viton), EPDM, Neoprene, Aflas

Below is an image showing the governor weight actuation and the opening and closing of the static seal:

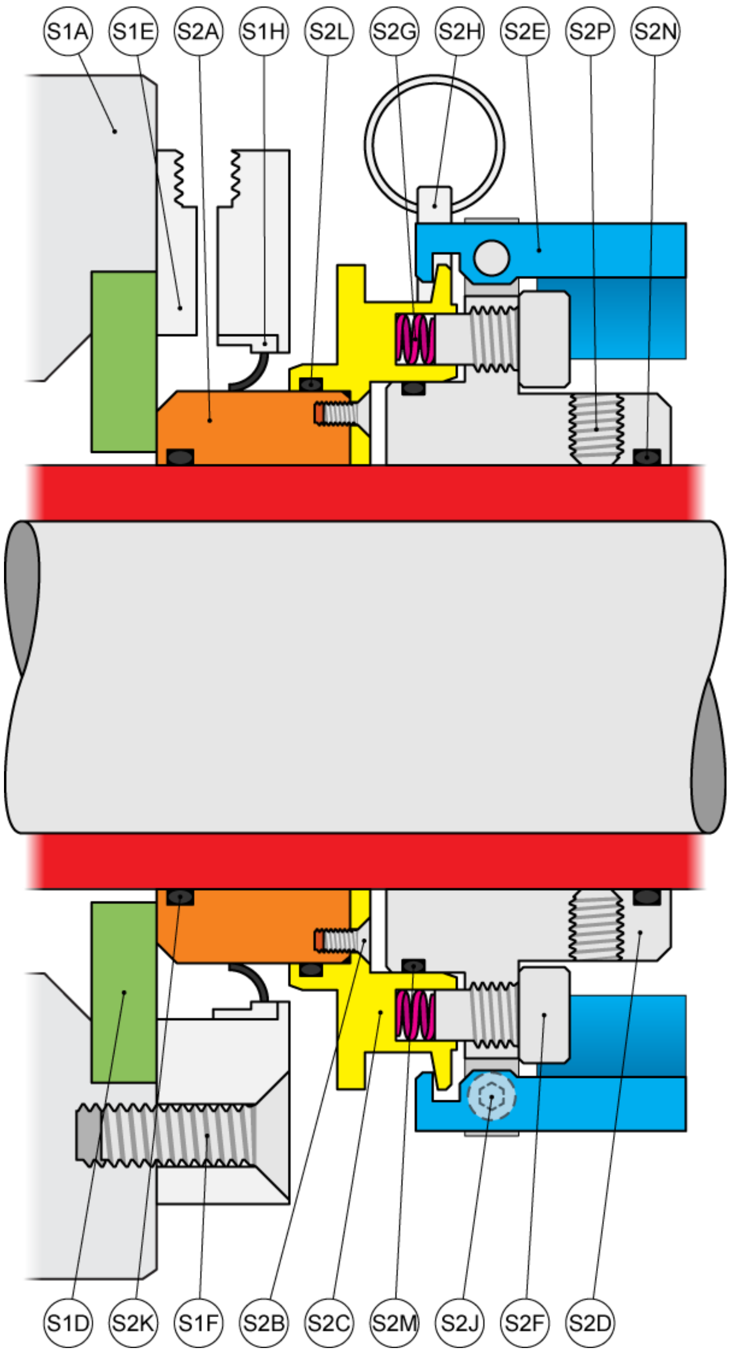


PUMP OFF / SEAL CLOSED



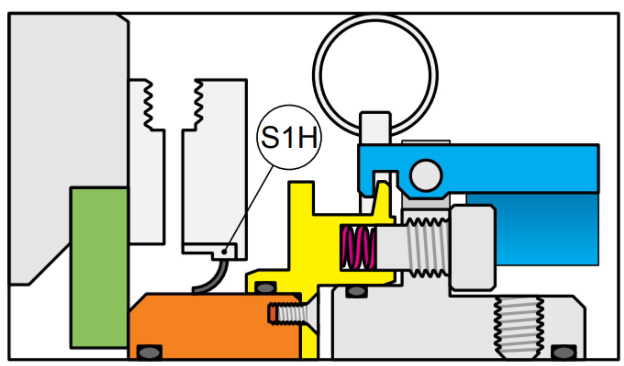
PUMP RUNNING / SEAL OPEN

General Arrangement – Solidlock



Ref. #	Description	Qty.
S1A	Stationary Seal Housing	1
S1D	Stationary Seal	1
S1E	Seal Lock	1
S1F	Stationary Seal Bolt	3-8
S1H	Lip Seal	1
S2A	Rotary Seal	1
S2B	Rotary Seal Bolt	4
S2C	Rotary Seal Carrier	1
S2D	Weight Spider	1
S2E	Weight	2
S2F	Spring Bolt	TBD[1]
S2G	Spring	TBD[1]
S2H	Pull Pin	2
S2J	Weight Bolt	2
S2K	O-Ring, Rotary Seal	1
S2L	O-Ring, Rotary Seal Carrier	1
S2M	O-Ring, Weight Spider	1
S2N	O-Ring, Weight Spider to Shaft Sleeve	1
S2P	Shaft Sleeve Set Screw	4
5A/ 39	Shaft Sleeve	1

Note that the Solidlock seal on the A7/A9 Chemical Pump includes a purge port and lip seal backup (S1H). This allows for flushing for seal faces and generally makes the Solidlock even more reliable in chemical pumps.



If additional back up sealing is required, such as controlling vapors that may escape during dynamic seal operation, consider back up seal options as offered in the A7 family of pumps. Proper pump placement may depend on application specific data.

Contact your Wilfley representative for assistance in these unique applications.

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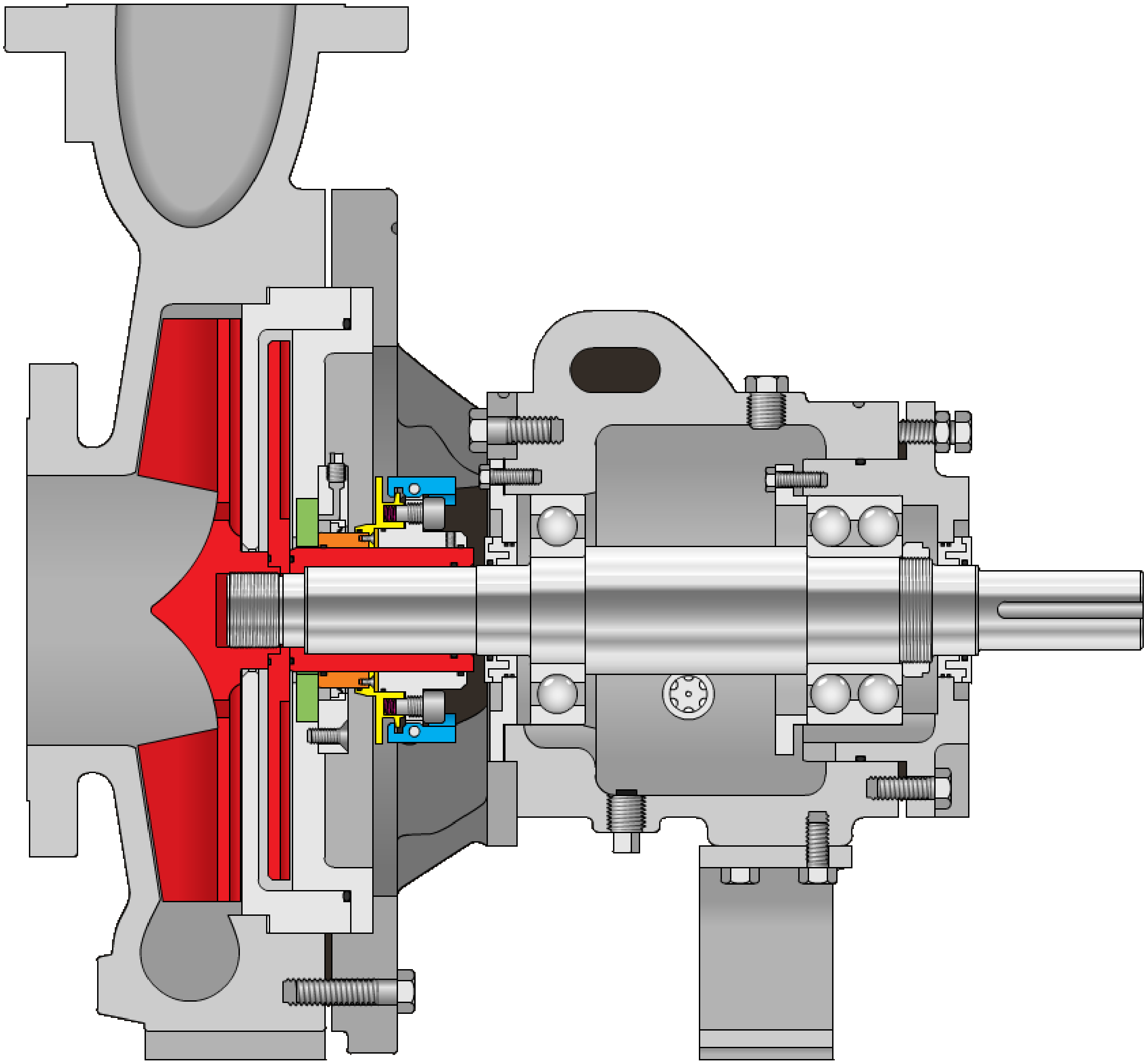
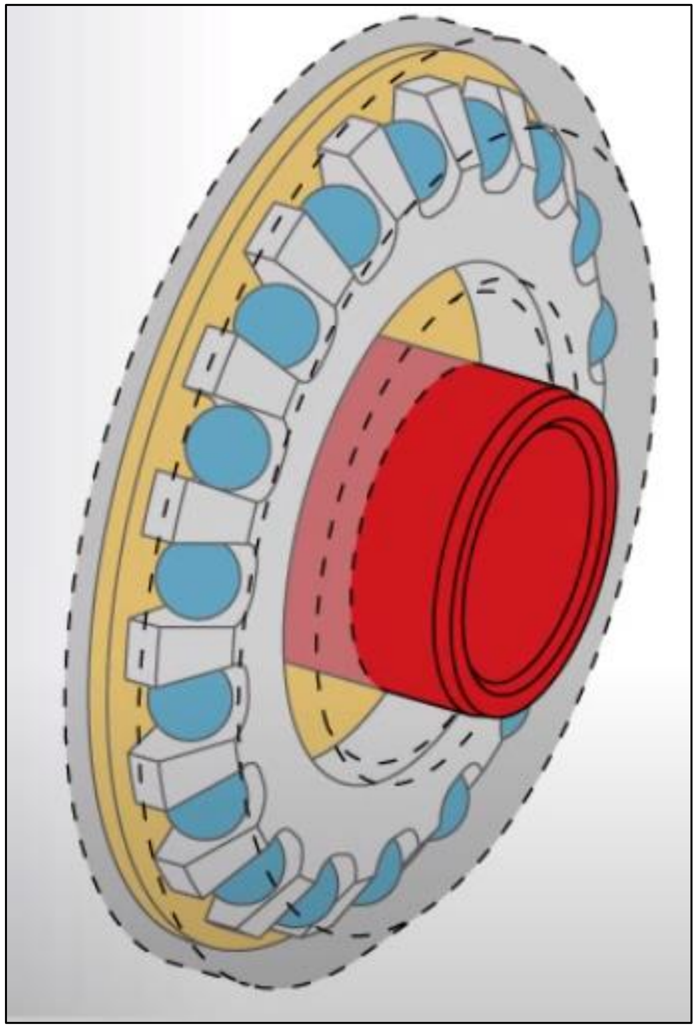
A7/A9 Arrangement – Solidlock



DRYLOCK® SEAL – DETAIL

Product Description

The DryLock® seal was developed specifically for chemical process, mining, and water/wastewater applications which are considered “clean liquid” installations. With the correct selection of materials, the seal will operate below 400°F (200°C) and handle non-crystallizing liquids with less than 60% solids. It will operate without a continuous flush to increase plant efficiency, reduce operating costs and eliminate product dilution. Applications outside these criteria may require special operating technique or special engineering.



No flushing plan is required with the Drylock seal, and as such, it may operate dry without issue, such as if a tank level is dropped accidentally. The cartridge design allows the units to be offered in many Wilfley pump families.

Upon start up, centrifugal forces act upon actuating balls physically separate the seal faces during rotation. At shut down, isolated springs force the seal faces to physically close the two faces. The hard stationary seal face will close against the hard rotary seal face to eliminate leakage. The life of the seal is dependent upon the correct placement of the seal based on suction pressure, pump speed and characteristics of the pumping liquid.

Since chemical processes are all unique, the construction material for the DryLock® components should be reviewed for compatibility with the pumped liquid:

Seal Faces – Chemical Grade Carbon, PTFE with Glass Filler, PTFE with Graphite Filler, Carbon Peek, Himod 958 and others

Spring/Hardware – Stainless Steel

Gaskets – Fluoroelastomer FKM(Viton), PTFE Elastomer, EPDM, Aflas, Kalrez

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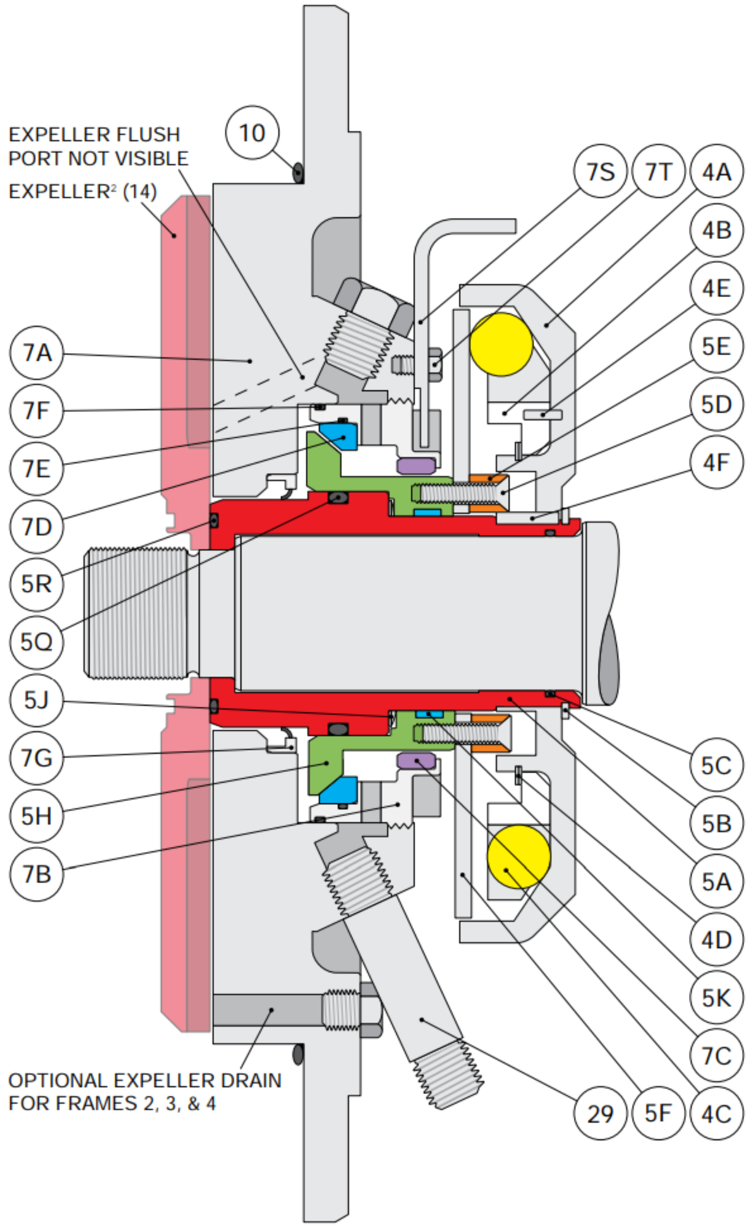


General Arrangement - Drylock

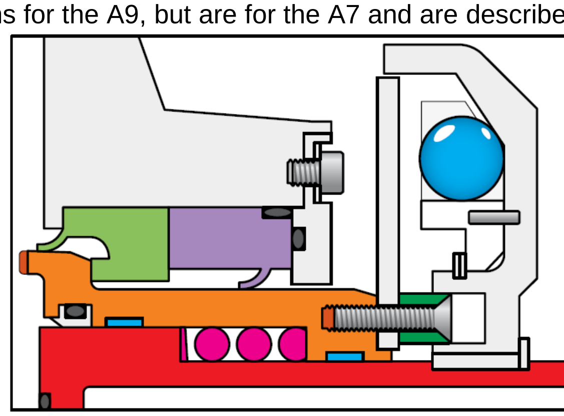
ITEM NO.	QTY.	DESCRIPTION
4A	1	BALL HOUSING
4B	1	BALL RETAINER
4C	3-18	BALLS
4D	1	RETAINING RING
4E	1	SPRING PIN
4F	1	KEY
5A	1	SHAFT SLEEVE
5B	1	RETAINING RING
5C[1]	**1**	**O'RING, SHAFT SLEEVE**
5D	4	DRIVE SCREW
5E	4	DRIVE SCREW SLEEVE
5F	1	ACTUATOR PLATE
5H	1	ROTARY SEAL SLEEVE
5J	1	WAVE SPRING
5K[1]	**1**	**SLIDE RING**
5Q[1]	**1**	**O-RING, SEAL SLEEVE**
5R[1]	**2**	**O-RING, EXPELLER**
7A	1	SEAL HOUSING
7B	1	SEAL CARTRIDGE
7C	1	DISASTER BUSHING
7D[1]	**1**	**STATIONARY SEAL RING**
7E[1]	**1**	**O-RING, STATIONARY SEAL RING**
7F[1]	**1**	**O-RING, CARTRIDGE**
7G[1]	**1**	**VARILIP**
7S	1	POSI-LOCK PIN
7T	1	POSI-LOCK BOLT
10[1]	**1**	**O-RING, SEAL HOUSING**
29	1	DRAIN SPOUT

DRAWING IS NOT TO SCALE AND REPRESENTS ONLY THE GENERAL ARRANGEMENT OF PARTS

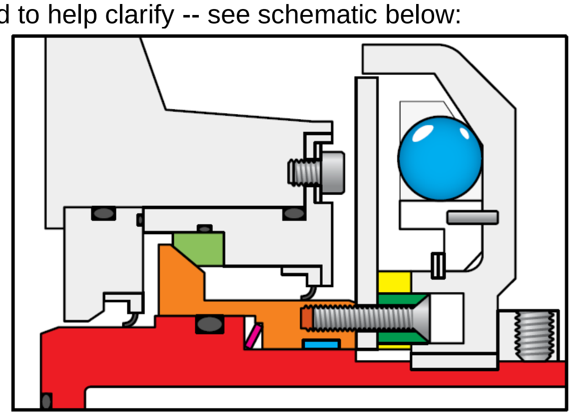
[1] RECOMMENDED SPARE PARTS

[2] EXPELLER NEEDS TO BE ORDERED IN ADDITION TO THE DRYLOCK® II ASSEMBLY

Note that minor differences exist in the seal as differentiated by the name (Drylock I vs III). These are not options for the A9, but are for the A7 and are described to help clarify -- see schematic below:

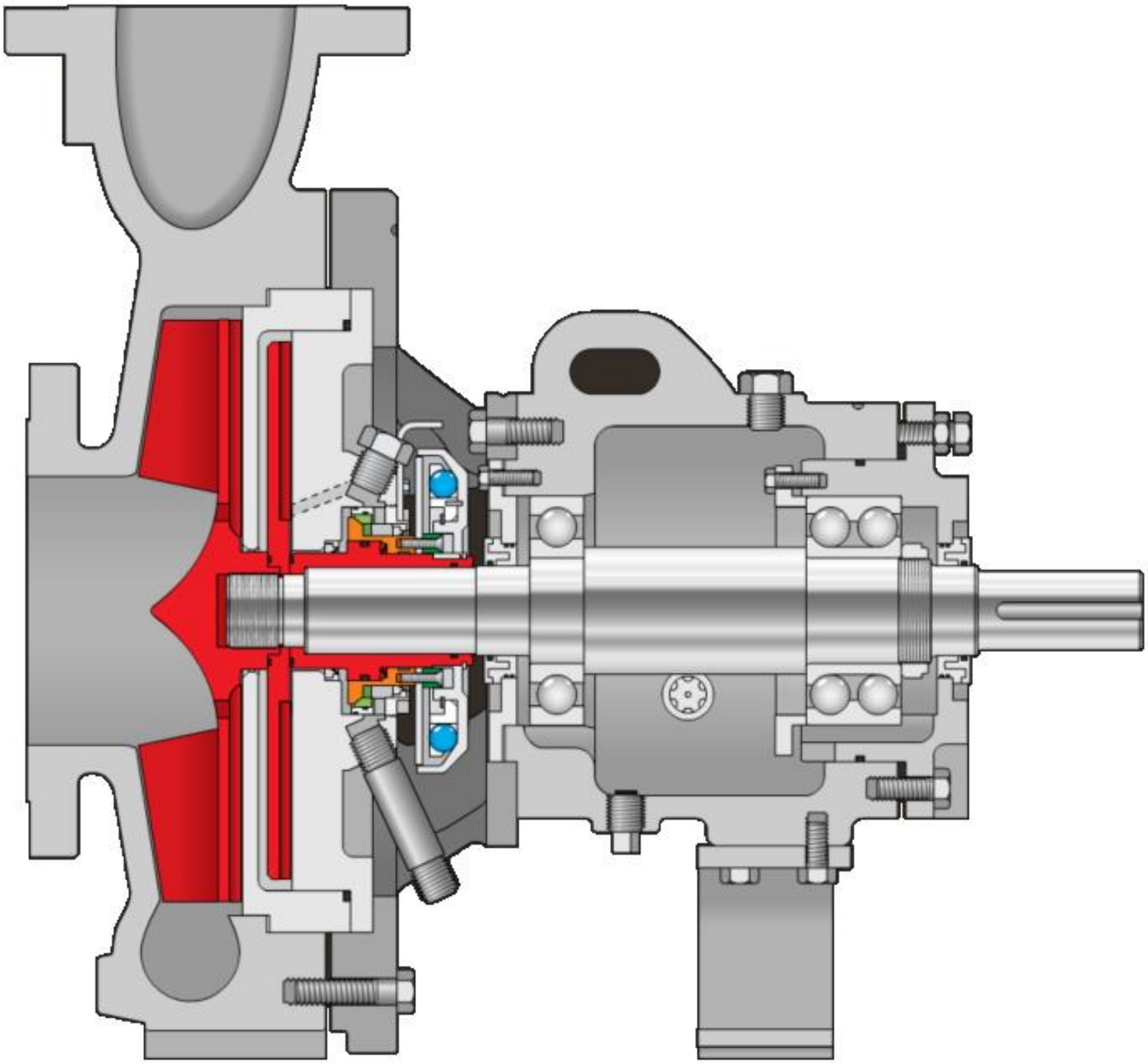


DRYLOCK® 1



DRYLOCK® 3

A7/A9 Arrangement – Drylock 3 Shown

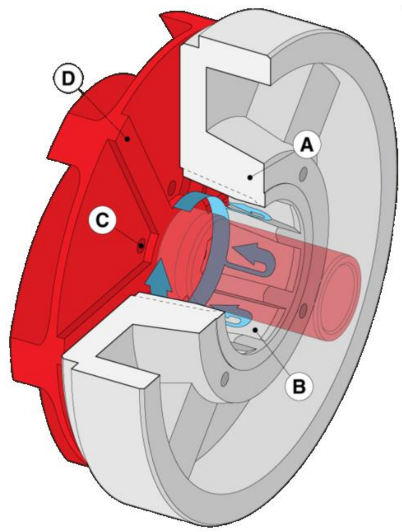


MECHANICAL SEAL

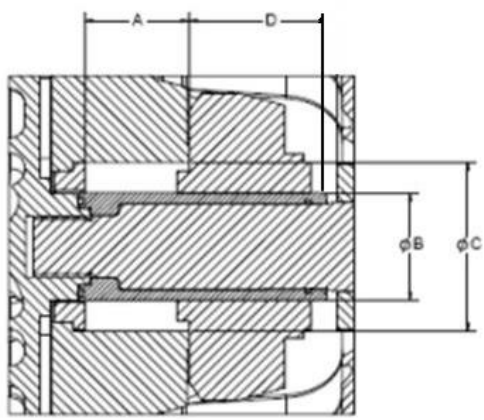
Mechanical seals may be appropriate if hazardous or volatile materials are being pumped. Wilfley A7/A9 pumps can accommodate a large variety of mechanical seals. The mechanical seal should be selected for the specific application. A taper bore seal is recommended on the A7/A9 for the following reasons:

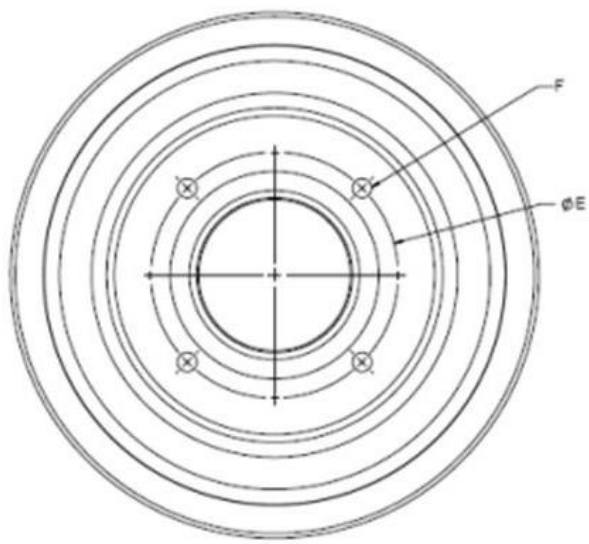
A. Oversized taper seal housing is self-venting and removes heat build-up from seal faces
B. Flow is recirculated in the seal area, removing solids and homogenizing two phase fluids
C. Pressure balance holes transmit lowest possible pressure to seal for reduced wear and seal drag
D. Fluid is recirculated by pump out vanes to promote heat removal and solids expelling

For mechanical seal selection, see table below.



SEAL CAVITY GEOMETRY





Size/Type	DIM "A"	DIM "B"	DIM "C"	DIM "D"	DIM "E"	DIM "F"
Frame 1 – Tapered	1.78	1.75	3.50	2.11	5.25	0.42
Frame 1 – Straight	2.03	1.75	2.75	1.86	4.00	0.31
Low Flow – Tapered	1.31	1.88	3.63	2.39	5.25	0.42
Low Flow – Straight	1.31	1.88	2.88	2.39	4.13	0.42
Frame 2 – Tapered	1.61	1.88	3.63	2.34	5.25	0.42
Frame 2 – Straight	1.61	1.88	2.88	2.34	4.13	0.42
Frame 3 – Tapered	1.71	2.50	4.50	2.26	6.25	0.42
Frame 3 – Straight	1.71	2.50	3.63	2.26	5.00	0.42
Frame 4 – Tapered	1.67	3.25	4.38	2.73	4.60	0.53
Frame 4 – Straight	N/A					
Frame 5 – Tapered	1.63	3.25	4.38	2.81	6.50	0.53
Frame 5 – Straight	N/A					

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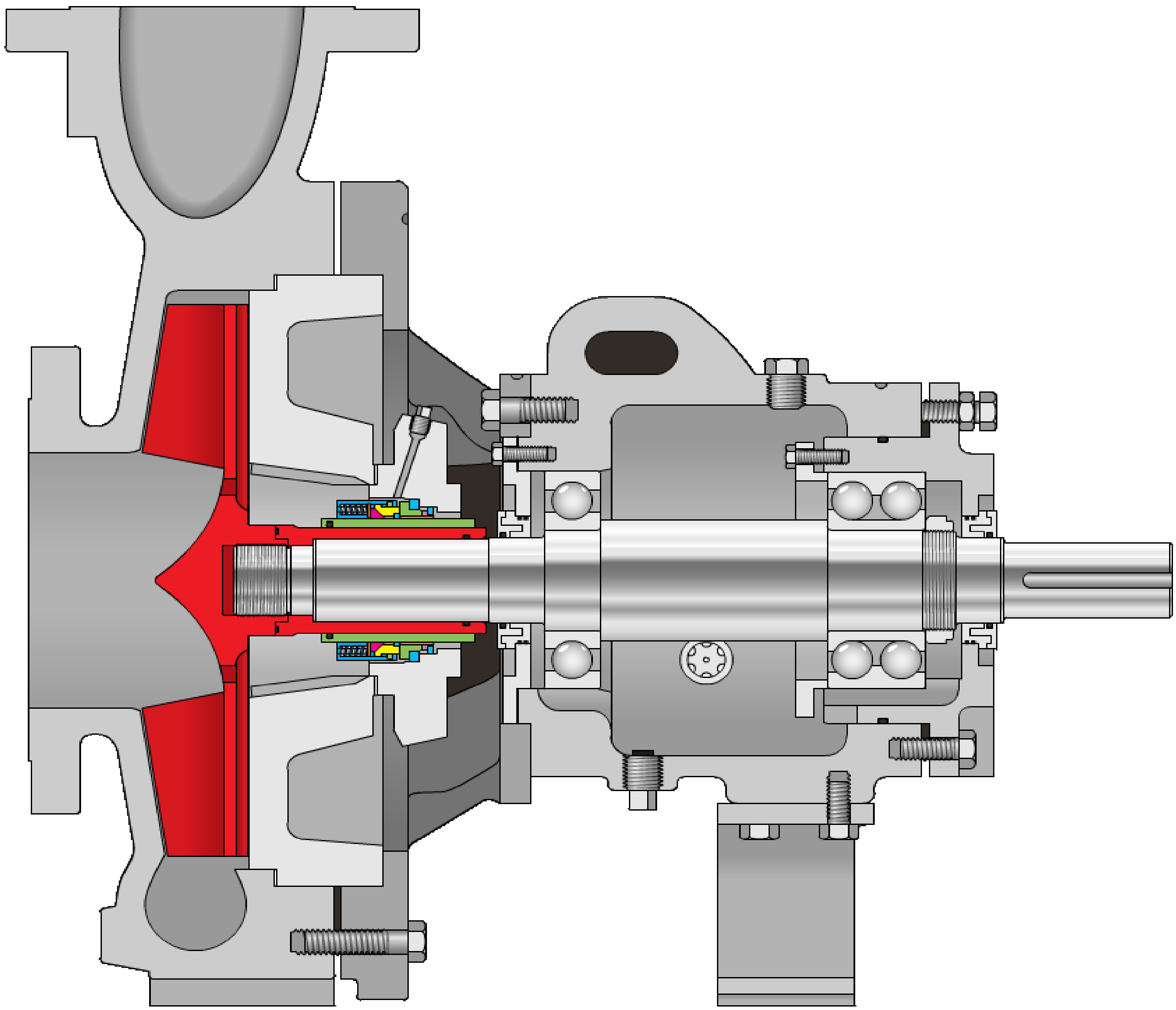
MECHANICAL SEAL FITS

FRAME 1		**FRAME 2**	
AES		AES	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
CURC	CURC	CURC	CURC
CSSN	CSSN	CSSN	
CDPN	CDPN	CDPN	
CDSA	CDSA		
EagleBurgmann		EagleBurgmann	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
Cartex ANSI Dual Seals (big bore)	Cartex ANSI Dual Seals (standard bore)	Cartex ANSI Dual Seals (big bore)	Cartex ANSI Dual Seals (standard bore)
Cartex ANSI Single Seals (big bore)	Cartex ANSI Single Seals (standard bore)	Cartex ANSI Single Seals (big bore)	Cartex ANSI Single Seals (standard bore)
FlowServe		FlowServe	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
N/A	ISC2 single (standard bore)	N/A	ISC2 single (standard bore)
JohnCrane		JohnCrane	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
5610 (oversize bore)	5610 (standard bore)	5610 (oversize bore)	5610 (standard bore)
5610Q (oversize bore)	5610Q (standard bore)	5610Q (oversize bore)	5610Q (standard bore)

FRAME 3		**FRAME 4**	
AES		AES	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
CURC	CSSN	CURC	N/A
CSSN	DMSF	CSSN	
CDPN		CDPN	
CDSA		CDSA	
DMSF			
EagleBurgmann		EagleBurgmann	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
Cartex ANSI Dual Seals (big bore)	Cartex ANSI Dual Seals (standard bore)	Cartex ANSI Single Seals (standard bore)	N/A
Cartex ANSI Single Seals (big bore)	Cartex ANSI Single Seals (standard bore)		
FlowServe		FlowServe	
TAPER BORE	STRAIGHT BORE	TAPER BORE	STRAIGHT BORE
ISC2 single (big bore)	ISC2 single (standard bore)	ISC2 single (standard bore)	N/A
JohnCrane		JohnCrane	
None sampled		TAPER BORE	STRAIGHT BORE
		5610Q (standard bore)	N/A

All the seals mentioned in the table above are "commercial off the shelf," and will fit without modification. Seals not shown may or may not fit-- refer to seal cavity geometry for confirmation.

A7/A9 Arrangement – Single Mechanical seal



MECHANICAL SEAL HORSEPOWER CONSUMPTION (Approximate)

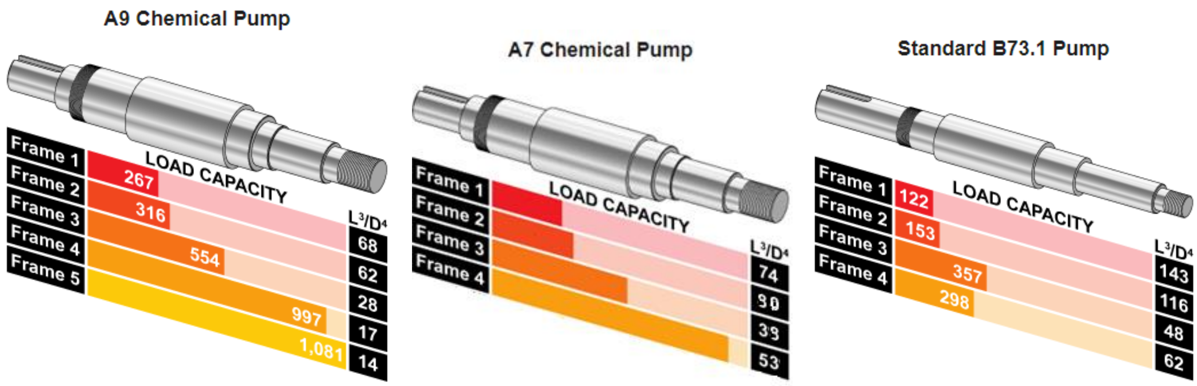
RPM	SINGLE	TANDEM	SINGLE	TANDEM	SINGLE	TANDEM
	1.75” Shaft		2.50” Shaft		3.25” Shaft	
3550	0.50	1.50	1.20	3.00	2.88	5.75
1750	0.07	0.17	0.15	0.38	0.38	0.88
1450	0.04	0.11	0.09	0.22	0.22	0.53
1150	0.03	0.08	0.07	0.18	0.17	0.44

Mechanical Seal Troubleshooting

PROBLEM	POSSIBLE CAUSE	RECOMMENDED REMEDY
Mechanical seal has short life. (*and/or*) Mechanical seal leaks excessively.	Misalignment due to pipe strain.	Check flange connections and eliminate strains using elastic couplings or another permitted method.
	Shaft bent.	Check that shaft run-outs are within acceptable values. Contact Wilfley.
	Bearings worn.	Replace bearings.
	Shaft sleeve worn or scored or running off center.	Check and renew defective parts.
	Mechanical seal improperly installed.	Check alignment of faces or damaged parts and assembly method used.
	Incorrect type of mechanical seal for operating conditions.	Consult Wilfley.
	Impeller out of balance, resulting in vibration.	
	Abrasive solids in liquid pumped.	
	Internal misalignment of parts prevents seal ring and seat from properly mating.	
	Mechanical seal was run dry.	Check mechanical seal condition and source of dry running. Repair.
	Internal misalignment due to improper repairs, causing impeller to rub.	Check method of assembly, possible damage, or state of cleanliness during assembly. Consult Wilfley if needed.
Mechanical seal leaks excessively.	Leakage under shaft sleeve due to joint failure.	Replace joint and check for damage.

DYNAMIC SHAFT DEFLECTION AT MAXIMUM HYDRAULIC LOAD

The rotor stiffness ratio indicates shaft deflection under load. The A9 shaft has an excellent stiffness ratio compared to other pumps, which allows for reduced deflections in the seal area and increased reliability of a mechanical seal. The recommended L3/D4 is below 75 for maximum mechanical seal life. The A9 shaft is beefier than the A7 shaft and is one of the differentiators of the two pumps.

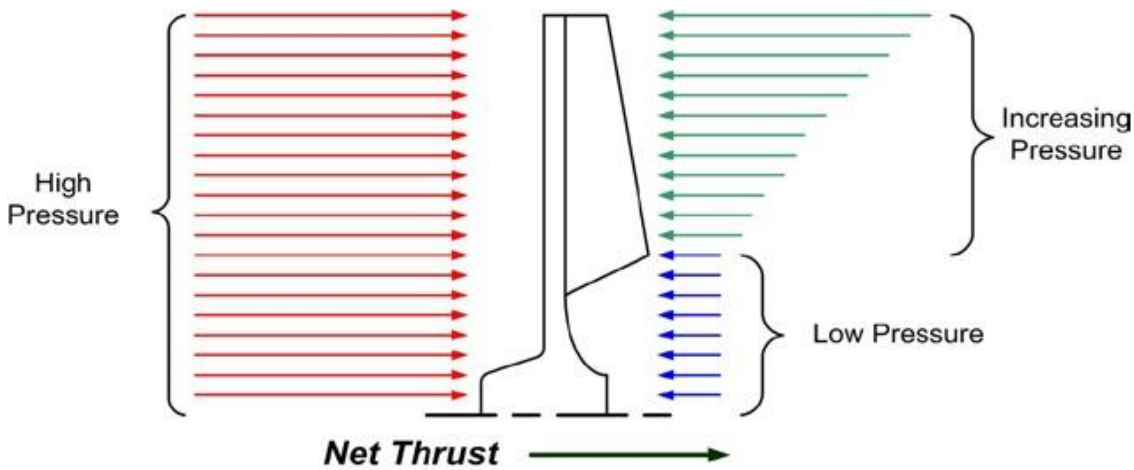


PER ASME B73.1M ---- Dimensions in inches. Deflection calculated at speed shown in table with maximum impeller diameter. For maximum pump operating speed, consult engineering. (Eng-ref.A2637)

FRAME	SIZE	SHAFT DEFLECTION AT IMPELLER (BEP)	SHAFT DEFLECTION AT IMPELLER (% BEP)	SHAFT DEFLECTION AT SEAL (min. flow)	SPEED [RPM]
1 A9	1.5 x 1 x 6	0.0003	0.0010 (0%)	0.0003	3550
	3 x 1.5 x 6	0.0006	0.0015 (0%)	0.0005	
	3 x 2 x 6	0.0010	0.0025 (0%)	0.0008	
	1.5 x 1 x 8	0.0005	0.0012 (0%)	0.0004	
2 A9	3 x 1.5 x 8	0.0008	0.0025 (0%)	0.0008	
	3 x 2 x 8	0.0011	0.0033 (0%)	0.0011	
	4 x 3 x 8	0.0012	0.0035 (0%)	0.0012	
	2 x 1 x 10	0.0006	0.0020 (0%)	0.0006	
	3 x 1.5 x 10	0.0009	0.0032 (0%)	0.0010	
	3 x 2 x 10	0.0011	0.0038 (0%)	0.0012	
	4 x 3 x 10	0.0018	0.0049 (0%)	0.0016	
	6 x 4 x 10	0.0014	0.0039 (0%)	0.0013	1750
3 A9	3 x 1.5 x 13	0.0010	0.0023 (30%)	0.0007	3550
	3 x 2 x 13	0.0016	0.0025 (40%)	0.0008	
	4 x 3 x 13	0.0018	0.0045 (40%)	0.0015	
	6 x 4 x 13	0.0013	0.0020 (40%)	0.0006	1750
4 A9	8 x 6 x 13	0.0012	0.0025 (40%)	0.0008	
	6 x 4 x 15	0.0011	0.0021 (50%)	0.0007	
	8 x 6 x 15	0.0020	0.0042 (50%)	0.0013	
	10 x 8 x 17	0.0022	0.0049 (50%)	0.0016	
5 A9	6 x 4 x 19	<0.0025	n/a	<0.0020	
	8 x 6 x 19	<0.0035		<0.0020	
	10 x 8 x 19	<0.0035		<0.0020	

IMPELLER BALANCE HOLES

Impeller balance holes are used generally to compensate axial thrust by balancing the pressure at the impeller. The default configuration for A7/A9 pumps is impellers with pressure-balancing holes in order to maximize bearing life by minimizing axial thrust. Additionally, balance holes aid in fluid recirculation to ensure fluid mixing and avoid fluid overheating the secondary expeller cavity.



SEMI-OPEN IMPELLER

Balance Hole Advantages:

- Continuous liquid circulation in the secondary expeller cavity
- Constant suction pressure across entire flow range
- Higher bearing life (in low-suction-pressure applications)
- Higher suction pressure capability at maximum impeller diameter

Balance Hole Disadvantages:

- Lower efficiency
- Lower head generation
- Higher $NPSH_{Required}$

Published $NPSH_R$ data shown on pump curves is determined based on a pump impeller without balance holes. For pump impellers with balance holes, a correction must be applied to increase the $NPSH_R$ by 1.6-ft (0.5m) greater than the published curves

APPLICATION	BAL. HOLES	NOTES
Very high suction pressures	No	Lower bearing life in some situations
Thermally sensitive fluids	Yes	Good heat transfer in the expeller cavity
Maximized suction pressure capability	Yes	Higher MIH at zero flow and maximum impeller diameter

Impellers without balancing holes may be provided and should be considered for high-suction-pressure applications where adequate bearing life cannot be obtained with a standard impeller.

IMPELLER-CASE CLEARANCES

Set the impeller clearance based on the intended operating temperature of the fluid. High temperature configuration parts (Case Plate and Seal Housing) must be specified for temperatures above 200°F (93°C) to ensure safe operation. See the impeller clearance settings from A2922 (values shown below) with detailed instructions from the A2550 User Manual for setting the clearance. Below are the values for reference.

A9	Impeller Clearance Settings			
	SET FROM	0-200°F (93°C)	200-300°F (149°C)	300-400°F (204°C)
1 A9	FRONT	0.010” (0.254mm)	0.012” (0.305mm)	0.014” (0.346mm)
WLQ & 2 A9	FRONT	0.011” (0.279mm)	0.013” (0.330mm)	0.015” (0.381mm)
3 A9	FRONT	0.013” (0.330mm)	0.015” (0.381mm)	0.017” (0.432mm)
4 A9	BACK	0.020” (0.508mm)		
5 A9	FRONT	0.017” (0.432mm)	0.019” (0.483mm)	0.021” (0.533mm)
3 A9 Vortex	BACK	0.015” (0.381mm)		
4 A9 Vortex	BACK	0.020” (0.508mm)		

A7	Impeller Clearance Settings			
	SET FROM	0-200°F (93°C)	200-300°F (149°C)	300-400°F (204°C)
1 A7	FRONT	0.010” (0.254mm)	0.012” (0.305mm)	0.014” (0.346mm)
2 A7	FRONT	0.012” (0.305mm)	0.014” (0.356mm)	0.015” (0.381mm)
3 A7	FRONT	0.015” (0.381mm)	0.017” (0.324mm)	0.017” (0.432mm)
4 A7 Open	FRONT	0.020” (0.508mm)	0.022” (0.559mm)	0.024” (0.610mm)
4 A7 Closed	BACK	0.020” (0.508mm)		
3 A7 Vortex	BACK	0.015” (0.381mm)		
4 A7 Vortex	BACK	0.020” (0.508mm)		

HIGH TEMPERATURE TRAVEL

For high temperature service above 200°F and/or where materials of high galling tendency are used (e.g.: 316, A20, etc.), the total pump assembly clearance must be increased with parts machined for the high temperature conditions. Minimum allowable impeller travel values are shown below.

A9	Minimum Impeller Travel	
	0-200°F (-17-93°C)	200+ °F (93+ °C)
1 A9	0.025” (.63mm)	0.025” (.63mm)
WLQ & 2 A9	0.032” (.81mm)	0.082” (2.08mm)
3 A9	0.036” (.91mm)	0.036” (.91mm)
4 A9	0.164” (4.16mm)	0.164” (4.16mm)
5 A9	0.064” (1.62mm)	0.064” (1.62mm)

A7	Minimum Impeller Travel	
	0-200°F (-17-93°C)	200+ °F (93+ °C)
1 A7	0.026” (.63mm)	0.025” (.63mm)
2 A7	0.030” (.81mm)	0.082” (2.08mm)
3 A7	0.036” (.91mm)	0.036” (.91mm)
4 A7	0.025” (4.16mm)	0.039” (.99mm)

IMPELLER BALANCING CRITERIA

Centrifugal pump impellers must be properly balanced to avoid excessive vibration at running speed and achieve reliable operation. High imbalance will be a detriment to the shaft, seals, coupling and bearing life. Balancing may be done to different quality grades as given in ISO 1940/1.

The standard grade of balance for A7/A9 impellers follows ISO 1940/1 quality grade G 6.3 or better. Semi-open impellers are single-plane balanced while closed impellers are two-plane balanced. Note that secondary expellers are not balanced. Requests for tighter balance criteria are should be made to your Wilfley regional contact.

SUCTION HEAD LIMITS

For dynamic seals (Solidlock, Drylock), there is a unique consideration required for operation. Due to the nature of the open seal while operating, the seal in combination with the secondary expeller presents the possibility for air ingress into the process fluid. Therefore, care must be taken to ensure that the dimensions of the expeller are in harmony with the dynamic seal. This will also prevent the possibility of seal leakage when suction pressures (tank levels) get very large.

If the maximum expeller diameter will not hold the suction pressure, consider the following:

- Increase speed and trim the impeller
- Select another pump size with larger expeller

Potential for Air Ingress

In certain applications with low suction pressure, air may be pulled in through the expeller and entrained in the liquid being pumped. If a standard impeller is used, the air induced through the seal will pass through the pressure balancing holes to the intake side of the impeller. The immediate effect is a drop in capacity and power followed by a loss of prime if more gas than the impeller can handle is present. The presence of 2% free air will result in 10% reduction in capacity, while 4% of free air will reduce the capacity by 44%.

If an impeller without balancing holes is used, the air will be passed directly to the discharge section of the pump. The air passing through the expeller cavity into the discharge will also have a detrimental effect on pump performance and pump wear. It is therefore important to avoid air ingress and operate within the suction pressure range indicated in the “Suction Head Limits” curves. Operating below the minimum suction pressure curve must be avoided. Consideration must be given to the use of alternate or secondary sealing to minimize or prevent the air ingress.

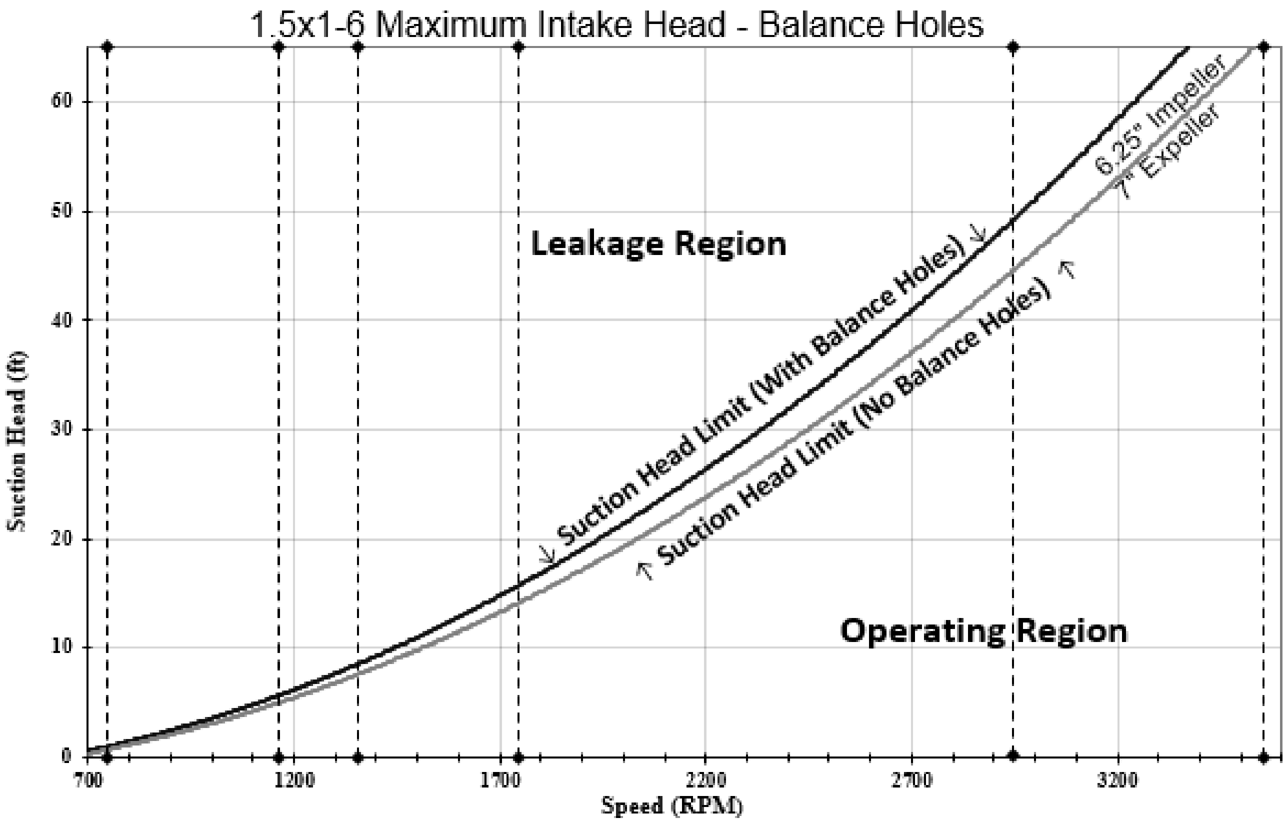
Always select the smallest expeller for the job to prevent the potential for air ingress problems at low suction heads (tank levels).

Note that with small impeller diameters, the expeller will be able to hold back additional static head. The below tables reference full size diameter impellers with full size expellers. The exact limit may be adjusted with special cutting of expeller, impeller, or both. If tank levels and intake heads are a concern, it is recommended that your application be reviewed by a qualified Wilfley representative.

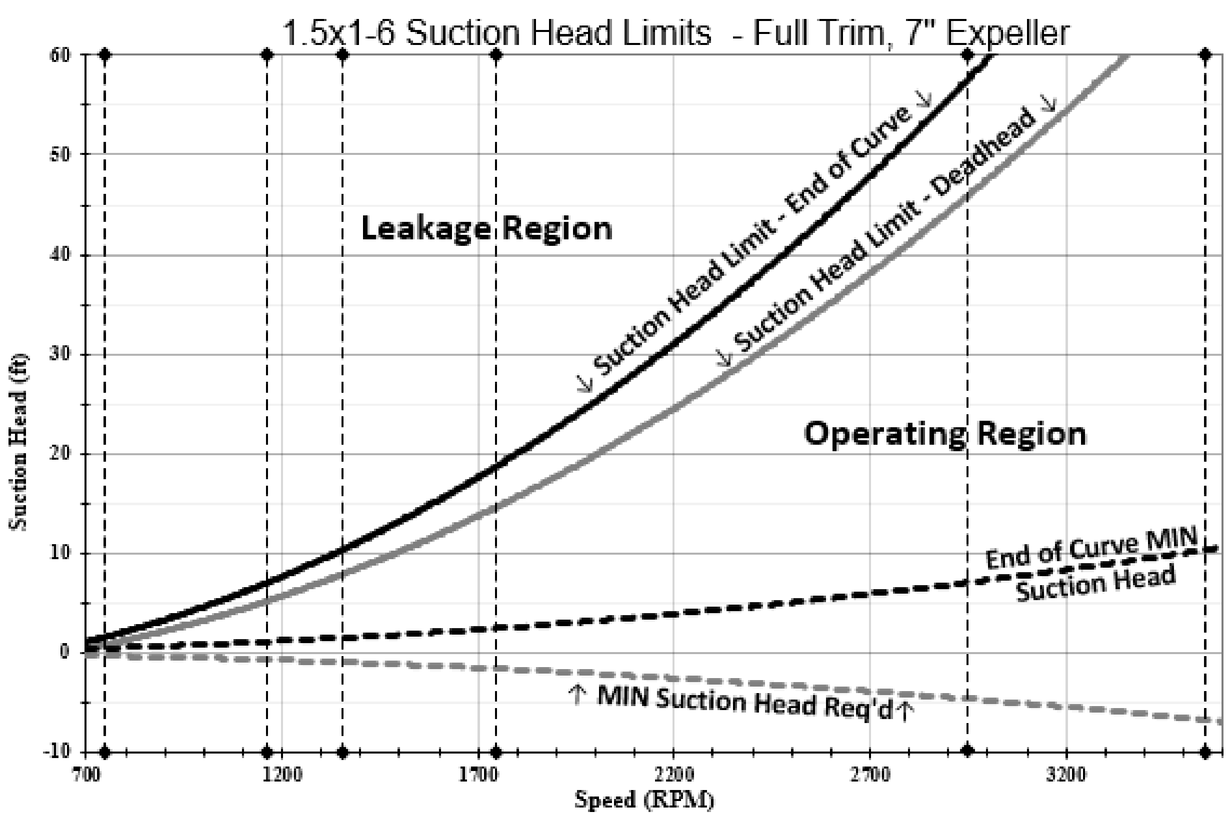
Suction Head Impact by Impeller and Expeller

The maximum and minimum intake head may be slightly different when optional features are specified with A7/A9 Pumps. When trimming the impeller, removing balancing holes, or changing the expeller size, the suction head limits change. See below for the limits of the 1.5x1-6 A7/A9 pump with tweaks to these components.
These trends should follow for other size pumps but are shown as an example of performance impact.

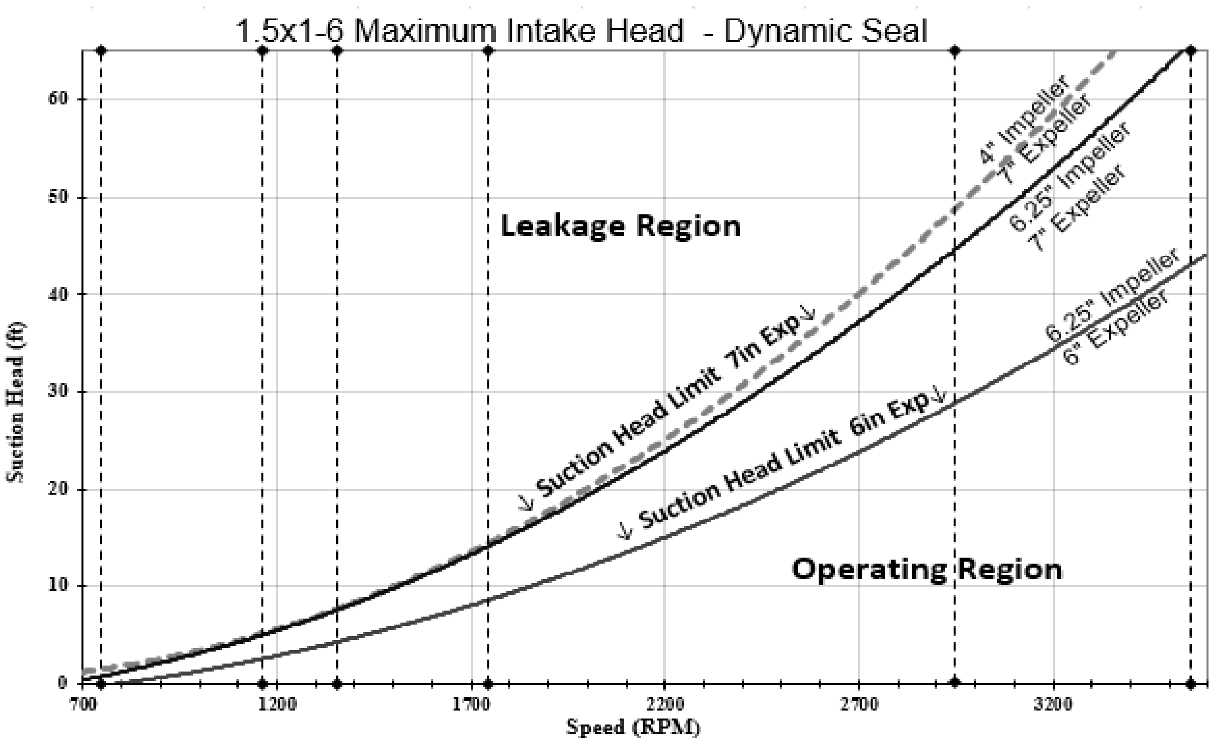
When balance holes are removed, suction head limits decrease.



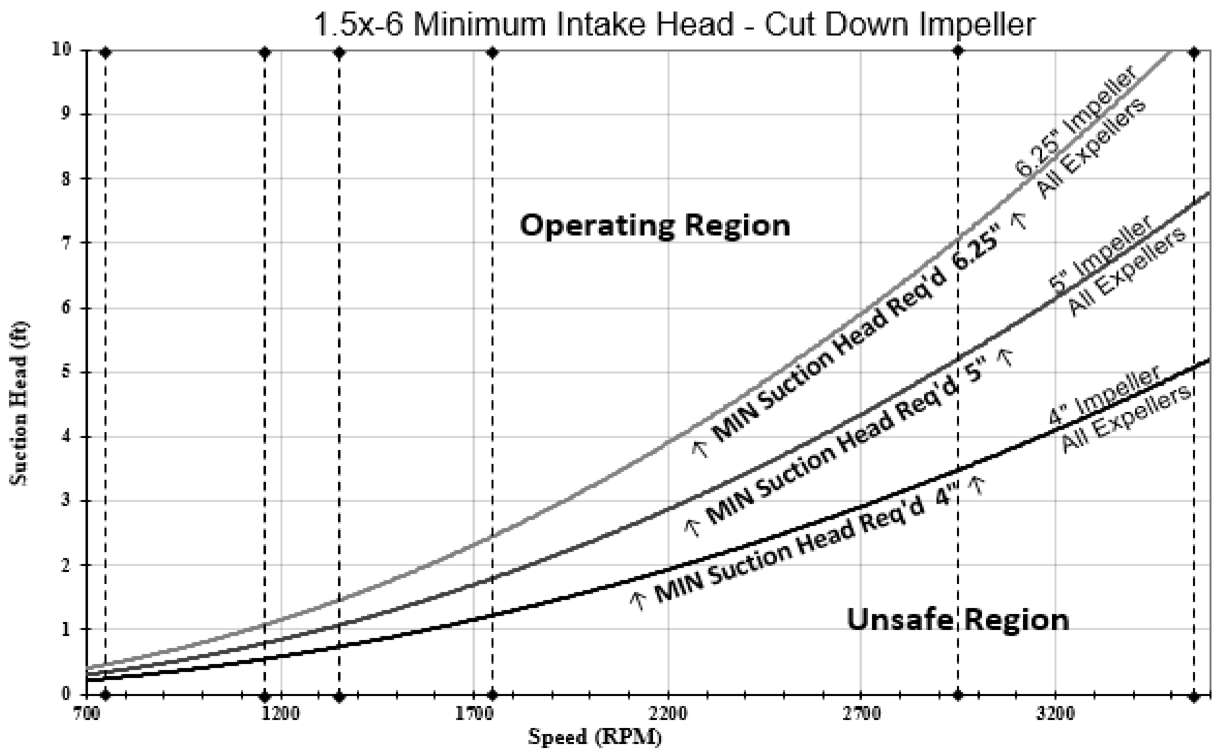
Additionally, the true limits of intake head depend on the difference in discharge pressure based on the operating position along the performance curve. Note the difference between 0% and 120% BEP.



Maximum intake head increases when the impeller blades are trimmed to a smaller diameter. When the secondary expeller is reduced in size, the maximum intake head reduces.

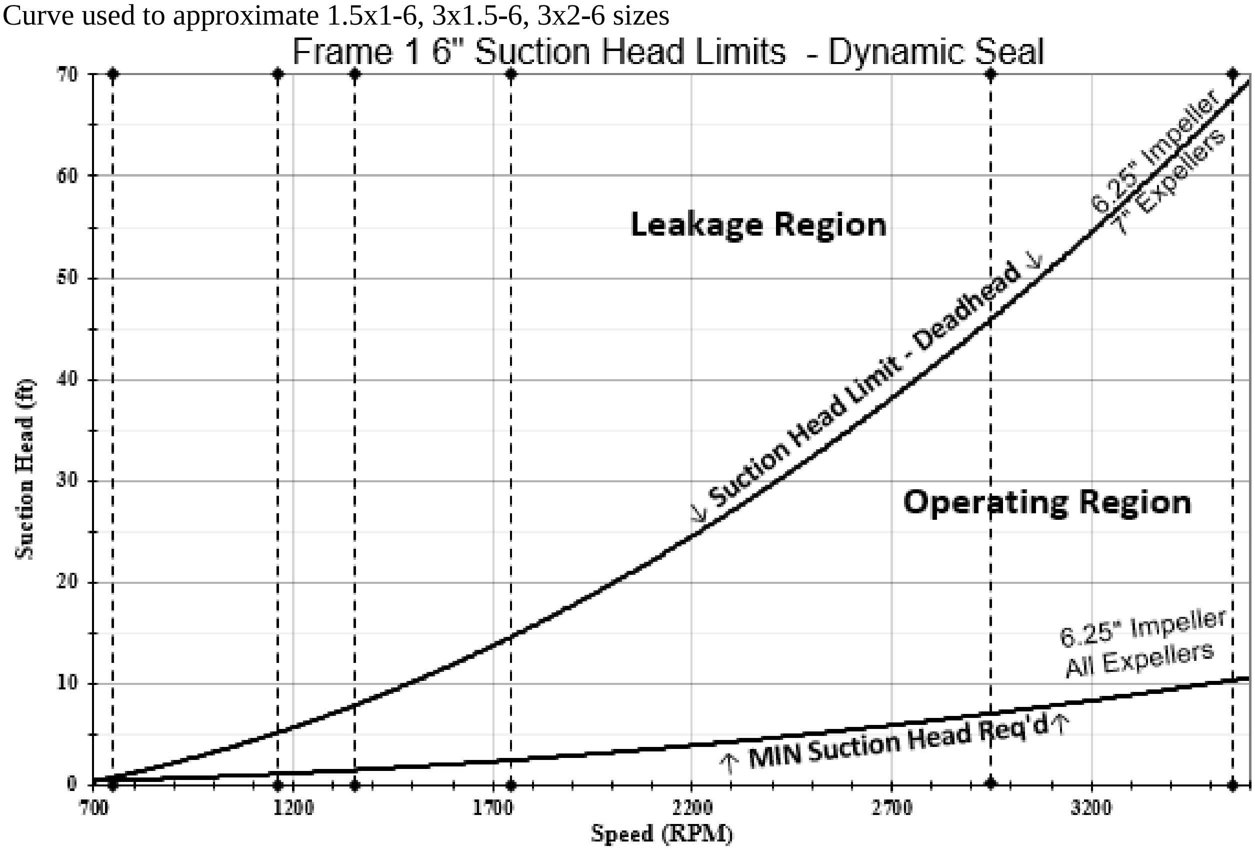


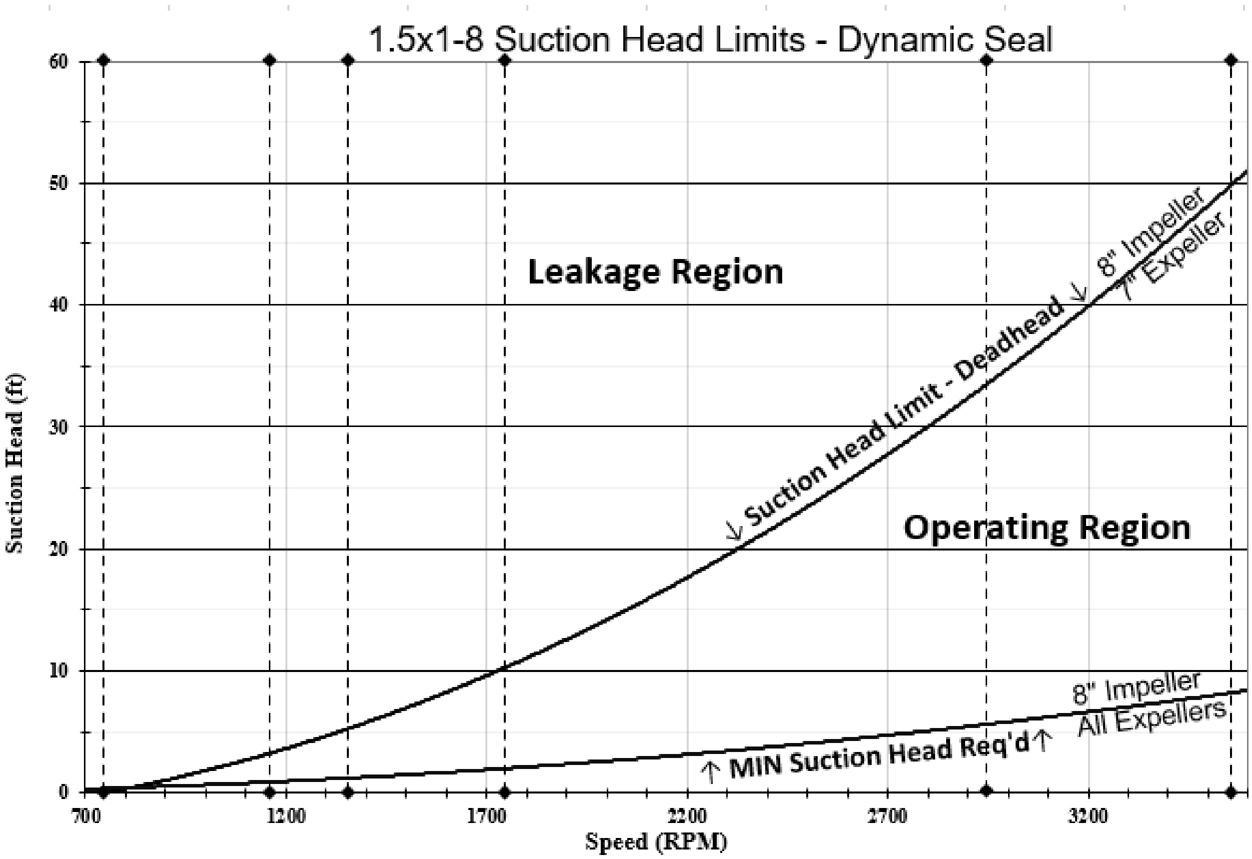
The cut down of the impeller also affects the minimum intake head allowed (at zero flow).



Suction Head Limits – Frame 1

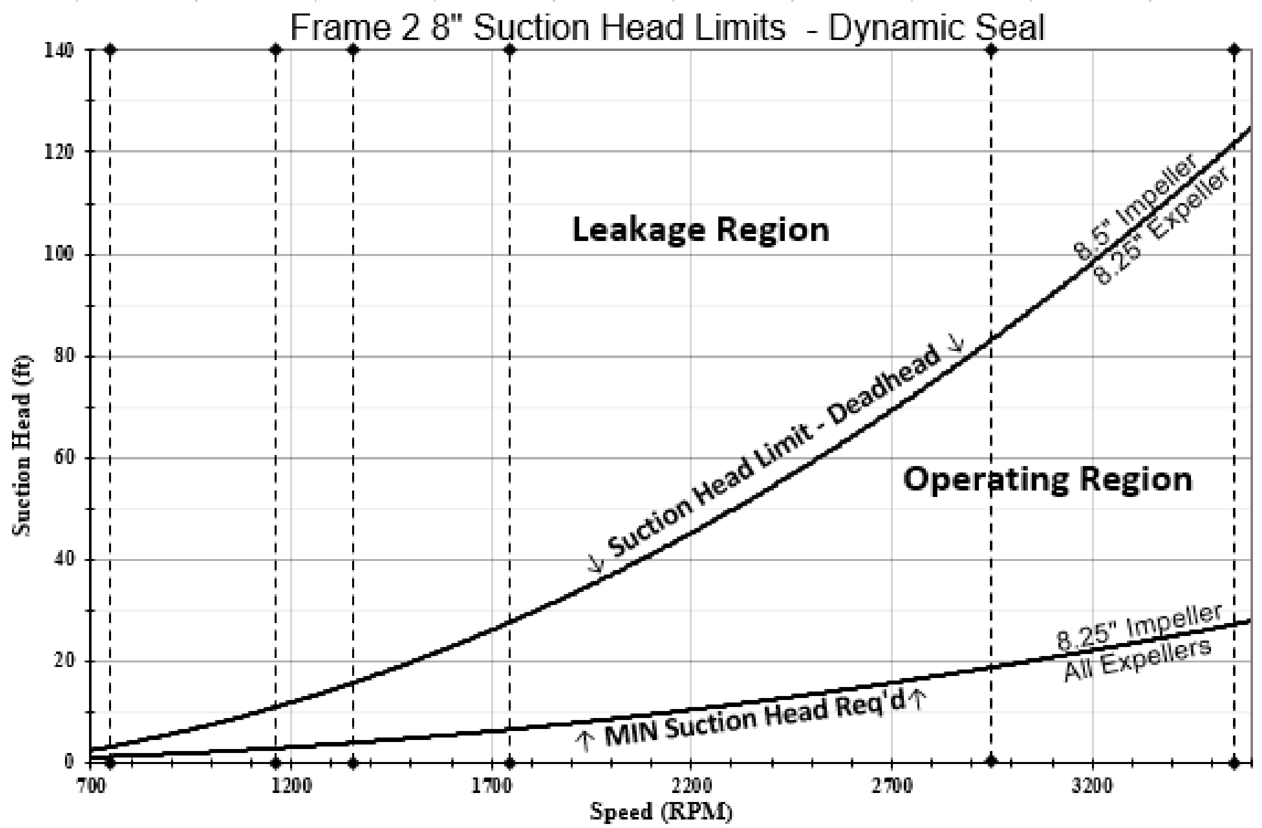
Curve used to approximate 1.5x1-6, 3x1.5-6, 3x2-6 sizes

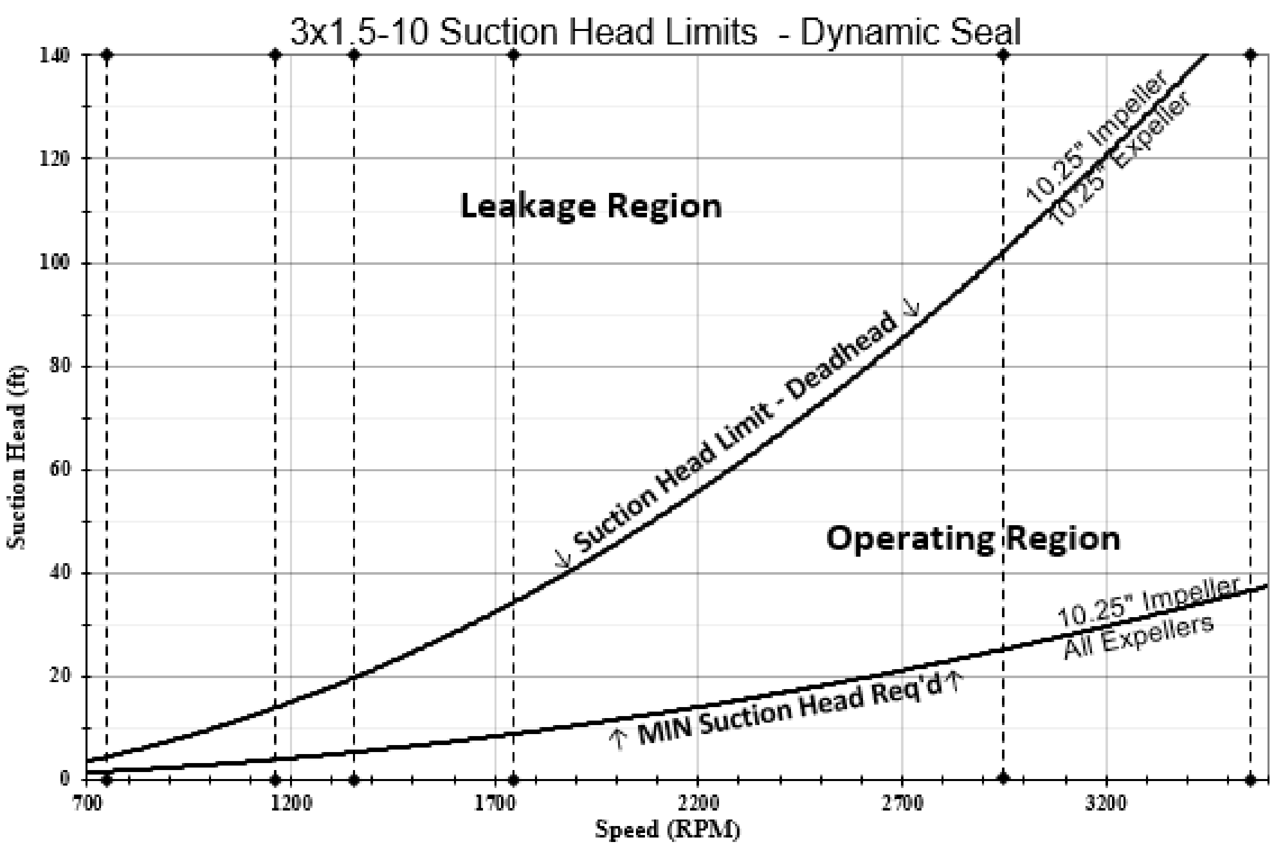


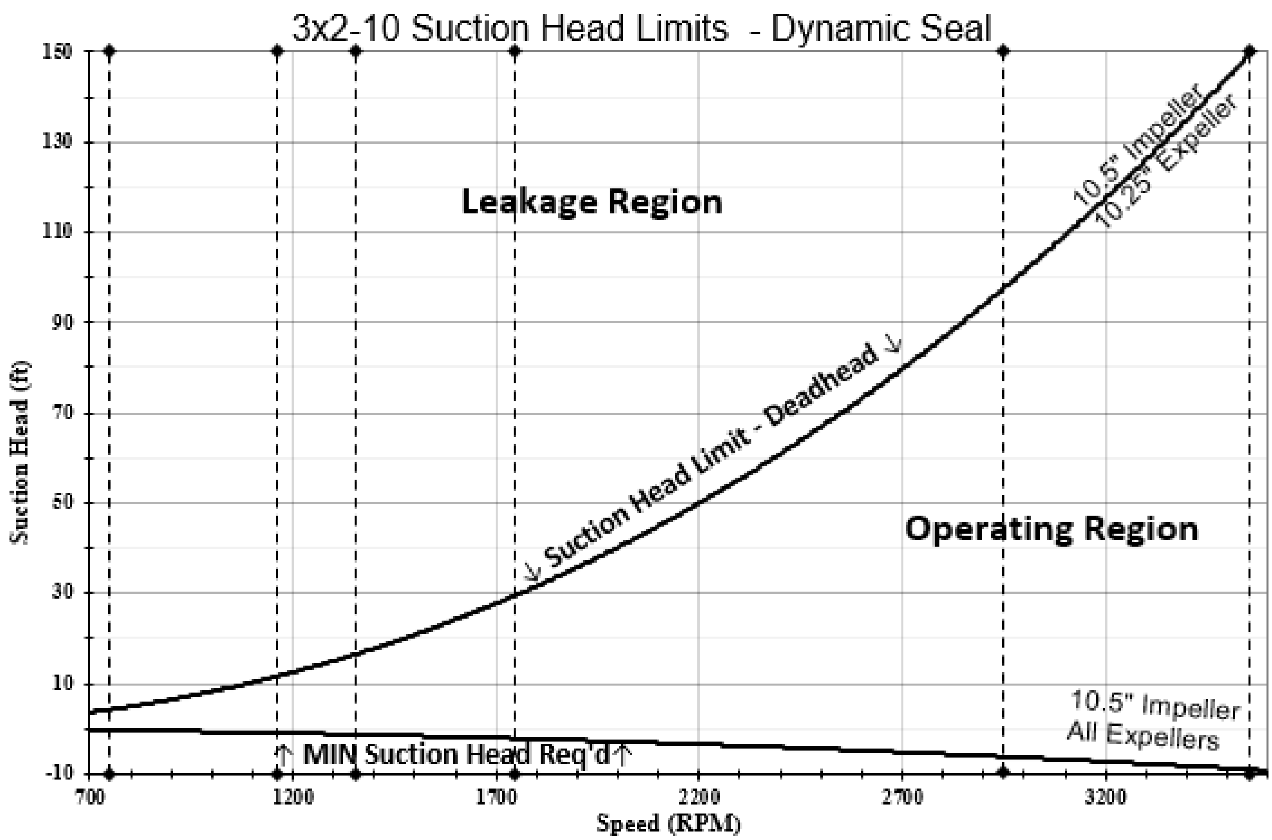


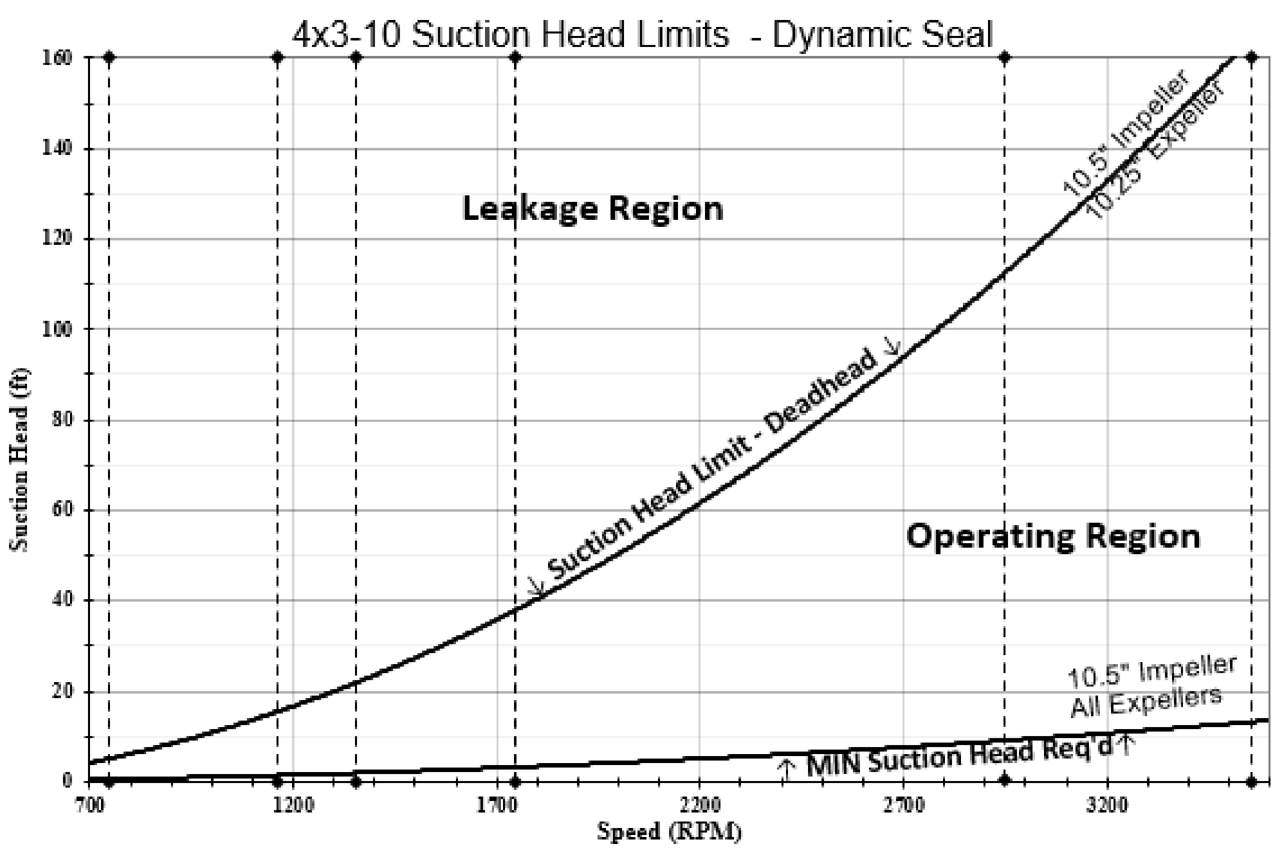
Suction Head Limits – Frame 2

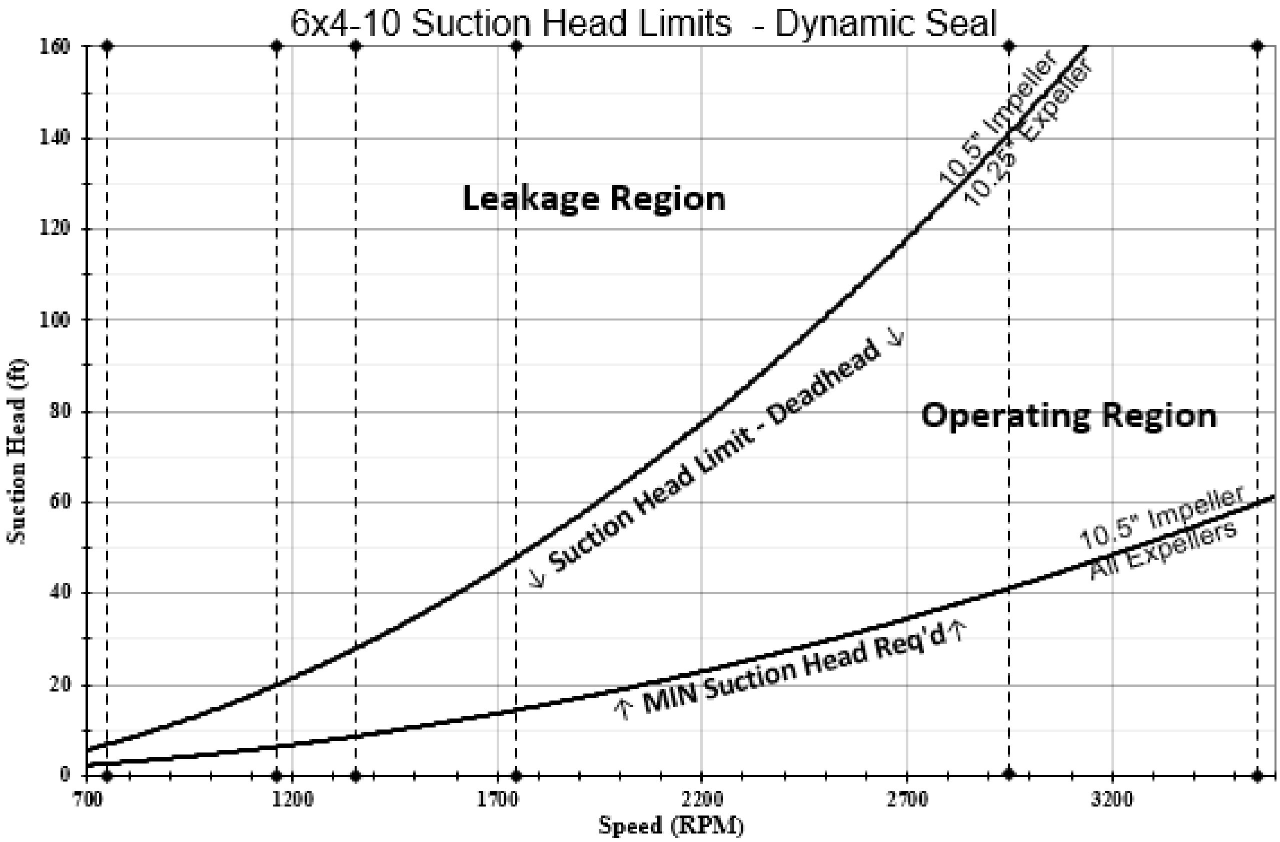
Curve used to approximate 3x1.5-8, 3x2-8, 4x3-8 sizes


Frame 2 8" Suction Head Limits - Dynamic Seal
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
8.5" Impeller
8.25" Expeller
8.25" Impeller
All Expellers
↑ MIN Suction Head Req'd ↑
Suction Head (ft)
Speed (RPM)
0
20
40
60
80
100
120
140
700
1200
1700
2200
2700
3200

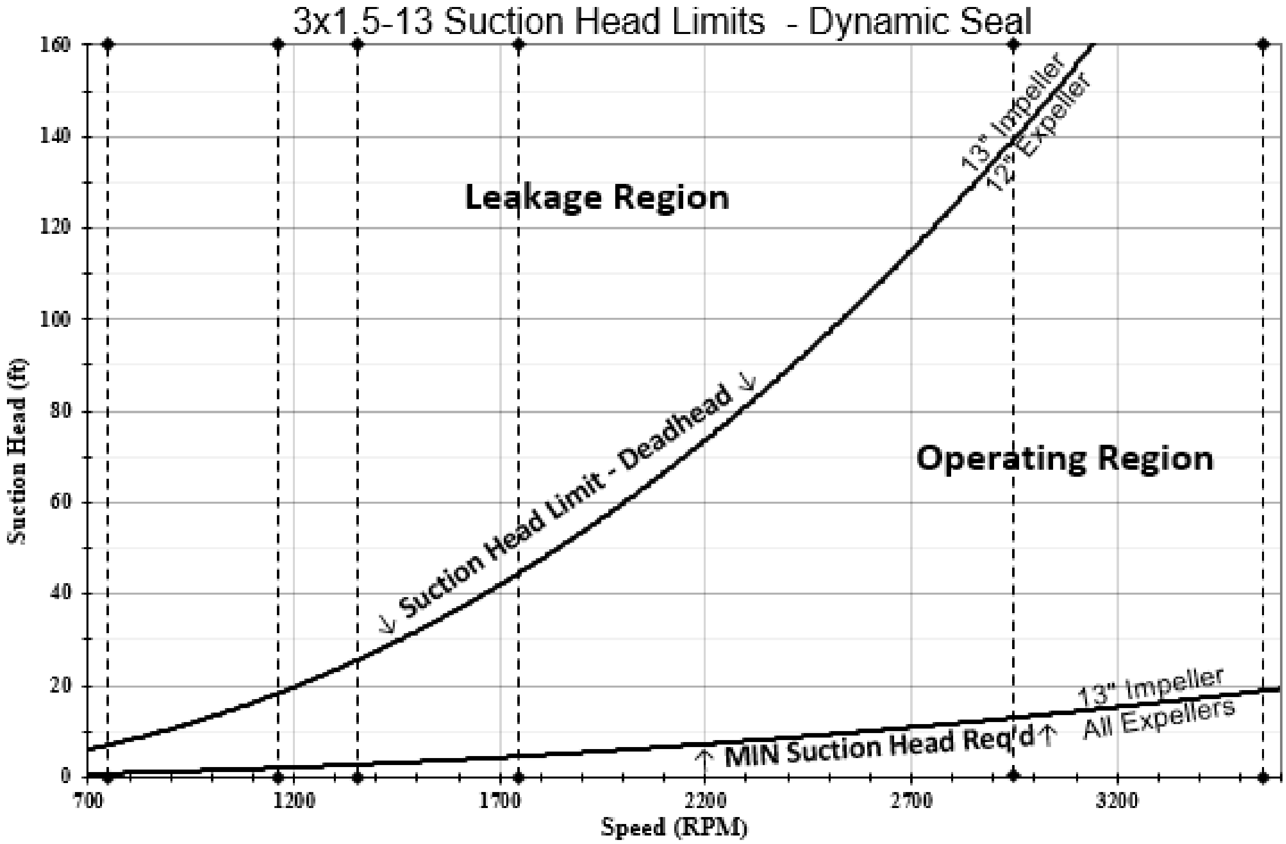

3x1.5-10 Suction Head Limits - Dynamic Seal
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
10.25" Impeller
10.25" Expeller
10.25" Impeller
All Expellers
↑ MIN Suction Head Req'd ↑
Suction Head (ft)
Speed (RPM)
0
20
40
60
80
100
120
140
700
1200
1700
2200
2700
3200

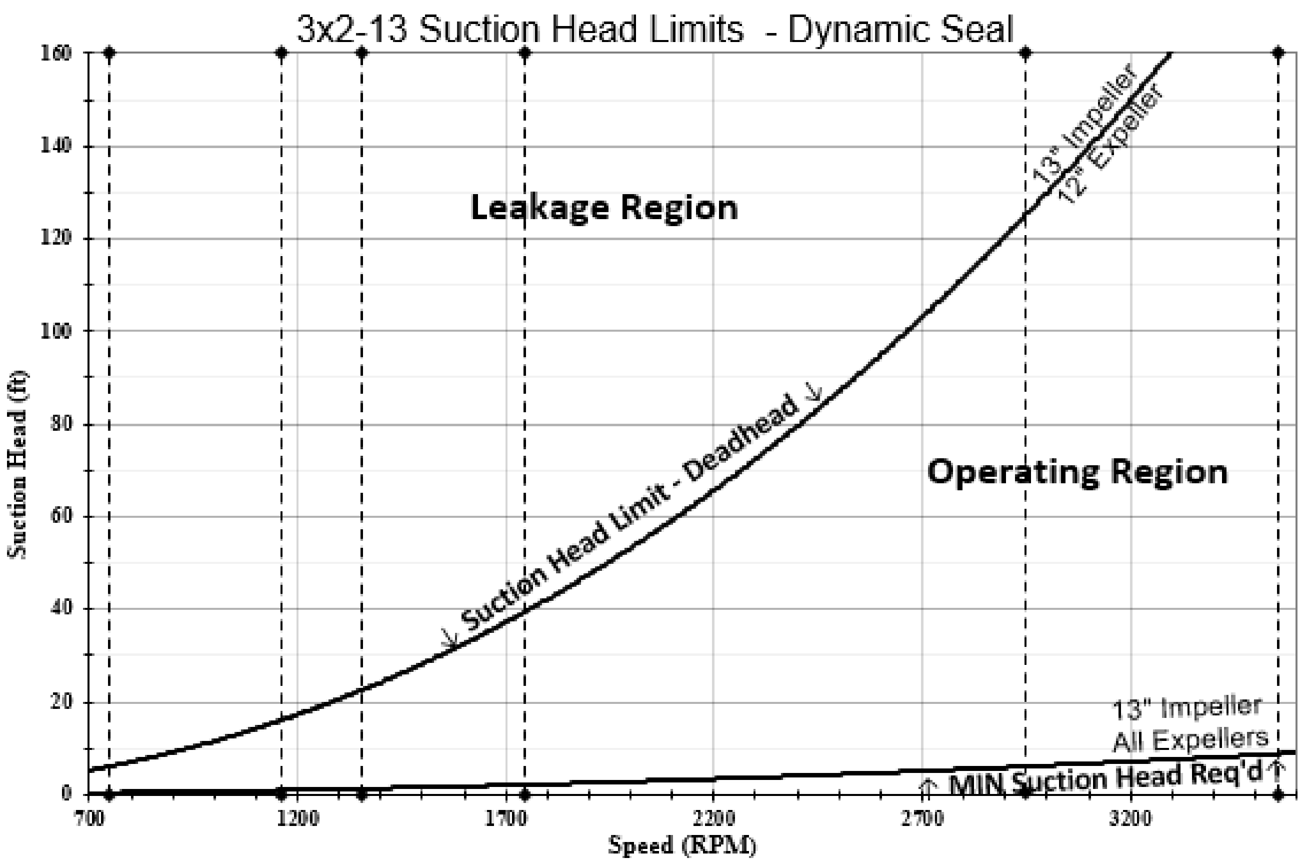

3x2-10 Suction Head Limits - Dynamic Seal
Suction Head (ft)
150
130
110
90
70
50
30
10
-10
700
1200
1700
2200
2700
3200
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
10.5" Impeller
10.25" Expeller
10.5" Impeller
All Expellers
↑ MIN Suction Head Req'd ↑

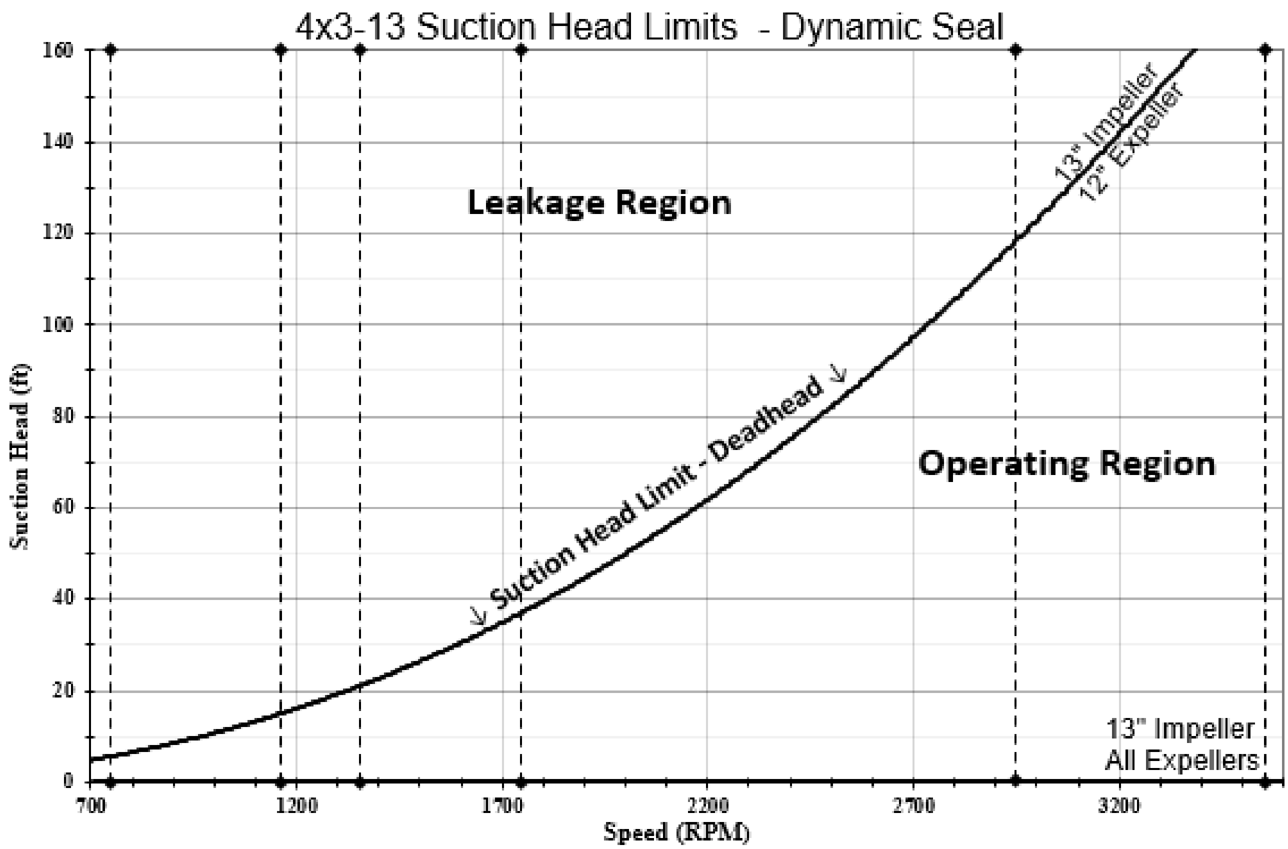

4x3-10 Suction Head Limits - Dynamic Seal
Suction Head (ft)
160
140
120
100
80
60
40
20
0
700
1200
1700
2200
2700
3200
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
10.5" Impeller
10.25" Expeller
10.5" Impeller
All Expellers
↑ MIN Suction Head Req'd ↑

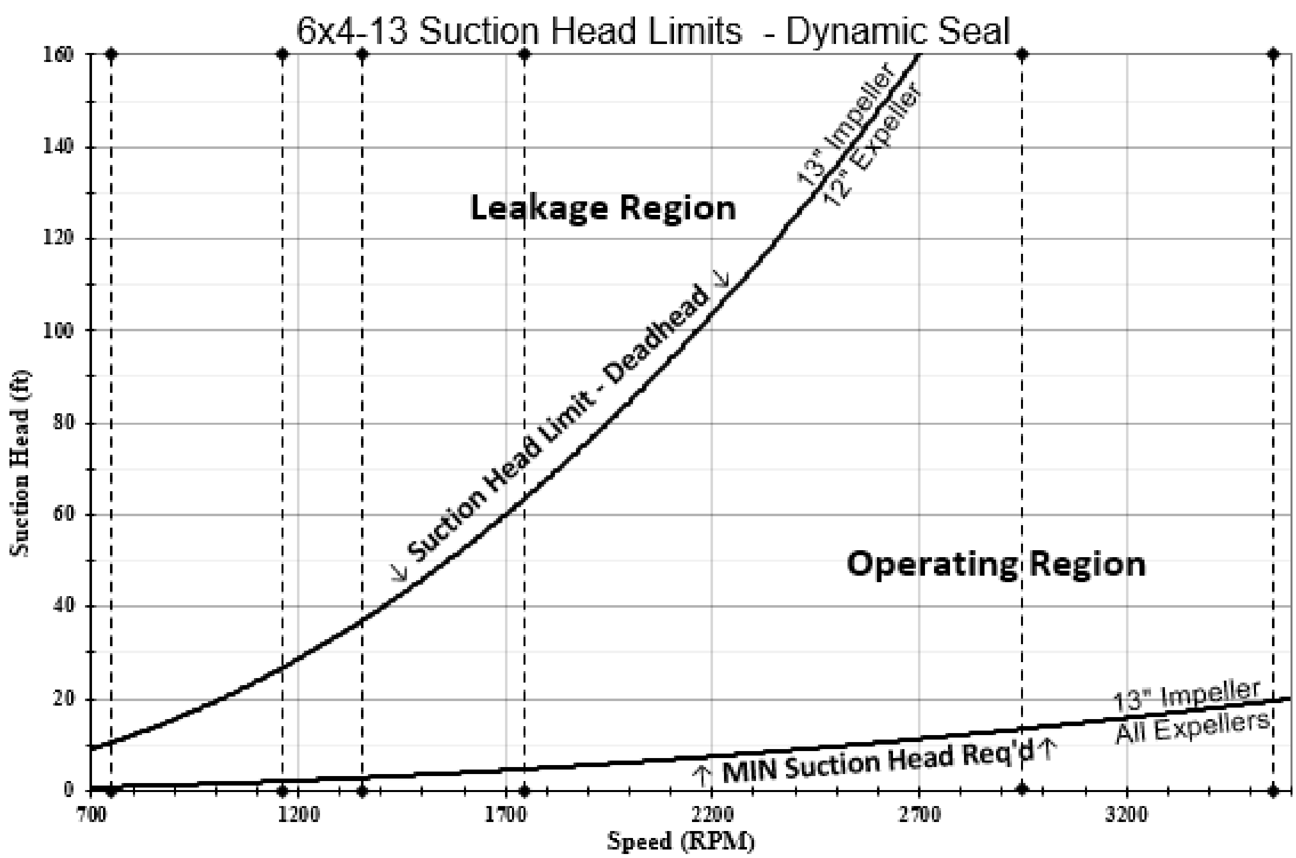

6x4-10 Suction Head Limits - Dynamic Seal
Suction Head (ft)
Speed (RPM)
0
20
40
60
80
100
120
140
160
700
1200
1700
2200
2700
3200
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
↑ MIN Suction Head Req'd↑
10.5" Impeller
10.25" Expeller
10.5" Impeller
All Expellers

Suction Head Limits – Frame 3

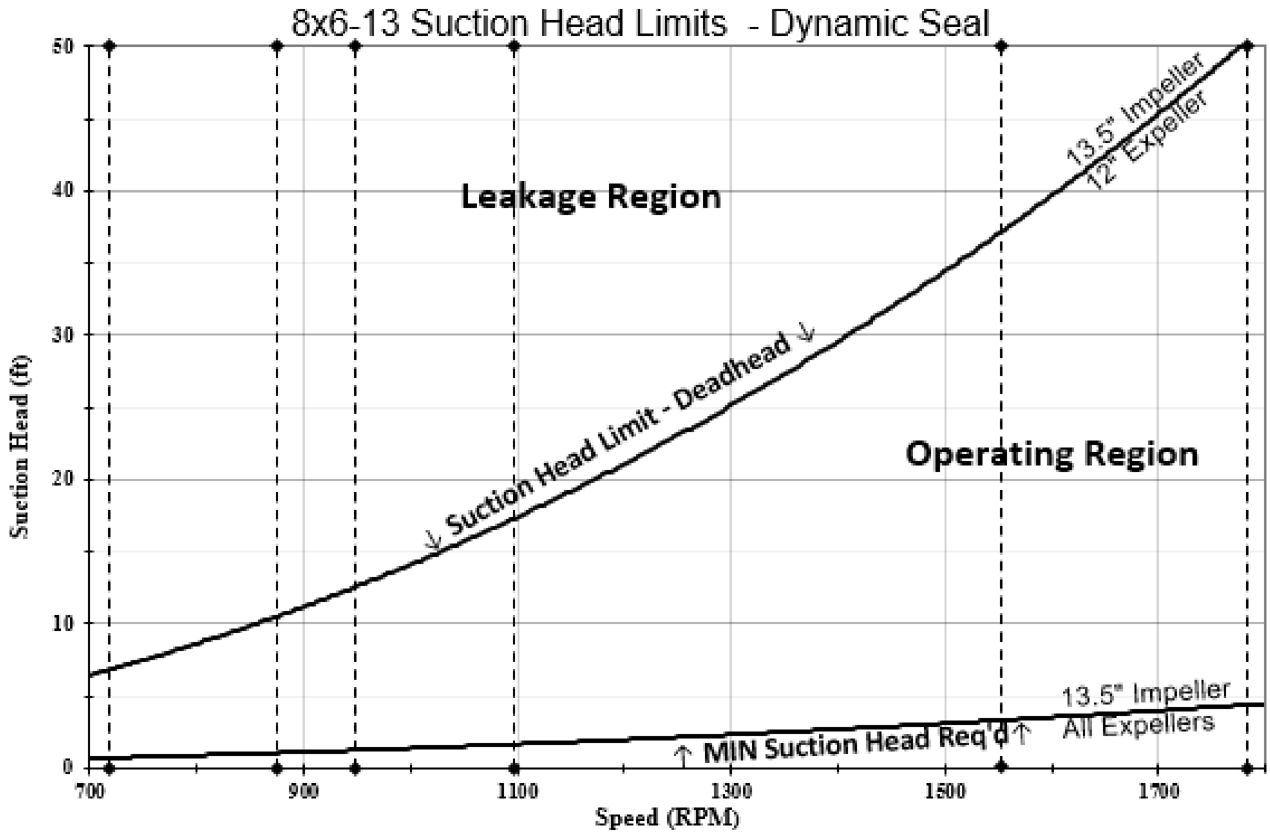


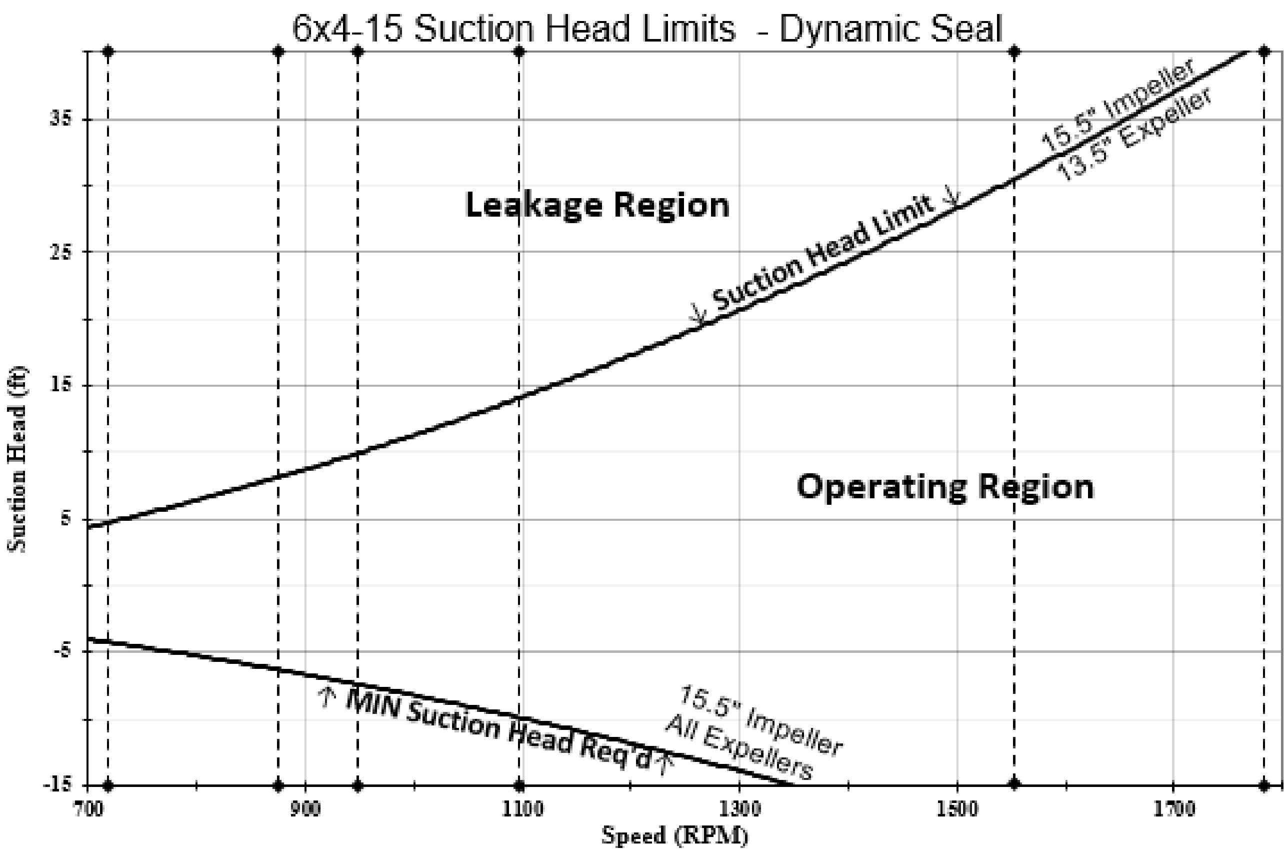


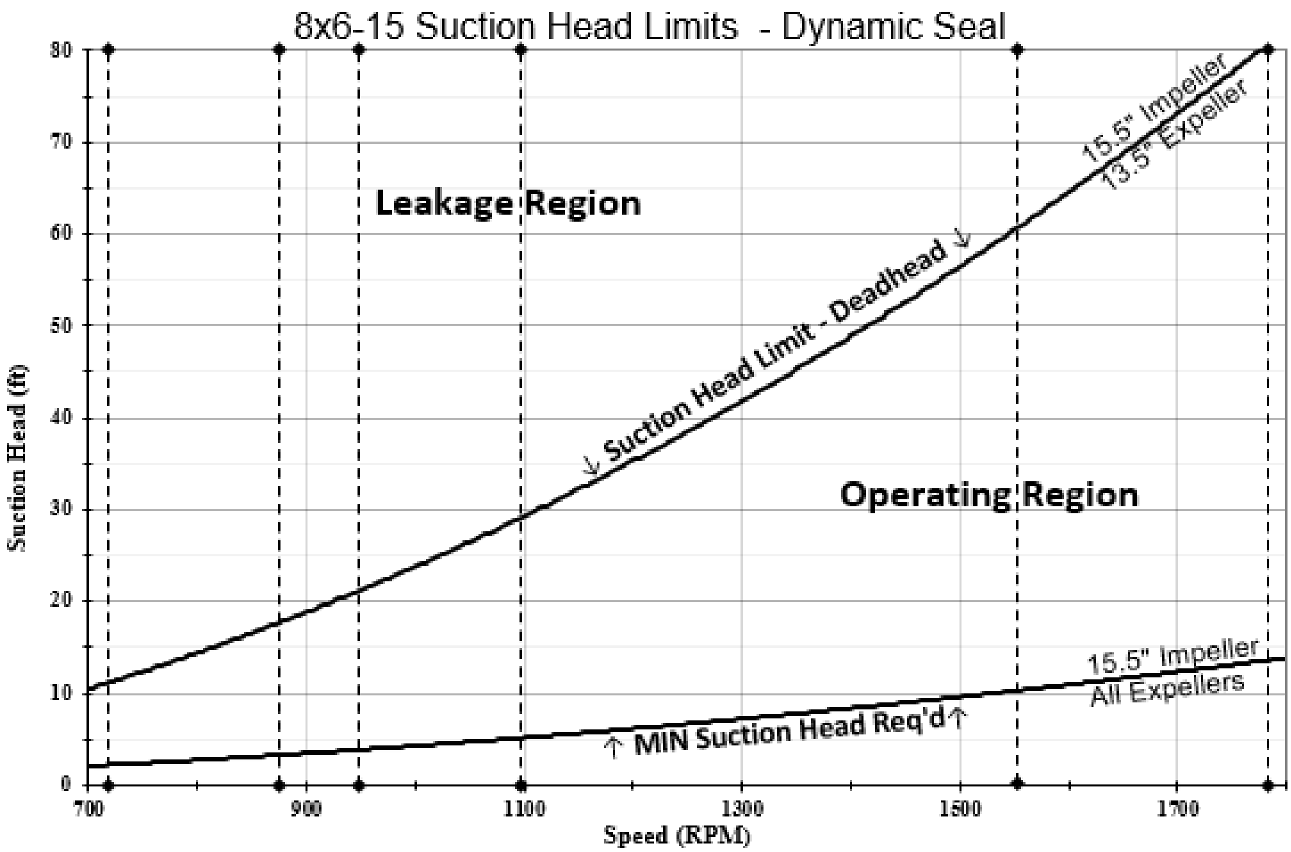

4x3-13 Suction Head Limits - Dynamic Seal
Suction Head (ft)
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
13" Impeller
12" Expeller
13" Impeller
All Expellers

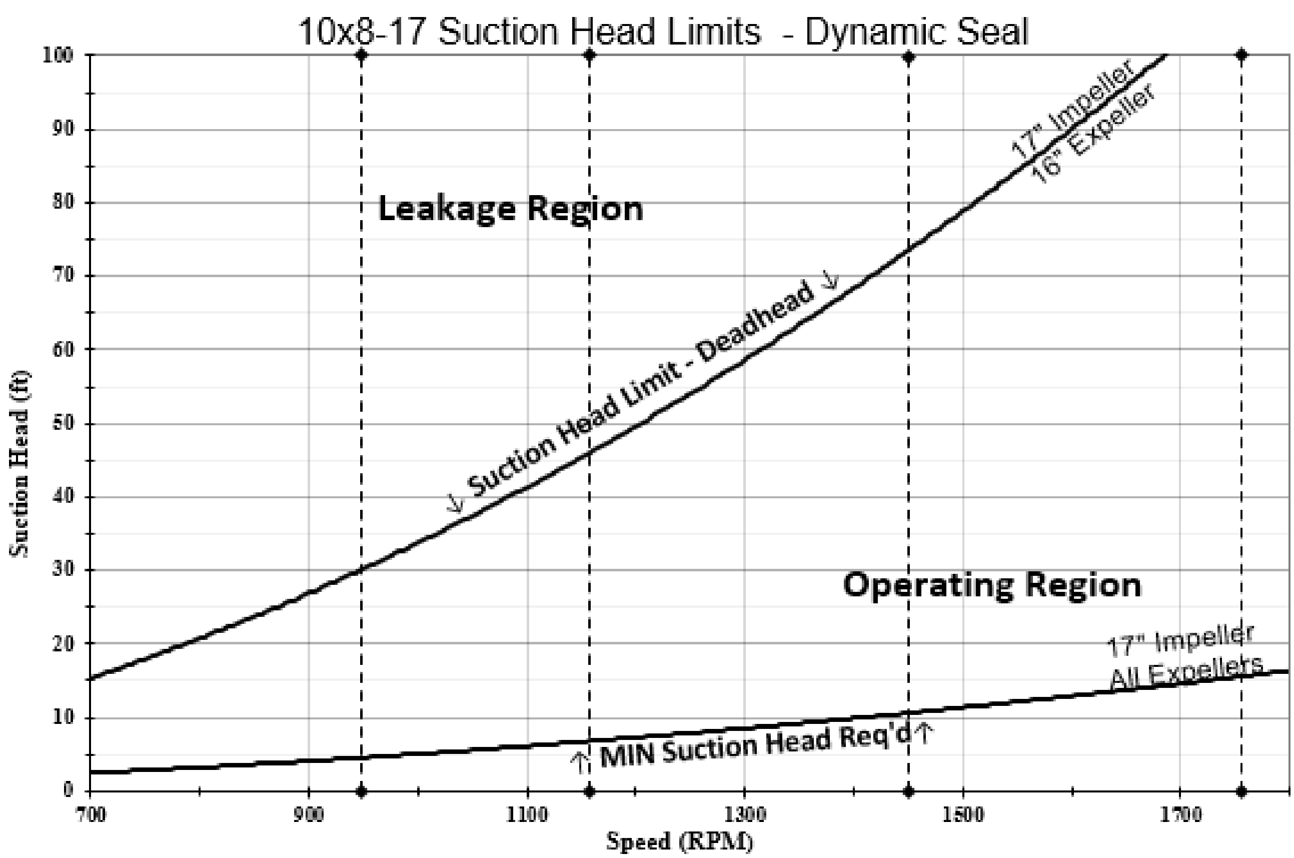

6x4-13 Suction Head Limits - Dynamic Seal
Suction Head (ft)
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
13" Impeller
12" Expeller
↑ MIN Suction Head Req'd ↑
13" Impeller
All Expellers

Suction Head Limits – Frame 4

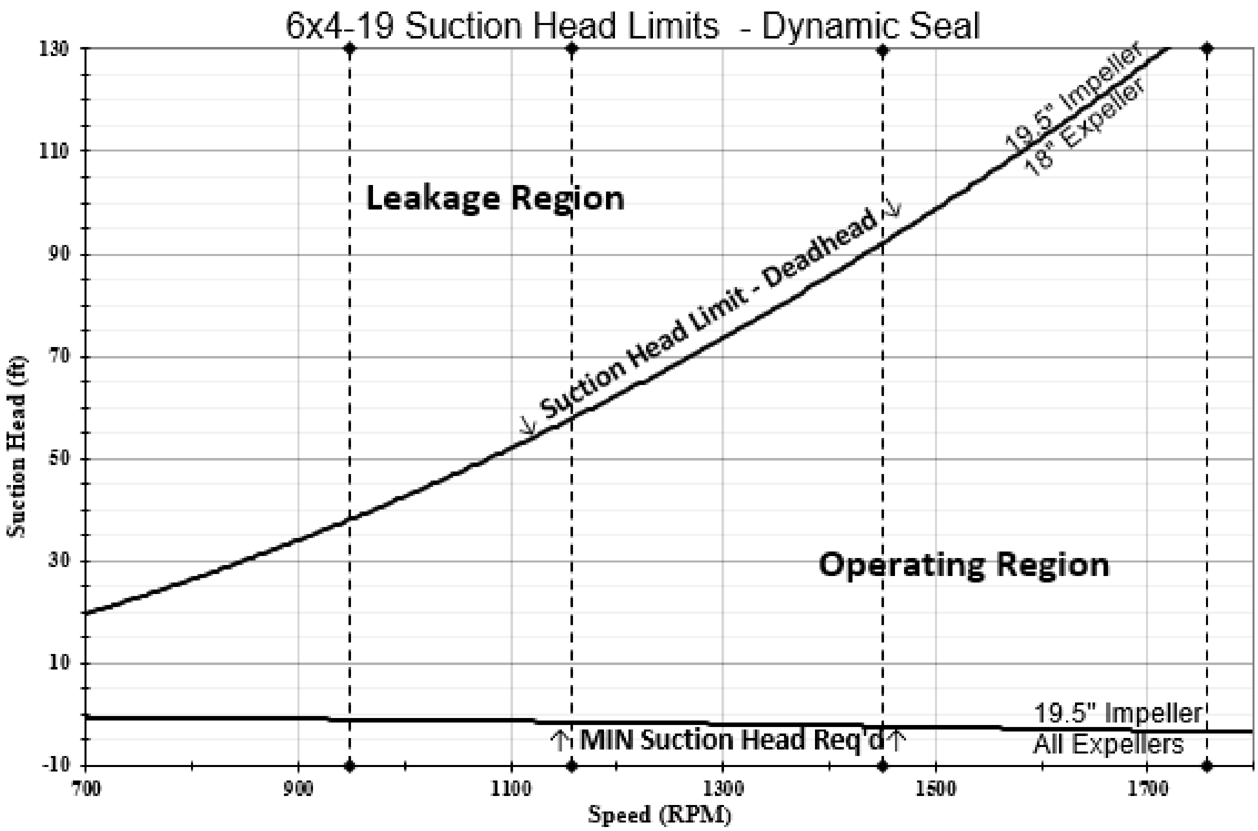


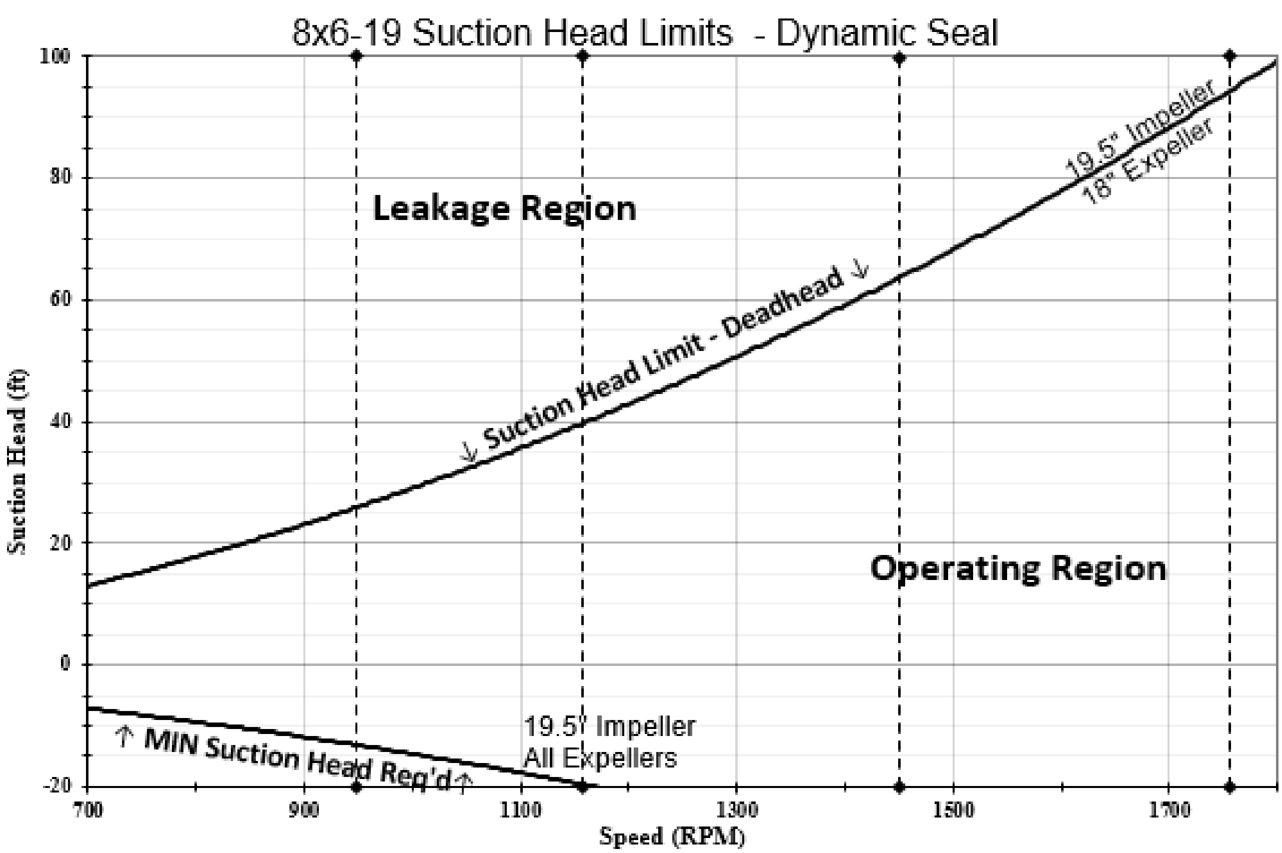


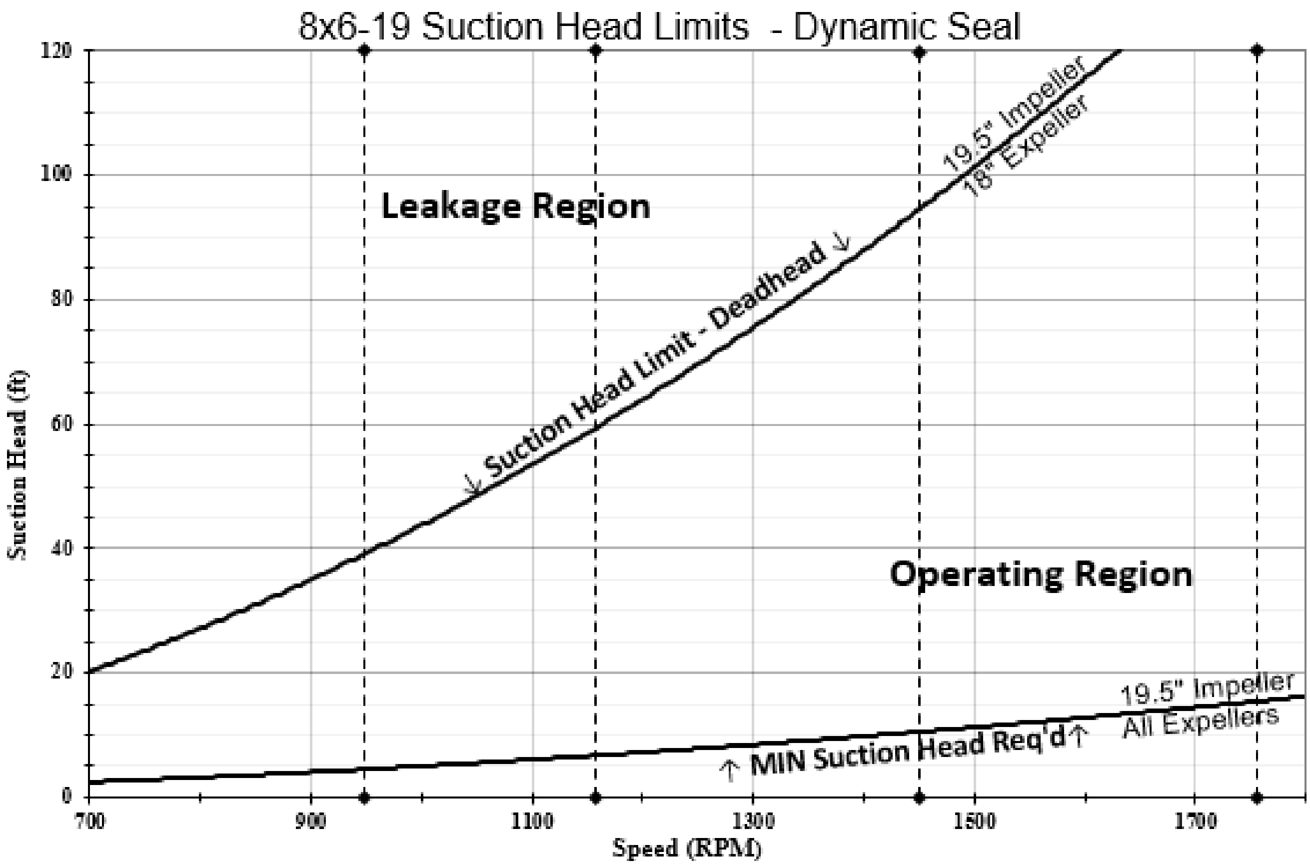

8x6-15 Suction Head Limits - Dynamic Seal
Suction Head (ft)
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
15.5" Impeller
13.5" Expeller
↑ MIN Suction Head Req'd ↑
15.5" Impeller
All Expellers
80
70
60
50
40
30
20
10
0
700
900
1100
1300
1500
1700


10x8-17 Suction Head Limits - Dynamic Seal
Suction Head (ft)
Speed (RPM)
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
17" Impeller
16" Expeller
↑ MIN Suction Head Req'd ↑
17" Impeller
All Expellers
100
90
80
70
60
50
40
30
20
10
0
700
900
1100
1300
1500
1700

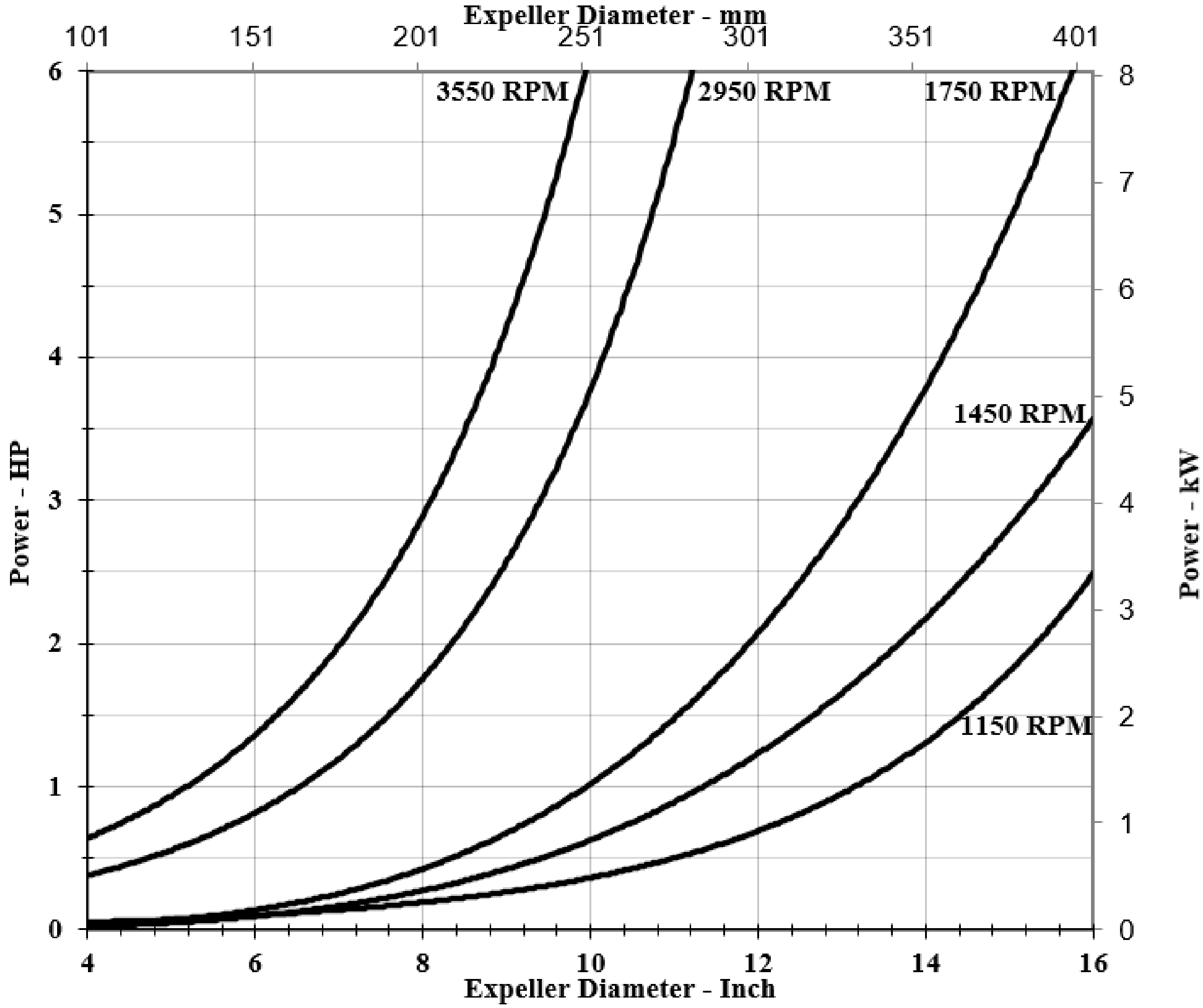
Suction Head Limits – Frame 5






8x6-19 Suction Head Limits - Dynamic Seal
Leakage Region
Operating Region
↓ Suction Head Limit - Deadhead ↓
19.5" Impeller
18" Expeller
↑ MIN Suction Head Req'd ↑
19.5" Impeller
All Expellers
Suction Head (ft)
Speed (RPM)
0
20
40
60
80
100
120
700
900
1100
1300
1500
1700

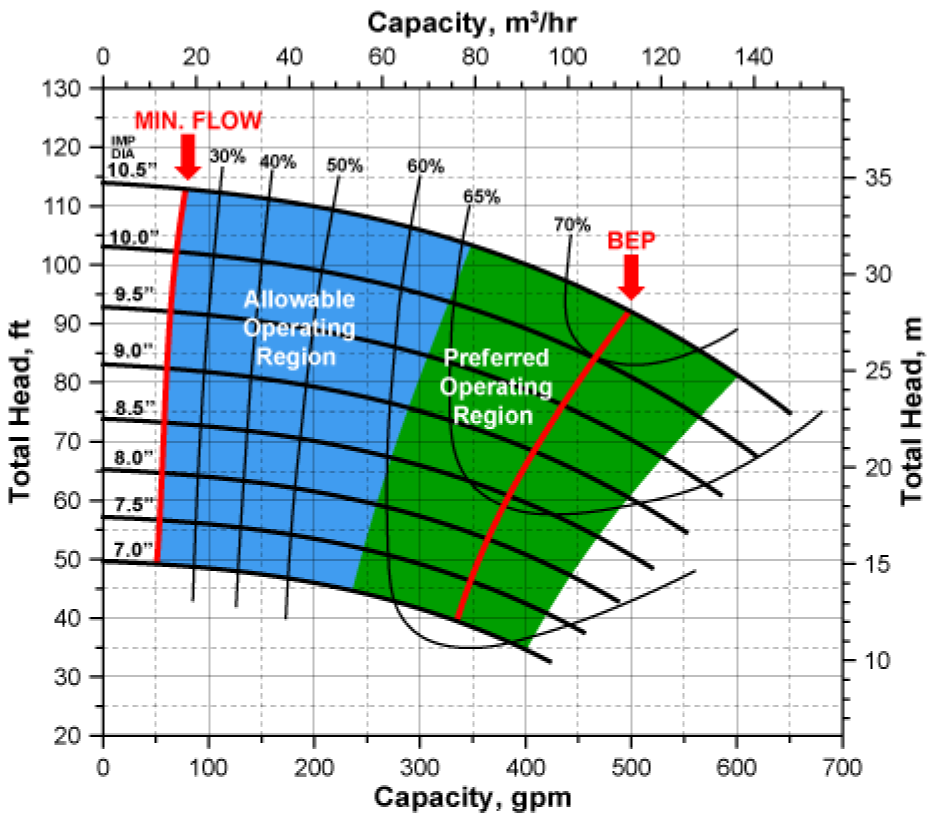
EXPELLER POWER CONSUMPTION



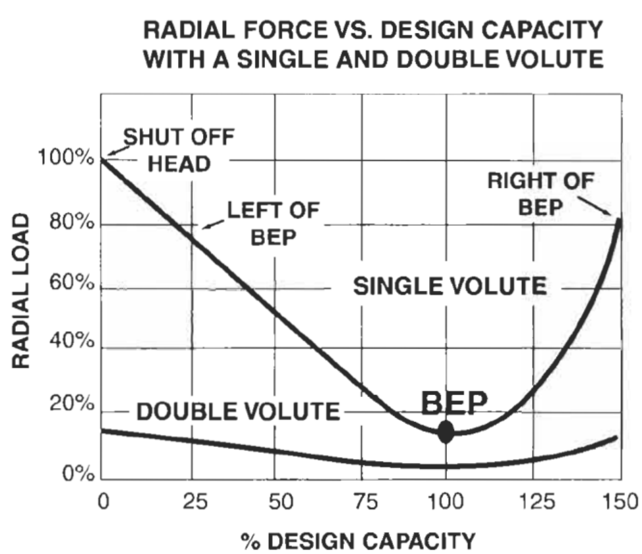
CONTINUOUS OPERATING RANGE

Always aim to operate a centrifugal pump in the preferred operating region, which is where the pump will operate nearest to the best efficiency point along the head-flow curve. Outside of this is the allowable operating region where pumps will still operate safely and reliably, although with lower than optimal efficiencies.

The recommended continuous operating range represents the range in which the pump may be operated reliably with most fluids with a specific gravity close to 1.0. Operation outside of the recommended range may still be possible depending on the operating parameters and conditions of service. The maximum flow is defined as 1.1 x Q_{BEP} at the rated diameter. Service conditions beyond this flow point should only be placed in service with extreme caution as pump reliability may be compromised.



Sometimes, pumps must run far to the left or right of their best efficiency points. Pumps operating away from their best efficiency points tend to develop hydraulic side loads that can stress the shaft, damaging the bearings, wear bands, and mechanical seal. The Wilfley A9 is not immune to these conditions due to the Single Volute design, however, the low shaft deflection values (see Shaft Deflection) allow these high loading conditions to be toleranced better that other competitive chemical pumps.



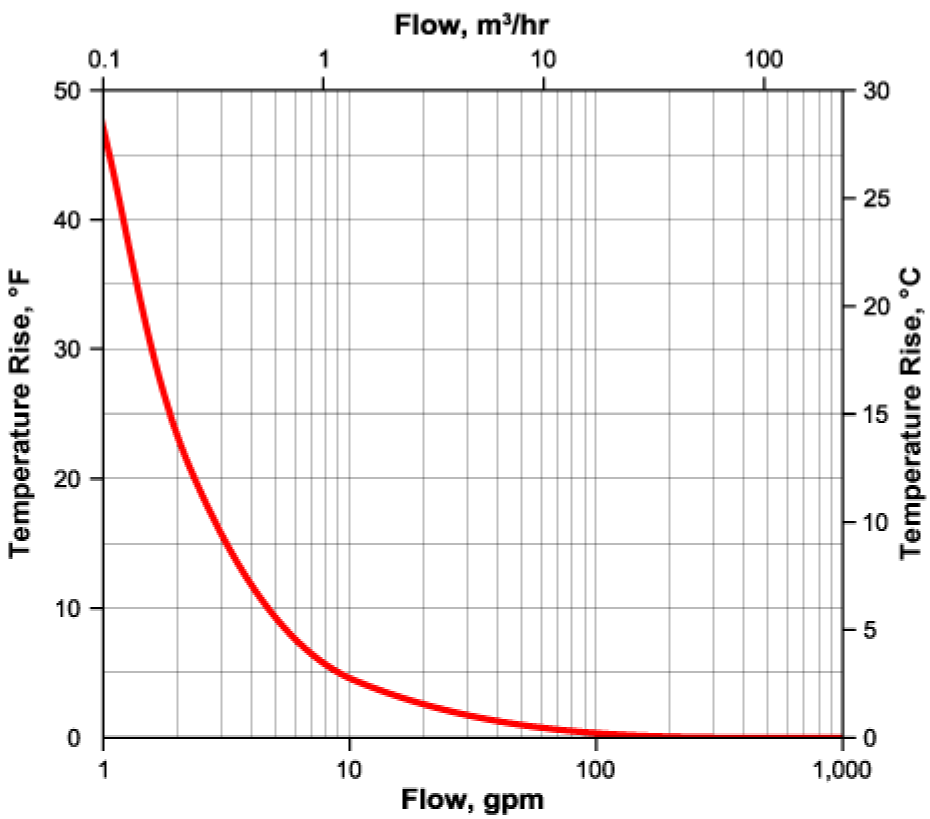
MINIMUM CONTINUOUS THERMAL FLOW

Concerns of exaggerated temperature rise, low $NPSH_A$, high axial loads, efficiency losses, or shaft power limitations are just a few of the potential issues that must be considered when operating outside of the preferred operating region. If, for example, an A9 pump is operated for a duration of time at very low flow, a temperature rise of the seal, the pump, and the process fluid will occur. Temperature rises in the process fluid and pump have the potential to create a safety hazard. Process fluid could reach a boiling point and which has the potential for a fire or even an explosion. All pump application personal should take extreme caution regarding minimum continuous thermal flow since it a huge safety concern.

The minimum continuous thermal flow must be considered if any of the following conditions exists:

- The suction pressure is approximately equal to the vapor pressure of the pumped media.
- A high suction pressure exists at relatively low pumping temperature.
- The $NPSH_A$ is close to $NPSH_R$.
- The specific gravity of the pumped media is at or below 0.65.
- The vapor pressure of the pumped media increases rapidly with a small temperature increase.

It should be evident that Minimum Thermal Flow is application dependent. See chart below showing the temperature rise based on flow of an arbitrary A9 pump.



Procedure to calculate MCTF:

1. Obtain data on the specific gravity, vapor pressure and specific heat for the fluid over the range of the pumping temperature to 15°F (10°C) above pumping temperature.
2. Calculate the absolute pressure at the pump suction nozzle.
3. Deduct $NPSH_R$ from the absolute suction pressure.
4. From the vapor pressure data, determine the saturation temperature that corresponds to the resultant pressure from Step 3.

5. Subtract the pumping temperature from the saturation temperature from Step 4; this is the allowable temperature rise.
6. Determine the pump Power at or near shutoff.
7. Calculate the minimum thermal flow using the following equation:

$Q = \frac{5.09 \times P}{\Delta T \times S.G. \times S.H.}$	$Q = \frac{P \times 3600}{\Delta T \times \rho \times S.H.}$
Q = Minimum continuous thermal flow (GPM). P = Power at or near shutoff (HP). ΔT = Allowable temperature rise (°F). S.G. = Specific gravity of the pumped fluid. S.H. = Specific heat of the pumped fluid (BTU/°F/lb).	Q = Minimum continuous thermal flow (m^3/h). P = Power at or near shutoff (kW). ΔT = Allowable temperature rise (°C). ρ = Density of the pumped fluid (kg/m^3). S.H. = Specific heat of the pumped fluid (kJ/kgK).

GENERAL RECOMMENDATIONS FOR MINIMUM CONTINUOUS FLOW

These are the ASME B73.1 recommendation which should be followed for optimum reliability and pump life. The pump may operate below the values shown, but at the expense of reduced bearing life.

PUMP		% BEP	
SIZE	**ASME B73.1 DESIGNATION**	**Below 3600 RPM**	**Below 1800 RPM**
1.5x1 - 6	AA-6	15	10
3x1.5 - 6	AB-6	15	10
3x2 - 6	AC-6	15	10
1.5x1 - 8	AA-8	20	10
3x1.5 - 8	A50-8	20	10
3x2 - 8	A60-8	20	10
4x3 - 8	A70-8	20	10
2x1 - 10	A05-10	25	10
3x1.5 - 10	A50-10	25	10
3x2 - 10	A60-10	30	15
4x3 - 10	A70-10	30	15
6x4 - 10	A80-10	30	15
3x1.5 - 13	A20-13	30	15
3x2 - 13	A30-13	40	15
4x3 – 13 / 13H	A40-13	40	40
6x4 – 13 / 13H	A80-13	40	40
8x6 - 13	A90-13	-	40
6x4 - 15	A105-15	-	50
8x6 – 15 / 15H	A110-15	-	50
10x8 – 17 /17H	A120-17	-	50
6x4 – 19	n/a	-	50
8x6 – 19	n/a	-	50
10x8 - 19	n/a	-	50
Low Flow (WLQ)	n/a	30	30
Vortex	n/a	--	10

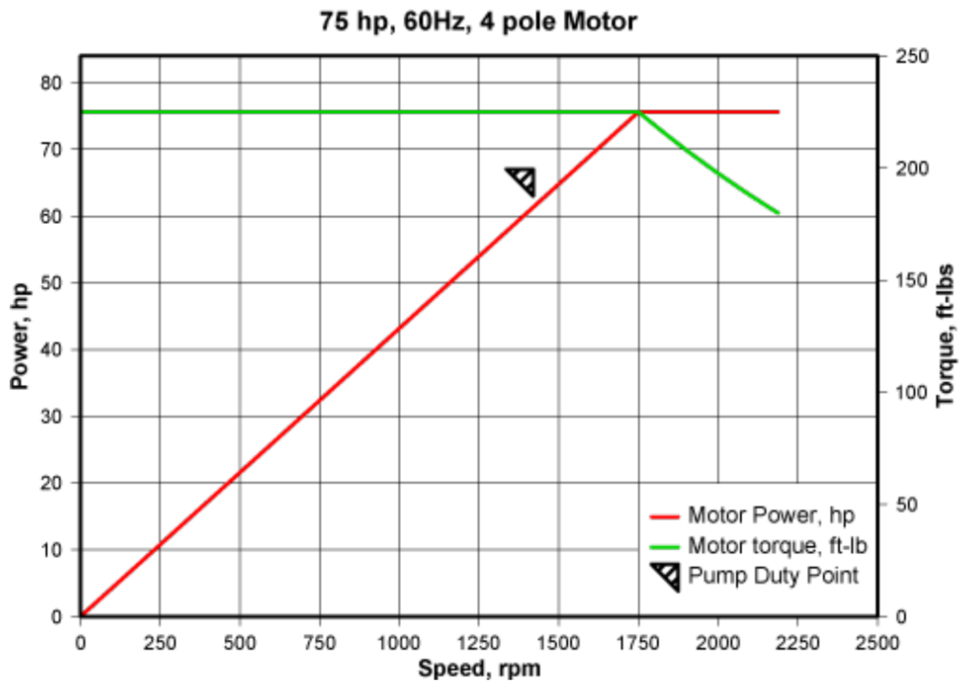
MOTOR HORSEPOWER SIZING

The relationship of power output to torque is defined as:

$$T = \frac{HP \times 5250}{rpm} \qquad T = \frac{kW \times 9545}{rpm}$$

(US units, ft-lb) (SI units, N-m)

For example, a 75 hp / 1,750 rpm motor is capable of 225 ft-lb of torque. Similarly, a 55 kW / 1,450 rpm motor is capable of 362 N-m of torque. Considering the traits and equation above, a motor's output can be graphically demonstrated below:



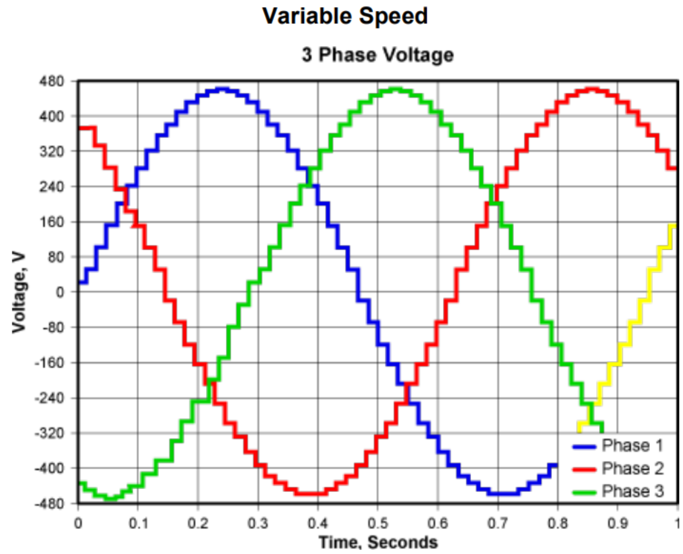
Most pump manufacturers choose to fix the pump diameter at maximum values when sizing for variable speed applications to reduce the number of iterations and maximize efficiency. And inconveniently enough, the resultant speeds rarely fall at or near fixed frequency motor speeds.

As you can see from the table below, there are significant speed gaps between the synchronous speeds. It may be desirable to run a centrifugal at its most efficient point between these speeds, even with a trimmed impeller.

Number of Poles	Synchronous Speed at 60Hz	Synchronous Speed at 50Hz
2	3,600	3,000
4	1,800	1,500
6	1,200	1,000
8	900	750
10	720	600

Therefore, in order to change the speed of the motor you must change the electrical frequency, which is fixed on the electrical grid. This is where Variable Frequency Drive's (VFD's) come into play, as they take the fixed input frequency and permit a variable output frequency to the motor.

NEMA motors are often nameplated with a service factor of 1.15, meaning that the motor can continuously supply 115% of rated power and operate within the stated temperature rise. Conversely, IEC motors are rated with no service factor. However, unless the nameplate explicitly indicates VFD rated, the stated values are based upon a natural sine wave. When power is supplied from a VFD, the service factor is lost or decreased to maintain the nameplate temperature rise. When sizing a VFD for your centrifugal pump application, beware relying on the service factor. Also, don't overlook elevation limits, belt losses and transient conditions.



Selecting a motor depends on the specific gravity of the fluid as well as the operating speed and corresponding efficiency of the pump. Always give margin when selecting a motor such that the rated BHP is at least matching the maximum system flow rate. This runout flow rate will ensure that the motor is not overloaded in standard operating conditions. If flow conditions will not exceed duty flow, use BHP at operating conditions as your basis for motor selection.

Suction pressure

As process fluids get heavier than water (a specific gravity of 1.0), a centrifugal pump will require more power at the same operating power as an equivalent unit pumping water. Correction factors for the motor must be accounted for when looking at a pump performance curve as tested on water.

Minimum motor HP Formula:

1.1 = Safety Factor
HP=Safety Factor x S.G. x (Power $_{\text{from curve}}$ + Suction$_p$)

PUMP SHAFT POWER LIMITS

Power limits of the pump shaft are identified as power per 100 RPM. Those limits are shown below.

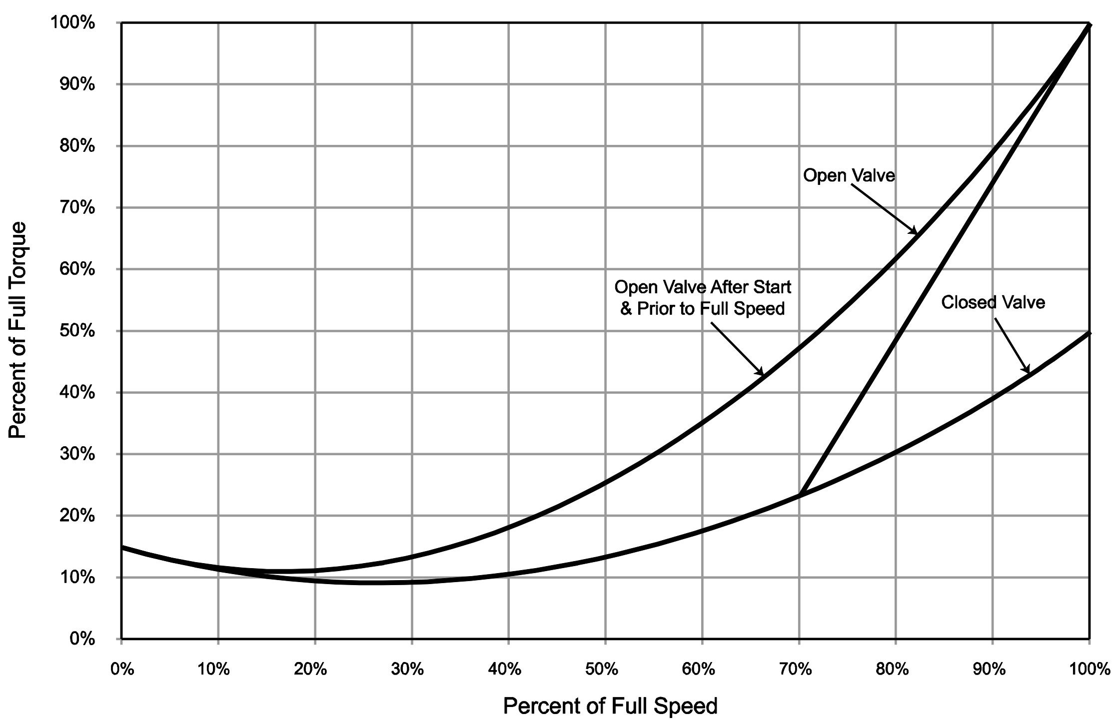
A9	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5
Power per 100 RPM	1.75hp	4.35hp	11.50hp	23.50hp	30.00hp
	1.30kW	3.24kW	8.58kW	17.52kW	22.37kW

A7	Frame 1	Frame 2	Frame 3	Frame 4	Frame 5
Power per 100 RPM	1.50hp	2.70hp	5.50hp	14.50hp	n/a
	1.12kW	2.01kW	4.10W	10.81kW	n/a

- Sizing the correct motor per the pump shaft power limits ensures the minimum L_{10} life of bearings.
- For specific gravity higher than 1.3 or pump selection below minimum flow conditions, extreme-duty bearings should be reviewed and considered – consult Wilfley Engineering.
- Power Limits basis material of 4340/4140 HT only – for other alloys (e.g.: 316, Nitronic) the material strength is lower and therefore the power limits must be derated/reduced.
- Frame 5 is specific only for 19” pumps (non-ASME B73.1) and not available for other products.
- For specific gravity higher than 1.8, consult the Denver factory.

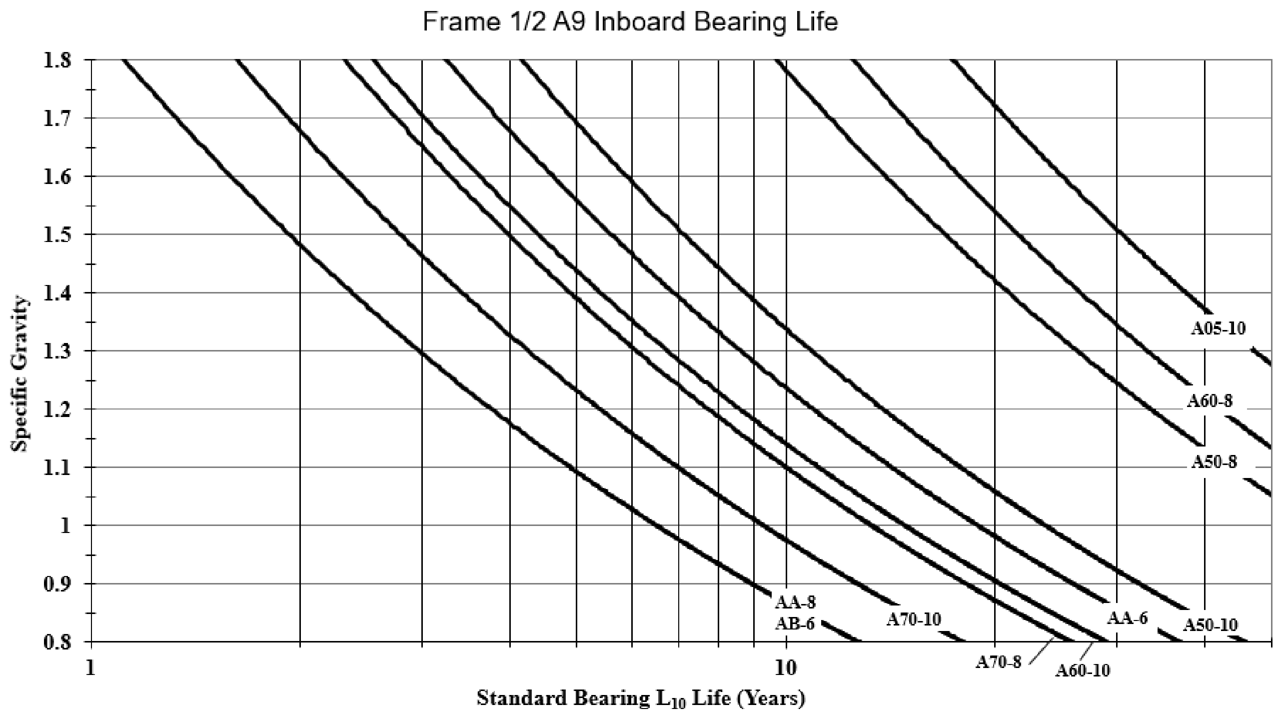
TORQUE FOR A CENTRIFUGAL PUMP

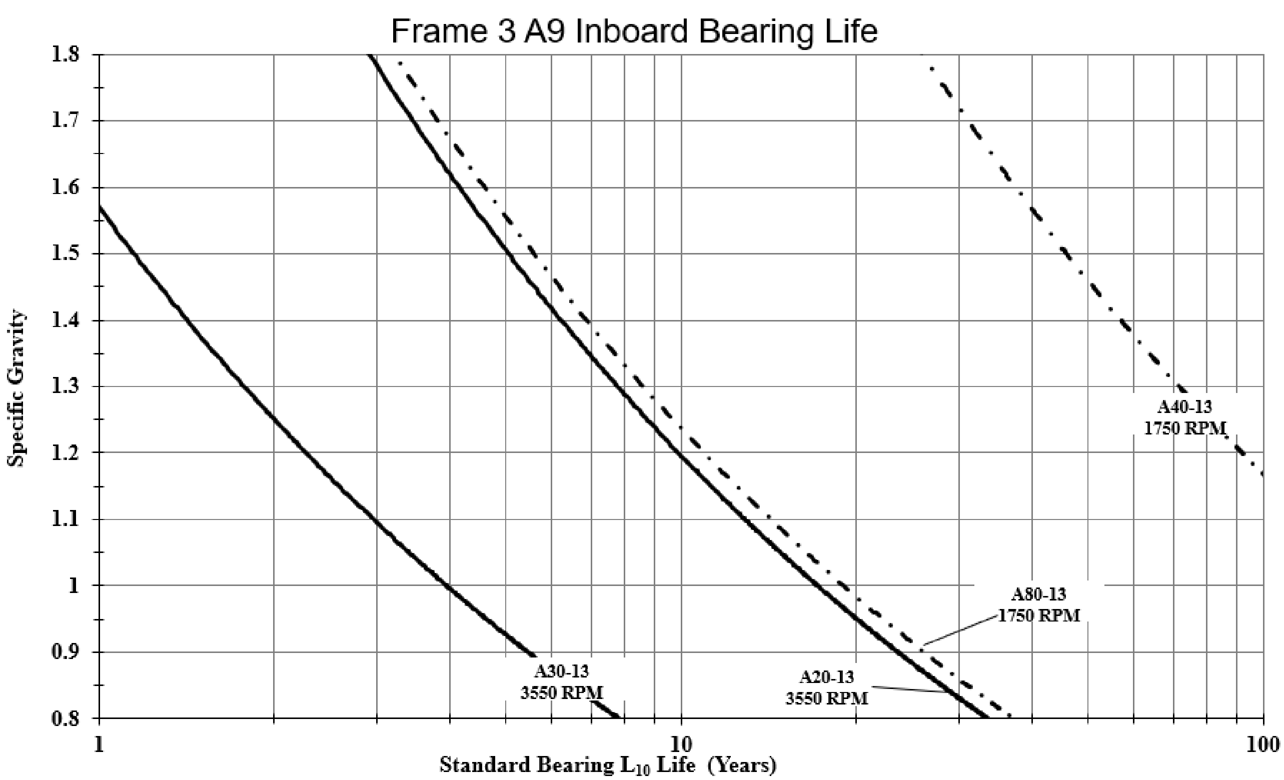
Note that the torque running through the shaft changes based on operating conditions. See the trend of torque based on operating conditions below.

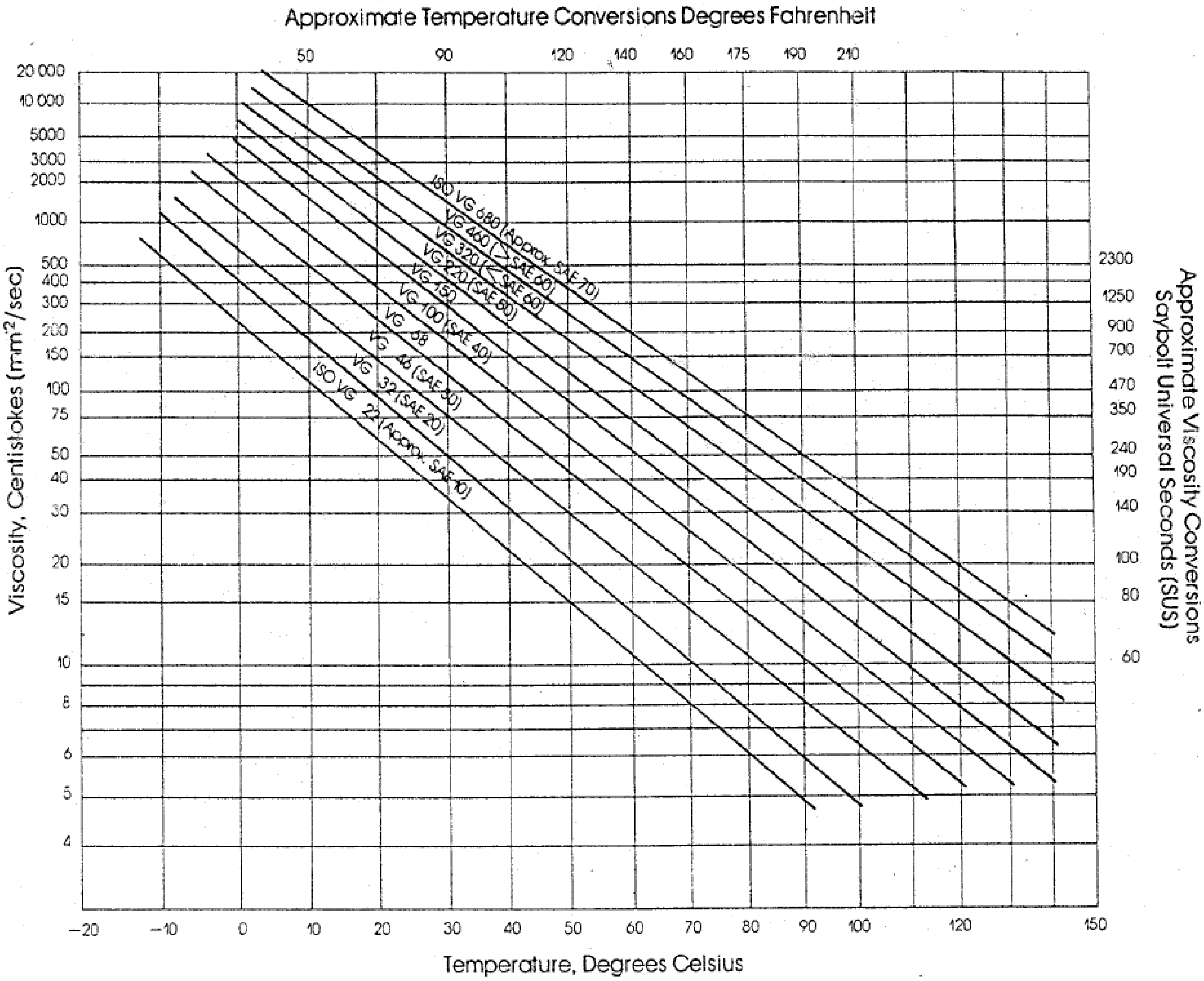


BEARING GUIDE

Standard lubrication is wet sump method with sight glassed. Oil mist and constant-level oilers are optional features. Based on the specific gravity of the pumped fluid, the bearing life may be reduced. Below are L10 Bearing life charts for the inboard bearings for the various frame sizes.







Viscosity-Temperature Chart

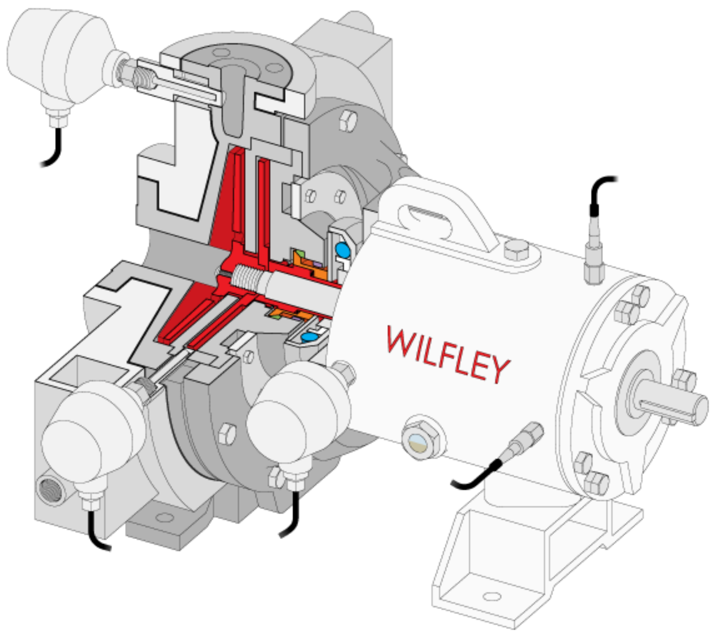
NOTE: Viscosity classification numbers are according to International Standard ISO 3448 – 1975 for oils having a viscosity index of 95.
Approximate equivalent SAE viscosity grades are shown in parentheses.

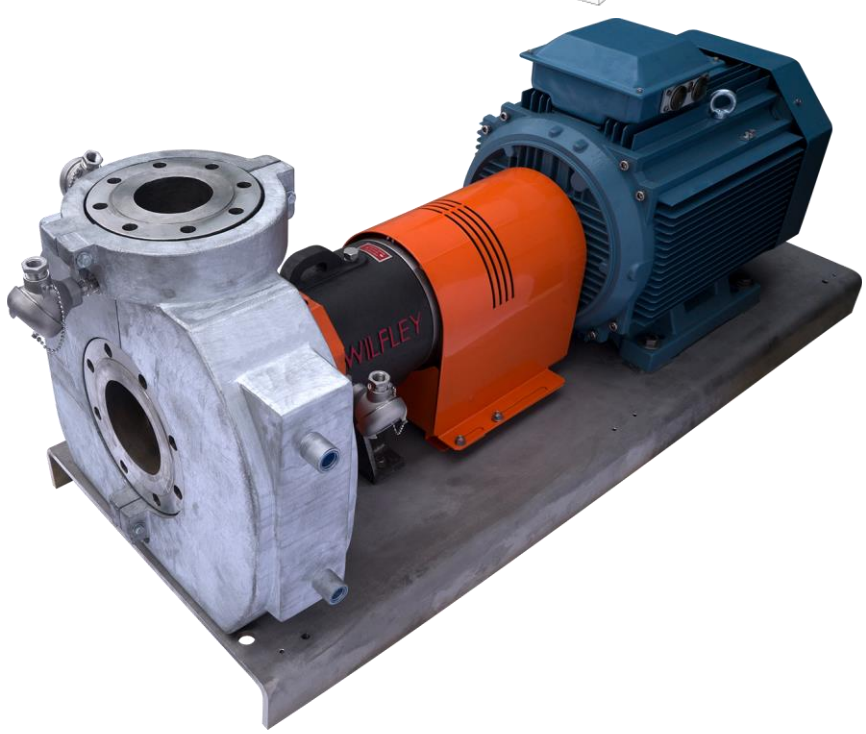
OPTIONAL EXTRAS

Condition monitoring

Additional options exist on the A7 & A9 pump such as process fluid and seal cavity temperature monitoring (thermowells). These features are useful to monitor operating conditions of the pump for specific applications of service. Additionally, jacketed cases are offered as well for control and cooling of the pump while in extreme duty services.

See the image below for a pump outfitted for Ammonium Nitrate with all of these features.

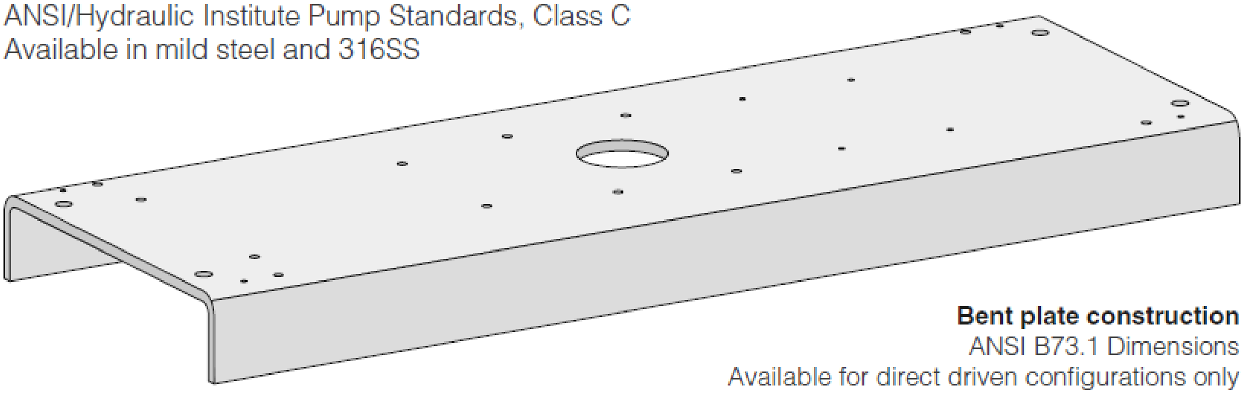




Baseplates

CHANNEL

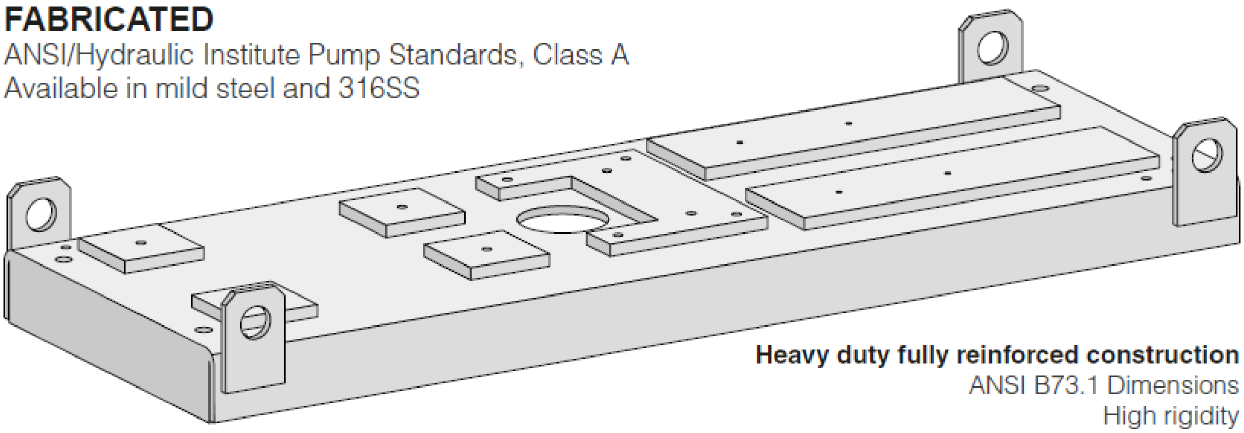
ANSI/Hydraulic Institute Pump Standards, Class C
Available in mild steel and 316SS



Bent plate construction
ANSI B73.1 Dimensions
Available for direct driven configurations only

FABRICATED

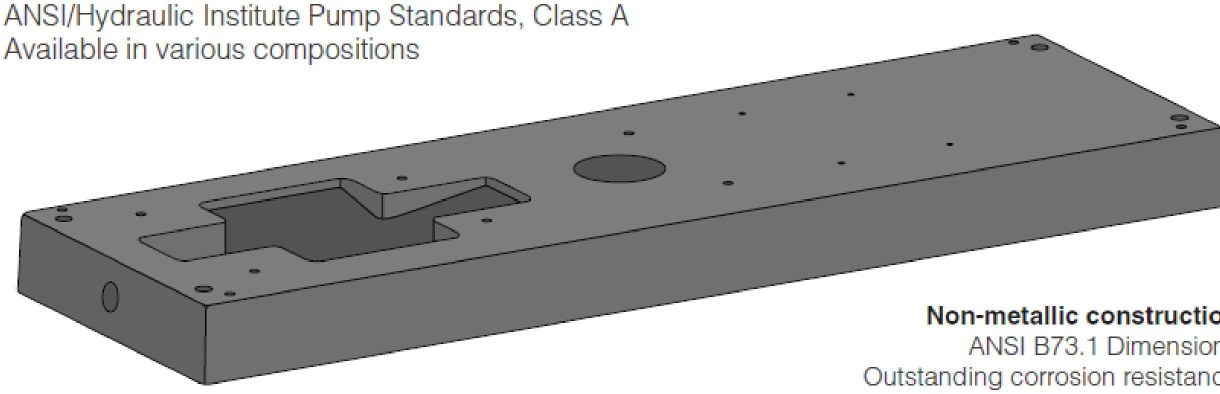
ANSI/Hydraulic Institute Pump Standards, Class A
Available in mild steel and 316SS



Heavy duty fully reinforced construction
ANSI B73.1 Dimensions
High rigidity
Available for direct and overhead belt driven configurations

NON-METALLIC

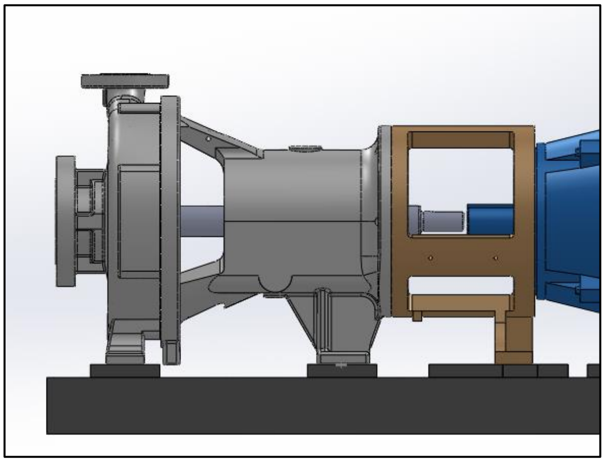
ANSI/Hydraulic Institute Pump Standards, Class A
Available in various compositions

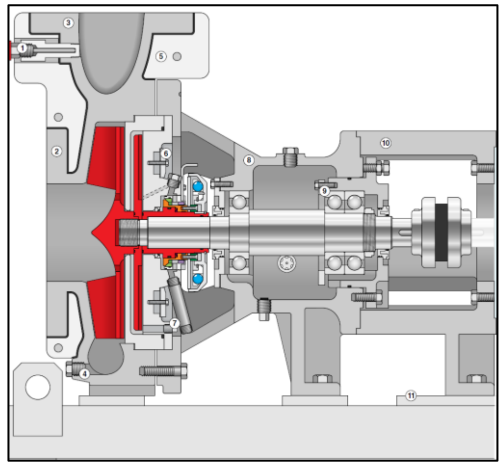


Non-metallic construction
ANSI B73.1 Dimensions
Outstanding corrosion resistance
Superior vibration damping

C-Frame Adapter

C-frame adapters are available for frame 2 and frame 3 A7 and A9 pumps. The adapter allows the pumps to be coupled to the motor such that coupling and alignment concerns are minimized. This is a convenience when applications dictate longer long expectations and maximized life from motor couplings.

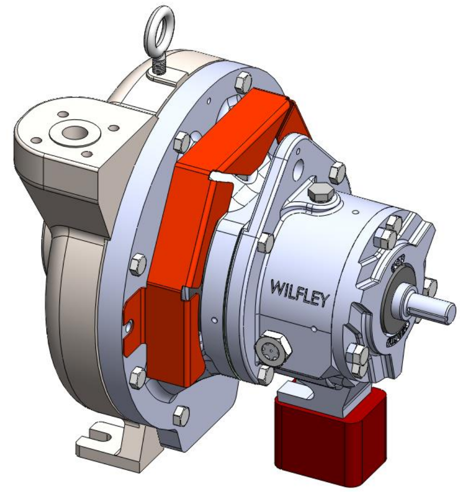




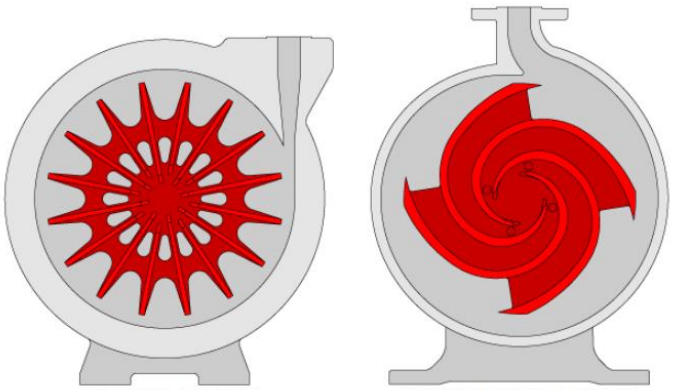
The c-frame adapters are configured to handle TSC and TC motors. To accommodate for the increased shaft length on TC frame motors, an extension is used with the standard adapter. TC motors are preferred as TSC frames are not as readily available. The table below lists the appropriate C-Frame adapter and extension to use for available motors.

Motor	Motor Speed			Frame 2		Frame 3	
	1150	1750	3550	Adapter	Extension	Adapter	Extension
182TC	Yes	Yes	Yes	A0488		A0492	
184TC	Yes	Yes	Yes				
213TC	Yes	Yes	Yes				
215TC	Yes	Yes	Yes				
254TC	Yes	Yes	Yes				
256TC	Yes	Yes	Yes				
284TSC	No	No	Yes	A0489		A0493	
284TC	Yes	Yes	No		A0961		A0961
286TSC	No	No	Yes				
286TC	Yes	Yes	No		A0961		A0961
324TSC	No	No	Yes	A0490		A0494	
324TC	Yes	Yes	No		A0963		A0963
326TSC	No	No	Yes				
326TC	Yes	Yes	No		A0963		A0963
364TSC	No	Yes	Yes				
364TC	Yes	No	No		A0964		A0964
365TSC	No	Yes	Yes				
365TC	Yes	No	No		A0964		A0964
404TC	Yes	No	No		A0965		A0965
405TSC	No	Yes	Yes				
405TC	Yes	No	No		A0965		A0965

Low Flow, High Head Pumps



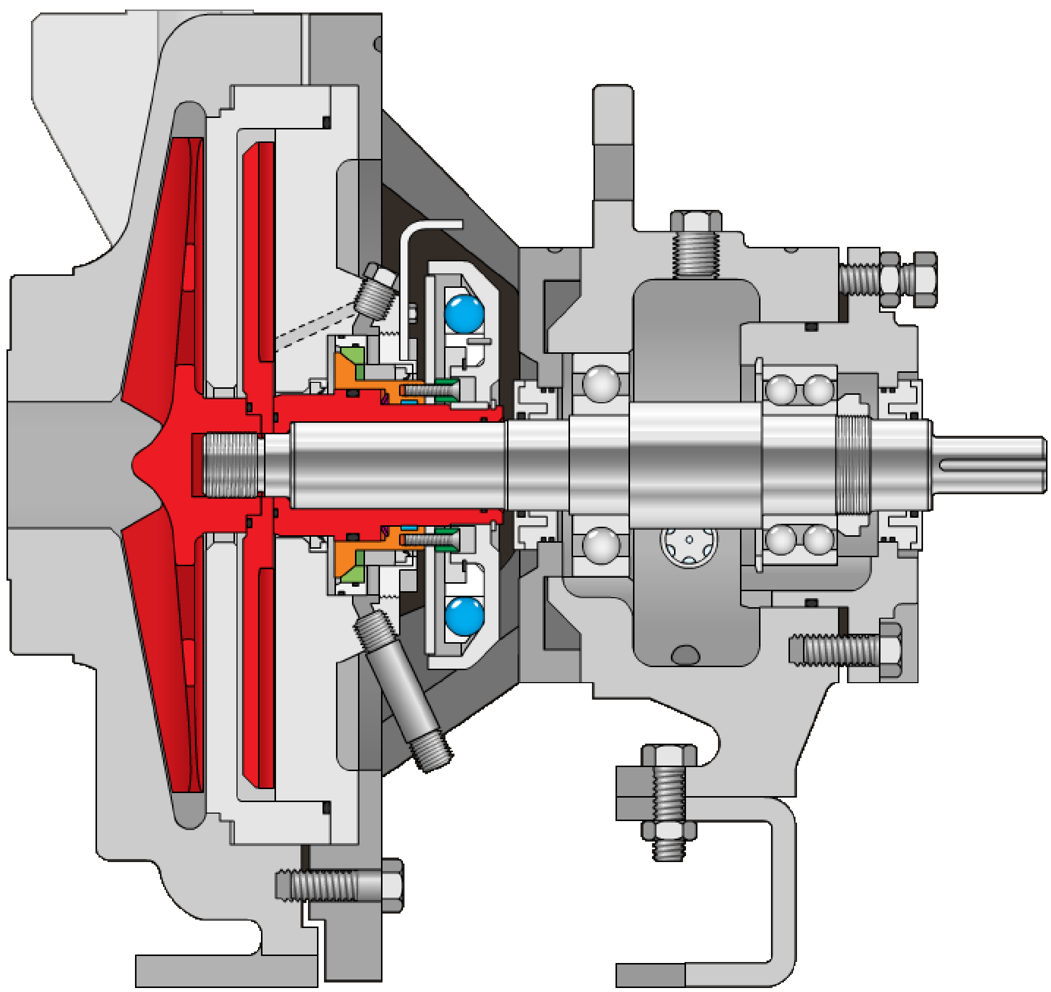
An extension of the A9 product line is the low flow, high head variant. The unique Barske impeller design provides a continuously rising performance curve with exceptional low-flow stability The frame and footprint follow the frame 1 sizing but due to the location of the tangential discharge, does not meet ANSI B73.1. These pumps can develop up to 600 feet of head.



A9LF Case & Impeller

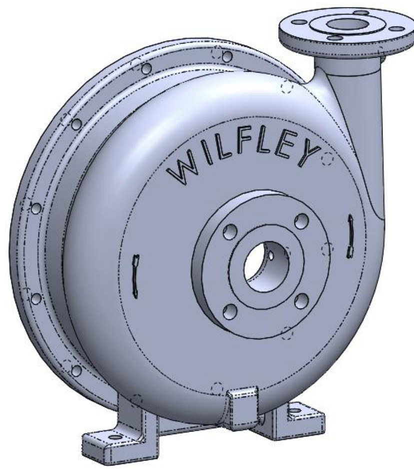
Standard A9 Case & Impeller

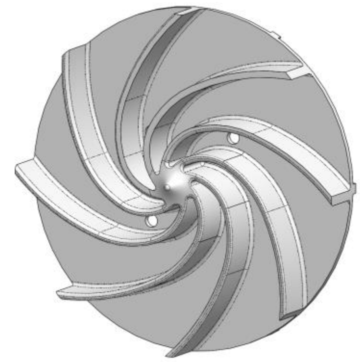
These pumps are offered in both frame mounted and close-coupled configurations.

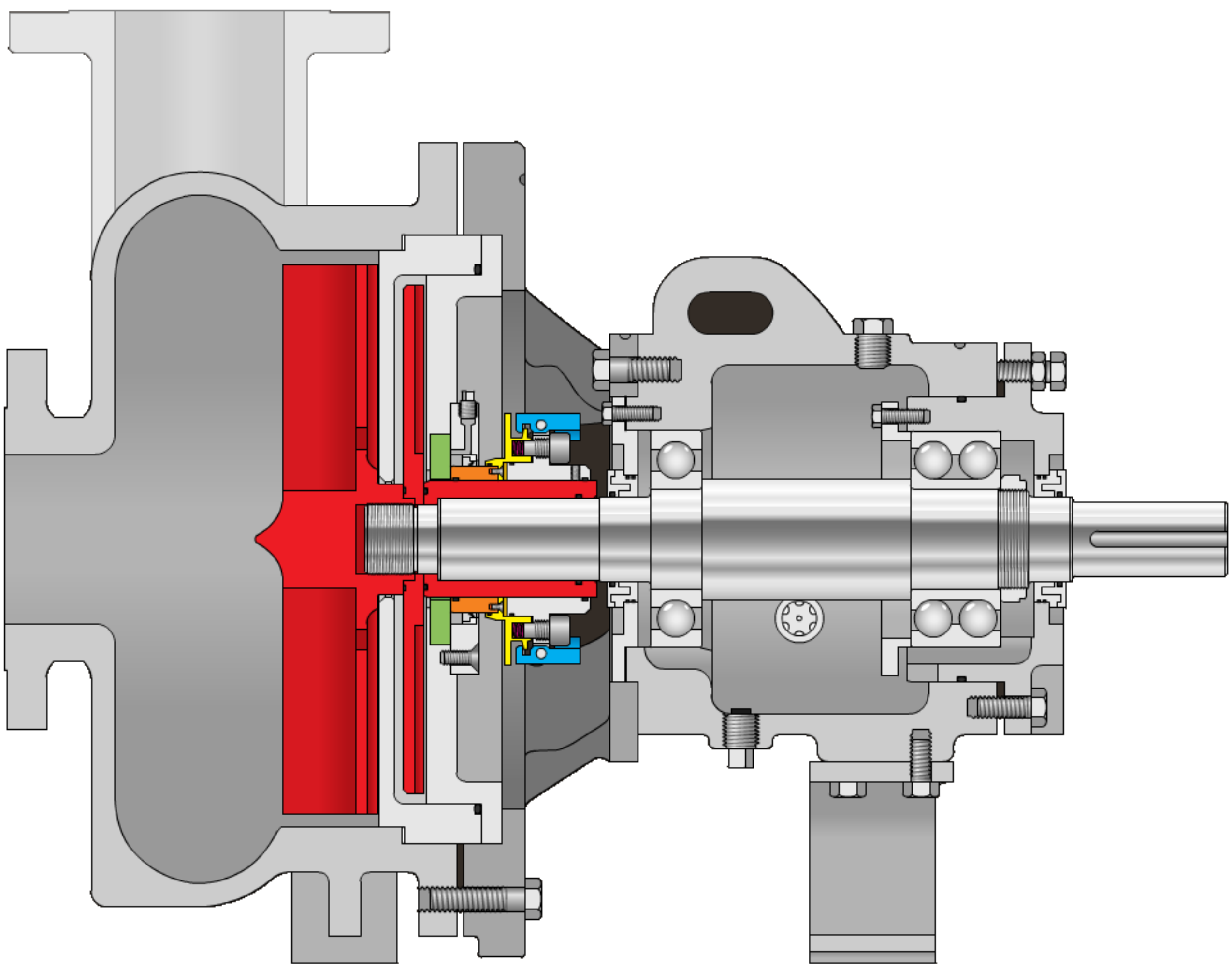


Vortex (Recessed) Pumps

The A7/A9 Vortex pump is designed to handle large diameter solids and fibrous material without clogging. These pumps will handle solids up to the same diameter as the discharge. There is reduced radial loading for trouble free operation. Even with low flows, the recessed design allows throttling to a low performance range unacceptable to many centrifugal pumps. For pumping sewage and other trash, this layout will allow the A7/A9 pump to handle solids in liquid suspension. Contact of solids with the impeller is reduced so the wear rate, solids degradation and shearing of liquid are greatly minimized.

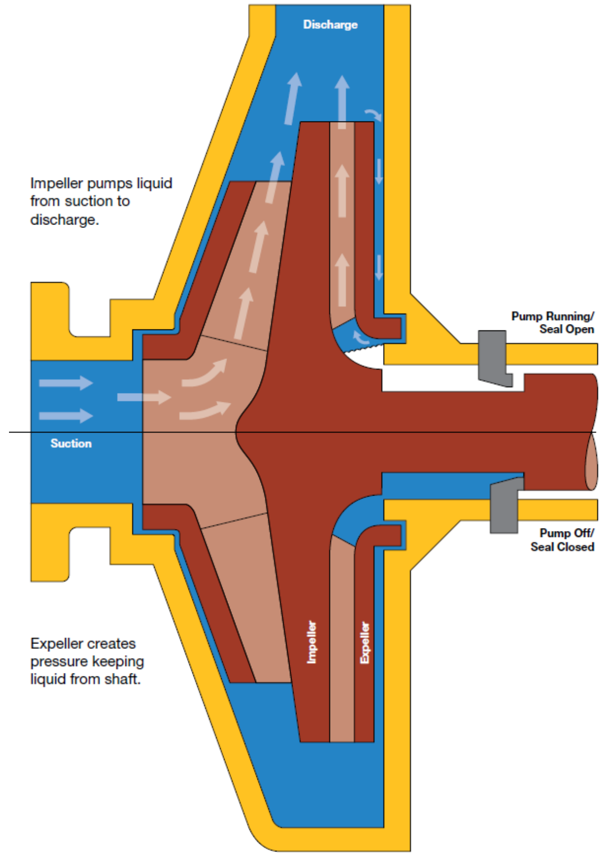






Nonmetallic A7 Pumps

Wilfley's non-metallic Model A7 pump series offers maximum efficiency coupled with ultimate seal flexibility. It is designed to be sealless,but can also be used with virtually any traditional seal—packing or mechanical. The non-metallic Model A7 handles liquids that are highly corrosive. Discharge sizes range from 1" to 4" in diameter. Flow rates range to 800 gallons per minute and temperatures of up to 200 F. Used in special applications, this pump is less common than the metallic pumps. Note that this pump uses an enclosed impeller which is combined with the expeller as a single part. The function of the dynamic seal remains although it looks slightly different than the separate expeller of metal A7/A9 pumps.



A7 NM Size Offering			
Size	**Armored**	**Max Impeller**	**Expeller**
1.5X1-6	--	6.50"	8.00"
3x2-6	--	6.75"	8.00"
3x2-8	--	8.25"	10.00"
4x3-8	--	8.25"	10.00"
2x1-10	--	10.00"	11.00"
3x2-10	--	9.50"	11.00"
5x4-10*	YES	10.0"	11.00"
6x5-11*	YES	11.00"	12.00"

*Does not meet ANSI B63.1 Footprint

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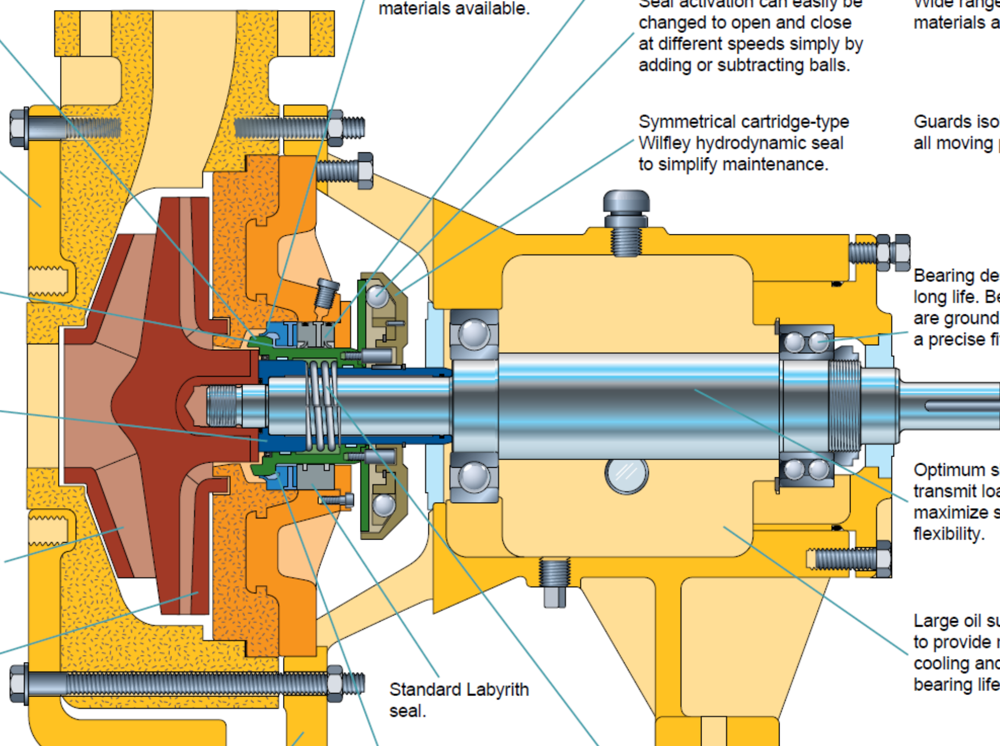

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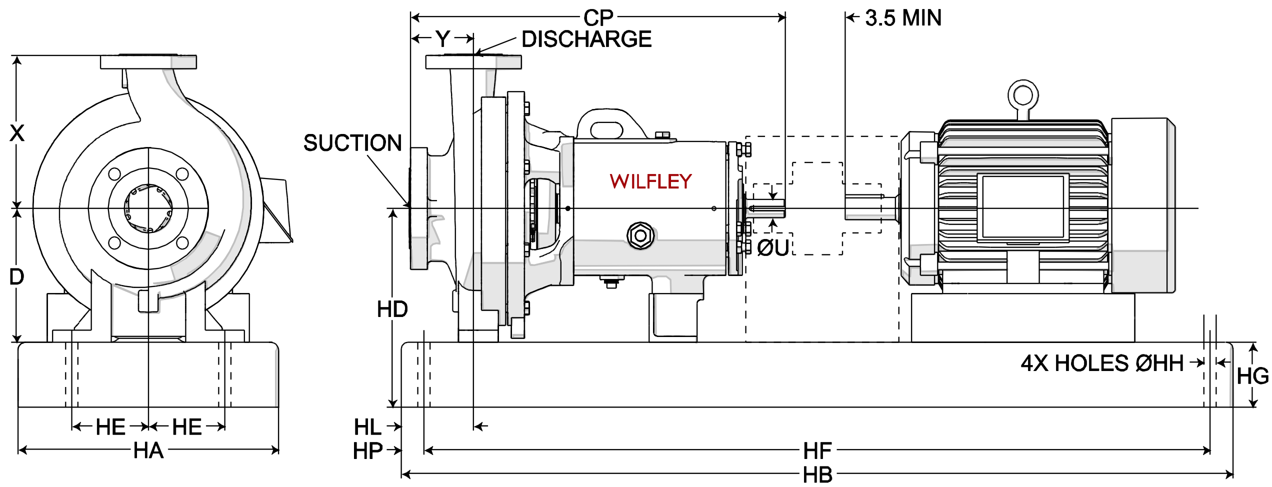
DURABLE. WATERLESS SEALING. INDUSTRIAL PUMPS

PUMP FOOTPRINT

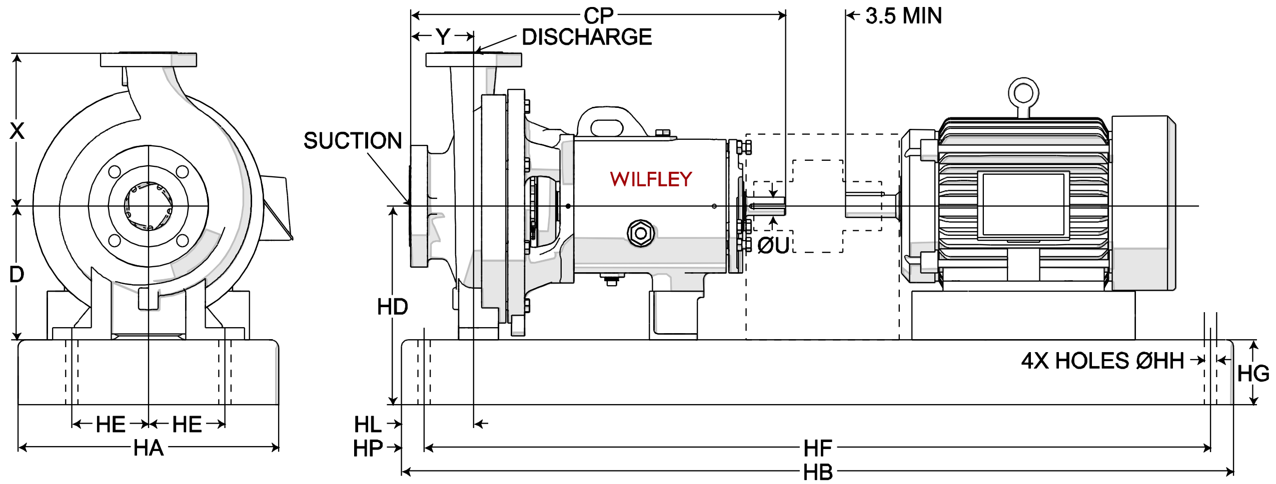
MODEL A7/A9 PUMP: FRAMES 1–4 DIRECT DRIVEN PUMP DIMENSIONS



Frame Size	Pump Designation	Size	CP	D	Y	X	U	
							Dia.	Keyway
1	AA-6, -8	1.5 x 1	17.5	5.25	4	6.5	0.88	.188 x.094
	AB-6	3 x 1.5	17.5	5.25	4	6.5	0.88	.188 x.094
	AC-6	3 x 2	17.5	5.25	4	6.5	0.88	.188 x.094
2	A05-10	2 x 1	23.5	8.25	4	8.5	1.12	.250 x.125
	A50-8, A50-10	3 x 1.5	23.5	8.25	4	8.5	1.12	.250 x.125
	A60-8, A60-10	3 x 2	23.5	8.25	4	9.5	1.12	.250 x.125
	A70-8, A70-10	4 x 3	23.5	8.25	4	11	1.12	.250 x.125
	A80-10	6 x 4	23.5	8.25	4	13.5	1.12	.250 x.125
3	A20-13	3 x 1.5	23.5	10	4	10.5	1.62	.375 x.188
	A30-13	3 x 2	23.5	10	4	11.5	1.62	.375 x.188
	A40-13	4 x 3	23.5	10	4	12.5	1.62	.375 x.188
	A80-13, A80-10	6 x 4	23.5	10	4	13.5	1.62	.375 x.188
4	A90-13	8 x 6	33.88	14.5	6	16	2.38	.625 x.313
	A105-15	6 x 4	33.88	14.5	6	16	2.38	.625 x.313
	A110-15	8 x 6	33.88	14.5	6	18	2.38	.625 x.313
	A120-17	10 x 8	33.88	14.5	6	19	2.38	.625 x.313

DURABLE. WATERLESS SEALING. INDUSTRIAL PUMPS

MODEL A7/A9 PUMP: FRAMES 1-4 DIRECT DRIVEN MOTOR DIMENSIONS



Frame Size	Base Size	Motor Size	HA	HB	HD	HE	HF	HG	HH	HL	HP
1	139	143T-184T, 80M-112M	15	39	9	4.5	36.5	3.75	.75	4.5	1.25
	148	213T-256T, 132S-160L	18	48	10.50	6	45.5	4.13	.75	4.5	1.25
	153	284TS-326TS, 180M-180L	21	53	12.88	7.5	50.5	4.75	.75	4.5	1.25
2	245	143T-184T, 100L -112M	15	45	12	4.5	42.5	3.75	.75	4.5	1.25
	252	213T-215T, 132S-132M	18	52	12.38	6	49.5	4.13	.75	4.5	1.25
	258	254T-286T, 160M-180L	21	58	13	7.5	55.5	4.75	1	4.5	1.25
	264	324TS-365T, 200L-225M	21	64	13.88	7.5	61.5	4.75	1	4.5	1.25
	268	404TS-405TS, 250M	26	68	14.88	9.5	65.5	4.75	1	4.5	1.25
	280	405T-445T, 280S-280M	26	80	15.88	9.5	77.5	4.75	1	4.5	1.25
3	245	143T-184T, 100L-112M	15	45	13.75	4.5	42.5	3.75	.75	4.5	1.25
	252	213T-215T, 132S-132M	18	52	14.13	6	49.5	4.13	.75	4.5	1.25
	258	254T-286TS, 160M-180L	21	58	14.75	7.5	55.5	4.75	1	4.5	1.25
	264	324T-365TS, 200L-225M	21	64	14.75	7.5	61.5	4.75	1	4.5	1.25
	268	404T-405TS, 250M	26	68	14.88	9.5	65.5	4.75	1	4.5	1.25
	280	405T-447TS, 280S-280M	26	80	15.88	9.5	77.5	4.75	1	4.5	1.25
4	368	284T-286T, 180M-180L	26	68	19.25	9.5	65.5	4.75	1	6.5	1.25
	380	324T-405TS, 200L-250M	26	80	19.25	9.5	77.5	4.75	1	6.5	1.25
	398	444T-449TS, 280S-315L	26	98	19.25	9.5	95.5	4.75	1	6.5	1.25

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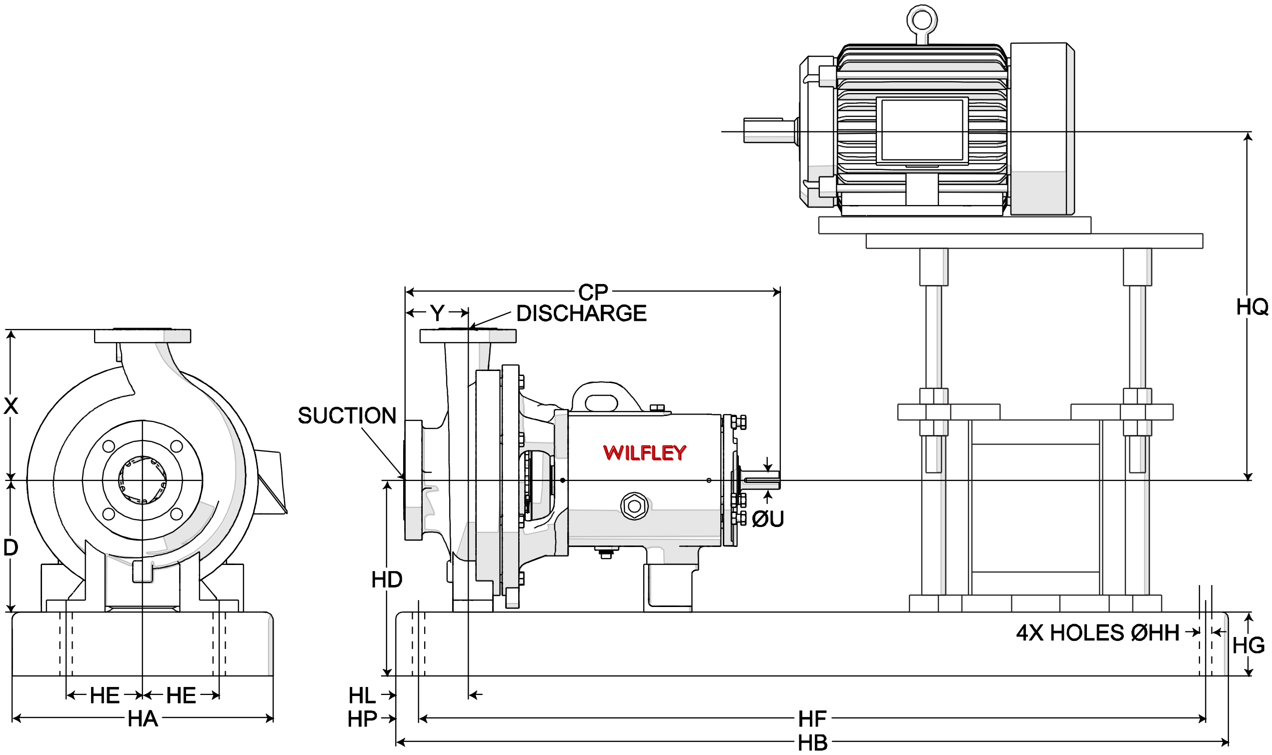
DURABLE. WATERLESS SEALING. INDUSTRIAL PUMPS

MODEL A7/A9 PUMP: FRAMES 1-4 OVERHEAD V-BELT PUMP DIMENSIONS



Frame Size	Pump Designation	Size	CP	D	Y	X	U	
							Dia.	Keyway
1	AA-6, -8	1.5 x 1	17.5	5.25	4	6.5	1.12	.250 x .125
	AB-6	3 x 1.5	17.5	5.25	4	6.5	1.12	.250 x .125
	AC-6	3 x 2	17.5	5.25	4	6.5	1.12	.250 x .125
2	A05-10	2 x 1	24.88	8.25	4	8.5	1.75	.375 x .188
	A50-8, A50-10	3 x 1.5	24.88	8.25	4	8.5	1.75	.375 x .188
	A60-8, A60-10	3 x 2	24.88	8.25	4	9.5	1.75	.375 x .188
	A70-8, A70-10	4 x 3	24.88	8.25	4	11	1.75	.375 x .188
	A80-10 (Mount as Fr 3)	6 x 4	Mounting is per Frame 3 (A80-13) Case					
3	A20-13	3 X 1.5	24.88	10	4	10.5	1.75	.375 x .188
	A30-13	3 X 2	24.88	10	4	11.5	1.75	.375 x .188
	A40-13	4 X 3	24.88	10	4	12.5	1.75	.375 x .188
	A80-13, A80-10	6 X 4	24.88	10	4	13.5	1.75	.375 x .188
4	A90-13	8x6	34.88	14.5	6	16	2.50	.625 x .313
	A105-15	6x4	34.88	14.5	6	16	2.50	.625 x .313
	A110-15	8X6	34.88	14.5	6	16	2.50	.625 x .313

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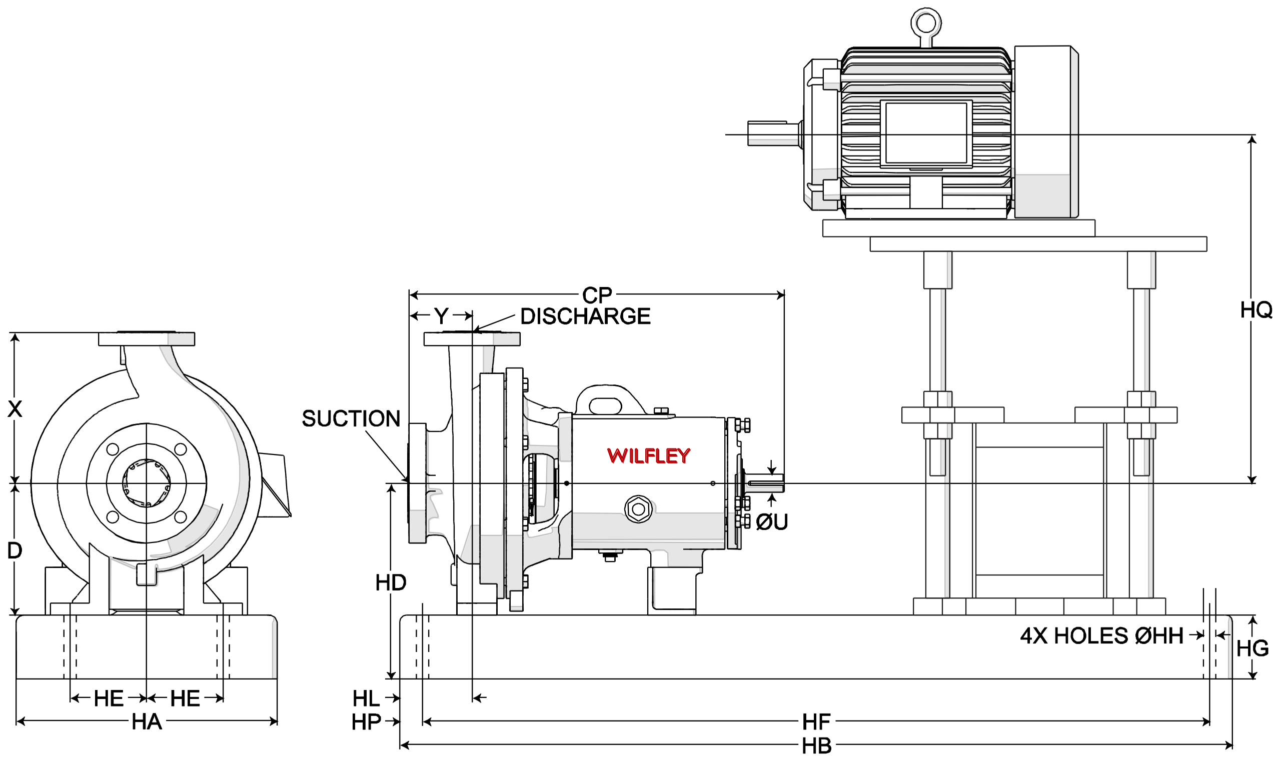
DURABLE. WATERLESS SEALING. INDUSTRIAL PUMPS

MODEL A7/A9 PUMP: FRAMES 1–2 OVERHEAD V-BELT MOTOR DIMENSIONS



Frame Size	Base Size	Motor Size	HA	HB	HD	HE	HF	HG	HH	HL	HP	HQ
1	148	143T–145T; 80–90	18	48	10.5	6	45.5	4.13	0.75	4.5	1.25	23
	148	182T–184T; 100–112	18	48	10.5	6	45.5	4.13	0.75	4.5	1.25	23
	148	213T–215T; 132	18	48	10.5	6	45.5	4.13	0.75	4.5	1.25	23
	148	254T–256T; 160	18	48	10.5	6	45.5	4.13	0.75	4.5	1.25	23
	153	284T,TS–286T,TS; 180	21	53	12.88	7.5	50.5	4.75	0.75	4.5	1.25	36.5
	153	324T,TS–326T,TS; 200	21	53	12.88	7.5	50.5	4.75	0.75	4.5	1.25	36.5
2	252	143T–145T; 80–90	18	52	12.38	6	49.5	4.13	0.75	4.5	1.25	20
	252	182T–184T; 100–112	18	52	12.38	6	49.5	4.13	0.75	4.5	1.25	20
	252	213T–215T; 132	18	52	12.38	6	49.5	4.13	0.75	4.5	1.25	20
	258	160	21	58	13	7.5	55.5	4.75	1	4.5	1.25	21.5
	258	180	21	58	13	7.5	55.5	4.75	1	4.5	1.25	21.5
	258	254T–256T; 160	21	58	13	7.5	55.5	4.75	1	4.5	1.25	21.5
	258	284T,TS–286T,TS; 180	21	58	13	7.5	55.5	4.75	1	4.5	1.25	21.5
	264	324T,TS–326T,TS; 200	21	64	13.88	7.5	61.5	4.75	1	4.5	1.25	38.5
	264	364T,TS–365T,TS; 225	21	64	13.88	7.5	61.5	4.75	1	4.5	1.25	39.5
	268	404T,TS–405T,TS; 250	26	68	14.88	9.5	65.5	4.75	1	4.5	1.25	40.5
	280	444T,TS-445T,TS; 280	26	80	15.88	9.5	77.5	4.75	1	4.5	1.25	42

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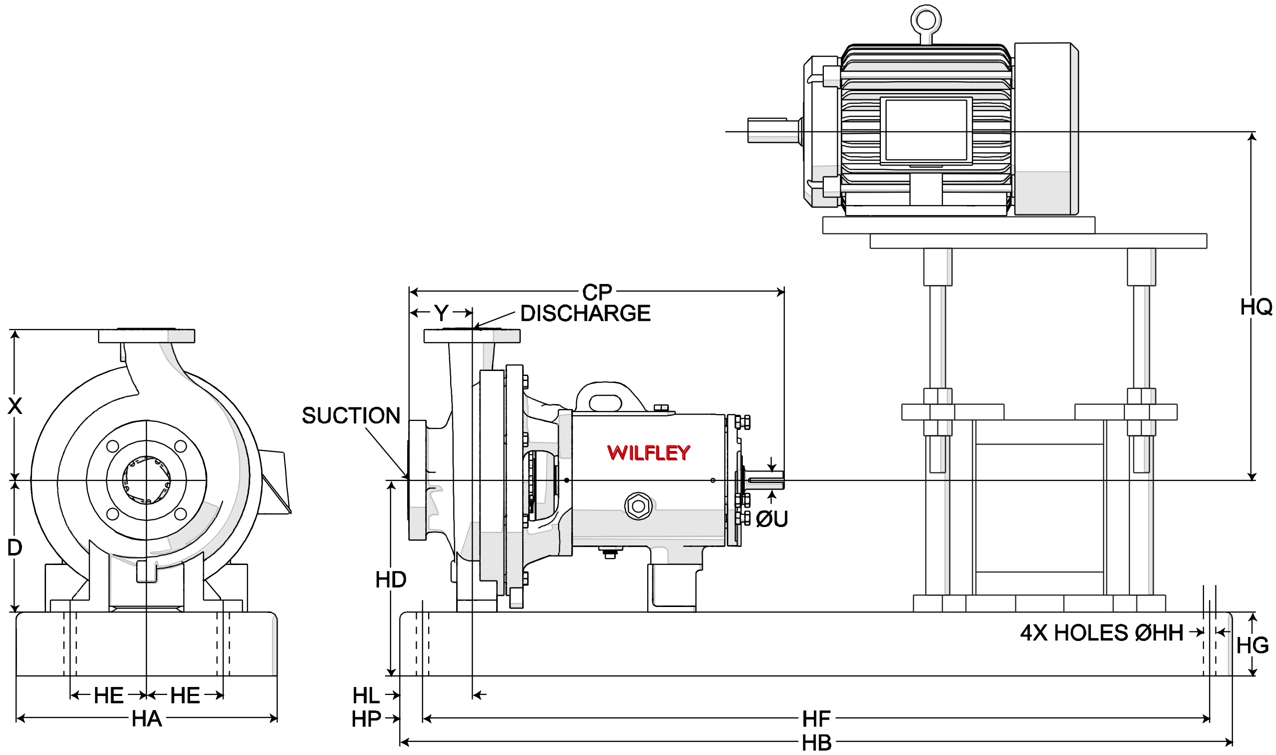
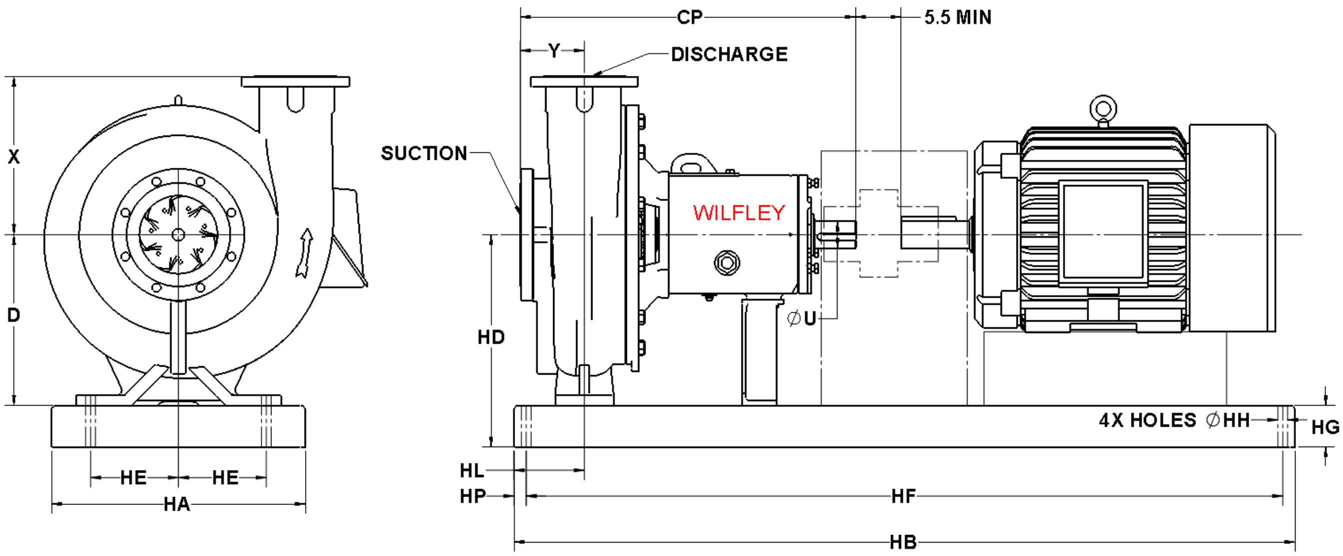
DURABLE. WATERLESS SEALING. INDUSTRIAL PUMPS

MODEL A7/A9 PUMP: FRAMES 3-4 OVERHEAD V-BELT MOTOR DIMENSIONS



Frame Size	Base Size	Motor Size	HA	HB	HD	HE	HF	HG	HH	HL	HP	HQ
3	252	143T–145T; 80–90	18	52	14.13	6	49.5	4.13	0.75	4.5	1.25	18.5
	252	182T–184T; 100–112	18	52	14.13	6	49.5	4.13	0.75	4.5	1.25	19.5
	252	213T–215T; 132	18	52	14.13	6	49.5	4.13	0.75	4.5	1.25	19
	258	160	21	58	14.75	7.5	55.5	4.75	1	4.5	1.25	20
	258	180	21	58	14.75	7.5	55.5	4.75	1	4.5	1.25	21
	258	254T–256T; 160	21	58	14.75	7.5	55.5	4.75	1	4.5	1.25	20
	258	284T,TS–286T,TS; 180	21	58	14.75	7.5	55.5	4.75	1	4.5	1.25	21
	264	324T,TS–326T,TS; 200	21	64	14.75	7.5	61.5	4.75	1	4.5	1.25	37
	264	364T,TS–365T,TS; 225	21	64	14.75	7.5	61.5	4.75	1	4.5	1.25	38
	268	404T,TS–405T,TS; 250	26	68	14.88	9.5	65.5	4.75	1	4.5	1.25	39
	280	444T,TS–445T,TS; 280	26	80	15.88	9.5	77.5	4.75	1	4.5	1.25	40.5
4	368	284T–286T; 180	26	68	19.25	9.5	65.5	4.75	1	6.5	1.25	16.5
	380	324T–405T; 250	26	80	19.25	9.5	77.5	4.75	1	6.5	1.25	34

MODEL A9 PUMP: FRAME 5 DIRECT DRIVEN PUMP DIMENSIONS



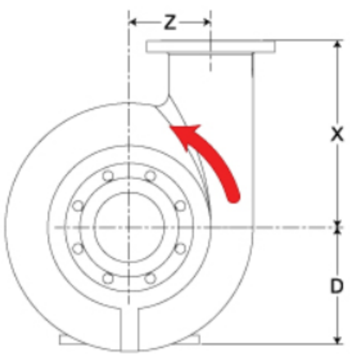
A9 Frame Size	Pump Designation	Size	CP	D	Y	X	U	
							Dia.	Keyway
5	19 inch*	6 x 4	33.75	17.5	6.25	16.25	2.875	.750 x.375
	19 inch*	8 x 6	34.50	17.5	6.58	16.25	2.875	.750 x.375
	19 inch*	10 x 8	35.38	20.5	7.44	16.38	2.875	.750 x.375

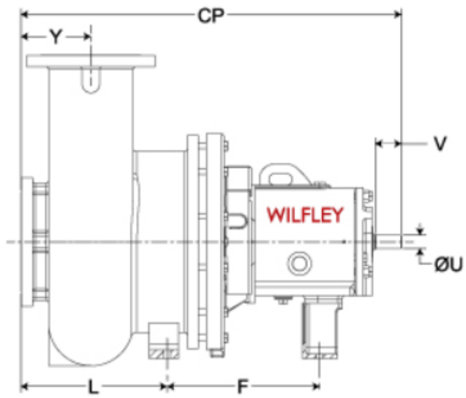
*NON-ASME PUMP, TANGENTIAL DISCHARGE

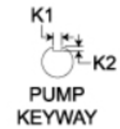
A9 Frame Size	Motor Frame	Base Size	HA	HB	HD	HE	HF	HG	HH	HL	HP
5	444T-449TS	10x8-19L	47.3	100.7	27.38	18	92.67 46.34	6.88	1.13	11.75	4
		6x4-19L	37.7	100.7	24.38	15	92.67 46.34	6.88	1.13	11.75	4
		8x6-19L	37.7	100.7	24.38	15	92.67 46.34	6.88	1.13	11.75	4
	324T-405TS	6x4-19M	37.7	85.7	24.38	15	77.67 38.84	6.88	1.13	11.75	4
		8X6-19M	37.7	85.7	24.38	15	77.67 38.84	6.88	1.13	11.75	4

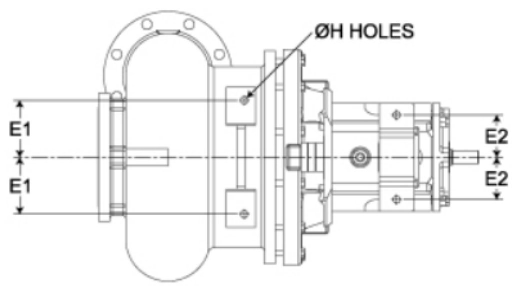
Fabricated baseplate only for 5 A9 products.

MODEL A7/ A9 PUMP: VORTEX (RECESSED IMPELLER) PUMPS



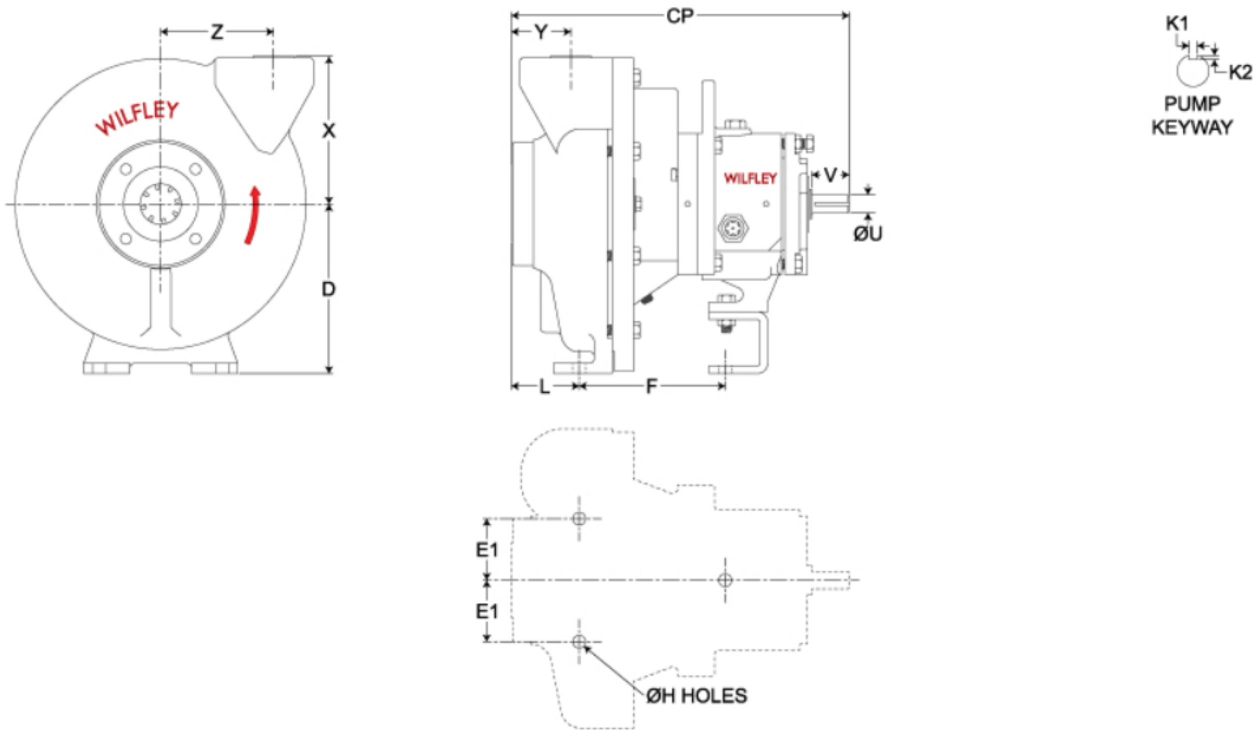






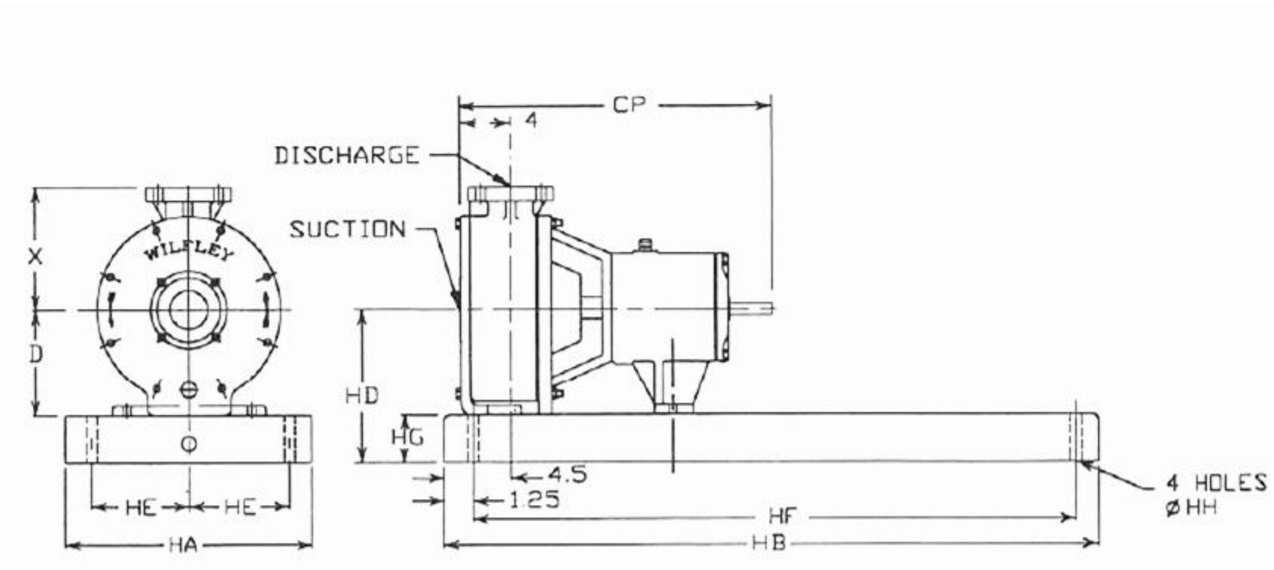
A9 Frame Size	Pump Designation	Size	CP	D	Y	X	F	E1	E2	U	
										Dia.	Keyway
3R	2.5x2-13 Vortex	2.5 x 2	25.25	10.0	4.0	10.0	12.5	4.88	3.62	1.63	.375 x .188
	4x4-13 Vortex	4 x 4	27.5	10.0	4.62	12.5	12.5	4.88	3.62	1.63	.375 x .188
	6x6-13 Vortex	6 x 6	32.0	10.0	6.0	16.0	12.5	4.88	3.62	1.63	.375 x .188
4R	6x6-16 Vortex	10 x 10	45.5	14.5	9.0	18.75	18.75	8.0	4.5	2.38	.625 x .313

MODEL A9 PUMP: LOW FLOW (WLQ) PUMPS



A9 Frame Size	Pump Designation	Size	CP	D	Y	X	F	E1	Z	U	K
										Dia.	Keyway
1 WLQ	2x1-9 A/B/C	2 x 1	16.45	8.25	3.02	7.19	7.25	3.0	5.0	0.88	.188 x .094
	2x1-10 A/B/C	2 x 1	16.45	8.25	2.96	7.19	7.25	3.0	5.5	0.88	.188 x .094

MODEL A7 NONMETALLIC PUMP: DIRECT DRIVEN PUMP DIMENSIONS



Frame Size	Pump Designation	Size	CP	D	X	U	
						Dia.	Keyway
1	AA-6	1.5 x 1	17.5	5.25	6.5	0.88	.188 x.094
	AC-6	3 x 2	17.5	5.25	6.5	0.88	.188 x.094
2	A05-10	2 x 1	23.5	8.25	8.5	1.12	.250 x.125
	A60-8	3 x 2	23.5	8.25	9.5	1.12	.250 x.125
	A60-10	3 x 2	23.5	8.25	9.5	1.12	.250 x.125
	A70-8	4 x 3	23.5	8.25	11.0	1.12	.250 x.125
	Wilfley 5x4-10*	5 x 4	28.0	10.0	12.25	1.12	.250 x.125
	Wilfley 6x5-11*	6 x 5	28.0	11.75	15.0	1.12	.250 x.125

*NON-ANSI PUMP SIZE

10.0 Revision History

Revision	Description	Date
J	Reorganized and updated with additional information. Too many changes to list.	June 2020