



USER INSTRUCTIONS

PolyChem S-series pumps

ISO and ANSI

Horizontal, end suction, single stage, centrifugal, chemical process pumps

PCN=71569207 11-08 (E) (Based on P-30-502-E.)
Original instructions.

**Installation
Operation
Maintenance**



These instructions must be read prior to installing, operating, using and maintaining this equipment.

Experience In Motion

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1 INTRODUCTION AND SAFETY

1.1 General

 ***These instructions must always be kept close to the product's operating location or directly with the product.***

Flowserve products are designed, developed and manufactured with state-of-the-art technologies in modern facilities. The unit is produced with great care and commitment to continuous quality control, utilising sophisticated quality techniques and safety requirements.

Flowserve is committed to continuous quality improvement and being at service for any further information about the product in its installation and operation or about its support products, repair and diagnostic services.

These instructions are intended to facilitate familiarization with the product and its permitted use. Operating the product in compliance with these instructions is important to help ensure reliability in service and avoid risks. The instructions may not take into account local regulations; ensure such regulations are observed by all, including those installing the product. Always coordinate repair activity with operations personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

 ***These instructions must be read prior to installing, operating, using and maintaining the equipment in any region worldwide. The equipment must not be put into service until all the conditions relating to safety, noted in the instructions, have been met. Failure to follow and apply the present user instructions is considered to be misuse. Personal injury, product damage, delay or failure caused by misuse are not covered by the Flowserve warranty.***

1.2 CE marking and approvals

It is a legal requirement that machinery and equipment put into service within certain regions of the world shall conform with the applicable CE Marking Directives covering Machinery and, where applicable, Low Voltage Equipment, Electromagnetic Compatibility (EMC), Pressure Equipment Directive (PED) and Equipment for Potentially Explosive Atmospheres (ATEX).

Where applicable, the Directives and any additional Approvals, cover important safety aspects relating to machinery and equipment and the satisfactory provision of technical documents and safety instructions. Where

applicable this document incorporates information relevant to these Directives and Approvals.

To confirm the Approvals applying and if the product is CE marked, check the serial number plate markings and the Certification. (See section 9, *Certification*.)

1.3 Disclaimer

Information in these User Instructions is believed to be reliable. In spite of all the efforts of Flowserve Corporation to provide sound and all necessary information the content of this manual may appear insufficient and is not guaranteed by Flowserve as to its completeness or accuracy.

Flowserve manufactures products to exacting International Quality Management System Standards as certified and audited by external Quality Assurance organisations. Genuine parts and accessories have been designed, tested and incorporated into the products to help ensure their continued product quality and performance in use. As Flowserve cannot test parts and accessories sourced from other vendors the incorrect incorporation of such parts and accessories may adversely affect the performance and safety features of the products. The failure to properly select, install or use authorised Flowserve parts and accessories is considered to be misuse. Damage or failure caused by misuse is not covered by the Flowserve warranty. In addition, any modification of Flowserve products or removal of original components may impair the safety of these products in their use.

1.4 Copyright

All rights reserved. No part of these instructions may be reproduced, stored in a retrieval system or transmitted in any form or by any means without prior permission of Flowserve.

1.5 Duty conditions

This product has been selected to meet the specifications of your purchaser order. The acknowledgement of these conditions has been sent separately to the Purchaser. A copy should be kept with these instructions.

 ***The product must not be operated beyond the parameters specified for the application. If there is any doubt as to the suitability of the product for the application intended, contact Flowserve for advice, quoting the serial number.***

If the conditions of service on your purchase order are going to be changed (for example liquid pumped, temperature or duty) it is requested that the user seeks the written agreement of Flowserve before start up.

1.6 Safety

1.6.1 Summary of safety markings

These User Instructions contain specific safety markings where non-observance of an instruction would cause hazards. The specific safety markings are:

 **DANGER** This symbol indicates electrical safety instructions where non-compliance will involve a high risk to personal safety or the loss of life.

 This symbol indicates safety instructions where non-compliance would affect personal safety and could result in loss of life.

 This symbol indicates "hazardous and toxic fluid" safety instructions where non-compliance would affect personal safety and could result in loss of life.

 **CAUTION** This symbol indicates safety instructions where non-compliance will involve some risk to safe operation and personal safety and would damage the equipment or property.

 This symbol indicates explosive atmosphere zone marking according to ATEX. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

 This symbol is used in safety instructions to remind not to rub non-metallic surfaces with a dry cloth; ensure the cloth is damp. It is used in safety instructions where non-compliance in the hazardous area would cause the risk of an explosion.

Note: This sign is not a safety symbol but indicates an important instruction in the assembly process.

1.6.2 Personnel qualification and training

All personnel involved in the operation, installation, inspection and maintenance of the unit must be qualified to carry out the work involved. If the personnel in question do not already possess the necessary knowledge and skill, appropriate training and instruction must be provided. If required the operator may commission the manufacturer/supplier to provide applicable training.

Always coordinate repair activity with operations and health and safety personnel, and follow all plant safety requirements and applicable safety and health laws and regulations.

1.6.3 Safety action

This is a summary of conditions and actions to help prevent injury to personnel and damage to the environment and to equipment. For products used in potentially explosive atmospheres section 1.6.4 also applies.

 **DANGER** NEVER DO MAINTENANCE WORK WHEN THE UNIT IS CONNECTED TO POWER

 DRAIN THE PUMP AND ISOLATE PIPEWORK BEFORE DISMANTLING THE PUMP
The appropriate safety precautions should be taken where the pumped liquids are hazardous.

 **FLUORO-ELASTOMERS** (When fitted.)
When a pump has experienced temperatures over 250 °C (482 °F), partial decomposition of fluoro-elastomers (example: Viton) will occur. In this condition these are extremely dangerous and skin contact must be avoided.

 **HANDLING COMPONENTS**

Many precision parts have sharp corners and the wearing of appropriate safety gloves and equipment is required when handling these components. To lift heavy pieces above 25 kg (55 lb) use a crane appropriate for the mass and in accordance with current local regulations.

 NEVER OPERATE THE PUMP WITHOUT THE COUPLING GUARD AND ALL OTHER SAFETY DEVICES CORRECTLY INSTALLED

 GUARDS MUST NOT BE REMOVED WHILE THE PUMP IS OPERATIONAL

 **HOT (and cold) PARTS**

If hot or freezing components or auxiliary heating supplies can present a danger to operators and persons entering the immediate area action must be taken to avoid accidental contact. If complete protection is not possible, the machine access must be limited to maintenance staff only, with clear visual warnings and indicators to those entering the immediate area. Note: bearing housings must not be insulated and drive motors and bearings may be hot.

If the temperature is greater than 68 °C (175 °F) or below 5 °C (20 °F) in a restricted zone, or exceeds local regulations, action as above shall be taken.

 NEVER APPLY HEAT TO REMOVE IMPELLER
This could damage the liner plus trapped lubricant or vapor could cause an explosion.



THERMAL SHOCK

Rapid changes in the temperature of the liquid within the pump can cause thermal shock, which can result in damage or breakage of components and should be avoided.



HAZARDOUS LIQUIDS

When the pump is handling hazardous liquids care must be taken to avoid exposure to the liquid by appropriate siting of the pump, limiting personnel access and by operator training. If the liquid is flammable and/or explosive, strict safety procedures must be applied.



CAUTION PREVENT EXCESSIVE EXTERNAL PIPE LOAD

Do not use pump as a support for piping. Do not mount expansion joints, unless allowed by Flowserve in writing, so that their force, due to internal pressure, acts on the pump flange.



CAUTION ENSURE CORRECT LUBRICATION

(See section 5, *Commissioning, startup, operation and shutdown.*)



NEVER EXCEED THE MAXIMUM DESIGN PRESSURE (MDP) AT THE TEMPERATURE SHOWN ON THE PUMP NAMEPLATE

See section 3 for pressure versus temperature ratings based on the material of construction.



CAUTION NEVER OPERATE THE PUMP WITH THE DISCHARGE VALVE CLOSED

(Unless otherwise instructed at a specific point in the User Instructions.)

(See section 5, *Commissioning start-up, operation and shutdown.*)



CAUTION NEVER RUN THE PUMP DRY OR WITHOUT PROPER PRIME (Casing flooded)



CAUTION NEVER OPERATE THE PUMP WITH THE SUCTION VALVE CLOSED

It should be fully opened when the pump is running.



CAUTION NEVER OPERATE THE PUMP AT ZERO FLOW OR FOR EXTENDED PERIODS BELOW THE MINIMUM CONTINUOUS FLOW



CAUTION THE PUMP SHAFT MUST TURN CLOCKWISE WHEN VIEWED FROM THE MOTOR END

It is absolutely essential that the rotation of the motor be checked before installation of the coupling spacer and starting the pump. Incorrect rotation of the pump for even a short period can unscrew the impeller, which can cause significant damage.

1.6.4 Products used in potentially explosive atmospheres



The following instructions for pumps and pump units when installed in potentially explosive atmospheres must be followed to help ensure explosion protection. The terminology and procedures ensure that the installed pump is in compliance with the European Directive 94/9/EC, known as the ATEX Directive, which is mandatory in Europe and may also be specified in other countries. Where applicable, both electrical and non-electrical equipment must meet the requirements 94/9/EC. Even if the installation is in a region where ATEX is not the applicable regulation, the general measures described shall be followed to ensure safe operation.

The measures are explained under the headings of:

- Avoiding excessive surface temperature
- Preventing build up of explosive mixtures
- Preventing the generation of sparks
- Preventing leakages
- Maintaining the pump to avoid hazard

1.6.4.1 Scope of compliance



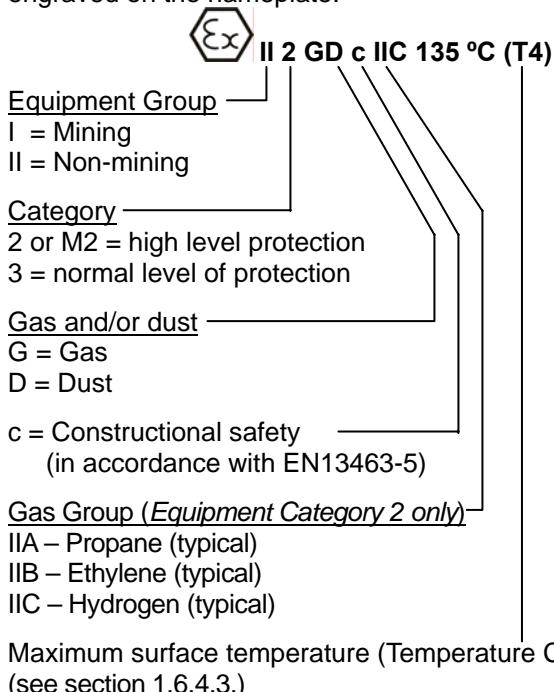
Use equipment only in the zone for which it is appropriate. Always check that the driver, drive coupling assembly, seal and pump equipment are suitably rated and/or certified for the classification of the specific atmosphere in which they are to be installed.

Where Flowserve has supplied only the bare shaft pump, the Ex rating applies only to the pump. The party responsible for assembling the pump set shall select the coupling, driver and any additional equipment, with the necessary CE Certificate/Declaration of Conformity establishing it is suitable for the area in which it is to be installed.

The output from a variable frequency drive (VFD) can cause additional heating effects in the motor and so, for pumps sets with a VFD, the ATEX Certification for the motor must state that it covers the situation where electrical supply is from the VFD. This particular requirement still applies even if the VFD is in a safe area.

1.6.4.2 Marking

An example of ATEX equipment marking is shown below. The actual classification of the pump will be engraved on the nameplate.



1.6.4.3 Avoiding excessive surface temperatures

ENSURE THE EQUIPMENT TEMPERATURE CLASS IS SUITABLE FOR THE HAZARD ZONE

Pump liquid temperature

Pumps have a temperature class as stated in the ATEX Ex rating on the nameplate. These are based on a maximum ambient of 40 °C (104 °F); refer to Flowserve for higher ambient temperatures.

The surface temperature on the pump is influenced by the temperature of the liquid handled. The maximum permissible liquid temperature depends on the temperature class and must not exceed the values in the table applicable below. The temperature rise at the seals and bearings and due to the minimum permitted flow rate is taken into account in the temperatures stated.

Temperature class to EN13463-1	Maximum surface temperature permitted	Temperature limit of liquid handled (* depending on material and construction variant - check which is lower)
T6	85 °C (185 °F)	Consult Flowserve
T5	100 °C (212 °F)	Consult Flowserve
T4	135 °C (275 °F)	115 °C (239 °F) *
T3	200 °C (392 °F)	180 °C (356 °F) *
T2	300 °C (572 °F)	275 °C (527 °F) *
T1	450 °C (842 °F)	400 °C (752 °F) *

The responsibility for compliance with the specified maximum liquid temperature is with the plant operator.

Temperature classification “Tx” is used when the liquid temperature varies and when the pump is required to be used in differently classified potentially explosive atmospheres. In this case the user is responsible for ensuring that the pump surface temperature does not exceed that permitted in its actual installed location.

Do not attempt to check the direction of rotation with the coupling element/pins fitted due to the risk of severe contact between rotating and stationary components.

Where there is any risk of the pump being run against a closed valve generating high liquid and casing external surface temperatures it is recommended that users fit an external surface temperature protection device.

Avoid mechanical, hydraulic or electrical overload by using motor overload trips, temperature monitor or a power monitor and perform routine vibration monitoring.

In dirty or dusty environments, regular checks must be made and dirt removed from areas around close clearances, bearing housings and motors.

1.6.4.4 Preventing the build up of explosive mixtures

ENSURE THE PUMP IS PROPERLY FILLED AND VENTED AND DOES NOT RUN DRY

Ensure the pump and relevant suction and discharge pipeline system is totally filled with liquid at all times during the pump operation, so that an explosive atmosphere is prevented. In addition it is essential to make sure that seal chambers, auxiliary shaft seal systems and any heating and cooling systems are properly filled.

If the operation of the system cannot avoid this condition the fitting of an appropriate dry run protection device is recommended (for example liquid detection or a power monitor).

To avoid potential hazards from fugitive emissions of vapor or gas to atmosphere the surrounding area must be well ventilated.

1.6.4.5 Preventing sparks

To prevent a potential hazard from mechanical contact, the coupling guard must be non-sparking.

To avoid the potential hazard from random induced current generating a spark, the earth contact on the baseplate must be used.

Avoid electrostatic charge: do not rub non-metallic surfaces with a dry cloth; ensure cloth is damp.

When applicable the coupling must be selected to comply with 94/9/EC and correct alignment must be maintained.

Additional requirement for metallic pumps on non-metallic baseplates

When metallic components are fitted on a non-metallic baseplate they must be individually earthed.

1.6.4.6 Preventing leakage

The pump must only be used to handle liquids for which it has been approved to have the correct corrosion resistance.

Avoid entrapment of liquid in the pump and associated piping due to closing of suction and discharge valves, which could cause dangerous excessive pressures to occur if there is heat input to the liquid. This can occur if the pump is stationary or running.

Bursting of liquid containing parts due to freezing must be avoided by draining or protecting the pump and ancillary systems.

Where there is the potential hazard of a loss of a seal barrier fluid or external flush, the fluid must be monitored.

If leakage of liquid to atmosphere can result in a hazard, the installation of a liquid detection device is recommended.

1.6.4.7 Maintenance of the centrifugal pump to avoid a hazard

CORRECT MAINTENANCE IS REQUIRED TO AVOID POTENTIAL HAZARDS WHICH GIVE A RISK OF EXPLOSION

The responsibility for compliance of maintenance and compliance during maintenance with the specified product is with the plant operator.

To avoid potential explosion hazards during maintenance, the tools, cleaning and painting materials used must not give rise to sparking or adversely affect the ambient conditions. Where there is a risk from such tools or materials, maintenance must be conducted in a safe area.

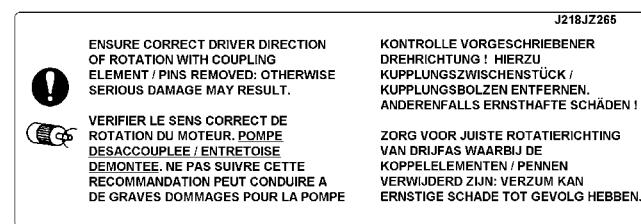
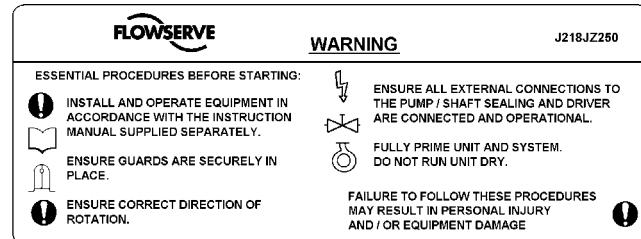
It is recommended that a maintenance plan and schedule is adopted. (See section 6, *Maintenance*.)

1.7 Nameplate and safety labels

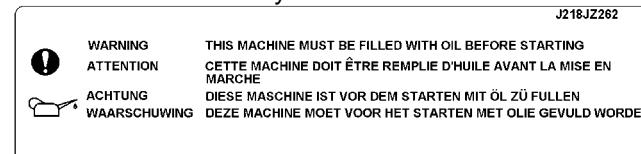
1.7.1 Nameplate

For details of nameplate, see the *Declaration of Conformity* and section 3.

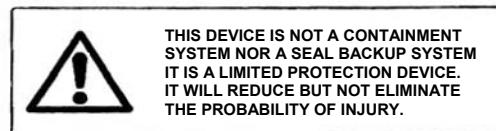
1.7.2 Safety labels



Oil lubricated units only:



DurcoShield™ (Splash/Shaft Guard) only:



1.8 Specific machine performance

For performance parameters see section 1.5, *Duty conditions*. Where performance data has been supplied separately to the purchaser these should be obtained and retained with these User Instructions if required.

1.9 Noise level

Attention must be given to the exposure of personnel to the noise, and local legislation will define when guidance to personnel on noise limitation is required, and when noise exposure reduction is mandatory. This is typically 80 to 85 dBA.

The usual approach is to control the exposure time to the noise or to enclose the machine to reduce emitted sound. You may have already specified a limiting noise level when the equipment was ordered, however if no noise requirements were defined, then attention is drawn to the following table to give an indication of equipment noise level so that you can take the appropriate action in your plant.

Pump noise level is dependent on a number of operational factors, flow rate, pipework design and acoustic characteristics of the building, and so the

values given are subject to a 3 dBA tolerance and cannot be guaranteed.

Similarly the motor noise assumed in the “pump and motor” noise is that typically expected from standard and high efficiency motors when on load directly driving the pump. Note that a motor driven by an inverter may show an increased noise at some speeds.

If a pump unit only has been purchased for fitting with your own driver then the “pump only” noise levels in the table should be combined with the level for the driver obtained from the supplier. Consult Flowserve or a noise specialist if assistance is required in combining the values.

It is recommended that where exposure approaches the prescribed limit, then site noise measurements should be made.

The values are in sound pressure level L_{pA} at 1 m (3.3 ft) from the machine, for “free field conditions over a reflecting plane”.

For estimating sound power level L_{WA} (re 1 pW) then add 14 dBA to the sound pressure value.

Motor size and speed kW (hp)	Typical sound pressure level L_{pA} at 1 m reference 20 μPa , dBA							
	3 550 r/min		2 900 r/min		1 750 r/min		1 450 r/min	
	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor	Pump only	Pump and motor
<0.55 (<0.75)	72	72	64	65	62	64	62	64
0.75 (1)	72	72	64	66	62	64	62	64
1.1 (1.5)	74	74	66	67	64	64	62	63
1.5 (2)	74	74	66	71	64	64	62	63
2.2 (3)	75	76	68	72	65	66	63	64
3 (4)	75	76	70	73	65	66	63	64
4 (5)	75	76	71	73	65	66	63	64
5.5 (7.5)	76	77	72	75	66	67	64	65
7.5 (10)	76	77	72	75	66	67	64	65
11(15)	80	81	76	78	70	71	68	69
15 (20)	80	81	76	78	70	71	68	69
18.5 (25)	81	81	77	78	71	71	69	71
22 (30)	81	81	77	79	71	71	69	71
30 (40)	83	83	79	81	73	73	71	73
37 (50)	83	83	79	81	73	73	71	73
45 (60)	86	86	82	84	76	76	74	76
55 (75)	86	86	82	84	76	76	74	76
75 (100)	87	87	83	85	77	77	75	77
90 (120)	87	88	83	85	77	78	75	78
110 (150)	89	90	85	87	79	80	77	80
150 (200)	89	90	85	87	79	80	77	80
200 (270)	①	①	①	①	85	87	83	85
300 (400)		—			87	90	85	86

① The noise level of machines in this range will most likely be of values which require noise exposure control, but typical values are inappropriate.
Note: for 1 180 and 960 r/min reduce 1 450 r/min values by 2 dBA. For 880 and 720 r/min reduce 1 450 r/min values by 3 dBA.

2 TRANSPORT AND STORAGE

2.1 Consignment receipt and unpacking

Immediately after receipt of the equipment it must be checked against the delivery/shipping documents for its completeness and that there has been no damage in transportation. Any shortage and or damage must be reported immediately to Flowserve and must be received in writing within thirty (30) calendar days of receipt of the equipment. Later claims cannot be accepted.

Check any crate, boxes or wrappings for any accessories or spare parts that may be packed separately with the equipment or attached to side walls of the box or equipment.

Each product has a unique serial number. Check that this number corresponds with that advised and always quote this number in correspondence as well as when ordering spare parts or further accessories.

2.2 Handling

Boxes, crates, pallets or cartons may be unloaded using fork lift vehicles or slings dependent on their size and construction.

2.3 Lifting



Pumps and motors often have integral lifting lugs or eye bolts. These are intended for use in only lifting the individual piece of equipment.



Do not use eye bolts or cast-in lifting lugs to lift pump, motor and baseplate assemblies.



To avoid distortion, the pump unit should be lifted as shown.



Care must be taken to lift components or assemblies above the center of gravity to prevent the unit from flipping. This is especially true with In-Line pumps.

2.3.1 Lifting pump components

2.3.1.1 Casing [1100]

Use a choker hitch pulled tight around the discharge nozzle.

2.3.1.2 Rear cover [1220]

Insert an eye hook in the drilled and tapped hole on the face of the cover. Use either a sling or hook through the eye bolt.

2.3.1.3 Bearing housing [3200]

Group A and 1: insert a sling between the upper and lower support ribs between the housing barrel and the casing attachment flange. Use a choker hitch when slinging. (Make sure there are no sharp edges on the bottom side of the ribs that could cut the sling.)

Group B, C and 2: insert either a sling or hook through the lifting lug located on the top of the housing.

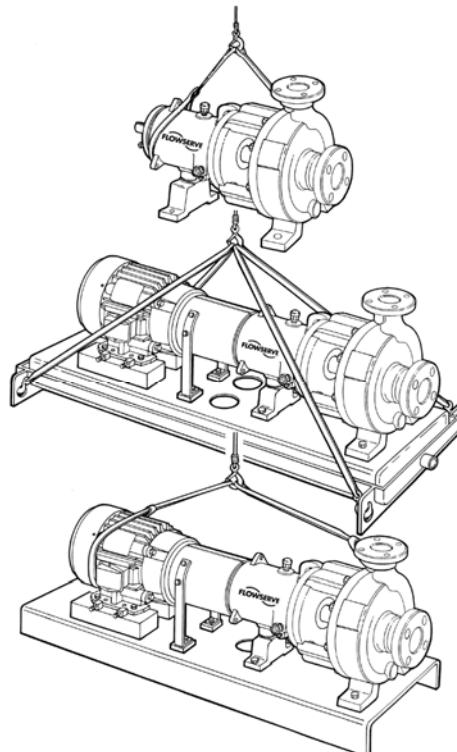
2.3.1.4 Power end

Same as bearing housing.

2.3.1.5 Bare pump

Horizontal pumps: sling around the pump discharge nozzle and around the outboard end of the bearing housing with separate slings. Choker hitches must be used at both attachment points and pulled tight. Make sure the completion of the choker hitch on the discharge nozzle is toward the coupling end of the pump shaft as shown in Figure 2-1. The sling lengths should be adjusted to balance the load before attaching the lifting hook. Pump models with non standard flanges can not accommodate a sling around the discharge nozzle; when lifting these pumps an individual trained in properly lifting equipment must be consulted.

Figure 2-1



2.3.2 Lifting pump, motor and baseplate assembly

If the baseplate has lifting holes cut in the sides at the end (Type D and Type E bases) insert lifting S hooks at the four corners and use slings or chains to connect to the lifting eye. (Figure 2-1.) Do not use slings through the lifting holes.

For other baseplates, sling around the pump discharge nozzle, and around the outboard end of the motor frame using choker hitches pulled tight. Pump models with non standard flanges can not accommodate a sling around the discharge nozzle; when lifting these pumps an individual trained in properly lifting equipment must be consulted. (Figure 2-1.)

The sling should be positioned so the weight is not carried through the motor fan housing. Make sure the completion of the choker hitch on the discharge nozzle is toward the coupling end of the pump shaft as shown in Figure 2-1.

2.4 Storage



CAUTION Store the pump in a clean, dry location away from vibration. Leave piping connection covers in place to keep dirt and other foreign material out of pump casing. Turn pump at intervals to prevent brinelling of the bearings and the seal faces, if fitted, from sticking.

The pump may be stored as above for up to 6 months. Consult Flowserve for preservative actions when a longer storage period is needed.

2.4.1 Short term storage and packaging

Normal packaging is designed to protect the pump and parts during shipment and for dry, indoor storage for up to six months or less. The following is an overview of our normal packaging:

- All loose unmounted items are packaged in a water proof plastic bag and placed under the coupling guard
- Inner surfaces of the bearing housing, shaft (area through bearing housing) and bearings are coated with Cortec VCI-329 rust inhibitor, or equal.

Note:

Bearing housings are not filled with oil prior to shipment

- Regreasable bearings are packed with grease (MOBIL POLYREX EM)
- Exposed shafts are taped with Polywrap
- Flange covers are secured to both the suction and discharge flanges
- In some cases with assemblies ordered with external piping, components may be disassembled for shipment
- The pump must be stored in a covered, dry location

2.4.2 Long term storage and packaging

Long term storage is defined as more than six months, but less than 12 months. The procedure Flowserve follows for long term storage of pumps is given below. These procedures are in addition to the short term procedure.

- Each assembly is hermetically (heat) sealed from the atmosphere by means of tack wrap sheeting and rubber bushings (mounting holes)
- Desiccant bags are placed inside the tack wrapped packaging
- A solid wood box is used to cover the assembly

This packaging will provide protection for up to twelve months from humidity, salt laden air, dust etc.

After unpacking, protection will be the responsibility of the user. Addition of oil to the bearing housing will remove the inhibitor. If units are to be idle for extended periods after addition of lubricants, inhibitor oils and greases should be used. Every three months, the pump shaft should be rotated approximately 10 revolutions.

2.5 Recycling and end of product life

At the end of the service life of the product or its parts, the relevant materials and parts should be recycled or disposed of using an environmentally acceptable method and local requirements. If the product contains substances that are harmful to the environment, these should be removed and disposed of in accordance with current regulations. This also includes the liquids and/or gases that may be used in the "seal system" or other utilities.



Make sure that hazardous substances are disposed of safely and that the correct personal protective equipment is used. The safety specifications must be in accordance with the current regulations at all times.

3 DESCRIPTION

3.1 Configurations

PolyChem S-series chemical process pumps are horizontal, end suction, single stage, centrifugal pumps. The ISO version of this pump conforms dimensionally to ISO 2858/5199 while the ANSI model agrees dimensionally with ASME B73.1. Both have centerline discharge.

3.2 Nomenclature

The pump size will be engraved on the nameplate typically as below:

PS 40 – 200 / 190CL (ISO)
PS 2 x 1 - 10 / 8.25CL (ANSI)

P = PolyChem pump line
S = Sealed

Power end:

Mark 3A – Standard

ANSI 3A – Optional (lifetime guarantee)

ISO pump:

"40" = Nominal discharge port size (mm)

"200" = Nominal (max.) impeller diameter (mm)

"190" = Actual impeller diameter (mm)

ANSI pump:

"2" = Nominal suction port size (in.)

"1" = Nominal discharge port size (in.)

"10" = Nominal (max) impeller diameter (in.)

"8.25" = Actual impeller diameter (in.)

Impeller style (ISO or ANSI):

CL = closed vane impeller

OP = Open impeller

Pump design variation (ANSI only):

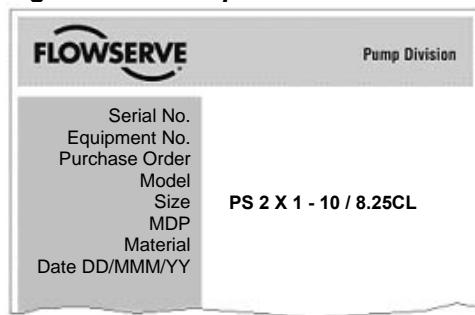
HD = Heavy duty shaft which is available on all Group 2

pump models. The shaft increases from

47.63 mm (1.875 in.) to 53.98 mm (2.125 in.).

An example of the nameplate used on the PolyChem pump is shown in Figure 3-1. This nameplate is always mounted on the bearing housing.

Figure 3-1: Nameplate mounted to housing



3.3 Design of major parts

3.3.1 Pump casing

Removal of the casing is not required when performing maintenance of the rotating element. The rotating element is easily removed (back pull out).

3.3.2 Impeller

Depending on the pump size, the impeller is either closed vane or open.

3.3.3 Shaft/sleeve

Solid and sleeved shafts are available, supported on bearings, threaded impeller end and keyed drive end.

3.3.4 Pump bearings and lubrication

Ball bearings are fitted as standard and may be either oil or grease lubricated.

3.3.5 Bearing housing

Large oil bath reservoir.

3.3.6 Seal chamber (cover plate)

The seal chamber has a spigot (rabbet) fit between the pump casing and bearing housing (adapter) for optimum concentricity. The design enables a number of sealing options to be fitted.

3.3.7 Shaft seal

The mechanical seal(s), attached to the pump shaft, seals the pumped liquid from the environment.

3.3.8 Driver

The driver is normally an electric motor. Different drive configurations may be fitted such as internal combustion engines, turbines, hydraulic motors etc driving via couplings, belts, gearboxes, drive shafts etc.

3.3.9 Accessories

Accessories may be fitted when specified by the customer.

3.4 Performance and operation limits

This product has been selected to meet the specification of your purchase order. See section 1.5.

The following data is included as additional information to help with your installation. It is typical, and factors such as liquid being pumped, temperature, material of construction, and seal type may influence this data. If required, a definitive statement for your application can be obtained from Flowserve.

3.4.1 Material cross reference chart

Figure 3-2 is the material cross-reference chart for all PolyChem S-series pumps.

Figure 3-2: Material cross-reference chart

Flowserve material code	Designation	Durco legacy codes	Equivalent wrought designation	EN/ASTM specifications	Nozzle load material group
Z0L48	PFA lined Ductile iron (cast)	DIPA	None	Note 1	1.0
E2025	Ductile Iron Casting	7043	None	EN1563, Gr. JS 1025	1.0
E3020	Ductile Iron Casting	DCI	None	A395, Gr. 60-40-18	1.0
D0005	Carbon Steel	SR	None		N/A
D2044	Quenched and Tempered Steel	CK45	None	EN 10083-1	N/A
D3013	1018 Carbon Steel	Z	None		N/A
D3058	304 Stainless Steel	304	None	A276, Type 304	N/A
D3277	Carbon Steel	BB	1144	UNS G11440	N/A
E2008	Ductile Iron Casting	7040	None	EN1563, Gr. JS 1030	N/A
E3006	Cast Iron Casting	CI	None	A48, Gr. 25A	N/A
E3035	Ductile Iron Casting	DCI2	None	A536, Gr. 65-45-12	N/A
E4034	Ductile Iron Casting	DCI4	None	Note 2	N/A
I3011	Titanium	TIW		B348, Gr. 3	N/A
J0020	Sintered silicon carbide	SC3	None	None	N/A
K3019	Hastelloy C276	C276	C276	UNS N10276	N/A
K4008	Chlorimet 3	DC3	Hastelloy® C	A494, Gr. CW6M	N/A
L0009	Carbon Filled Teflon	TFEC	None		N/A
L1010	Ethylene Propylene Diene Monomer	EPDM	None		N/A
L1011	Viton	VA	None		N/A
L1017	Nitrile Butadiene Rubber	NBR	None		N/A
L1049	Kalrez 4079	KAL	None		N/A
L1103	Pollyulphone	PS	None		N/A
M1001	ISO 3506 Grade A2 Class 70	A270	None		N/A
M1006	ISO898 QT	12.9	None		N/A
M1013	ISO 898/1 Class 8.8	88	None		N/A
Z0067	Protective Plated Carbon Steel	SRCD	None		N/A
Z0L49	PFA lined carbon steel (wrought)	SRPA	None		N/A
Z0L52	Carbon filled fluoropolymer	CFTM	None		N/A
Z0L53	Carbon fiber reinforced PFA	CRPA	None		N/A
Z0L59	1018 (SR) welded to 316 (SS)	ZH	None		N/A
Z0L60	1018 (SR) welded to C20 (Alloy 20)	ZC20	None		N/A
Z0L61	304 (SS) welded to B2 (B2)	EHB	None		N/A
Z0L62	304 (SS) welded to C276 (C276)	EHC	None		N/A
Z0L64	Teflon lined A193, Gr. B7	B7TF	None		N/A
Z0L65	Teflon lined A194, Gr. 2H	SRTF	None		N/A
Z0L72	Teflon – Silicon Rubber – Carbon Steel	TSSR	None		N/A
Z0M21	PFA lined stainless steel (cast)	D4PA	None		N/A
Z0M22	Viton – Carbon Steel	VSR	None		N/A
Z0M35	Carbon fiber reinforced fluoropolymer	CRTM	None		N/A

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Note 1. The casting used for ISO pumps is E2025 and for ANSI pumps is E3020

Note 2. Dual Spec. EN1563 Gr. JS1030 & A536 Gr. 65-45-12

3.4.2 Pressure-temperature ratings

PN 16 flanges are standard for the ISO model pump while Class 150 flanges are standard for the ANSI model. Refer to Figure 3-3A and 3-3B for each pump's pressure-temperature (P-T) ratings.



The maximum discharge pressure must be less than or equal to the P-T rating. Discharge pressure may be approximated by adding the suction pressure to the differential pressure developed by the pump.

3.4.3 Suction pressure limits

The suction pressure limits for PolyChem S-series pumps are limited by the P-T rating.

Figure 3-3A: Pressure-temperature rating
(ISO pump with PN 16 flanges – Material Group No. 1.0)

Temperature °C (°F)	-29 (-20)	-18 (0)	38 (100)	93 (200)	121 (250)	149 (300)
Bar (psi)	16 (232)	16 (232)	16 (232)	16 (232)	16 (232)	15.5 (225)

Figure 3-3B: Pressure-temperature rating
(ANSI pump with Class 150 flanges – Material Group No. 1.0)

Temperature °C (°F)	-29 (-20)	-18 (0)	38 (100)	93 (200)	149 (300)
Bar (psi)	17.2 (250)	17.2 (250)	17.2 (250)	16.2 (235)	14.8 (215)

3.4.4 Minimum continuous flow

The minimum continuous flow (MCF) is based on a percentage of the *best efficiency point* (BEP). Figure 3-4 identifies the MCF for all PolyChem S-series pumps.

Figure 3-4: Minimum continuous flow

Pump size	MCF % of BEP		
	3 500/2 900 r/min	1 750/1 450 r/min	1 180/960 r/min
PS3x2-6	20 %	10 %	10 %
PS3x2-10 PS50-250	30 %	10 %	10 %
PS4x3-10 PS65-250	n/a	10 %	10 %
PS3x2-13 PS50-315	n/a	10 %	10 %
PS4x3-13 PS65-315	n/a	20 %	10 %
PS6x4-13HD PS100-315	n/a	40 %	10 %
All other sizes	10 %	10 %	10 %

4 INSTALLATION



Equipment operated in hazardous locations must comply with the relevant explosion protection regulations. See section 1.6.4, *Products used in potentially explosive atmospheres*.

4.1 Location

The pump should be located to allow room for access, ventilation, maintenance, and inspection with ample headroom for lifting and should be as close as practicable to the supply of liquid to be pumped.

Refer to the general arrangement drawing for the pump set.

4.2 Part assemblies

The supply of motors and baseplates are optional. As a result, it is the responsibility of the installer to ensure that the motor is assembled to the pump and aligned as detailed in section 4.5 and 4.8.

4.3 Foundation

4.3.1 Protection of openings and threads

When the pump is shipped, all threads and all openings are covered. This protection/covering should not be removed until installation. If, for any reason, the pump is removed from service, this protection should be reinstalled.

4.3.2 Rigid baseplates - overview

The function of a baseplate is to provide a rigid foundation under a pump and its driver that maintains alignment between the two. Baseplates may be generally classified into two types:

- Foundation-mounted, grouted design. (Figure 4-1.)
- Stilt mounted, or free standing. (Figure 4-2.)

Figure 4-1

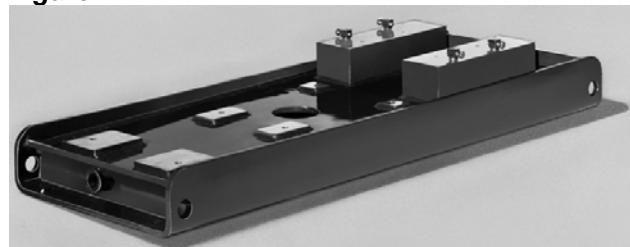


Figure 4-2



Baseplates intended for grouted installation are designed to use the grout as a stiffening member. Stilt mounted baseplates, on the other hand, are designed to provide their own rigidity. Therefore the designs of the two baseplates are usually different.

Regardless of the type of baseplate used, it must provide certain functions that ensure a reliable installation. Three of these requirements are:

- The baseplate must provide sufficient rigidity to assure the assembly can be transported and installed, given reasonable care in handling, without damage. It must also be rigid enough when properly installed to resist operating loads.
- The baseplate must provide a reasonably flat mounting surface for the pump and driver. Uneven surfaces will result in a soft-foot condition that may make alignment difficult or impossible.

Experience indicates that a baseplate with a top surface flatness of 1.25 mm/m (0.015 in./ft) across the diagonal corners of the baseplate provides such a mounting surface. Therefore, this is the tolerance to which we supply our standard baseplate. Some users may desire an even flatter surface, which can facilitate installation and alignment. Flowserve will supply flatter baseplates upon request at extra cost. For example, mounting surface flatness of 0.17 mm/m (0.002 in./ft) is offered on the Flowserve Type E "Ten Point" baseplate shown in Figure 4-1.

- The baseplate must be designed to allow the user to final field align the pump and driver to within their own particular standards and to compensate for any pump or driver movement that occurred during handling. Normal industry practice is to achieve final alignment by moving the motor to match the pump. Flowserve practice is to confirm in our shop that the pump assembly can be accurately aligned. Before shipment, the factory verifies that there is enough horizontal movement capability at the motor to obtain a "perfect" final alignment when the installer puts the baseplate assembly into its original, top levelled, unstressed condition.

4.3.3 Stilt and spring mounted baseplates

Flowserve offers stilt and spring mounted baseplates. (See Figure 4-2 for stilt mounted option.) The low vibration levels of PolyChem pumps allow the use of these baseplates - provided they are of a rigid design. The baseplate is set on a flat surface with no tie down bolts or other means of anchoring it to the floor.

General instructions for assembling these baseplates are given below. For dimensional information, please refer to the appropriate Flowserve "Sales print".

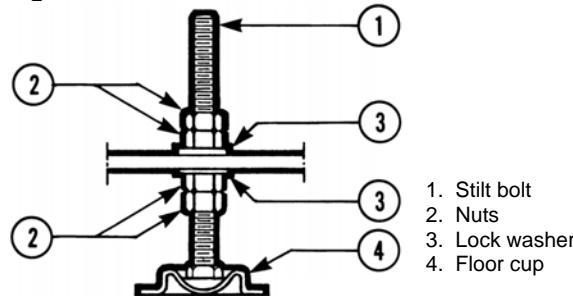
4.3.3.1 Stilt mounted baseplate assembly instructions

Refer to Figure 4-3.

- a) Raise or block up baseplate/pump above the floor to allow for the assembly of the stilts.
- b) Predetermine or measure the approximate desired height for the baseplate above the floor.
- c) Set the bottom nuts [2] above the stilt bolt head [1] to the desired height.
- d) Assemble lock washer [3] down over the stilt bolt.
- e) Assemble the stilt bolt up through hole in the bottom plate and hold in place.
- f) Assemble the lock washer [3] and nut [2] on the stilt bolt. Tighten the nut down on the lock washer.
- g) After all four stilts have been assembled, position the baseplate in place, over the floor cups [4] under each stilt location, and lower the baseplate to the floor.

- h) Level and make final height adjustments to the suction and discharge pipe by first loosening the top nuts and turning the bottom nuts to raise or lower the baseplate.
- i) Tighten the top and bottom nuts at the lock washer [3] first then tighten the other nuts.
- j) It should be noted that the connecting pipelines must be individually supported, and that the stilt mounted baseplate is not intended to support total static pipe load.

Figure 4-3



1. Stilt bolt
2. Nuts
3. Lock washer
4. Floor cup

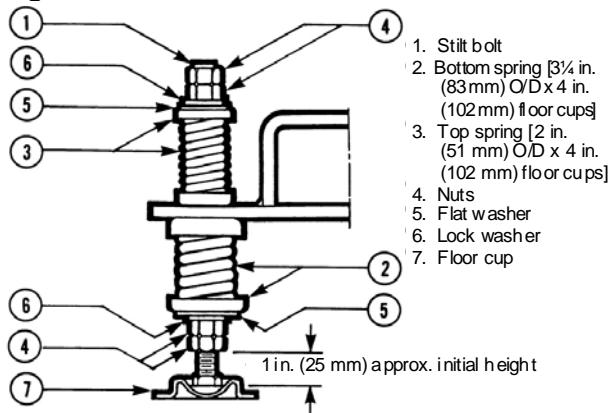
4.3.3.2 Stilt/spring mounted baseplate assembly instructions

Refer to Figure 4-4.

- a) Raise or block up baseplate/pump above the floor to allow for the assembly of the stilts.
- b) Set the bottom nuts [4] above the stilt bolt head [1]. This allows for 51 mm (2 in.) upward movement for the final height adjustment of the suction/discharge flange.
- c) Assemble the lock washer [6] flat washer [5] and bottom spring/cup assembly [2] down over the stilt bolt [1].
- d) Assemble the stilt bolt/bottom spring up through hole in the bottom plate and hold in place.
- e) Assemble top spring/cup assembly [3] down over stilt bolt.
- f) Assemble flat washer [5], lock washer [6] and nuts [4] on the stilt bolt.
- g) Tighten down top nuts, compressing the top spring approximately 13 mm (0.5 in.). Additional compression may be required to stabilize the baseplate.
- h) After all four stilts have been assembled, position the baseplate in place, over the floor cups [7] under each stilt location, and lower the baseplate down to the floor.
- i) Level and make final height adjustments to the suction and discharge pipe by first loosening the top nuts, and turning the bottom nuts to raise or lower the baseplate.
- j) Recompress the top spring to the compression established in step g) and lock the nuts.

- k) It should be noted that the connecting pipelines must be individually supported, and that the spring mounted baseplate is not intended to support total static pipe loads.

Figure 4-4



4.3.3.3 Stilt/spring mounted baseplates - motor alignment

The procedure for motor alignment on stilt or spring mounted baseplates is similar to grouted baseplates. The difference is primarily in the way the baseplate is levelled.

- Level the baseplate by using the stilt adjusters. (Shims are not needed as with grouted baseplates.)
- After the base is level, it is locked in place by locking the stilt adjusters.
- Next the initial pump alignment must be checked. The vertical height adjustment provided by the stilts allows the possibility of slightly twisting the baseplate. If there has been no transit damage or twisting of the baseplate during stilt height adjustment, the pump and driver should be within 0.38 mm (0.015 in.) parallel, and 0.0025 mm/mm (0.0025 in./in.) angular alignment. If this is not the case, check to see if the driver mounting fasteners are centered in the driver feet holes.
- If the fasteners are not centered there was likely shipping damage. Re-center the fasteners and perform a preliminary alignment to the above tolerances by shimming under the motor for vertical alignment, and by moving the pump for horizontal alignment.
- If the fasteners are centered, then the baseplate may be twisted. Slightly adjust (one turn of the adjusting nut) the stilts at the driver end of the baseplate and check for alignment to the above tolerances. Repeat as necessary while maintaining a level condition as measured from the pump discharge flange.
- Lock the stilt adjusters.

The remaining steps are as listed for new grouted baseplates.

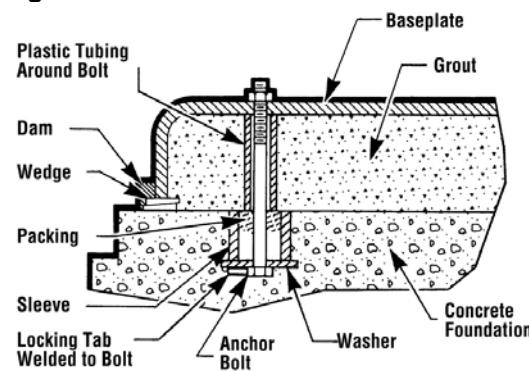
4.4 Grouting

- The pump foundation should be located as close to the source of the fluid to be pumped as practical.
- There should be adequate space for workers to install, operate, and maintain the pump. The foundation should be sufficient to absorb any vibration and should provide a rigid support for the pump and motor.
- Recommended mass of a concrete foundation should be three times that of the pump, motor and base. Refer to Figure 4-5.

Note:

Foundation bolts are imbedded in the concrete inside a sleeve to allow some movement of the bolt.

Figure 4-5



- Level the pump baseplate assembly. If the baseplate has machined coplanar mounting surfaces, these machined surfaces are to be referenced when leveling the baseplate. This may require that the pump and motor be removed from the baseplate in order to reference the machined faces. If the baseplate is without machined coplanar mounting surfaces, the pump and motor are to be left on the baseplate. The proper surfaces to reference when leveling the pump baseplate assembly are the pump suction and discharge flanges. DO NOT stress the baseplate.
- Do not bolt the suction or discharge flanges of the pump to the piping until the baseplate foundation is completely installed. If equipped, use leveling jackscrews to level the baseplate. If jackscrews are not provided, shims and wedges should be used. (See Figure 4-5.) Check for levelness in both the longitudinal and lateral directions. Shims should be placed at all base anchor bolt locations, and in the middle edge of the base if the base is more than 1.5 m (5 ft.) long. Do not rely on the bottom of the baseplate to be flat. Standard baseplate bottoms are not machined, and it is not likely that the field mounting surface is flat.

- f) After leveling the baseplate, tighten the anchor bolts. If shims were used, make sure that the baseplate was shimmed near each anchor bolt before tightening. Failure to do this may result in a twist of the baseplate, which could make it impossible to obtain final alignment.
- g) Check the level of the baseplate to make sure that tightening the anchor bolts did not disturb the level of the baseplate. If the anchor bolts did change the level, adjust the jackscrews or shims as needed to level the baseplate.
- h) Continue adjusting the jackscrews or shims and tightening the anchor bolts until the baseplate is level.
- i) Check initial alignment. If the pump and motor were removed from the baseplate proceed with step j) first, then the pump and motor should be reinstalled onto the baseplate using Flowserve's factory preliminary alignment procedure as described in section 4.5, and then continue with the following. As described above, pumps are given a preliminary alignment at the factory. This preliminary alignment is done in a way that ensures that, if the installer duplicates the factory conditions, there will be sufficient clearance between the motor hold down bolts and motor foot holes to move the motor into final alignment. If the pump and motor were properly reinstalled to the baseplate or if they were not removed from the baseplate and there has been no transit damage, and also if the above steps where done properly, the pump and driver should be within 0.38 mm (0.015 in.) FIM (Full Indicator Movement) parallel, and 0.0025 mm/mm (0.0025 in./in.) FIM angular. If this is not the case, first check to see if the driver mounting fasteners are centered in the driver feet holes. If not, re-center the fasteners and perform a preliminary alignment to the above tolerances by shimming under the motor for vertical alignment, and by moving the pump for horizontal alignment.
- j) Grout the baseplate. A non-shrinking grout should be used. Make sure that the grout fills the area under the baseplate. After the grout has cured, check for voids and repair them. Jackscrews, shims and wedges should be removed from under the baseplate at this time. If they were to be left in place, they could rust, swell, and cause distortion in the baseplate.
- k) Run piping to the suction and discharge of the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant loads.

4.5 Initial alignment

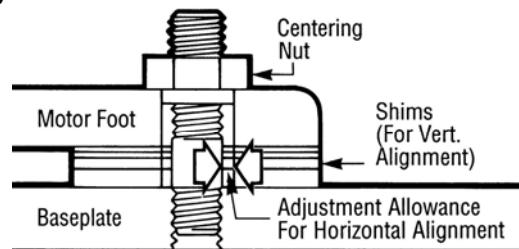
4.5.1 Horizontal initial alignment procedure

The purpose of factory alignment is to ensure that the user will have full utilization of the clearance in the motor holes for final job-site alignment. To achieve this, the factory alignment procedure specifies that the pump be aligned in the horizontal plane to the motor, with the motor foot bolts centered in the motor holes. This procedure ensures that there is sufficient clearance in the motor holes for the customer to field align the motor to the pump, to zero tolerance. This philosophy requires that the customer be able to place the base in the same condition as the factory. Thus the factory alignment will be done with the base sitting in an unrestrained condition on a flat and level surface. This standard also emphasizes the need to ensure the shaft spacing is adequate to accept the specified coupling spacer.

The factory alignment procedure is summarized below:

- a) The baseplate is placed on a flat and level workbench in a free and unstressed position.
- b) The baseplate is levelled as necessary. Levelling is accomplished by placing shims under the rails of the base at the appropriate anchor bolt hole locations. Levelness is checked in both the longitudinal and lateral directions.
- c) The motor and appropriate motor mounting hardware is placed on the baseplate and the motor is checked for any planar soft-foot condition. If any is present it is eliminated by shimming.
- d) The motor feet holes are centered on the motor mounting fasteners. This is done by using a centering nut as shown in Figure 4-6.

Figure 4-6



- e) The motor is fastened in place by tightening the nuts on two diagonal motor mounting studs.
- f) The pump is put onto the baseplate and levelled. The foot piece under the bearing housing is adjustable. It is used to level the pump, if necessary. If an adjustment is necessary, add or remove shims [3126.1] between the foot piece and the bearing housing.
- g) The spacer coupling gap is verified.

- h) The parallel and angular vertical alignment is made by shimming under the motor.
- i) The motor feet holes are again centered on the motor mounting studs using the centering nut. At this point the centering nut is removed and replaced with a standard nut. This gives maximum potential mobility for the motor to be horizontally moved during final, field alignment. All four motor feet are tightened down.
- j) The pump and motor shafts are then aligned horizontally, both parallel and angular, by moving the pump to the fixed motor. The pump feet are tightened down.
- k) Both horizontal and vertical alignment is again final checked as is the coupling spacer gap.
- l) See section 4.8, *Final shaft alignment*.

4.6 Piping

CAUTION Protective covers are fitted to both the suction and discharge flanges of the casing and must be removed prior to connecting the pump to any pipes.

4.6.1 Suction and discharge piping

All piping must be independently supported, accurately aligned and preferably connected to the pump by a short length of flexible piping. The pump should not have to support the weight of the pipe or compensate for misalignment. It should be possible to install suction and discharge bolts through mating flanges without pulling or prying either of the flanges. All piping must be tight. Pumps may air-bind if air is allowed to leak into the piping. If the pump flange(s) have tapped holes, select flange fasteners with thread engagement at least equal to the fastener diameter but that do not bottom out in the tapped holes before the joint is tight.

The following is the recommended procedure for attaching piping to the PolyChem S-series pump. (See section 6.6 for torque values.)

- a) Check the surface of both flanges (pump/pipe) to ensure they are clean, flat, and without defects.
- b) Lubricate the fasteners.
- c) Hand tighten all of the fasteners in a crisscross pattern.
- d) The fasteners should be torqued in increments – based a crisscross pattern.
 - The first increment should be at 75% of the full torque
 - The second increment should be at the full torque
 - Verify that the torque value of the first fastener is still at the full torque value
- e) Retorque all fasteners after 24 hours or after the first thermal cycle.

- f) Retorque all fasteners at least annually

4.6.2 Suction piping

To avoid NPSH and suction problems, suction piping must be at least as large as the pump suction connection. Never use pipe or fittings on the suction that are smaller in diameter than the pump suction size.

Figure 4-7 illustrates the ideal piping configuration with a minimum of 10 pipe diameters between the source and the pump suction. In most cases, horizontal reducers should be eccentric and mounted with the flat side up as shown in Figure 4-8 with a maximum of one pipe size reduction. Never mount eccentric reducers with the flat side down. Horizontally mounted concentric reducers should not be used if there is any possibility of entrained air in the process fluid. Vertically mounted concentric reducers are acceptable. In applications where the fluid is completely de-aerated and free of any vapor or suspended solids, concentric reducers are preferable to eccentric reducers.

Figure 4-7

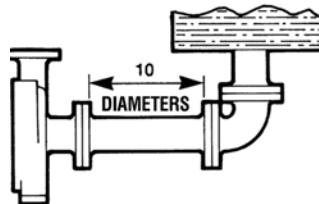
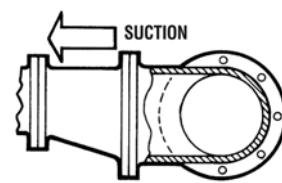


Figure 4-8



Avoid the use of throttling valves and strainers in the suction line. Start up strainers must be removed shortly before start up. When the pump is installed below the source of supply, a valve should be installed in the suction line to isolate the pump and permit pump inspection and maintenance. However, never place a valve directly on the suction nozzle of the pump.

Refer to the Durco Pump Engineering Manual and the Centrifugal Pump IOM Section of the Hydraulic Institute Standards for additional recommendations on suction piping. (See section 10.)

Refer to section 3.4 for performance and operating limits.

4.6.3 Discharge piping

Install a valve in the discharge line. This valve is required for regulating flow and/or to isolate the pump for inspection and maintenance.

CAUTION When fluid velocity in the pipe is high, for example, 3 m/s (10 ft/sec) or higher, a rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

4.6.4 Allowable nozzle loads

4.6.4.1 Introduction



Never use the pump as a support for piping.

Maximum forces and moments allowed on pump flanges vary based on the pump size. When these forces and moments are minimized, there is a corresponding reduction in misalignment, hot bearings, worn couplings, vibration and possible failure of the pump casing. The following points should be strictly followed:

- Prevent excessive external pipe load
- Never draw piping into place by applying force to pump flange connections
- Do not mount expansion joints so that their force, due to internal pressure, acts on the pipe flange

The PolyChem product line is designed to meet the requirements of ANSI/HI 9.6.2. Allowable nozzle loads for ISO pumps may be calculated using ANSI/HI 9.6.2 by selecting a comparable pump size.

Figure 4-9: Casing material correction factors – Material Group No. 1.0

Temperature °C (°F)	-29 (-20)	38 (100)	93 (200)	150 (300)
Correction factors	0.89	0.89	0.83	0.78

Figure 4-10: Baseplate correction factors

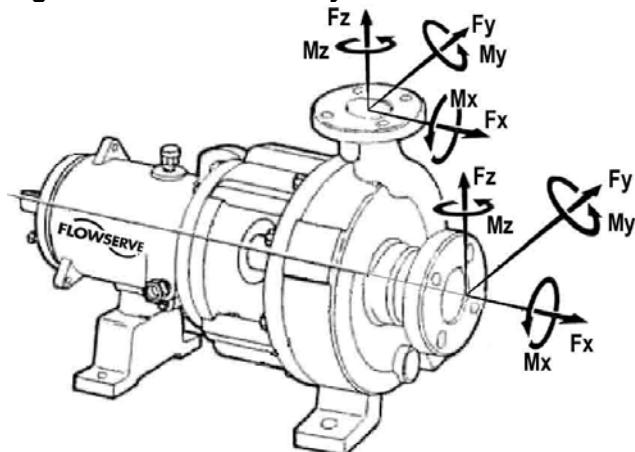
Base type	Grouted	Bolted	Stilt mounted
Type A	1.0	0.7	0.65
Type B - Polybase	1.0	n/a	0.95
Type C	n/a	1.0	1.0
Type D	1.0	0.8	0.75
Type E - PIP	1.0	0.95	n/a
Polyshield - baseplate/foundation	1.0	n/a	n/a

4.6.4.2 PolyChem S-series pumps

The following steps are based upon ANSI/HI 9.6.2. All information necessary to complete the evaluation is given below. For complete details please review the standard.

- a) PolyChem S-series pumps are only manufactured from Ductile Iron. For reference the "Material Group No." for this material is 1.0.
- b) Find the "Casing Material Correction Factor" in Figure 4-9 based upon the operating temperature. Interpolation may be used to determine the correction factor for a specific temperature.
- c) Find the "Baseplate Correction Factor" in Figure 4-10. The correction factor depends upon how the baseplate is to be installed.

- d) Locate the pump model being evaluated in Figure 4-14 and multiply each load rating by the casing correction factor. Record the adjusted Figure 4-14 loads.
- e) Locate the pump model being evaluated in Figures 4-15 and 4-16 and multiply each load rating by the baseplate correction factor. Record the adjusted Figure 4-15 and 4-16 loads.
- f) Compare the adjusted Figure 4-14 values (step D) to the values shown in Figure 4-13. The lower of these two values should be used as the adjusted Figure 4-13 values. (*The HI standard also asks that Figure 4-13 loads be reduced if Figure 4-15 or 4-16 values are lower. Flowserve does not follow this step.*)
- g) Calculate the applied loads at the casing flanges according to the coordinate system found in Figure 4-11. The 12 forces and moments possible are Fxs, Fys, Fzs, Mxs, Mys, Mzs, Fxd, Fyd, Fzd, Mxd, Myd and Mzd. For example, Fxd designates force in the "x" direction on the discharge flange. Mys designates the moment about the "y"-axis on the suction flange.
- h) Figure 4-12 gives the acceptance criteria equations. For long coupled pumps, equation sets 1 through 5 must be satisfied. For C-Face pumps (Ultralign), only equation sets 1 and 2 must be satisfied.
- i) Equation set 1. Each applied load is divided by the corresponding adjusted Figure 4-13 value. The absolute value of each ratio must be less than or equal to one.
- j) Equation set 2. The summation of the absolute values of each ratio must be less than or equal to two. The ratios are the applied load divided by the adjusted Figure 4-14 values.
- k) Equation sets 3 and 4. These equations are checking for coupling misalignment due to nozzle loading in each axis. Each applied load is divided by the corresponding adjusted load from Figure 4-15 and 4-16. The result of each equation must be between one and negative one.
- l) Equation set 5. This equation calculates the total shaft movement from the results of equations 3 and 4. The result must be less than or equal to one.

Figure 4-11: Coordinate system

Figure 4-12: Acceptance criteria equations

Set	Equations	Figure	Remarks
1	$\left \frac{F_{xs}}{F_{xs_adj}} \right \leq 1.0, \left \frac{F_{ys}}{F_{ys_adj}} \right \leq 1.0, \left \frac{F_{zs}}{F_{zs_adj}} \right \leq 1.0, \left \frac{M_{xs}}{M_{xs_adj}} \right \leq 1.0, \left \frac{M_{ys}}{M_{ys_adj}} \right \leq 1.0, \left \frac{M_{zs}}{M_{zs_adj}} \right \leq 1.0,$ $\left \frac{F_{xd}}{F_{xd_adj}} \right \leq 1.0, \left \frac{F_{yd}}{F_{yd_adj}} \right \leq 1.0, \left \frac{F_{zd}}{F_{zd_adj}} \right \leq 1.0, \left \frac{M_{xd}}{M_{xd_adj}} \right \leq 1.0, \left \frac{M_{yd}}{M_{yd_adj}} \right \leq 1.0, \left \frac{M_{zd}}{M_{zd_adj}} \right \leq 1.0$	Adjusted 4-13	Maximum individual loading
2	$\left \frac{F_{xs}}{F_{xs_adj}} \right + \left \frac{F_{ys}}{F_{ys_adj}} \right + \left \frac{F_{zs}}{F_{zs_adj}} \right + \left \frac{M_{xs}}{M_{xs_adj}} \right + \left \frac{M_{ys}}{M_{ys_adj}} \right + \left \frac{M_{zs}}{M_{zs_adj}} \right +$ $\left \frac{F_{xd}}{F_{xd_adj}} \right + \left \frac{F_{yd}}{F_{yd_adj}} \right + \left \frac{F_{zd}}{F_{zd_adj}} \right + \left \frac{M_{xd}}{M_{xd_adj}} \right + \left \frac{M_{yd}}{M_{yd_adj}} \right + \left \frac{M_{zd}}{M_{zd_adj}} \right \leq 2.0$	Adjusted 4-14	Nozzle stress, bolt stress, pump slippage
3	$A = \frac{F_{ys}}{F_{ys_adj}} + \frac{M_{xs}}{M_{xs_adj}} + \frac{M_{ys}}{M_{ys_adj}} + \frac{M_{zs}}{M_{zs_adj}} +$ $\frac{F_{yd}}{F_{yd_adj}} + \frac{M_{xd}}{M_{xd_adj}} + \frac{M_{yd}}{M_{yd_adj}} + \frac{M_{zd}}{M_{zd_adj}}$ <p style="text-align: center;">$-1.0 \leq A \leq 1.0$</p>	Adjusted 4-15	y-axis movement
4	$B = \frac{F_{xs}}{F_{xs_adj}} + \frac{F_{zs}}{F_{zs_adj}} + \frac{M_{xs}}{M_{xs_adj}} + \frac{M_{ys}}{M_{ys_adj}} + \frac{M_{zs}}{M_{zs_adj}} +$ $\frac{F_{xd}}{F_{xd_adj}} + \frac{F_{yd}}{F_{yd_adj}} + \frac{F_{zd}}{F_{zd_adj}} + \frac{M_{xd}}{M_{xd_adj}} + \frac{M_{yd}}{M_{yd_adj}} + \frac{M_{zd}}{M_{zd_adj}}$ <p style="text-align: center;">$-1.0 \leq B \leq 1.0$</p>	Adjusted 4-16	z-axis movement
5	$\sqrt{A^2 + B^2} \leq 1.0$	-	Combined axis movement

Note. All of the above equations are found by dividing the applied piping loads by the **adjusted** figure values.

Figure 4-13: Maximum individual loading

Pump size	Suction						Discharge					
	Forces N (lbf)			Moments Nm (lbf·ft)			Forces N (lbf)			Moments Nm (lbf·ft)		
	Fxs	Fys	Fzs	Mxs	Mys	Mzs	Fxd	Fyd	Fzd	Mxd	Myd	Mzd
PS 1.5x1-6 PS32-160	4 670 (1 050)	3 336 (750)	3 336 (750)	976 (720)	231 (170)	231 (170)	3 558 (800)	6 005 (1 350)	13 344 (3 000)	556 (410)	556 (410)	556 (410)
PS 3x1.5-6	4 670 (1 050)	5 516 (1 240)	5 560 (1 250)	1 220 (900)	664 (490)	664 (490)	3 558 (800)	6 005 (1 350)	13 344 (3 000)	678 (500)	746 (550)	692 (510)
PS 3x2-6 PS65-160	4 670 (1 050)	4 670 (1 050)	4 670 (1 050)	1 220 (900)	298 (220)	298 (220)	3 558 (800)	6 005 (1 350)	13 344 (3 000)	678 (500)	1 356 (1 000)	692 (510)
PS 1.5x1-8 PS40-200	4 670 (1 050)	5 382 (1 210)	5 382 (1 210)	976 (720)	258 (190)	258 (190)	3 558 (800)	6 005 (1 350)	13 344 (3 000)	488 (360)	488 (360)	488 (360)
PS 2x1-10 & 10HD PS32-250	10 408 (2 340)	4 270 (960)	4 270 (960)	1 722 (1 270)	298 (220)	298 (220)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	895 (660)	895 (660)	895 (660)
PS 3x2-10 & 10HD PS50-250	12 010 (2 700)	6 005 (1 350)	6 583 (1 480)	1 763 (1 300)	420 (310)	420 (310)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	759 (560)	759 (560)	759 (560)
PS 4x3-10 & 10HDPS65-250	10 230 (2 300)	6 005 (1 350)	6 672 (1 500)	1 763 (1 300)	420 (310)	420 (310)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	1 627 (1 200)	1 980 (1 460)	936 (690)
PS 3x2-13 & 13HD PS50-315	8 540 (1 920)	5 471 (1 230)	5 471 (1 230)	1 763 (1 300)	475 (350)	475 (350)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	1 627 (1 200)	1 722 (1 270)	936 (690)
PS 4x3-13 & 13HD PS65-315	12 010 (2 700)	6 005 (1 350)	6 672 (1 500)	1 763 (1 300)	542 (400)	542 (400)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	1 627 (1 200)	2 034 (1 500)	936 (690)
PS 6x4-13HD PS100-315	12 010 (2 700)	6 005 (1 350)	6 672 (1 500)	1 763 (1 300)	1 763 (1 300)	1 492 (1 100)	6 227 (1 400)	6 005 (1 350)	14 456 (3 250)	1 627 (1 200)	2 034 (1 500)	936 (690)

Figure 4-14: Maximum combined loading

Pump size	Suction						Discharge					
	Forces N (lbf)			Moments Nm (lbf·ft)			Forces N (lbf)			Moments Nm (lbf·ft)		
	Fxs	Fys	Fzs	Mxs	Mys	Mzs	Fxd	Fyd	Fzd	Mxd	Myd	Mzd
PS 1.5x1-6 PS32-160	8 985 (2 020)	3 336 (750)	3 336 (750)	2 481 (1 830)	231 (170)	231 (170)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	556 (410)	556 (410)	556 (410)
PS 3x1.5-6 PS65-250	8 985 (2 020)	5 516 (1 240)	9 385 (2 110)	3 105 (2 290)	664 (490)	664 (490)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	746 (550)	746 (550)	692 (510)
PS 3x2-6	8 985 (2 020)	4 670 (1 050)	4 670 (1 050)	3 105 (2 290)	298 (220)	298 (220)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	1 397 (1 030)	1 397 (1 030)	692 (510)
PS 1.5x1-8 PS40-200	8 985 (2 020)	5 382 (1 210)	5 382 (1 210)	2 481 (1 830)	258 (190)	258 (190)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	488 (360)	488 (360)	488 (360)
PS 2x1-10 & 10HD PS32-250	10 408 (2 340)	4 270 (960)	4 270 (960)	4 936 (3 640)	298 (220)	298 (220)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	895 (660)	895 (660)	895 (660)
PS 3x2-10 & 10HD PS50-250	12 010 (2 700)	6 005 (1 350)	6 583 (1 480)	5 058 (3 730)	420 (310)	420 (310)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	759 (560)	759 (560)	759 (560)
PS 4x3-10 & 10HD PS65-250	10 230 (2 300)	6 005 (1 350)	7 295 (1 640)	5 058 (3 730)	420 (310)	420 (310)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	1 980 (1 460)	1 980 (1 460)	936 (690)
PS 3x2-13 & 13HD PS32-315	8 540 (1 920)	5 471 (1 230)	5 471 (1 230)	5 058 (3 730)	475 (350)	475 (350)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	1 980 (1 460)	1 980 (1 460)	936 (690)
PS 4x3-13 & 13HD PS65-315	12 010 (2 700)	6 005 (1 350)	10 631 (2 390)	5 058 (3 730)	542 (400)	542 (400)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	2 346 (1 730)	2 346 (1 730)	936 (690)
PS 6x4-13HD PS100-315	12 010 (2 700)	6 005 (1 350)	27 756 (6 240)	5 058 (3 730)	6 753 (4 980)	1 492 (1 100)	8 985 (2 020)	6 005 (1 350)	27 756 (6 240)	2 915 (2 150)	2 915 (2 150)	936 (690)

Figure 4-15: Maximum Y-axis loading for shaft deflection

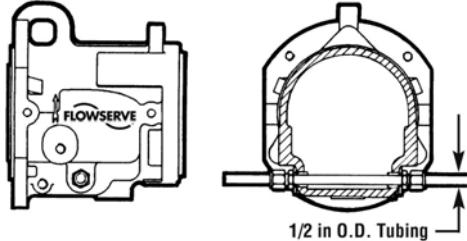
Pump size	Suction						Discharge					
	Forces N (lbf)			Moments Nm (lbf·ft)			Forces N (lbf)			Moments Nm (lbf·ft)		
	Fxs	Fys	Fzs	Mxs	Mys	Mzs	Fxd	Fyd	Fzd	Mxd	Myd	Mzd
Grupo 1 & A	-	-8 896 (-2 000)	-	1 220.4 (900)	1 627.2 (1 200)	1 695 (1 250)	-	6 672 (1 500)	-	-678 (-500)	2 034 (1 500)	1 695 (1 250)
Grupo 2, B & C	-	-15 568 (-3 500)	-	1 762.8 (1 300)	1 762.8 (1 300)	4 068 (3 000)	-	11 120 (2 500)	-	-1 627 (-1 200)	2 034 (1 500)	4 068 (3 000)

Figure 4-16: Maximum Z-axis loading for shaft deflection

Pump size	Suction						Discharge					
	Forces N (lbf)			Moments Nm (lbf·ft)			Forces N (lbf)			Moments Nm (lbf·ft)		
	Fxs	Fys	Fzs	Mxs	Mys	Mzs	Fxd	Fyd	Fzd	Mxd	Myd	Mzd
Grupo 1 & A	4 670 (1 050)	-	-5 560 (-1 250)	2 034 (1 500)	1 627 (1 200)	-3 390 (-2 500)	3 558 (800)	8 896 (2 000)	-13 344 (-3 000)	-2 034 (-1 500)	1 356 (1 000)	-3 390 (-2 500)
Grupo 2, B & C	15 568 (3 500)	-	-6 672 (-1 500)	2 034 (1 500)	1 763 (1 300)	-4 746 (-3 500)	6 227 (1 400)	11 120 (2 500)	-14 456 (-3 250)	-2 034 (-1 500)	2 915 (2 150)	-4 746 (-3 500)

4.6.5 Pump and shaft alignment check

After connecting the piping, rotate the pump drive shaft clockwise (viewed from motor end) by hand several complete revolutions to be sure there is no binding and that all parts are free. Recheck shaft alignment. (See section 4.5.) If piping caused unit to be out of alignment, correct piping to relieve strain on the pump.


Figure 4-17

4.6.6 Auxiliary piping

4.6.6.1 Mechanical seal

When the pump is intended to be equipped with a mechanical seal, it is Flowserve standard practice to install the mechanical seal in the pump prior to shipment. Specific order requirements may specify that the seal be shipped separately, or none be supplied. It is the pump installer's responsibility to determine if a seal was installed. If a seal was supplied but not installed, the seal and installation instructions will be shipped with the pump.



Failure to ensure that a seal is installed may result in serious leakage of the pumped fluid.

Seal and seal support system must be installed and operational as specified by the seal manufacturer.

The seal chamber/gland may have ports that have been temporarily plugged at the factory to keep out foreign matter. It is the installer's responsibility to determine if these plugs should be removed and external piping connected. Refer to the seal drawings and or the local Flowserve representative for the proper connections.

4.6.6.2 Piping connection – seal support system



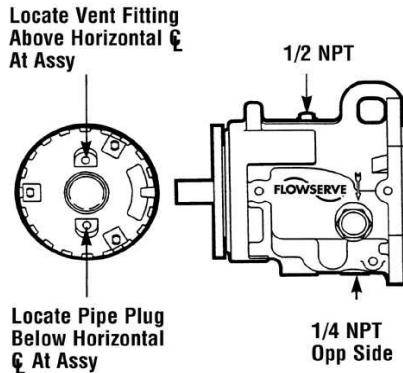
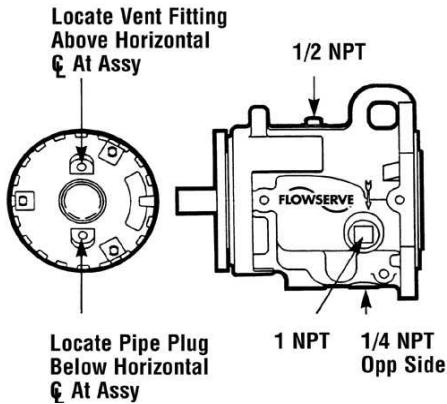
If the pump has a seal support system it is mandatory that this system be fully installed and operational before the pump is started.

4.6.6.3 Piping connection - bearing housing cooling system

Make connections as shown below. Liquid at less than 32 °C (90 °F) should be supplied at a regulated flow rate of at least 0.06 l/s (1 US gpm).

4.6.6.4 Piping connection - oil mist lubrication system

The piping connections for an oil mist lubrication system are shown below.

Figure 4-18: Oil mist ready housing wet sump

Figure 4-19: Oil mist ready housing dry sump


4.7 Electrical connections

 **DANGER** Electrical connections must be made by a qualified Electrician in accordance with relevant local national and international regulations.

 A device to provide emergency stopping must be fitted. If not supplied pre-wired to the pump unit, the controller/starter electrical details will also be supplied within the controller/starter. For electrical details on pump sets with controllers see the separate wiring diagram.

 It is important to be aware of the EUROPEAN DIRECTIVE on potentially explosive areas where compliance with IEC60079-14 is an additional requirement for making electrical connections.

 It is important to be aware of the EUROPEAN DIRECTIVE on electromagnetic compatibility when wiring up and installing equipment on site. Attention must be paid to ensure that the techniques used during wiring/installation do not increase electromagnetic emissions or decrease the electromagnetic immunity of the equipment, wiring or any connected devices. If in any doubt contact Flowserv for advice.

 **DANGER** The motor must be wired up in accordance with the motor manufacturer's instructions (normally supplied within the terminal box) including any temperature, earth leakage, current and other protective devices as appropriate. The identification nameplate should be checked to ensure the power supply is appropriate.

 **CAUTION** See section 5.4, *Direction of rotation*, before connecting the motor to the electrical supply.

4.8 Final shaft alignment check

- Level baseplate if appropriate.
- Mount and level pump if appropriate. Level the pump by putting a level on the discharge flange. If not level, adjust the footpiece by adding or removing shims [3126.1] between the footpiece and the bearing housing.
- Check initial alignment. If pump and driver have been remounted or the specifications given below are not met, perform an initial alignment as described in section 4.5. This ensures there will be sufficient clearance between the motor hold down bolts and motor foot holes to move the motor into final alignment. The pump and driver should be within 0.38 mm (0.015 in.) FIM (full indicator movement) parallel, and 0.0025 mm/mm (0.0025 in./in.) FIM angular.

Stilt mounted baseplates

If initial alignment cannot be achieved with the motor fasteners centered, the baseplate may be twisted. Slightly adjust (one turn of the adjusting nut) the stilts at the driver end of the baseplate and check for alignment to the above tolerances. Repeat as necessary while maintaining a level condition as measured from the pump discharge flange.

- Run piping to the suction and discharge to the pump. There should be no piping loads transmitted to the pump after connection is made. Recheck the alignment to verify that there are no significant changes.
- Perform final alignment. Check for soft-foot under the driver. An indicator placed on the coupling, reading in the vertical direction, should not indicate more than 0.05 mm (0.002 in.) movement when any driver fastener is loosened. Align the driver first in the vertical direction by shimming underneath its feet.
- When satisfactory alignment is obtained the number of shims in the pack should be minimized. It is recommended that no more than five shims be used under any foot. Final horizontal alignment is made by moving the driver. Maximum pump reliability is obtained by having near perfect alignment. Flowserv recommends no more than 0.05 mm (0.002 in.) parallel, and 0.0005 mm/mm (0.0005 in./in.) angular misalignment. (See section 6.8.4.7.)
- Operate the pump for at least an hour or until it reaches final operating temperature. Shut the pump down and recheck alignment while the pump is hot. Piping thermal expansion may change the alignment. Realign pump as necessary.

4.9 Protection systems

 The following protection systems are recommended particularly if the pump is installed in a potentially explosive area or is handling a hazardous liquid. If in any doubt consult Flowserv.

If there is any possibility of the system allowing the pump to run against a closed valve or below minimum continuous safe flow a protection device should be installed to ensure the temperature of the liquid does not rise to an unsafe level.

If there are any circumstances in which the system can allow the pump to run dry, or start up empty, a power monitor should be fitted to stop the pump or prevent it from being started. This is particularly relevant if the pump is handling a flammable liquid.

If leakage of product from the pump or its associated sealing system can cause a hazard it is recommended that an appropriate leakage detection system is installed.

To prevent excessive surface temperatures at bearings it is recommended that temperature or vibration monitoring are carried out.

5 COMMISSIONING, STARTUP, OPERATION AND SHUTDOWN



CAUTION *These operations must be carried out by fully qualified personnel.*

5.1 Pre-commissioning procedure

5.1.1 Pre start-up checks

Prior to starting the pump it is essential that the following checks be made. These checks are all described in detail in the *Maintenance* section of this manual.

- Pump and motor properly secured to the baseplate
- All fasteners tightened to the correct torque
- Coupling guard in place and not rubbing
- Rotation check, see section 5.4.
This is absolutely essential
- Impeller clearance setting
- Shaft seal properly installed
- Seal support system operational
- Bearing lubrication
- Bearing housing cooling system operational
- Pump instrumentation is operational
- Pump is primed
- Rotation of shaft by hand

As a final step in preparation for operation, it is important to rotate the shaft by hand to be certain that all rotating parts move freely, and that there are no foreign objects in the pump casing.

5.2 Pump lubricants

5.2.1 Oil bath

The standard bearing housing bearings are oil bath lubricated and are not lubricated by Flowserve. Before operating the pump, fill the bearing housing to the center of the oil sight glass with the proper type oil. (See Figure 5-1 for approximate amount of oil required - do not overfill.)

An optional oil slinger is available. The oil slinger is not necessary; however, if used, it provides an advantage by allowing a larger tolerance in acceptable oil level. Without an oil slinger, the oil level in the bearing housing must be maintained at

± 3 mm ($\pm \frac{1}{8}$ in.) from the center of the sight glass. The sight glass has a 6 mm ($\frac{1}{4}$ in.) hole in the center of its reflector. The bearing housing oil level must be within the circumference of the center hole to ensure adequate lubrication of the bearings.

See Figure 5-2 for a general description of the lubricants to be used and Figure 5-7 for recommended lubricants.

DO NOT USE DETERGENT OILS. The oil must be free of water, sediment, resin, soaps, acid and fillers of any kind. It should contain rust and oxidation inhibitors. The proper oil viscosity is determined by the bearing housing operating temperature as given in Figure 5-3.

To add oil to the housing, clean and then remove the vent plug [6521] at the top of the bearing housing, pour in oil until it is visually half way up in the sight glass [3855]. Fill the constant level oiler bottle, if used, and return it to its position. The correct oil level is obtained with the constant level oiler in its lowest position, which results in the oil level being at the top of the oil inlet pipe nipple, or half way up in the sight glass window. Oil must be visible in the bottle at all times.

Note that on ANSI 3A™ power ends there is no constant level oiler. As stated above, proper oil level is the center of the "bull's eye" sight glass [3856].

In many pumping applications lubricating oil becomes contaminated before it loses its lubricating qualities or breaks down. For this reason it is recommended that the first oil change take place after approximately 160 hours of operation, at which time, the used oil should be examined carefully for contaminants. During the initial operating period monitor the bearing housing operating temperature. Record the external bearing housing temperature. See Figure 5-4 for maximum acceptable temperatures. The normal oil change interval is based on temperature and is shown in Figure 5-5.

Figure 5-1: Amount of oil required

Pump	Mark 3A and ANSI 3A
Group A	458 ml (15.5 fl. oz.)
Group 1	251 ml (8.5 fl. oz.)
Group B	946 ml (32 fl. oz.)
Group 2	946 ml (32 fl. oz.)
Group C	793 ml (26.8 fl. oz.)

Figure 5-2: Recommended lubricants

Mineral oil	Quality mineral oil with rust and oxidation inhibitors. Mobil DTE heavy/medium (or equivalent)
Synthetic	Royal Purple or Conoco SYNCON (or equivalent). Some synthetic lubricants require Viton O-rings.
Grease	MOBIL POLYREX EM (or compatible)

Figure 5-3: Oil viscosity grades

Maximum oil temperature	ISO viscosity grade	Minimum viscosity index
Up to 60 °C (140 °F)	32	95
Up to 71 °C (160 °F)	46	95
Up to 80 °C (175 °F)	68	95
Up to 94 °C (200 °F)	100	95

Figure 5-4: Maximum external housing temperatures

Lubrication	Temperature
Oil bath	82 °C (180 °F)
Oil mist	82 °C (180 °F)
Grease	94 °C (200 °F)



The maximum temperature that the bearing can be exposed to is 105 °C (220 °F). Bearing temperatures may be up to 16 °C (30 °F) higher than the housing temperature.

Figure 5-5: Lubrication intervals*

Lubricant	Under 71 °C (160 °F)	71-80 °C (160-175 °F)	80-94 °C (175-200 °F)
Grease	6 months	3 months	1.5 months
Mineral oil	6 months	3 months	1.5 months
Synthetic oil**	18 months	18 months	18 months

* Assuming good maintenance and operation practices, and no contamination.

** May be increased to 36 months with ANSI 3A™ power end.

Figure 5.7: Recommended oil lubricants

Centrifugal pump lubrication	Oil	Splash lubrication		Oil mist lubrication
	Viscosity mm²/s 40 °C	32	68	46
	Temp. max. °C (°F)	65 (149)	80 (176)	-
	Designation according to DIN51502 ISO VG	HL/HLP 32	HL/HLP 68	HL/HLP 46
Oil companies and lubricants	BP	BP Energol HL32 BP Energol HLP32	BP Energol HL68 BP Energol HLP68	BP Energol HL46 BP Energol HLP46
	DEA	Anstron HL32 Anstron HLP32	Anstron HL68 Anstron HLP68	Anstron HL46 Anstron HLP46
	Elf	OLNA 32 HYDRELEF 32 TURBELF 32 ELFOLNA DS32	TURBELF SA68 ELFOLNA DS68	TURBELF SA46 ELFOLNA DS46
	Esso	TERESSO 32 NUTO H32	TERESSO 68 NUTO H68	TERESSO 46 NUTO H46
	Mobil	Mobil DTE oil light Mobil DTE13 Mobil DTE24	Mobil DTE oil heavy medium Mobil DTE26	Mobil DTE oil medium Mobil DTE15M Mobil DTE25
	Q8	Q8 Verdi 32 Q8 Haydn 32	Q8 Verdi 68 Q8 Haydn 68	Q8 Verdi 46 Q8 Haydn 46
	Shell	Shell Tellus 32 Shell Tellus 37	Shell Tellus 01 C 68 Shell Tellus 01 68	Shell Tellus 01 C 46 Shell Tellus 01 46
	Texaco	Rando Oil HD 32 Rando Oil HD-AZ-32	Rando Oil 68 Rando Oil HD C-68	Rando Oil 46 Rando Oil HD B-46
	Wintershall (BASF Group)	Wiolan HN32 Wiolan HS32	Wiolan HN68 Wiolan HS68	Wiolan HN46 Wiolan HS46

Figure 5-6: Grease lubrication amounts

Group	Bearing	Initial lube	Relubrication
A	Inboard	Until grease comes out plug	7 cm³ (0.4 in³)
	Outboard - standard	Until grease comes out plug	12 cm³ (0.7 in³)
	Outboard - duplex	34 cm³ (2.1 in³)	17 cm³ (1.0 in³)
1	Inboard	Until grease comes out plug	7 cm³ (0.4 in³)
	Outboard - standard	Until grease comes out plug	12 cm³ (0.7 in³)
	Outboard - duplex	34 cm³ (2.1 in³)	17 cm³ (1.0 in³)
B	Inboard	Until grease comes out plug	12 cm³ (0.7 in³)
	Outboard - standard	Until grease comes out plug	20 cm³ (1.2 in³)
	Inboard	Until grease comes out plug	17 cm³ (1.0 in³)
2	Outboard - standard	Until grease comes out plug	28 cm³ (1.7 in³)
	Outboard - duplex	68 cm³ (4.1 in³)	34 cm³ (2.1 in³)
	Inboard	Until grease comes out plug	12 cm³ (0.7 in³)
C	Outboard - standard	Until grease comes out plug	20 cm³ (1.2 in³)

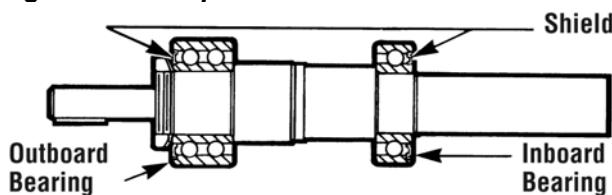
Note: if new bearings are not lubricated, they should be packed prior to installation.

5.2.2 Grease

5.2.2.1 Regreasable single shielded bearings

When the grease lubrication option is specified, single shielded bearings, grease fittings and vent pipe plugs are installed inboard and outboard.

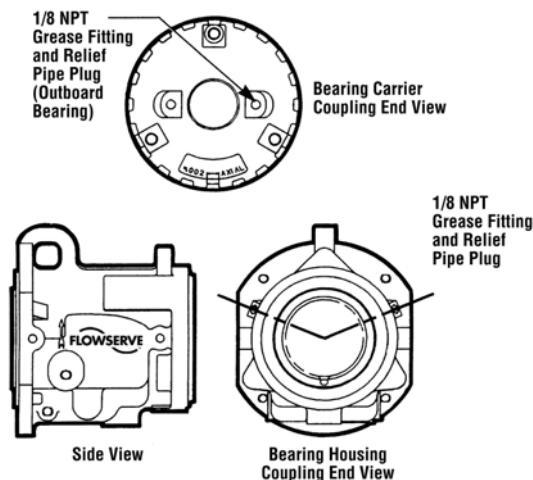
Figure 5-8: Pump shield orientation



The bearings are packed with MOBIL POLYREX EM grease prior to assembly. The grease reservoir should be packed prior to operating the pump in accordance with the relubrication instructions. For relubrication, a grease with the same type base (polyurea) and oil (mineral) should be used. To regrease, remove the pipe plug from both the inboard and outboard bearing location. (See Figure 5-9.) Add grease through each fitting until either grease is expelled out the purge hole or until the required volume of grease has been added. (See Figure 5-6.) After relubricating the bearings three times, it is typically recommended that the bearing housing is cleaned out.

CAUTION To regrease bearings under coupling guard, stop pump, lock the motor, remove coupling guard, and then regrease the bearings.

Figure 5-9: Regreasable configuration



CAUTION Do not fill the housing with oil when greased bearings are used. The oil will leach the grease out of the bearings and the life of the bearings may be drastically reduced.

5.2.2.2 Grease for life - double shielded or double sealed bearings

These bearings are packed with grease by the bearing manufacturer and should not be relubricated. The replacement interval for these bearings is greatly affected by their operating temperature and speed. Shielded bearings typically operate cooler.

5.2.3 Oil mist

The inlet port for all horizontal pumps is the plugged ½ in. NPT located at the top of the bearing housing. A vent fitting has been supplied on the bearing carrier as well as a plugged ¼ in. NPT bottom drain on the bearing housing. See section 4.6.6.4, *Piping connection - Oil mist lubrication system*. Do not allow oil level to remain above the center of the bearing housing sight glass window with purge mist (wet sump) systems.

The optional oil slinger must not be used with an oil mist system.

5.3 Impeller clearance

The impeller clearance was set at the factory. For open impellers the clearance is based on the application temperature at the time the pump was purchased. (See Figure 5-10.) If the process temperature changes the impeller clearance must be reset. All open style impellers are set to the casing. The preferred setting for a closed style impeller is midway between the casing and the cover. See section 6.6 for impeller adjustment instructions.

Figure 5-10: Open impeller clearance settings

Temperature °C (°F)	Clearance mm (in.)
< 38 (100)	0.58 ± 0.08 (0.023 ± 0.003)
38 to 65 (101 to 150)	0.71 (0.028)
66 to 93 (151 to 200)	0.84 (0.033)
94 to 121 (201 to 250)	0.97 (0.038)
122 to 149 (251 to 300)	1.09 (0.043)

Notes.

1. Rotation of bearing carrier from center of one lug to center of next results in axial shaft movement of 0.1 mm (0.004 in.).
2. Open impellers are set to casing.

5.4 Direction of rotation

5.4.1 Rotation check

CAUTION It is absolutely essential that the rotation of the motor be checked before connecting the shaft coupling. Incorrect rotation of the pump, for even a short time, can dislodge and damage the impeller, casing, shaft and shaft seal. All PolyChem S-series pumps turn clockwise as viewed from the motor end. A direction arrow is cast on the front of the casing as shown in Figure 5-11. Make sure the motor rotates in the same direction.



CAUTION If maintenance work has been carried out to the site's electrical supply, the direction of rotation should be re-checked as above in case the supply phasing has been altered.



Figure 5-11

5.4.2 Coupling installation



CAUTION The coupling should be installed as advised by the coupling manufacturer. Pumps are shipped without the spacer installed. If the spacer has been installed to facilitate alignment, then it must be removed prior to checking rotation. Remove all protective material from the coupling and shaft before installing the coupling.

5.5 Guarding



CAUTION Power must never be applied to the driver when the coupling guard is not installed.

Flowserve coupling guards are safety devices intended to protect workers from inherent dangers of the rotating pump shaft, motor shaft and coupling. It is intended to prevent entry of hands, fingers or other body parts into a point of hazard by reaching through, over, under or around the guard. No standard coupling guard provides complete protection from a disintegrating coupling. Flowserve cannot guarantee their guards will completely contain an exploding coupling.

5.5.1 Clam shell guard - standard

The standard coupling guard for all PolyChem S-series pumps is the "clam shell" design and is shown in Figure 5-12. It is hinged at the top and it can be removed by loosening one of the foot bolts and sliding the support leg out from under the cap screw (note that the foot is slotted). The leg can then be rotated upward and half of the guard can be disengaged (unhinged) from the other. Only one side of the guard needs to be removed. To reassemble simply reverse the above procedure.



Figure 5-12

The coupling guard shown in Figure 5-12 conforms to the USA standard ASME B15.1, "Safety standard for mechanical power transmission apparatus."

Flowserve manufacturing facilities worldwide conform to local coupling guard regulations.

5.5.2 ClearGuard™ - optional

Flowserve offers as an option a ClearGuard™, which allows you to see the condition of the coupling. (See Figure 5-13.) This guard can be used in place of the existing clamshell guard described above. Disassembly of the ClearGuard™ is accomplished by removing the fasteners that hold the two guard halves together followed by removing the foot bolts and rotating the support leg out of the slot on the guard.

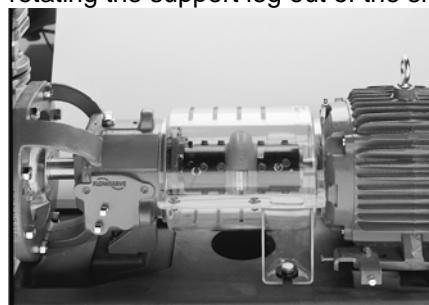


Figure 5-13

5.5.3 Trimming instructions

In order to correctly fit the pump/motor configuration, each guard must be trimmed to a specific length. This trimming is done on the motor end of the guard.

- a) Measure minimum distance from the center of mounting hole in the baseplate to the motor. (If clam shell guard proceed to step c.)
- b) Locate a reference center in the slot of the ClearGuard™ coupling guard flange, see figure 5-14. Transfer the length measurement to the guard using this reference center.
- c) Trim the motor end of the guard according to the above measurement. Trimming is best done with a band saw, but most other types of manual or power saws give acceptable results. Care must be taken to ensure that there is no gap larger than 6 mm (0.24 in.) between the motor and the coupling guard.

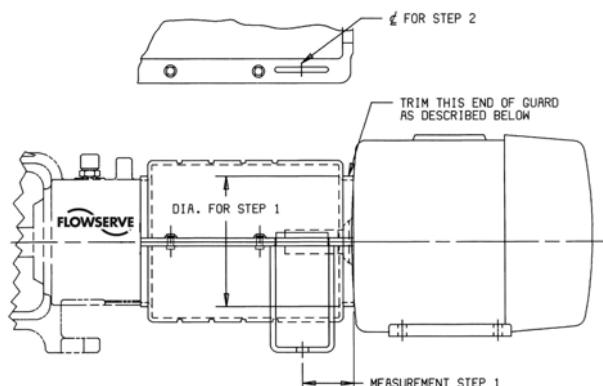


Figure 5-14

- Note:**
- d) If motor diameter is smaller than guard diameter, trim guard so that it extends over the end of the motor as far as possible.
 - e) Deburr the trimmed end with a file or a sharp knife if ClearGuard™. Care must be taken to eliminate all sharp edges.

5.5.4 Assembly instructions

5.5.4.1 Clam shell guard

- a) Mount support leg to each clam shell, figure 5-12.
- b) Attach one half of the guard to the baseplate.
- c) Engage the tabs of guard halves together.
- d) Attach the second support leg to the baseplate.

5.5.4.2 ClearGuard™

- a) Place the bottom and top halves of the guard around the coupling.
- b) Install the support legs by inserting and then rotating the tab on the leg through the slot in the guard until it comes through and locks the top and bottom halves of the guard together.
- c) Attach the support legs to the baseplate using the fasteners and washers provided.
- d) Install fasteners in the holes provided to secure the guard flanges together.

5.6 Priming and auxiliary supplies

The PolyChem S-series centrifugal pump will not move liquid unless the pump is primed. A pump is said to be "primed" when the casing and the suction piping are completely filled with liquid. Open discharge valves a slight amount. This will allow any entrapped air to escape and will normally allow the pump to prime, if the suction source is above the pump. When a condition exists where the suction pressure may drop below the pump's capability, it is advisable to add a low-pressure control device to shut the pump down when the pressure drops below a predetermined minimum.

5.7 Starting the pump

- a) Open the suction valve to full open position. It is very important to leave the suction valve open while the pump is operating. Any throttling or adjusting of flow must be done through the discharge valve. Partially closing the suction valve can create serious NPSH and pump performance problems.
- b) **CAUTION** Never operate pump with both the suction and discharge valves closed. This could cause an explosion.
- c) Ensure the pump is primed. (See section 5.6.)
- d) All cooling, heating, and flush lines must be started and regulated.
- e) Start the driver (typically, the electric motor).
- f) Slowly open the discharge valve until the desired flow is reached, keeping in mind the minimum continuous flow listed in section 3.4.4.
- g) **CAUTION** It is important that the discharge valve be opened within a short interval after starting the driver. Failure to do this could cause a dangerous build up of heat, and possibly an explosion.

5.8 Running or operation

5.8.1 Minimum continuous flow

Minimum continuous stable flow is the lowest flow at which the pump can operate and still meet the bearing life, shaft deflection and bearing housing vibration limits documented in the latest version of ASME B73.1. Pumps may be operated at lower flows, but it must be recognized that the pump may exceed one or more of these limits. For example, vibration may exceed the limit set by the ASME standard. The size of the pump, the energy absorbed, and the liquid pumped are some of the considerations in determining the minimum continuous flow (MCF).

The minimum continuous flow (capacity) is established as a percentage of the *best efficiency point* (BEP). (See section 3.4.4.)

5.8.2 Minimum thermal flow

All PolyChem S-series pumps also have a *minimum thermal flow*. This is defined as the minimum flow that will not cause an excessive temperature rise. Minimum thermal flow is application dependent.

CAUTION Do not operate the pump below minimum thermal flow, as this could cause an excessive temperature rise. Contact a Flowserve sales engineer for determination of minimum thermal flow.

Avoid running a centrifugal pump at drastically reduced capacities or with discharge valve closed for extended periods of time. This can cause severe temperature rise and the liquid in the pump may reach its boiling point. If this occurs, the mechanical seal will be exposed to vapor, with no lubrication, and may score or seize to the stationary parts. Continued running under these conditions when the suction valve is also closed can create an explosive condition due to the confined vapor at high pressure and temperature.

Thermostats may be used to safeguard against over heating by shutting down the pump at a predetermined temperature.

Safeguards should also be taken against possible operation with a closed discharge valve, such as installing a bypass back to the suction source. The size of the bypass line and the required bypass flow rate is a function of the input horsepower and the allowable temperature rise.

5.8.3 Reduced head

Note that when discharge head drops, the pump's flow rate usually increases rapidly. Check motor for temperature rise as this may cause overload. If overloading occurs, throttle the discharge.

5.8.4 Surging condition

A rapidly closing discharge valve can cause a damaging pressure surge. A dampening arrangement should be provided in the piping.

5.8.5 Operation in sub-freezing conditions

When using the pump in sub-freezing conditions where the pump is periodically idle, the pump should be properly drained or protected with thermal devices which will keep the liquid in the pump from freezing.

5.8.6 Bearing monitoring

If the pumps are operating in a potentially explosive atmosphere temperature or vibration monitoring of the bearings is recommended.

If bearing temperatures are to be monitored it is essential that a benchmark temperature is recorded at the commissioning stage and after the bearing temperature has stabilized.

- Record the bearing temperature (t) and the ambient temperature (ta)
- Estimate the likely maximum ambient temperature (tb)
- Set the alarm at $(t+tb-ta+5)$ °C ($(t+tb-ta+10)$ °F) and the trip at 100 °C (212 °F) for oil lubrication and 105 °C (220 °F) for grease lubrication.

It is important, particularly with grease lubrication, to keep a check on bearing temperatures. After start up the temperature rise should be gradual, reaching a maximum after approximately 1.5 to 2 hours. This temperature rise should then remain constant or marginally reduce with time.

5.8.6.1 Normal vibration levels, alarm and trip

For guidance, pumps generally fall under a classification for rigid support machines within the International rotating machinery standards and the recommended maximum levels below are based on those standards.

Alarm and trip values for installed pumps should be based on the actual measurements (N) taken on site on the bearing housings of the pump in the fully commissioned as new condition.

The example (N) value is given for the preferred operating flow region (typically this may extend to 70 to 120 % of the pump best efficiency point); outside the preferred flow region the actual vibration experienced may be multiplied by up to 2.

These standard values can vary with the rotational speed and the power absorbed by the pump. For any special case, do not hesitate to consult us.

Measuring vibration at regular intervals will then show any deterioration in pump or system operating conditions.

Vibration velocity – unfiltered	Horizontal pumps ≤ 15 kW (20 hp) mm/s (in./sec) r.m.s.	> 15 kW (20 hp) mm/s (in./sec) r.m.s.
Normal N	≤ 3.0 (0.12)	≤ 4.5 (0.18)
Alarm N x 1.25	≤ 3.8 (0.15)	≤ 5.6 (0.22)
Shutdown trip N x 2.0	≤ 6.0 (0.24)	≤ 9.0 (0.35)

5.9 Stopping and shutdown

5.9.1 Shutdown considerations

Pump sets are normally suitable for the number of equally spaced stop/starts per hour shown in the table below. Check the capability of the driver and control/starting system before commissioning.

Motor rating kW (hp)	Maximum start ups per hour
Up to 15 (20)	15
Between 15 and 90 (20 and 120)	10
Above 90 (120)	6

Where duty and standby pumps are installed it is recommended that they are run alternately every week.

5.10 Hydraulic, mechanical and electrical duty

This product has been supplied to meet the performance specifications of your purchase order, however it is understood that during the life of the product these may change. The following notes will help the user decide how to evaluate the implications of any change. If in doubt contact your nearest Flowserve office.

5.10.1 Specific gravity (SG)

Pump capacity and total head in metres (feet) do not change with SG, however pressure displayed on a pressure gauge is directly proportional to SG. Power absorbed is also directly proportional to SG. It is therefore important to check that any change in SG will not overload the pump driver or over-pressurize the pump.

5.10.2 Viscosity

For a given flow rate the total head reduces with increased viscosity and increases with reduced viscosity. Also for a given flow rate the power absorbed increases with increased viscosity, and reduces with reduced viscosity. It is important that checks are made with your nearest Flowserve office if changes in viscosity are planned.

5.10.3 Pump speed

Changing pump speed effects flow, total head, power absorbed, NPSH_R, noise and vibration. Flow varies in direct proportion to pump speed. Head varies as speed ratio squared and power varies as speed ratio cubed. The new duty, however, will also be dependent on the system curve. If increasing the speed, it is important therefore to ensure the maximum pump working pressure is not exceeded, the driver is not overloaded, NPSH_A > NPSH_R, and that noise and vibration are within local requirements and regulations.

5.10.4 Net positive suction head (NPSH_A)

NPSH available (NPSH_A) is a measure of the head available in the pumped liquid, above its vapor pressure, at the pump suction branch.

NPSH required (NPSH_R) is a measure of the head required in the pumped liquid, above its vapor pressure, to prevent the pump from cavitating. It is important that NPSH_A > NPSH_R. The margin between NPSH_A > NPSH_R should be at large as possible.

If any change in NPSH_A is proposed, ensure these margins are not significantly eroded. Refer to the pump performance curve to determine exact requirements particularly if flow has changed.

If in doubt please consult your nearest Flowserve office for advice and details of the minimum allowable margin for your application.

5.10.5 Pumped flow

Flow must not fall outside the minimum and maximum continuous safe flow shown on the pump performance curve and or data sheet.

6 MAINTENANCE

6.1 General

 It is the plant operator's responsibility to ensure that all maintenance, inspection and assembly work is carried out by authorized and qualified personnel who have adequately familiarized themselves with the subject matter by studying this manual in detail. (See also section 1.6.2.)

Any work on the machine must be performed when it is at a standstill. It is imperative that the procedure for shutting down the machine is followed, as described in section 5.9.

On completion of work all guards and safety devices must be re-installed and made operative again.

Before restarting the machine, the relevant instructions listed in section 5, *Commissioning, start up, operation and shut down* must be observed.

Oil and grease leaks may make the ground slippery. Machine maintenance must always begin and finish by cleaning the ground and the exterior of the machine.

If platforms, stairs and guard rails are required for maintenance, they must be placed for easy access to areas where maintenance and inspection are to be carried out. The positioning of these accessories must not limit access or hinder the lifting of the part to be serviced.

When air or compressed inert gas is used in the maintenance process, the operator and anyone in the vicinity must be careful and have the appropriate protection.

Do not spray air or compressed inert gas on skin.

Do not direct an air or gas jet towards other people.

Never use air or compressed inert gas to clean clothes.

Before working on the pump, take measures to prevent an uncontrolled start. Put a warning board on the starting device with the words:
"Machine under repair: do not start".

With electric drive equipment, lock the main switch open and withdraw any fuses. Put a warning board on the fuse box or main switch with the words:
"Machine under repair: do not connect".

Never clean equipment with inflammable solvents or carbon tetrachloride. Protect yourself against toxic fumes when using cleaning agents.

Refer to the parts list shown in section 8 for item number references used throughout this section.

6.2 Maintenance schedule



It is recommended that a maintenance plan and schedule be implemented, in accordance with these User Instructions, to include the following:

- a) Any auxiliary systems installed must be monitored, if necessary, to ensure they function correctly.
- b) Check for any leaks from gaskets and seals. The correct functioning of the shaft seal must be checked regularly.
- c) Check bearing lubricant level, and the remaining hours before a lubricant change is required.
- d) Check that the duty condition is in the safe operating range for the pump.
- e) Check vibration, noise level and surface temperature at the bearings to confirm satisfactory operation.
- f) Check dirt and dust is removed from areas around close clearances, bearing housings and motors.
- g) Check coupling alignment and re-align if necessary.

6.2.1 Preventive maintenance

The following sections of this manual give instructions on how to perform a complete maintenance overhaul. However, it is also important to periodically repeat the *Pre start-up checks* listed in section 5.1. These checks will help extend pump life as well as the length of time between major overhauls.

6.2.2 Need for maintenance records

A procedure for keeping accurate maintenance records is a critical part of any program to improve pump reliability. There are many variables that can contribute to pump failures. Often long term and repetitive problems can only be solved by analyzing these variables through pump maintenance records.

6.2.3 Cleanliness

One of the major causes of pump failure is the presence of contaminants in the bearing housing. This contamination can be in the form of moisture, dust, dirt and other solid particles such as metal chips. Contamination can also be harmful to the mechanical seal (especially the seal faces) as well as other parts of the pump. For example, dirt in the impeller threads could cause the impeller to not be seated properly against the shaft. This, in turn, could cause a series of other problems. For these reasons, it is very important that proper cleanliness be maintained. Some guidelines are listed below:

- After draining the oil from the bearing housing, periodically send it out for analysis. If it is contaminated, determine the cause and correct.
- The work area should be clean and free from dust, dirt, oil, grease etc.
- Hands and gloves should be clean.
- Only clean towels, rags and tools should be used.

6.3 Spare parts

The decision on what spare parts to stock varies greatly depending on many factors such as the criticality of the application, the time required to buy and receive new spares, the erosive/corrosive nature of the application, and the cost of the spare part. Section 8 identifies all of the components that make up each pump addressed in this manual. Please refer to the *Flowserve Durco Pump Parts Catalog* for more information. A copy of this book can be obtained from your local Flowserve sales engineer or distributor/representative.

6.3.1 Ordering of spare parts

Flowserve keeps records of all pumps that have been supplied. Spare parts can be ordered from your local Flowserve sales engineer or from a Flowserve distributor or representative. When ordering spare parts the following information should be supplied:

- 1) Pump serial number
- 2) Pump size and type
- 3) Part name – see section 8
- 4) Part item number – see section 8
- 5) Material of construction (alloy)
- 6) Number of parts required

The pump size and serial number can be found on the nameplate located on the bearing housing. See Figure 3-1.

6.4 Recommended spares and consumable items

Mechanical process fluid seals, bearing housing lip seals, bearings, shafting, impeller, and gaskets.

6.5 Tools required

A typical range of tools that will be required to maintain these pumps is listed below.

Standard hand tools

- Hand wrenches (Metric and SAE)
- Socket wrenches (Metric and SAE)
- Allen wrenches (Metric and SAE)
- Soft mallet
- Screwdrivers

Specialized equipment

- Bearing pullers
- Bearing induction heaters
- Dial indicators
- Spanner wrench
- Flowserve impeller tool kit (ISO and ANSI)

To simplify maintenance, it is recommended that the Flowserve impeller tool kit (shown in Figure 6-1) is used. This tool kit includes an impeller wrench, which simplifies installation and removal of the impeller. It also contains "nose cones" which protect shaft threads and mechanical seal O-rings during maintenance.

This tool kit can be ordered from your local Flowserve sales engineer or from a Flowserve distributor or representative.



Figure 6-1

6.6 Fastener torques

Non-metallic gaskets incur creep relaxation – before commissioning the pump, check and retighten fasteners to tightening torques stated.

Figure 6-2: Recommended pump fastener torques - SI (US)

Item	Comment	Size – Lubricated torque Nm (lbf·ft)				
		Group 1	Group A	Group 2	Group B	Group C
6570.2		3/8 in. - 27 (20)	10 mm - 27 (20)	3/8 in. - 27 (20)	10 mm - 27 (20)	10 mm - 27 (20)
6570.3		3/8 in. - 16 (12)	3/8 in. - 16 (12)	1/2 in. - 41 (30)	12 mm - 41 (30)	12 mm - 41 (30)
6570.4		1/2 in. - 54 (40)	12 mm - 54 (40)	3/4 in. - 217 (160)	16 mm - 108 (80)	16 mm - 108 (80)
6570.5		N/A	N/A	1/2 in. - 54 (40)	12 mm - 54 (40)	12 mm - 54 (40)
6570.12		#10 - 5 (4)	#10 - 5 (4)	#10 - 5 (4)	N/A	N/A
6580.1		1/2 in. - 34 (25)	12 mm - 34 (25)	5/8 in. - 61 (45)	16 mm - 61 (45)	16 mm - 61 (45)
6580.2		3/8 in. - 14 (10)	10 mm - 14 (10)	1/2 in. - 34 (25)	12 mm - 34 (25)	12 mm - 34 (25)

Note: for non-lubricated threads, increase the value by 25 %.

Figure 6-3: Recommended flange fastener torques - SI (US)

ISO pump with PN16 flanges

Flange size mm (in.)	Number of bolts	Bolt diam. mm (in.)	Bolt torque Nm (lbf·ft)
32 (1.3)	4	16 (0.63)	91 (67)
40 (1.6)	4	16 (0.63)	99 (73)
50 (2.0)	4	16 (0.63)	124 (91)
65 (2.6)	4	16 (0.63)	153 (112)
80 (3.1)	8	16 (0.63)	110 (81)
100 (3.9)	8	16 (0.63)	135 (99)
125 (4.9)	8	16 (0.63)	185 (137)

ANSI pump with Class 150 flanges

Flange size in. (mm)	Number of bolts	Bolt diam. in. (mm)	Bolt torque Nm (lbf·ft)
1 (25.4)	4	0.50 (12)	34 (25)
1 1/2 (38.1)	4	0.50 (12)	75 (55)
2 (50.8)	4	0.63 (16)	102 (75)
3 (76.2)	4	0.63 (16)	149 (110)
4 (101.6)	8	0.63 (16)	129 (95)
6 (152.4)	8	0.75 (19)	169 (125)

6.7 Setting impeller clearance and impeller replacement

A new impeller O-ring [4610.8] must be installed whenever the impeller has been removed from the shaft. Impeller clearance settings for open style impellers may be found in section 5.3. Impeller balancing instructions may be found in section 6.8.

6.7.1 Installation and clearance setting for closed vane impellers

Install the impeller [2200] by screwing it onto the shaft (use heavy gloves) until it firmly seats against the shaft/sleeve face.



The impeller could have sharp edges, which could cause an injury. It is very important to wear heavy gloves.



Do not adjust the impeller clearance with the seal set. Doing so may result in seal leakage and/or damage.

Tighten the impeller with the impeller wrench from the Flowserve impeller tool kit. To do this, grasp the impeller in both hands and, with the impeller wrench handle to the left (viewed from the impeller end of the shaft - Figure 6-4) spin the impeller forcefully in a clockwise direction to impact the impeller wrench handle on the work surface to the right. (Figure 6-5.)

CAUTION

Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.



Figure 6-4



Figure 6-5

The preferred impeller setting location is midway between the casing and the rear cover. This is accomplished by loosening the set screws [6570.3] and rotating the bearing carrier [3240]. Turn the bearing carrier counter-clockwise until the impeller comes into light rubbing contact with the rear cover. Rotating the shaft at the same time will accurately determine this zero setting. Using a felt tip pen place a reference mark on both the bearing housing and the carrier.

Now, rotate the bearing carrier clockwise while counting the number of indicator patterns (Figure 6-6) until you come into light rubbing contact with the casing. As before, rotating the shaft will help in establishing when contact is made. Rotating the bearing carrier the width of one of the indicator patterns cast into the bearing carrier moves the impeller axially 0.1 mm (0.004 in.).

Generally speaking the total axially clearance will be approximately 5.0 mm (0.20 in.). Once you know the total axial clearance, that number should be split in half and then divided by 0.10 mm (0.004 in.) to determine the number of indicator patterns that the bearing carrier should be rotated.

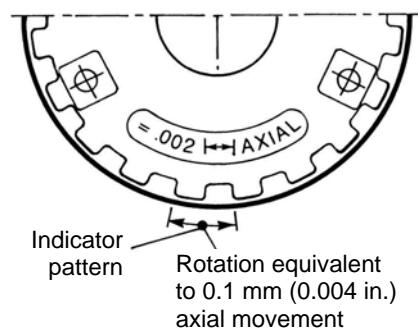


Figure 6-6

Rotate the bearing carrier counter-clockwise the required amount to get the desired clearance.

Note:

Lastly, uniformly tighten the set screws [6570.3] in incremental steps up to the final torque value to lock the bearing carrier in place.

An alternate approach for setting the impeller is to set it off the rear cover. Turn the bearing carrier counter-clockwise until the impeller comes into light rubbing contact with the rear cover. Rotating the shaft at the same time will accurately determine this zero setting. Using a felt tip pen place a reference mark on both the bearing housing and the carrier. The desired clearance setting is 2.5 mm (0.10 in.). Rotate the bearing carrier clockwise 25 indicator patterns to get the desired clearance.

Note:

Lastly, uniformly tighten the set screws [6570.3] in incremental steps up to the final torque value to lock the bearing carrier in place.

Tightening the set screws [6570.3] will cause the impeller to move 0.05 mm (0.002 in.) closer to the rear cover because of the internal looseness in the bearing carrier threads. This change is considered insignificant to the impeller clearance setting and need not be accounted for when setting a closed vane impeller.

Example. The impeller of a pump has been replaced and as a result the impeller setting must be reset. Since the preferred approach is to locate the impeller midway between the casing and the cover the first step is to determine the amount of axial clearance that is available. Turn the bearing carrier counter-clockwise until the impeller comes into light rubbing contact with the rear cover. Flowserve suggests that a felt tip pen be used to mark an initial reference point on the bearing housing and the bearing carrier. Rotate the bearing carrier clockwise until the impeller comes into light contact with the casing keeping track of the number of indicator patterns moved, which in this example is 46. This number of indicator patterns corresponds to a total axial clearance of 4.6 mm (0.18 in.).

Place a second mark with the felt tip pen on the bearing carrier and then rotate 23 indicator patterns counter-clockwise from this second mark. Uniformly tighten the set screws [6570.3] in incremental steps to lock the bearing carrier in place. The impeller is now set 2.3 mm (0.09 in.) off of the casing.

6.7.2 Installation and clearance setting for front vane open style impellers

Install the impeller [2200] by screwing it onto the shaft (use heavy gloves) until it firmly seats against the shaft shoulder.



CAUTION The impeller could have sharp edges, which could cause an injury. It is very important to wear heavy gloves.

Tighten the impeller with the impeller wrench from the Flowserve impeller tool kit. To do this, grasp the impeller in both hands and, with the impeller wrench handle to the left (viewed from the impeller end of the shaft - Figure 6-4), spin the impeller forcefully in a clockwise direction to impact the impeller wrench handle on the work surface to the right. (Figure 6-5.)



CAUTION Do not attempt to tighten the impeller on the shaft by hitting the impeller with a hammer or any other object or by inserting a pry bar between the impeller vanes. Serious damage to the impeller may result from such actions.

Like all front vane open style impellers, the Flowserve open impeller clearance must be set off the casing. The casing must be installed to accurately set the impeller clearance.

Attach the power end/rear cover plate assembly to the casing. Loosen the set screws [6570.3] and rotating the bearing carrier [3240] clockwise until the impeller comes into light rubbing contact with the casing. Rotating the shaft at the same time will accurately determine this zero setting. Using a felt tip pen place a reference mark on both the bearing housing and the carrier.

Now rotate the bearing carrier counter-clockwise to get the proper clearance. Refer to Figure 5-10 for the proper impeller clearance settings. Rotating the bearing carrier the width of one of the indicator pattern moves the impeller axially 0.1 mm (0.004 in.). (See Figure 6-6.) To determine how far to rotate the bearing carrier divide the desired impeller clearance by 0.1 mm (0.004 in.) (one indicator pattern). Tightening the set screws [6570.3] will cause the impeller to move 0.05 mm (0.002 in.) away from the casing because of the internal looseness in the

bearing carrier threads. This must be considered when setting the impeller clearance. Rotate the bearing carrier counter-clockwise the required amount to get the desired clearance to the casing.

Note:

Lastly, uniformly tighten the set screws [6570.3] in incremental steps up to the final torque value to lock the bearing carrier in place.

See section 5.3 for impeller clearance settings.

Example. The impeller of a pump is to be placed in a service based an operating temperature of 65 °C (150 °F) therefore the impeller setting would be 0.71 mm (0.028 in.) off the casing. This value however needs to be adjusted by 0.05 mm (0.002 in.) to compensate for the movement associated with tightening the set screws on the bearing carrier. This is accomplished by subtracting 0.05 mm (0.002 in.) from the desired impeller setting value of 0.71 mm (0.028 in.). As a result, the bearing carrier would need to be moved axially 0.64 mm (0.025 in.). First, turn the bearing carrier clockwise until the impeller comes into light rubbing contact with the casing. To determine the number of indicator patterns that you will need to rotate the carrier, divide 0.10 (0.004) into the desired setting; $0.71 \mid 0.10 = 7.1$ (.028 \mid 0.004 = 7). Rotate the bearing carrier counter-clockwise 7 indicator patterns which will give a clearance of 0.70 mm (0.028 in.). Flowserve suggests that a felt tip pen be used to mark an initial reference point on the bearing housing and the bearing carrier. A second mark should also be placed on the bearing carrier 7 indicator patterns clockwise from the initial reference point. Rotate the bearing carrier counter-clockwise until the second mark on the bearing carrier lines up with the initial reference point mark on the bearing housing. Uniformly tighten the set screws [6570.3] to lock the bearing carrier in place. The impeller is now set.

The above procedure is fairly straightforward when doing the final setting of the impeller. However, it can be quite laborious when doing the preliminary setting in order to establish the location of the mechanical seal. For this reason, the following practice is recommended. Before the pump is taken out of service, adjust the impeller until it touches the casing and then rotate the bearing carrier until the desired impeller clearance is obtained. Identify this location on the bearing carrier and then rotate the bearing carrier until the impeller contacts the rear cover. Record the distance from the desired impeller clearance setting to when the impeller contacts the rear cover. The pump is now removed from the casing and taken to the shop for maintenance. When it is time to set the seal, the impeller is simply set off the rear cover by the same distance recorded earlier.

Note:

The above technique is only applicable if all of the original pump components are reinstalled. If the casing, cover, impeller or shaft is replaced this method must not be used.

6.8 Pump removal and disassembly

6.8.1 Pump removal

- a) Before performing any maintenance, disconnect the driver from its power supply and lock it off line.



CAUTION Lock out power to driver to prevent personal injury.

- b) Close the discharge and suction valves, and drain all liquid from the pump.
 c) Close all valves on auxiliary equipment and piping, then disconnect all auxiliary piping.
 d) Decontaminate the pump as necessary.



CAUTION If Flowserve PolyChem S-series pumps contain dangerous chemicals it is important to follow plant safety guidelines to avoid personal injury or death.

- e) Remove the coupling guard. (See section 5.5.)
 f) Remove the spacer from the coupling.
 g) Remove casing fasteners [6580.1].
 h) Remove the fasteners holding the bearing housing foot to the baseplate.
 i) Move the power end, rear cover, and seal chamber assembly away from the casing.



CAUTION The power end and rear cover assembly is heavy. It is important to follow plant safety guidelines when lifting it.

- j) Transport the assembly to the maintenance shop.

6.8.2 Pump disassembly

- a) Remove coupling hub from the pump shaft [2100].



Do not apply heat to the impeller.

This could damage the liner plus if liquid is entrapped in the hub, an explosion could occur.

- b) Using the shaft key [6700], mount the impeller wrench from the Flowserve impeller tool kit (Figure 6-1) to the end of the shaft. With the wrench handle pointing to the left when viewed from the impeller end, grasp the impeller [2200] firmly with both hands (wear heavy gloves). By turning the impeller in the clockwise direction move the wrench handle to the 11 o'clock position and then spin the impeller quickly in a counter-clockwise direction so that the wrench makes a sudden impact with a hard surface on the bench. After several sharp raps, the impeller should be free. Unscrew the impeller and remove from the shaft. Discard the impeller O-ring [4610.8].

- c) If a cartridge type mechanical seal [4200] is used, the spacing clips or tabs should be installed prior to loosening the set screws which attaches the seal to the shaft or removing it from the cover. This will ensure that the proper seal compression is maintained.



CAUTION Three sleeve designs are utilized on the PolyChem S-series pump. The style of sleeve depends on the pump model/impeller.

Pump	Impeller	ANSI		
		1	2	3
1.5X1-6	Closed	X		
	Open		X	X
1.5X1-8	Closed	X		
	Open		X	X
3X1.5-6	Closed	X		
	Open		X	X
3X2-6	Closed	X		
	Open		X	X
2X1-10	Closed	X		
	Open		X	X
3X2-10	Closed	X		
	Open		X	X
3X2-10HD	Closed	X		
	Open		X	X
4X3-10	Closed	X		
	Open		X	X
4X3-10HD	Closed	X		
	Open		X	X
3X2-13	Open	X		
3X2-13HD	Open	X		
4X3-13	Open	X		
4X3-13HD	Open	X		
6X4-13HD	Open	X		

Pump	Impeller	ISO		
		1	2	3
PS32-160	Closed	X		
PS65-160	Closed	X		
PS40-200	Closed	X		
PS32-250	Closed	X		
PS50-250	Closed	X		
PS65-250	Closed	X		
PS50-315	Open	X		
PS65-315	Open	X		
PS100-315	Open	X		

Design 1 standard is silicon carbide although metallic versions of the sleeve are available. Depending on the seal design, if set screws are utilized to attach the rotary unit and they fall onto the sleeve you must replace the standard sleeve (silicon carbide) with a metal sleeve or convert to a solid shaft.

Design 2 standard is a metallic hook sleeve.

Design 3 standard is a carbon filled fluoropolymer sleeve. Depending on the seal design, if set screws are utilized to attach the rotary unit and they fall onto the sleeve, damage may occur. You may wish to convert to Design 2.

Sleeve design 1 and 2

- d) Remove the seal gland nuts [6580.2] if so equipped.
- e) Remove the two cap screws [6570.2] which attach the rear cover [1220] to the adapter. Carefully remove this part.
- f) If a component type inside mechanical seal [4200] is used, loosen the set screws on the rotating unit and remove it from the shaft. Then pull the gland [4120] and the stationary seat off the shaft. Remove the stationary seat from the gland.
- g) If a component type outside mechanical seal is used, remove the gland [4120] and the stationary seat. Remove the stationary seat from the gland. Loosen the set screws in the rotating unit and remove it from the shaft.
- h) Discard all O-rings and gaskets.
- i) If the pump has a sleeve [2400] it can now be removed. The unit now appears as shown in Figure 6-7. Proceed to step j).

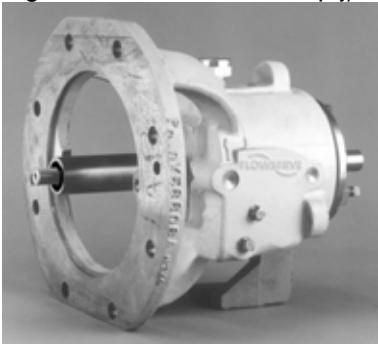


Figure 6-7

Sleeve design 3

- d) Remove the sleeve [2400]. The use of a gear puller may be necessary since the sleeve is mounted on tolerance rings. (See Figure 6-8.) Discard tolerance rings.



Figure 6-8

- e) Remove the two cap screws [6570.2] which attach the rear cover [1220] to the adapter. Carefully remove this part.

- f) Remove the seal gland nuts [6580.2]. Proceed to step j).
- j) If the power end is oil lubricated, remove the drain plug [6569.1] and drain the oil from the bearing housing [3200].
- k) If the pump has lip seals, a deflector [2540] will be present. Remove it.
- l) Loosen the three set screws [6570.3] on the bearing carrier [3240]. The bearing carrier must be completely unscrewed from the bearing housing.

Note:

Do not pry against the shaft.

ISO Group A and ANSI pumps:

The face of the bearing carrier has three square lugs that protrude from the surface. The bearing carrier is turned by using an open end wrench on one of the square lugs as shown in Figure 6-9.

ISO Group B and C pumps:

The bearing carrier is turned by using a strap wrench, with the strap located around the outside diameter of the carrier face.

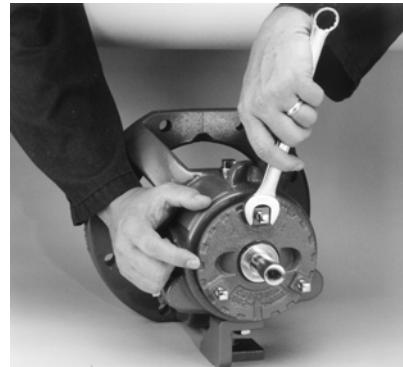


Figure 6-9

- m) Because the O-rings [4610.2] will cause some resistance in removing the bearing carrier assembly from the housing, hold the bearing carrier flange firmly and with slight rotation, pull it out of the bearing housing. The bearing carrier assembly with the shaft and bearings should come free. This unit will appear as shown in Figure 6-10. Further disassembly is not required unless the bearings are to be replaced.



Figure 6-10

- n) Remove the snap ring [2530]. (See Figure 6-11.)



Figure 6-11

Note:

- ISO Group A and the ANSI pump models when equipped with duplex angular contact bearings use a bearing retainer [2530.1] instead of a snap ring. Remove the carrier from the bearing.
- o)** The bearing locknut [3712] and lock washer [6541.1] may now be removed from the shaft [2100]. Discard the lock washer.
 - p)** An arbor or hydraulic press may be used to remove the bearings [3011 and 3013] from the shaft. It is extremely important to apply even pressure to the inner bearing race only. Never apply pressure to the outer race as this exerts excess load on the balls and causes damage.
- CAUTION** Applying pressure to the outer race could permanently damage the bearings.
- q)** The ISO Group A and the ANSI pump models has an optional oil slinger [2541] located between the bearings. If present, inspect it for damage or looseness. Remove if it needs to be replaced.
 - r)** On ISO Group B and C pumps and ANSI Group 2 pumps, the bearing housing [3200] must be separated from the bearing housing adapter [1340]. The adapter O-ring [4610.2] should be discarded. This is accomplished by removing the cap screws [6570.5], which thread into the bearing housing.
 - s)** If lip seals [4310.1] and [4310.2] are used, they should be removed from the bearing carrier and adapter and discarded.
 - t)** If the bearing isolators are removed from either the bearing carrier or adapter they must not be reused, discard appropriately.
 - u)** If magnetic seals are used, maintain the seals as specified by the manufacturer.
 - v)** Mark 3A design: Remove the Trico oiler/sight gauge [3855] and oil level tag (Figure 6-12) from the bearing housing.
ANSI 3A design: Remove the sight gauge [3856] and oil level tag (Figure 6-12) from the bearing housing.
- Note:** Save these parts for reuse.



Figure 6-12

6.9 Examination of parts

6.9.1 Cleaning/inspection

All parts should be thoroughly cleaned and inspected. New bearings, O-rings, gaskets, and lip seals should be used. Any parts that show wear or corrosion should be replaced with new genuine Flowserve parts.

**CAUTION**

It is important that only non-flammable, non-contaminated cleaning fluids are used. These fluids must comply with plant safety and environmental guidelines.

6.9.2 Critical measurements and tolerances

To maximize reliability of pumps, it is important that certain parameters and dimensions are measured and maintained within specified tolerances. It is important that all parts be checked. Any parts that do not conform to the specifications should be replaced with new Flowserve parts.

6.9.3 Parameters that should be checked by users

Flowserve recommends that the user check the measurements and tolerances in Figure 6-13 whenever pump maintenance is performed. Each of these measurements is described in more detail on the following pages.

6.9.4 Additional parameters checked by Flowserve

The parameters listed below are somewhat more difficult to measure and/or may require specialized equipment. For this reason, they are not typically checked by our customers, although they are monitored by Flowserve during the manufacturing and/or design process.

6.9.4.1 Shaft and sleeve (if fitted)

Replace the sleeve if grooved, pitted or worn. Prior to mounting bearings or installing the shaft into the bearing housing, check the following parameters.

Diameter/tolerance, under bearings:

In order to ensure proper fit between the shaft and bearings, verify that both the inboard (IB) and outboard (OB) shaft diameter is consistently within the minimum/maximum values shown in Figure 6-14. A micrometer should be used to check these outside diameter (OD) dimensions on the shaft.

Figure 6-13

Topic	ASME B73.1 standard mm (in.)	Suggested by major seal vendors mm (in.)	Suggested and/or provided by Flowserve mm (in.)
Shaft Diameter tolerance, under bearings	n/s		0.005 (0.0002)
Impeller Balance		See note 1	
Bearing housing Diameter (ID) tolerance at bearings	n/s		0.013 (0.0005)
Power end assembly Shaft runout Shaft sleeve runout Radial deflection - static Shaft endplay	0.05 (0.002) 0.05 (0.002) n/s n/s	0.03 (0.001) 0.05 (0.002) 0.076 (0.003) 0.05 (0.002)	0.05 (0.002) 0.05 (0.002) 0.05 (0.002)
Seal chamber Face squareness to shaft Register concentricity	0.08 (0.003)	0.03 (0.001) 0.13 (0.005)	0.08 (0.003) 0.13 (0.005)
Complete pump Shaft movement caused by pipe strain Alignment Vibration at bearing housing	n/s n/s See note 3	0.05 (0.002)	0.05 (0.002) See note 2 See note 3

n/s = not specified.

1. The maximum values of acceptable unbalance are:
1 500 r/min: 40 g·mm/kg (1 800 r/min: 0.021 oz-in./lb) of mass.
2 900 r/min: 20 g·mm/kg (3 600 r/min: 0.011 oz-in./lb) of mass.
Flowserve performs a single plane spin balance on most impellers. Balancing is performed to the ISO 1940 Grade 6.3 tolerance criteria.
2. ASME B73.1 does not specify a recommended level of alignment. Flowserve recommends that the motor be aligned to the pump within 0.05 mm (0.002 in.) parallel Full Indicator Movement (FIM) and 0.0005 mm/mm (0.0005 in./in.) angular FIM. Closer alignment will extend MTBPM. For detail discussion of this subject see Section 5, *Installation*, of this manual.
3. See ASME B73.1, paragraph 5.1.4.

6.9.4.2 Bearings

It is recommended that bearings not be re-used after removal from the shaft. Prior to mounting bearings, check the following parameters.

Diameter/tolerance, inside diameter:

In order to ensure proper fit between bearings and the shaft, verify that the inside diameter (ID) of both the IB and OB bearing are consistently within the minimum/maximum values shown in Figure 6-14. An inside caliper should be used to check these ID diameters on the bearings.

Diameter/tolerance, outside diameter:

In order to ensure proper fit between bearings and the bearing housing, verify that the OD on both the IB and OB bearings are consistently within the minimum/maximum values shown in Figure 6-15. A micrometer should be used to check these OD dimensions on the bearings.

Figure 6-14a: ISO pumps

		Group A	Group B	Group C
OB bearing/ shaft mm (in)	Bearing	30.000/29.990 (1.1811/1.1807)	45.000/44.988 (1.7717/1.7712)	55.000/54.985 (2.1654/2.1648)
	Shaft	30.013/30.002 (1.1816/1.1812)	45.014/45.004 (1.7722/1.7718)	55.016/55.004 (2.1660/2.1655)
	Fit	0.023T/0.002T (0.0009T/0.0001T)	0.026T/0.004T (0.0010T/0.0001T)	0.031T/0.004T (0.0012T/0.0001T)
IB bearing/ shaft mm (in)	Bearing	35.000/34.988 (1.3780/1.3775)	45.000/44.988 (1.7717/1.7712)	55.000/54.985 (2.1654/2.1648)
	Shaft	35.014/35.004 (1.3785/1.3781)	45.014/45.004 (1.7722/1.7718)	55.016/55.004 (2.1660/2.1655)
	Fit	0.025T/0.004T (0.0010T/0.0001T)	0.026T/0.004T (0.0010T/0.0001T)	0.030T/0.004T (0.0012T/0.0001T)

Figure 6-14b: ANSI pumps

		Group 1	Group 2	Group 2 HD
OB bearing/ shaft mm (in)	Bearing	30.000/29.990 (1.1811/1.1807)	50.000/49.988 (1.9685/1.9680)	50.000/49.988 (1.9685/1.9680)
	Shaft	30.013/30.002 (1.1816/1.1812)	50.013/50.002 (1.9690/1.9686)	50.013/50.002 (1.9690/1.9686)
	Fit	0.023T/0.002T (0.0009T/0.0001T)	0.025T/0.003T (0.0010T/0.0001T)	0.025T/0.002T (0.0010T/0.0001T)
IB bearing/ shaft mm (in)	Bearing	35.000/34.988 (1.3780/1.3775)	50.000/49.988 (1.9685/1.9680)	60.000/59.985 (2.3622/2.3616)
	Shaft	35.014/35.004 (1.3785/1.3781)	50.013/50.002 (1.9690/1.9686)	60.015/60.002 (2.3628/2.3623)
	Fit	0.026T/0.004T (0.0010T/0.0001T)	0.025T/0.002T (0.0010T/0.0001T)	0.030T/0.002T (0.0012T/0.0001T)

Figure 6-15a: ISO pumps

		Group A	Group B	Group C
OB bearing/ carrier mm (in)	Bearing	72.000/71.987 (2.8346/2.8341)	100.000/99.985 (3.9370/3.9364)	120.000/119.985 (4.7244/4.7238)
	Carrier	72.017/71.999 (2.8353/2.8346)	100.023/100.002 (3.9379/3.9371)	120.023/120.002 (4.7253/4.7245)
	Fit	0.030L/0.000L (0.0012L/0.0000L)	0.038L/0.002L (0.0015L/0.0001L)	0.028L/0.002L (0.0015L/0.0001L)
IB bearing/ housing mm (in)	Bearing	72.000/71.987 (2.8346/2.8341)	100.000/99.985 (3.9370/3.9364)	120.000/119.985 (4.7244/4.7238)
	Housing	72.017/71.999 (2.8353/2.8346)	100.018/100.002 (3.9377/3.9371)	120.018/120.002 (4.7251/4.7245)
	Fit	0.030L/0.000L (0.0012L/0.0000L)	0.033L/0.002L (0.0013L/0.0001L)	0.033L/0.002L (0.0013L/0.0001L)

Figure 6-15b: ANSI pumps

		Group 1	Group 2	Group 2 HD
OB bearing/ carrier mm (in)	Bearing	72.000/71.987 (2.8346/2.8341)	110.000/109.985 (4.3307/4.3301)	110.000/109.985 (4.3307/4.3301)
	Carrier	72.017/71.999 (2.8353/2.8346)	110.023/110.007 (4.3316/4.3310)	110.023/110.007 (4.3316/4.3310)
	Fit	0.030L/0.000L (0.0012L/0.0000L)	0.038L/0.007L (0.0015L/0.0003L)	0.038L/0.007L (0.0015L/0.0003L)
IB bearing/ housing mm (in)	Bearing	72.000/71.986 (2.8346/2.8341)	110.000/109.985 (4.3307/4.3301)	110.000/109.985 (4.3307/4.3301)
	Housing	72.017/71.999 (2.8353/2.8346)	110.023/110.007 (4.3316/4.3310)	110.023/110.007 (4.3316/4.3310)
	Fit	0.031L/0.000L (0.0012L/0.0000L)	0.038L/0.007L (0.0015L/0.0003L)	0.038L/0.007L (0.0015L/0.0003L)

6.9.4.3 Impeller balancing

Shaft whip is deflection where the centerline of the impeller is moving around the true axis of the pump. It is not caused by hydraulic force but rather by an imbalance with the rotating element. Shaft whip is very hard on the mechanical seal because the faces must flex with each revolution in order to maintain contact. To minimize shaft whip it is imperative that the impeller is balanced. All open impellers manufactured by Flowserve are balanced after they are trimmed. If for any reason a customer trims an impeller, it must be re-balanced. See note 1 under Figure 6-13 regarding acceptance criteria.

6.9.4.4 Bearing housing/carrier

Prior to installing the shaft into the bearing housing, check the following parameters.

Diameter/tolerance, at bearing surface

In order to ensure proper fit between the bearing housing/carrier and the bearings, verify that the ID of both the IB and OB bearing surfaces are consistently within the minimum/maximum values shown in Figure 6-15. An inside caliper should be used to check these ID dimensions in the bearing housing.

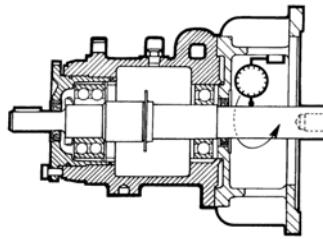
6.9.4.5 Power end

Assembled bearing housing, carrier, bearings, and shaft.

Shaft/shaft sleeve run-out

Shaft run-out is the amount the shaft is "out of true" when rotated in the pump. It is measured by attaching a dial indicator to a stationary part of the pump so that its contact point indicates the radial movement of the shaft surface as the shaft is rotated slowly. If a shaft sleeve is used then shaft sleeve run-out must be checked. It is analogous to shaft run-out. Measurement of shaft run-out/shaft sleeve run-out will disclose any out of roundness of the shaft, any eccentricity between the shaft and the sleeve, any permanent bend in the shaft, and/or any eccentricity in the way the shaft or bearings are mounted in the bearing housing.

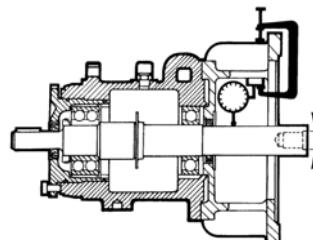
Shaft run-out can shorten the life of the bearings and the mechanical seal. The following diagram shows how to measure shaft/shaft sleeve run-out. Note that both ends need to be checked. The run-out should be 0.025 mm (0.001 in.) FIM or less.



Runout

Radial deflection - static

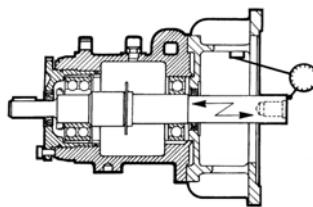
Radial movement of the shaft can be caused by a loose fit between the shaft and the bearing and/or the bearing and the housing. This movement is measured by attempting to displace the shaft vertically by applying an upward force of approximately 4.5 kg (10 lb) to the impeller end of the shaft. While applying this force, the movement of an indicator is observed as shown in the following diagram. The movement should be checked at a point as near as possible to the location of the seal faces. A movement of more than 0.05 mm (0.002 in.) is not acceptable.



Deflection

Shaft endplay

The maximum amount of axial shaft movement, or endplay, on a Durco pump should be 0.03 mm (0.001 in.) and is measured as shown below. Observe indicator movement while tapping the shaft from each end in turn with a soft mallet. Shaft endplay can cause several problems. It can cause fretting or wear at the point of contact between the shaft and the secondary sealing element. It can also cause seal overloading or underloading and possibly chipping of the seal faces. It can also cause the faces to separate if significant axial vibration occurs.



Endplay

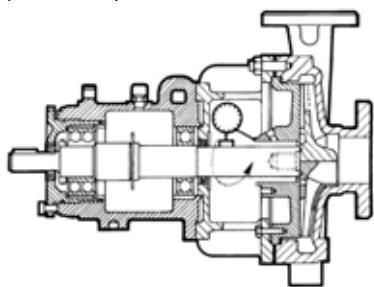
6.9.4.6 Seal chamber

Assembled power end and rear cover.

Face squareness to shaft

Also referred to as "Seal chamber face run-out." This run-out occurs when the seal chamber face is not perpendicular to the shaft axis.

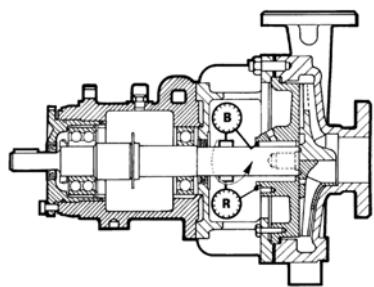
This will cause the gland to cock, which causes the stationary seat to be cocked, which causes the seal to wobble. This run-out should be less than 0.08 mm (0.003 in.) and should be measured as shown below:



Face squareness

Register concentricity

An eccentric seal chamber bore or gland register can interfere with the piloting and centering of the seal components and alter the hydraulic loading of the seal faces, resulting in reduction of seal life and performance. The seal chamber register concentricity should be less than 0.13 mm (0.005 in.). The diagram below shows how to measure this concentricity.



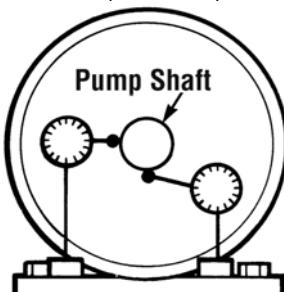
Concentricity

6.9.4.7 Installed pump

Complete pump installed.

Shaft movement caused by pipe strain

Pipe strain is any force put on the pump casing by the piping. Pipe strain should be measured as shown below. Install the indicators as shown before attaching the piping to the pump. The suction and discharge flanges should now be bolted to the piping separately while continuously observing the indicators. Indicator movement should not exceed 0.05 mm (0.002 in.).



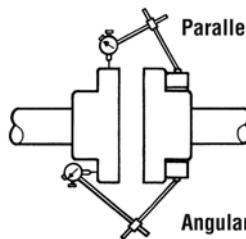
Pipe strain movement

Alignment

Misalignment of the pump and motor shafts can cause the following problems:

- Failure of the mechanical seal
- Failure of the motor and/or pump bearings
- Failure of the coupling
- Excessive vibration/noise

The schematics below show the technique for a typical rim and face alignment using a dial indicator. It is important that this alignment be done after the flanges are loaded, and at typical operating temperatures. If proper alignment cannot be maintained a C-flange motor adapter and/or stilt/spring mounting should be considered.



Alignment

Many companies today are using laser alignment which is a more sophisticated and accurate technique. With this method a laser and sensor measure misalignment. This is fed to a computer with a graphic display that shows the required adjustment for each of the motor feet.

See section 4.8 for recommended final shaft alignment limits.

Vibration analysis

Vibration analysis is a type of condition monitoring where a pump's vibration "signature" is monitored on a regular, periodic basis. The primary goal of vibration analysis is extension on MTBPM. By using this tool Flowserve can often determine not only the existence of a problem before it becomes serious, but also the root cause and possible solution.

Modern vibration analysis equipment not only detects if a vibration problem exists, but can also suggest the cause of the problem. On a centrifugal pump, these causes can include the following: unbalance, misalignment, defective bearings, resonance, hydraulic forces, cavitation and recirculation. Once identified, the problem can be corrected, leading to increased MTBPM for the pump.

Flowserve does not make vibration analysis equipment, however Flowserve strongly urges customers to work with an equipment supplier or consultant to establish an on-going vibration analysis program. See note 3 under Figure 6-13 regarding acceptance criteria.

6.10 Assembly of pump and seal

CAUTION

It is important that all pipe threads be sealed properly. PTFE tape provides a very reliable seal over a wide range of fluids, but it has a serious shortcoming if not installed properly. If, during application to the threads, the tape is wrapped over the end of the male thread, strings of the tape will be formed when threaded into the female fitting. These strings can then tear away and lodge in the piping system. If this occurs in the seal flush system, small orifices can become blocked effectively shutting off flow. For this reason, Flowserve does not recommend the use of PTFE tape as a thread sealant.

Flowserve has investigated and tested alternate sealants and has identified two that provide an effective seal, have the same chemical resistance as the tape, and will not plug flush systems. These are La-co Slic-Tite and Bakerseal. Both products contain finely ground PTFE particles in an oil based carrier. They are supplied in a paste form which is brushed onto the male pipe threads. Flowserve recommends using one of these paste sealants.

Full thread length engagement is required for all fasteners.

Note:

Refer to Figure 6-2 for recommended bolt torques.

6.10.1 Power end assembly

The Mark 3A design has an optional oil slinger. If the slinger was removed during disassembly, install a new slinger [2541]. (See Figure 6-16.)

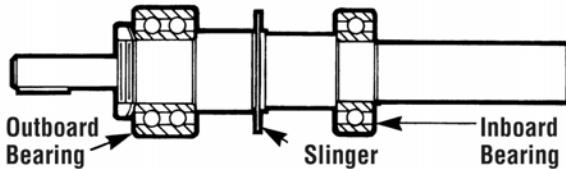


Figure 6-16

6.10.1.1 Bearing installation

Mounting of bearings on shafts must be done in a clean environment. Bearing and power end life can be drastically reduced if even very small foreign particles work their way into the bearings. Wear clean gloves.

Bearings should be removed from their protective packaging only immediately before assembly to limit exposure to possible contamination. After removing the packaging they should only come in contact with clean hands, fixtures, tools and work surfaces.

The chart shown in Figure 6-19 gives the SKF part numbers for bearings in Flowserve PolyChem pumps.

Note:

The term "inboard bearing" refers to the bearing nearest to the casing. "Outboard bearing" refers to the bearing nearest to the motor. (See Figure 6-16.)

CAUTION

Both bearings have a slight interference fit which requires that they be pressed on the shaft with an arbor or hydraulic press. Figure 6-14 identifies the bearing fits. Even force should be applied to only the inner race. Never press on the outer race, as the force will damage the balls and races.

An alternate method of installing bearings is to heat the bearings to 93 °C (200 °F) by means of an oven or induction heater. With this approach the bearing must be quickly positioned on the shaft.

Never heat the bearings above 110 °C (230 °F). To do so will likely cause the bearing fits to permanently change, leading to early failure.

- Install the inboard bearing [3011] on the shaft [2100] the bearing must be positioned against the shoulder as shown in Figure 6-16. (If the power end is equipped with single shielded regreasable bearings, see Figure 5-8 for proper orientation of the shields.)
- Install the outboard bearing retaining device onto the shaft.

Double row bearings. Place the snap ring [2530] onto the outboard end of the shaft and slide down to the inboard bearing. (Note: the proper orientation of the snap ring must be assured in this step. The flat side of the snap ring must face away from the inboard bearing.)

Duplex angular contact bearings. Place the bearing retainer [2530.1] onto the outboard end of the shaft and slide down to the inboard bearing. Note: the proper orientation of the bearing retainer must be assured in this step. The small side of the retainer must face away from the inboard bearing.

- Install the outboard bearing.

Double row bearings. Install the outboard bearing [3013] firmly against the shoulder as shown in Figure 6-16. If hot bearing mounting techniques are used, steps must be taken to ensure the outboard bearing is firmly positioned against the shaft shoulder. The outboard bearing, while still hot, is to be positioned against the shaft shoulder.

Duplex angular contact bearings. Duplex angular contact bearings must be mounted back-to-back with the wider thrust sides of the outer races in contact with each other as shown in Figure 6-17. Only bearings designed for universal mounting should be used. SKF's designation is "BECB". NTN's designation is "G". (Note: a special shaft is required when using duplex angular contact bearings.)



CAUTION It must be understood that fixtures and equipment used to press the bearing must be designed so no load is ever transmitted through the bearing balls. This would damage the bearing.

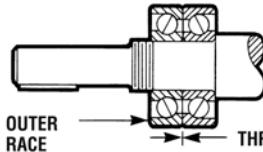


Figure 6-17

- d) After the bearing has cooled below 38 °C (100 °F) the bearing should be pressed against the shaft shoulder. Figure 6-18 identifies the approximate force needed to seat the bearing against the shaft shoulder. If a press is not available the locknut [3712] should be installed immediately after the bearing is placed on the shaft and tightened to ensure the bearing remains in contact with the shaft shoulder. The locknut should then be retightened repeatedly during the time the bearing is cooling. Once cool the locknut should be removed.

Figure 6-18

Pump	Press force N (lbf)	Locknut torque Nm (lbf·ft)
Group A/1	5 780 (1 300)	27 +4/-0 (20 +5/-0)
Group 2	11 100 (2 500)	54 +7/-0 (40 +5/-0)
Group B	9 600 (2 200)	46 +7/-0 (34 +5/-0)
Group C	12 000 (2 700)	63 +7/-0 (47 +5/-0)

- e) Install lock washer [6541.1] and locknut [3712]. The locknut should be torqued to the value shown in Figure 6-18. One tang on the lock washer must be bent into a corresponding groove on the locknut.

6.10.1.2 Bearing housing seals

Lip seals. If lip seals were used, install new lip seals in the bearing carrier [3240] and the housing [3200 - Group A and 1] or the adapter [1340 - Group B, C and 2]. The lip seals [4310.1 and 4310.2] are double lip style, the cavity between these two lips should be $\frac{1}{2}$ to $\frac{2}{3}$ filled with grease. When installing this part, the large metal face on the lip seal must face away from the bearings.

Labyrinth seals. The following are general installation instructions regarding the VBXX Inpro seal. Follow the instructions provided with the seal by the manufacturer. The elastomer O-ring located on the OD of the seal has been sized to overfill the groove in which it is located. When installing the seal into its corresponding housing, in addition to compressing the O-ring a certain amount of material may shear off. This sheared material should be removed. An arbor press should be used to install the seal. Install the inboard seal in the bore of the bearing housing (Group A and 1) or adapter (Group B, C and 2) with the single expulsion port positioned at the 6 o'clock position.

Install the outboard seal in the bore of the bearing carrier. There are no orientation issues since this is a multiport design seal.

Magnetic seals. Follow the installation instructions provided by the manufacturer.

6.10.1.3 Bearing carrier/power end assembly

- a) Install new O-rings [4610.2] onto the bearing carrier.
 - b) Slide the bearing carrier [3240] over the outboard bearing [3013].
 - c) Install the outboard bearing retaining device.
- Double row bearings on Group A, B, C, 1 and 2 pumps. Slide the snap ring [2530] in place with its flat side against the outboard bearing and snap it into its groove in the bearing carrier.
- Duplex angular contact bearings on Group A, 1 and 2 pumps. Slide the bearing retainer [2530.1] against the outboard bearing and install and tighten the socket head cap screws [6570.12]. (See Figure 6-2 for correct torque values.)



CAUTION Never compress the snap ring unless it is positioned around the shaft and between the bearings. In this configuration, it is contained therefore if it should slip off the compression tool it is unlikely to cause serious injury.

- d) The shaft, bearings, and bearing carrier assembly (Figure 6-10) can now be installed into the bearing housing [3200]. The bearing carrier [3240] should be lubricated with oil on the O-rings and threads before installing the assembly into the bearing housing. Thread the bearing carrier into the bearing housing by turning it clockwise to engage the threads. Thread the carrier onto the housing until the carrier flange is approximately 3 mm ($\frac{1}{8}$ in.) from the housing. Install the set screws [6570.3] loosely.
- e) Reinstall any tags, plugs, site gauges and oiler. Mark 3A design. Install the following items onto the bearing housing; oil level tag (Figure 6-12) and combination Trico oiler/sight gauge [3855], vent/breather [6521] and drain plug [6569.1].
- f) ANSI 3A design. Install the following items onto the bearing housing; oil level tag (Figure 6-12) and sight gauge [3855], plug [6521] and magnetic drain plug [6521.1].
- g) On Group B, C and 2 pumps, assemble the bearing housing adapter [1340] to the bearing housing [3200]. Be sure to install a new O-ring [4610.2]. Thread the cap screws [6570.5] through the adapter and into the tapped holes in the bearing housing.
- g) If the pump has lip seals, install the deflector [2540].

Figure 6-19: Flowserve PolyChem S-series bearings

Group	Type of bearing	Inboard single row, deep groove ⁵	Outboard double row, angular contact, deep groove ^{5 & 9}	Optional outboard duplex angular contact ⁵
1/A	Oil bath/mist - open ¹	6207-C3	5306-AC3 or 3306-AC3	7306-BECBY
	Regreasable - single shielded ²	6207-ZC3	5306-AZC3 or 3306-AZC3	N/A ⁶
	Greased for life - double shielded ³	6207-2ZC3	5306-A2ZC3 or 3306-A2ZC3	N/A ⁷
	Sealed for life - double sealed ⁴	6207-2RS1C3	5306-A2RSC3 or 3306-A2RS1C3	N/A ⁷
2	Oil bath/mist - open ¹	6310-C3	5310-AC3 (AHC3) or 3310-AC3	7310-BECBY
	Regreasable - single shielded ²	6310-ZC3	5310-AZC3 or 3310-AZC3	N/A ⁶
	Greased for life - double shielded ³	6310-2ZC3	5310-A2ZC3 or 3310-A2ZC3	N/A ⁷
	Sealed for life - double sealed ⁴	6310-2RS1C3	5310-A2RSC3 or 3310-A2RS1C3	N/A ⁷
2"HD"	Oil bath/mist - open ¹	6212-C3	5310-AC3 (AHC3) or 3310-AC3	7310-BECBY
	Regreasable - single shielded ²	6212-ZC3	5310-AZC3 or 3310-AZC3	N/A ⁶
	Greased for life - double shielded ³	6212-2ZC3	5310-A2ZC3 or 3310-A2ZC3	N/A ⁷
	Sealed for life - double sealed ⁴	6212-2RS1C3	5310-A2RSC3 or 3310-A2RS1C3	N/A ⁷
B	Oil bath/mist - open ¹	6309-C3	5309-AC3 (AHC3) or 3309-AC3	N/A ⁷
	Regreasable - single shielded ²	6309-ZC3	5309-AZC3 or 3309-AZC3	N/A ⁷
	Greased for life - double shielded ³	6309-2ZC3	5309-A2ZC3 or 3309-A2ZC3	N/A ⁷
	Sealed for life - double sealed ⁴	6309-2RS1C3	5309-A2RSC3 or 3309-A2RS1C3	N/A ⁷
C	Oil bath/mist - open ¹	6311-C3	5311-AC3 (AHC3) or 3311-AC3	N/A ⁷
	Regreasable - single shielded ²	6311-ZC3	5311-AZC3 or 3311-AZC3	N/A ⁷
	Greased for life - double shielded ³	6311-2ZC3	5311-A2ZC3 or 3311-A2ZC3	N/A ⁷
	Sealed for life - double sealed ⁴	6311-2RS1C3	5311-A2RSC3 or 3311-A2RS1C3	N/A ⁷

Notes:

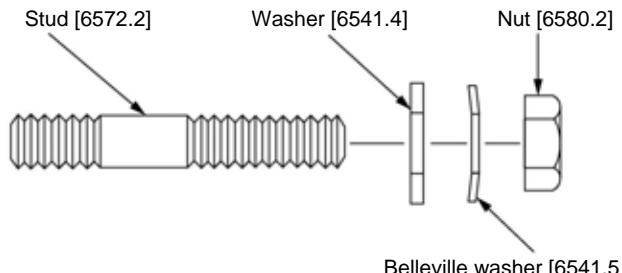
1. These bearings are open on both sides. They are lubricated by oil bath or oil mist.
2. These bearings are pre-greased by Flowserve. Replacement bearings will generally not be pre-greased, so grease must be applied by the user. They have a single shield, which is located on the side next to the grease buffer, or reservoir. The bearings draw grease from the reservoir as it is needed. The shield protects the bearing from getting too much grease, which would generate heat. The grease reservoir is initially filled with grease by Flowserve. Lubrication fittings are provided, to allow the customer to periodically replenish the grease, as recommended by the bearing and/or grease manufacturer.
3. These bearings are shielded on both sides. They come pre-greased by the bearing manufacturer. The user does not need to re grease these bearings. The shields do not actually contact the bearing race, so no heat is generated.
4. These bearings are sealed on both sides. They come pre-greased by the bearing manufacturer. The user does not need to re grease these bearings. The seals physically contact and rub against the bearing race, which generates heat. These bearings are not recommended at speeds above 1 750 rpm.
5. The codes shown are SKF codes. Inboard and outboard bearings have the C3, greater than "Normal" clearance. These clearances are recommended by SKF to maximize bearing life.
6. Regreasable - single shielded bearings are not available in the duplex configuration; however, open oil bath-type bearings can be used for the regreasable configuration. These bearings must be pre-greased during assembly. Lubrication fittings are provided, to allow the user to periodically replenish the grease, as recommended by the bearing and/or grease manufacturer.
7. Not available.
8. All bearing configurations are supplied only with steel cages.
9. SKF - the 5300 and 3300 bearing series are identical and therefore can be used interchangeably.

6.10.2 Wet end assembly



Three sleeve designs are utilized on the PolyChem S-series pump. The style of sleeve depends on the pump model/impeller. See section 6.7.2, *Pump disassembly*, for description. See Figure 6-20 for seal sizes.

To ensure proper sealing between the rear cover [1220] and the gland all PolyChem S-series pumps utilizes a combination of Belleville washers [6541.5] and flat washers [6541.4] to create a spring load. Care must be taken to ensure that the concaved side of the Belleville washer faces toward the rear cover. (Figure 6-21.)

Figure 6-21

Figure 6-20

Pump model	Seal size	
	mm	in.
Group A	35	1.378
Group B	43	1.693
Group C	53	2.087
Group 1	34.93	1.375
Group 2	47.63	1.875
Group 2 "HD"	53.98	2.125

6.10.2.1 Cartridge mechanical seals

Sleeve design 1 and 2

Review the seal assembly instructions and drawings provided by the seal manufacturer.

- a) If the pump is equipped with a sleeve [2400], slip it into place over the impeller end of the shaft [2100].
- b) Install a nose cone on the end of the shaft and then slide the cartridge seal [4200] onto the shaft until it lightly touches the bearing housing [3200] or adapter [1340].
- c) Install the rear cover plate [1220] to the bearing housing (Group A and 1) or the bearing housing adapter (Group B, C and 2) by using the cap screws [6570.2].
- d) Install the cartridge seal gland to the rear cover plate [1220] using studs [6572.2] and nuts [6580.2].
- e) Install the impeller [2200] as instructed in section 6.7.
- f) Tighten set screws on the seal to lock the rotating unit to the shaft. Finally, remove centering clips from the seal.

Sleeve design 3

Review the seal assembly instructions and drawings provided by the seal manufacturer.

- a) Loosely attach the cartridge seal gland to the rear cover plate [1220] using studs [6572.2] and nuts [6580.2].
- b) Install the rear cover plate [1220] to the bearing housing (Group 1) or the bearing housing adapter (Group 2) by using the cap screws [6570.2].
- c) Install new tolerance rings into each end of the sleeve [2400]. (See Figure 6-22.)



Figure 6-22

- d) Install sleeve assembly onto shaft [2100] utilizing the nose cone to ensure the end of the sleeve remains flush with the end of the shaft. (See Figure 23.)

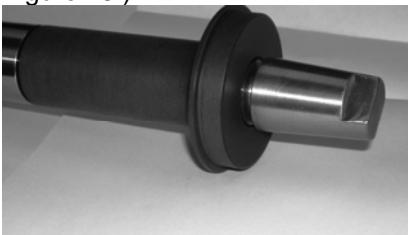


Figure 6-23

- e) Install O-ring onto flange portion of the sleeve. (See Figure 6-24.)

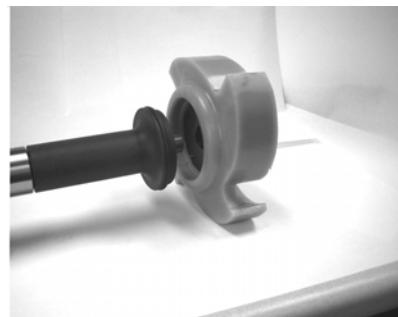


Figure 6-24

- f) Install the impeller [2200] as instructed in section 6.7.
- g) Tighten the nuts [6580.2] used to attach the gland to the cover plate [1220].
- h) Tighten set screws on the seal to lock the rotating unit to the shaft. Finally, remove centering clips from the seal.

6.10.2.2 Component type mechanical seal - sleeve design 1 and 2

Review the seal assembly instructions and drawings (seal set dimension) provided by the seal manufacturer. In order to properly set a component seal it is necessary to first locate the shaft in its final axial position. This is accomplished in the following manner:

- a) Install the rear cover plate [1220] to the bearing housing (Group A and 1) or the bearing housing adapter (Group B, C and 2) by using the cap screws [6570.2].
- b) Install and set the impeller [2200] clearance as outlined in section 6.6. Put bluing on the shaft/sleeve in the area near the face of the seal chamber [rear cover 1220]. Scribe a mark on the shaft at the face of the seal chamber. (Figure 6-25.)
- c) Remove the impeller and seal chamber (rear cover) following the instructions given in section 6.8 and install a nose cone onto the end of the shaft.

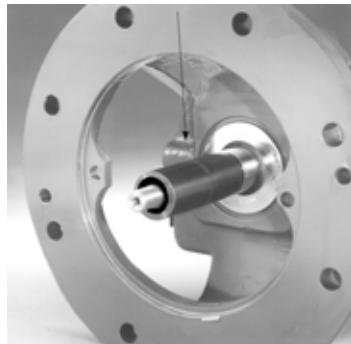


Figure 6-25

Single internal seal installation

- d) Place the gland [4120], gland gasket [4590.3], stationary seat and a second gland gasket [4590.3] onto the shaft until it lightly touches the bearing housing (Group A and 1) or adapter (Group B, C and 2).

- e) Locate the rotary seal unit onto the shaft (or sleeve) according to the set dimension provided by the seal manufacturer. Tighten set screws on the seal to lock the rotating unit to the shaft/sleeve.
- f) Install the rear cover plate [1220] to the bearing housing (Group A and 1) or the bearing housing adapter (Group B, C, and 2) by using the cap screws [6570.2].
- g) Inset the pilot diameter of the stationary seat into the seal chamber bore of the rear cover [1220].
- h) Pilot the gland onto the seat using studs [6572.2] and nuts [6580.2].

Single external seal installation

Carry out steps a) to c), above.

- d) Locate the rotary seal unit onto the shaft/sleeve according to the set dimension provided by the seal manufacturer. Tighten set screws on the seal to lock the rotating unit to the shaft/sleeve.
- e) Install the gland gasket [4590.3], stationary seat and a second gland gasket [4590.3] followed by the gland [4120] onto the rear cover plate [1220].
- f) Assemble using studs [6572.2] and nuts [6580.2].
- g) Install the rear cover plate [1220] to the bearing housing (Group A and 1) or the bearing housing adapter (Group B, C, and 2) by using the cap screws [6570.2].

Double seal installation

The PolyChem S-series pump line only has one rear cover plate [1220] design (FML) therefore a canister [1220.2] must be utilized to create a seal chamber in which the inside stationary seat can be located.

Carry out steps a) to c), above.

- d) Install the inboard stationary seat into the canister [1220.2]. (See Figure 6-26.)



Figure 6-26

- e) Place a gland gasket [4590.3] onto the canister [1220.2] and install this assembly into the rear cover plate [1220]. (See Figure 6-27.)
- f) Install the outboard stationary seat into the gland [4120] and place it onto the shaft until it lightly touches the bearing housing (Group 1) or adapter (Group 2 and 3).

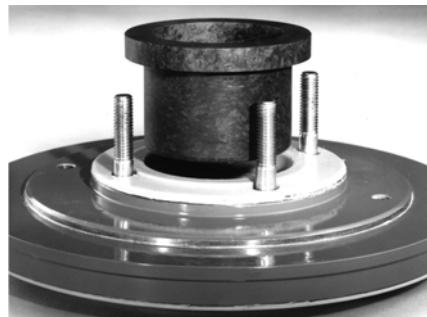


Figure 6-27

- g) Install a gland gasket [4590.3] into the gland.
- h) Locate the rotary seal unit onto the shaft/sleeve according to the set dimension provided by the seal manufacturer. Tighten set screws on the seal to lock the rotating unit to the shaft/sleeve. Install a stationary seat into the rear cover plate [1220].
- i) Install the rear cover plate [1220] to the bearing housing (Group A and 1) or the bearing housing adapter (Group B, C and 2) by using the cap screws [6570.2].
- j) Attach the gland/seat to the rear cover plate [1220] using studs [6572.2] and nuts [6580.2].

6.10.3 Impeller assembly

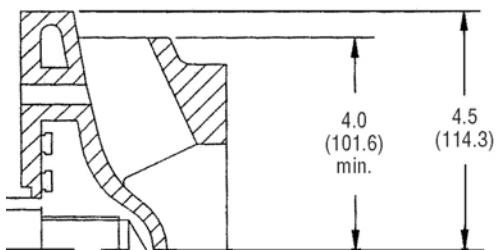
The impeller [2200] can now be installed as instructed in section 6.7. Remember that the impeller clearance is already set. It cannot be changed at this point without resetting the seal.

If a new impeller of maximum diameter has been acquired and needs trimming or if the existing impeller needs trimming this is accomplished by turning (machining). It is recommended that this trimming operation be performed by a Flowserve representative. However, if this cannot be accommodated the following guidelines should be followed.



CAUTION Closed vane impellers are fully trimable with the exception of the below noted pump model. Open vane impellers are manufactured using numerous component cores. See the chart below for minimum trim ranges.

- a) Obtain a machining arbor from a Flowserve representative or use the pump shaft.
- b) Carefully mount the arbor or shaft into a lathe. Take care to minimize the runout of the machining arbor/shaft.
- c) Install the impeller.
- d) All impellers trims are machined straight (parallel to the pump shaft).


Figure 6-28

6.10.3.1 Closed impeller vane exception

PS1.5x1-6 <114.3 mm (4.5 in.)

Trim impeller vane (Figure 6-28) below 114.3 mm (4.5 in.) with a staggered cut to avoid contacting the component core.

6.10.3.2 Open impeller vane minimum trim restriction

The minimum diameter to which an impeller can be trimmed is based on the size of the component core. The metal portion of the impeller has been etched and or stamped with a code to aid in identifying the size of the component core.

*Pump models PS1.5x1-6OP, PS3x1.5-6OP,
PS3x2-6OP, PS3x2-10OP and PS4x3-10OP*

Five digits are etched on those impellers without a stem and stamped on those impellers with a stem. The digits correspond to the impeller part number which in turn corresponds to the minimum trim to which the impeller can be machined. Figure 6-29 identifies the minimum impeller trim based on these numbers.

Figure 6-29

Pump model	Impeller code	Minimum trim	
		mm	in.
PS1.5x1-6OP	51998	152.4	6.00
	49989	139.7	5.50
	50009	127.0	5.00
	50012	114.3	4.50
	50015	101.6	4.00
PS3x1.5-6OP PS3x2-6OP	49926	152.4	6.00
	49966	139.7	5.50
	49969	127.0	5.00
PS3x2-10OP	49707	228.6	9.00
	50125	203.2	8.00
	50128	177.8	7.00
	50131	152.4	6.00
PS4x3-10OP	50204	228.6	9.00
	20207	203.2	8.00
	50210	177.8	7.00

*Pump models PS50-315, PS65-315, PS100-315,
PS3x2-13, PS4x3-13 and PS6x4-13HD*

The first five digits and letter located on the stem identifies the pump model while the next two or three digits represent the trim diameter of the component core. Figure 6-30 identifies the minimum impeller trim based on the component core size.

Figure 6-30

Impeller stem code	Minimum trim	
	mm	in.
116	304.8	12.00
106	279.4	11.00
96	254.0	10.00
86	228.6	9.00

7 FAULTS; CAUSES AND REMEDIES

The following is a guide to troubleshooting problems with Flowserve PolyChem pumps. Common problems are analyzed and solutions offered. Obviously, it is impossible to cover every possible scenario. If a problem exists that is not covered by one of the examples, then refer to one of the books listed in section 10, *Additional sources of information*, or contact a Flowserve sales engineer or distributor/representative for assistance.

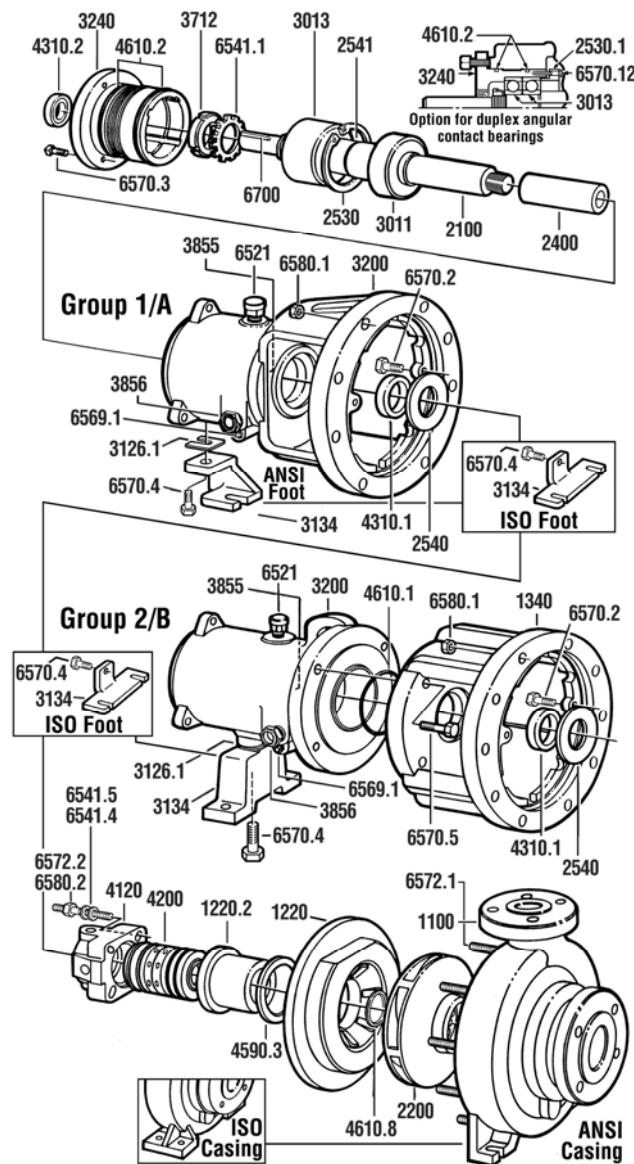
FAULT SYMPTOM

Pump not reaching design flow rate	
↓ Pump not reaching design head (TDH)	
↓ No discharge or flow with pump running	
↓ Pump operates for short period, then loses prime	
↓ Excessive noise from wet end	
↓ Excessive noise from power end	
↓	
↓	
PROBABLE CAUSES	
• •	Insufficient NPSH. (Noise may not be present.)
• • •	System head greater than anticipated.
• • •	Entrained air. Air leak from atmosphere on suction side.
• •	Entrained gas from process.
• •	Speed too low.
• • •	Direction of rotation wrong.
• •	Impeller too small.
• •	Impeller clearance too large.
• • •	Plugged impeller, suction line or casing which may be due to a product or large solids.
• •	Wet end parts (casing cover, impeller) worn, corroded or missing.
• •	Not properly primed.
• •	Impeller rubbing.
• •	Damaged pump shaft, impeller.
• •	Abnormal fluid rotation due to complex suction piping.
	Bearing contamination appearing on the raceways as scoring, pitting, scratching or rusting caused by adverse environment and entrance of abrasive contaminants from atmosphere.
POSSIBLE REMEDIES	
	Recalculate NPSH available. It must be greater than the NPSH required by pump at desired flow. If not, redesign suction piping, holding number of elbows and number of planes to a minimum to avoid adverse flow rotation as it approaches the impeller.
	Reduce system head by increasing pipe size and/or reducing number of fittings. Increase impeller diameter. (nb: Increasing impeller diameter may require use of a larger motor.)
	1. Check suction line gaskets and threads for tightness. 2. If vortex formation is observed in suction tank, install vortex breaker. 3. Check for minimum submergence
	Process generated gases may require larger pumps.
	Check motor speed against design speed.
	After confirming wrong rotation, reverse any two of three leads on a three phase motor. The pump should be disassembled and inspected before it is restarted.
	Replace with proper diameter impeller. (NOTE: Increasing impeller diameter may require use of a larger motor.)
	Reset impeller clearance.
	1. Reduce length of fiber when possible. 2. Reduce solids in the process fluid when possible. 3. Consider larger pump.
	Replace part or parts.
	Repeat priming operation, recheck instructions. If pump has run dry, disassemble and inspect the pump before operation.
	1. Check and reset impeller clearance. 2. Check outboard bearing assembly for axial end play.
	Replace damaged parts.
	Redesign suction piping, holding the number of elbows and planes to a minimum to avoid adverse fluid rotation as it approaches the impeller.
	1. Work with clean tools in clean surroundings. 2. Remove all outside dirt from housing before exposing bearings. 3. Handle with clean dry hands. 4. Treat a used bearing as carefully as a new one. 5. Use clean solvent and flushing oil. 6. Protect disassembled bearing from dirt and moisture. 7. Keep bearings wrapped in paper or clean cloth while not in use. 8. Clean inside of housing before replacing bearings. 9. Check oil seals and replace as required. 10. Check all plugs and tapped openings to make sure that they are tight.

Pump not reaching design flow rate					
↓ Pump not reaching design head (TDH)					
↓ No discharge or flow with pump running					
↓ Pump operates for short period, then loses prime					
↓ Excessive noise from wet end					
↓ Excessive noise from power end					
↓					
↓ PROBABLE CAUSES					
					Brinelling of bearing identified by indentation on the ball races, usually caused by incorrectly applied forces in assembling the bearing or by shock loading such as hitting the bearing or drive shaft with a hammer.
				●	False brinelling of bearing identified again by either axial or circumferential indentations usually caused by vibration of the balls between the races in a stationary bearing.
				●	Thrust overload on bearing identified by flaking ball path on one side of the outer race or in the case of maximum capacity bearings, may appear as a spalling of the races in the vicinity of the loading slot. (Please note: maximum capacity bearings are not recommended) These thrust failures are caused by improper mounting of the bearing or excessive thrust loads.
				●	Misalignment identified by fracture of ball retainer or a wide ball path on the inner race and a narrower cocked ball path on the outer race. Misalignment is caused by poor mounting practices or defective drive shaft. For example, bearing not square with the centerline or possibly a bent shaft due to improper handling.
				●	Bearing damaged by electric arcing identified as electro- etching of both inner and outer ring as a pitting or cratering. Electrical arcing is caused by a static electrical charge emanating from belt drives, electrical leakage or short circuiting.
				●	Bearing damage due to improper lubrication, identified by one or more of the following: 1. Abnormal bearing temperature rise. 2. A stiff cracked grease appearance. 3. A brown or bluish discoloration of the bearing races.
POSSIBLE REMEDIES					
					When mounting the bearing on the drive shaft use a proper size ring and apply the pressure against the inner ring only. Be sure when mounting a bearing to apply the mounting pressure slowly and evenly.
				●	1. Correct the source of vibration. 2. Where bearings are oil lubricated and employed in units that may be out of service for extended periods, the drive shaft should be turned over periodically to relubricate all bearing surfaces at intervals of one to three months.
				●	Follow correct mounting procedures for bearings.
				●	Handle parts carefully and follow recommended mounting procedures. Check all parts for proper fit and alignment.
				●	1. Where current shunting through the bearing cannot be corrected, a shunt in the form of a slip ring assembly should be incorporated. 2. Check all wiring, insulation and rotor windings to be sure that they are sound and all connections are properly made. 3. Where pumps are belt driven, consider the elimination of static charges by proper grounding or consider belt material that is less generative.
				●	1. Be sure the lubricant is clean. 2. Be sure proper amount of lubricant is used. The constant level oiler supplied with Flowserve pumps will maintain the proper oil level if it is installed and operating properly. In the case of greased lubricated bearings, be sure that there is space adjacent to the bearing into which it can rid itself of excessive lubricant, otherwise the bearing may overheat and fail prematurely. 3. Be sure the proper grade of lubricant is used.

8 PARTS LISTS AND DRAWINGS

8.1 PolyChem S-series



Item	Description
1100	Casing
1220	Cover
1220.2	Canister
1340	Adapter
2100	Shaft
2200	Impeller
2400	Sleeve
2530	Retainer ring, snap
2530.1	Retainer ring, ring
2540	Deflector
2541	Oil slinger
3011	Radial ball bearing, I.B.
3013	Thrust ball bearing, O.B.
3126.1	Shim, foot
3134	Support foot
3200	Bearing housing
3240	Bearing carrier
3712	Bearing lock nut
3855	Constant level oiler
3856	Sight oil gauge
4120	Gland
4200	Mechanical seal
4310.1	Lip seal, I.B.
4310.2	Lip seal, O.B.
4590.3	Gasket, Gland
4610.1	O-ring, adapter
4610.2	O-ring, carrier
4610.8	O-ring, impeller
6521	Vent plug
6541.1	Lock washer, bearing
6541.4	Lock washer, flat
6541.5	Lock washer, Belleville
6569.1	Plug, bearing housing
6570.2	Screw, cover
6570.3	Screw, carrier
6570.4	Screw, foot
6570.5	Screw, adapter
6570.12	Screw, duplex
6572.1	Stud, casing
6572.2	Stud, gland
6580.1	Nut, casing
6580.2	Nut, gland
6700	Key, shaft
	Tag - oil level

9 CERTIFICATION

Certificates, determined from the contract requirements are provided with these instructions where applicable. Examples are certificates for CE marking and ATEX marking etc. If required, copies of other certificates sent separately to the Purchaser should be obtained from Purchaser for retention with these User Instructions.

Technical specification for centrifugal pumps – Class II, ISO 5199

International Organization for Standardization

American National Standard for Centrifugal Pumps for Installation, Operation, and Maintenance (ANSI/HI 1.4)

Hydraulic Institute, 9 Sylvan Way, Parsippany, New Jersey 07054-3802.

10 OTHER RELEVANT DOCUMENTATION AND MANUALS

10.1 Supplementary User Instructions

Supplementary instructions such as for a driver, instrumentation, controller, seals, sealant systems etc are provided as separate documents in their original format. If further copies of these are required they should be obtained from the supplier for retention with these User Instructions.

Flowserve PolyChem Sales Bulletin PS-10-17.

RESP73H Application of ASME B73.1-1991, Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process, Process Industries Practices

Construction Industry Institute, The University of Texas at Austin, 3208 Red River Street, Suite 300, Austin, Texas 78705.

Pump Handbook

2nd edition, Igor J. Karassik et al, McGraw-Hill, Inc., New York, NY, 1986.

Centrifugal Pump Sourcebook

John W. Dufour and William E. Nelson, McGraw-Hill, Inc., New York, NY, 1993.

Pumping Manual, 9th edition

T.C. Dickenson, Elsevier Advanced Technology, Kidlington, United Kingdom, 1995.

10.2 Change notes

If any changes, agreed with Flowserve, are made to the product after it is supplied, a record of the details should be maintained with these User Instructions.

10.3 Additional sources of information

The following are excellent sources for additional information on Flowserve PolyChem S-series pumps, and centrifugal pumps in general.

Pump Engineering Manual

R.E. Syska, J.R. Birk,
Flowserve Corporation, Dayton, Ohio, 1980.

Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process, ASME B73.1

The American Society of Mechanical Engineers, New York, NY.

End-suction centrifugal pumps (rating 16 bar) – Designation, nominal duty point and dimensions, ISO 2858

International Organization for Standardization.

American National Standard for Centrifugal Pumps for Nomenclature, Definitions, Design and Application (ANSI/HI 1.1-1.3)

Hydraulic Institute, 9 Sylvan Way, Parsippany, New Jersey 07054-3802.



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