PRIMARY FLUSH PLANS

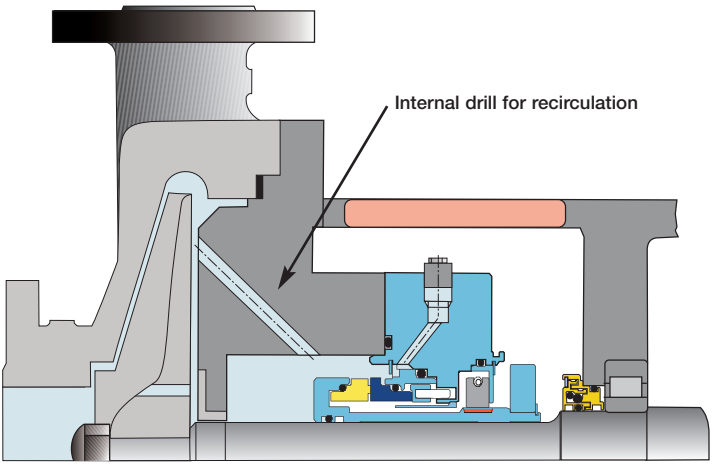
SECONDARY FLUSH PLANS

CONTAINMENT SEAL PLANS

GAS SEAL PLANS

PRIMARY FLUSH PLANS

API PLAN 01



API PLAN **01**

Description

Integrated (internal) product recirculation from pump discharge to seal chamber.

Features

1. Minimizes risk of freezing/polymerizing of fluid in flush piping plans exposed to atmosphere.
2. Removes heat from the seal chamber as well as acting as a vent connection in horizontal pumps.

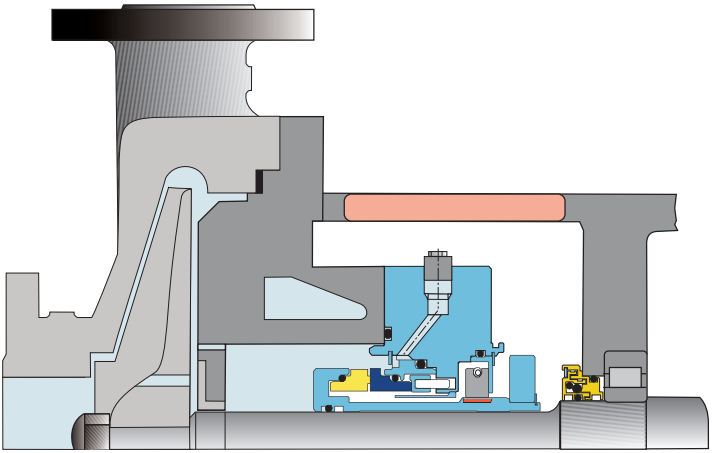
Use

1. Recommended in clean fluids.
2. Recommended for fluids which thicken at ambient temperature.

Caution

1. Ensure that the recirculation is sufficient for seal heat removal.

API PLAN 02



API PLAN **02**

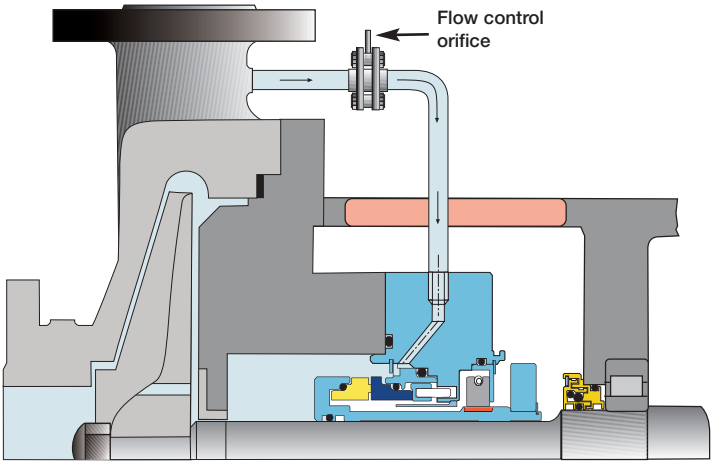
Description
Dead ended seal chamber with no flush fluid circulation.

Features
1. Applicable to low seal chamber pressure and process temperature.
2. Can be used with tapered seal chambers, especially for slurries.
3. Normally is used along with a jacketed seal chamber.

Use
1. in cool clean fluids with high specific heat, such as water, in relatively low speed pumps.

Caution
1. To avoid flashing, process fluid temperature must be taken into consideration.
2. Avoid use without cooling / heating jacket (for cylindrical chambers).
3. Ensure top point vent in throat bush (for cylindrical chambers in horizontal pumps).

API PLAN 11



API PLAN **11**

Description

Product recirculation from pump discharge to seal through a flow control orifice.

Features

1. Prevents product from vaporizing by maintaining positive pressure above vapor pressure.
2. Becomes a self-venting plan for horizontal pumps.
3. Default API plan for most single seals.

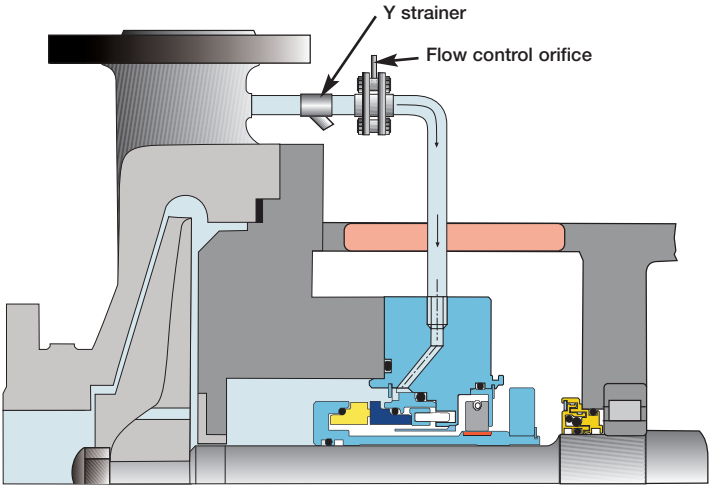
Use

1. In general, applications with clean non-polymerizing fluids with moderate temperatures.

Caution

1. Calculation of recirculation flow rate, heat removal and orifice size are required.
2. Orifice size should be at least 1/8" (3.2mm).
3. Check the margin between discharge pressure & seal chamber pressure to ensure proper flow of fluid.
4. Do not use with media containing solids & abrasives.

API PLAN 12



API PLAN 12

Description

Product recirculation from pump discharge through a Y strainer and a flow control orifice to seal chamber.

Features

1. Becomes a self-venting plan for horizontal pumps.
2. Can handle dirty liquids to some extent.

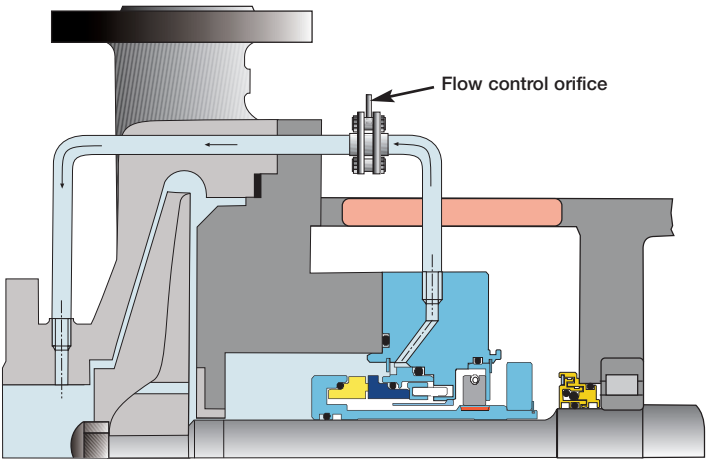
Use

1. In general used in slightly dirty and non-polymerizing fluids.

Caution

1. Always ensure that orifice is placed after the Y strainer.
2. This plan is normally discouraged due to non-reliability of Y strainer.
3. Calculation of recirculation.

API PLAN 13



API PLAN 13

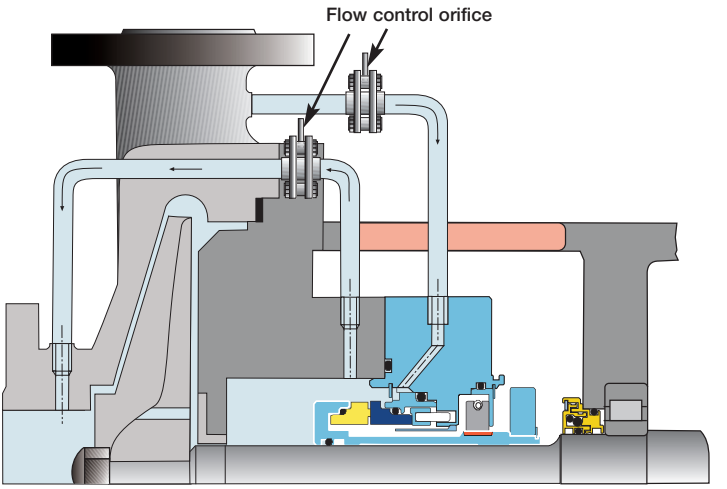
Description
Product recirculation from seal chamber to pump suction via a flow control orifice.

Features
1. Provides continuous vent for vertical pumps.

Use
1. Wherever Plan 11 is not usable due to low-pressure margin between discharge & seal chamber pressure.
2. Used in vertical pumps.

Caution
1. Check margin between seal chamber pressure & suction pressure.
2. Orifice size should be at least 1/8”(3.2mm).

API PLAN 14



Description

Product recirculation from pump discharge to seal chamber through a flow control orifice and seal chamber back to suction through another flow control orifice.

Features

1. Ensures product recirculation as well as venting.
2. Reduces seal chamber pressure.

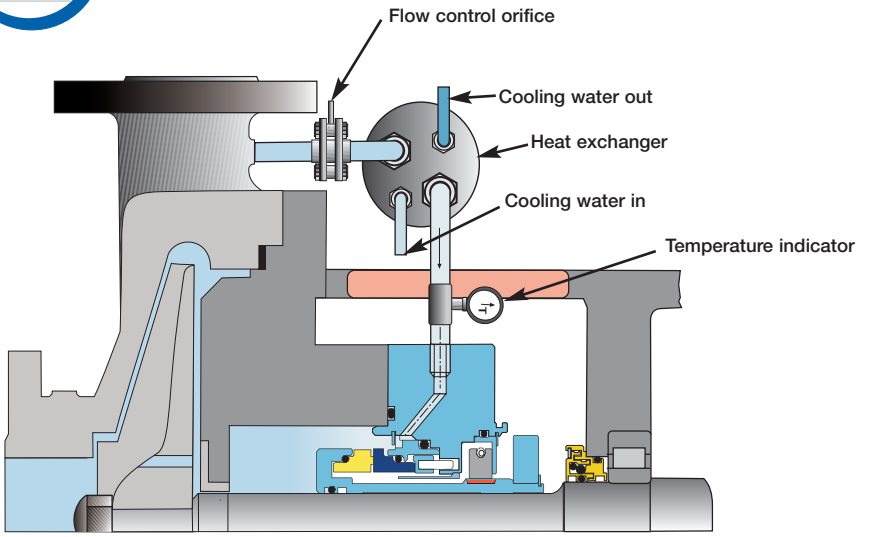
Use

1. Used in vertical pumps.
2. Used in light hydrocarbon services.

Caution

1. Check for pressure margin between discharge to seal chamber pressure and seal chamber to suction pressure.

API PLAN 21


Flow control orifice
Cooling water out
Heat exchanger
Cooling water in
Temperature indicator

API PLAN **21**

Description

Product recirculation from discharge through flow control orifice and heat exchanger to seal chamber.

Features

1. Improves pressure margin over vapor pressure.
2. Improves temperature margin to meet secondary sealing element limits, to reduce coking or polymerizing & to improve lubricity.
3. Self venting plan.
4. Provides sufficient pressure difference to allow proper flow rate.

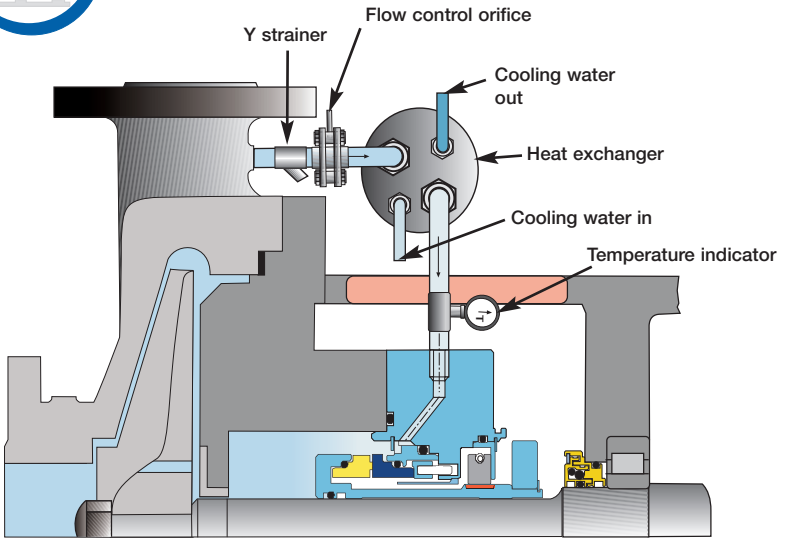
Use

1. For high temperature applications e.g. hot water application (temperature > 80°c), hot hydrocarbons etc.
2. In hot non-polymerizing fluids.

Caution

1. Always ensure that cooler is placed after the orifice.
2. Check pressure difference between discharge and seal chamber.
3. Cooler duty is high leading to fouling on waterside.
4. Potential plugging on process side if fluid viscosity gets high quickly.

API PLAN 22


Y strainer
Flow control orifice
Cooling water out
Heat exchanger
Cooling water in
Temperature indicator

API PLAN **22**

Description

Product recirculation from pump discharge through a Y strainer, a flow control orifice and a heat exchanger to seal chamber.

Features

1. Improves pressure margin over vapor pressure.
2. Improves temperature margin to meet secondary sealing element limits, to reduce coking or polymerizing & to improve lubricity.
3. Self venting plan.
4. Provides sufficient pressure difference to allow proper flow rate.

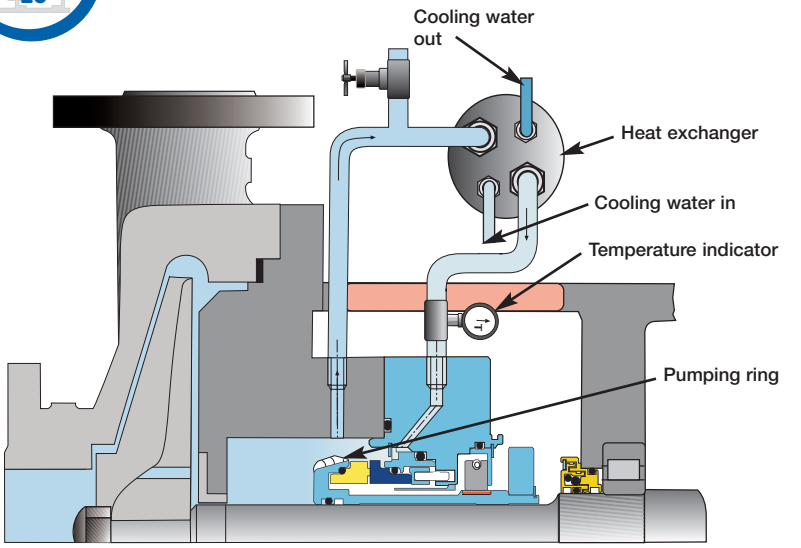
Use

1. For high temperature applications with slightly dirty liquid.

Caution

1. Always ensure that cooler is placed after the orifice.
2. Check pressure difference between discharge and seal chamber.
3. Cooler duty is high leading to fouling on waterside.
4. This plan is normally discouraged due to non-reliability of Y strainer.

API PLAN 23


Cooling water out
Heat exchanger
Cooling water in
Temperature indicator
Pumping ring

Description

Product recirculation from seal chamber to heat exchanger and back to seal chamber.

Features

1. Circulation is maintained by pumping ring.
2. In idle condition heat transfer is maintained by thermosyphon effect and in running condition by a pumping ring.
3. Lower product stabilization temperature is achieved.
4. Establishes required margin between fluid vapor pressure and seal chamber pressure.

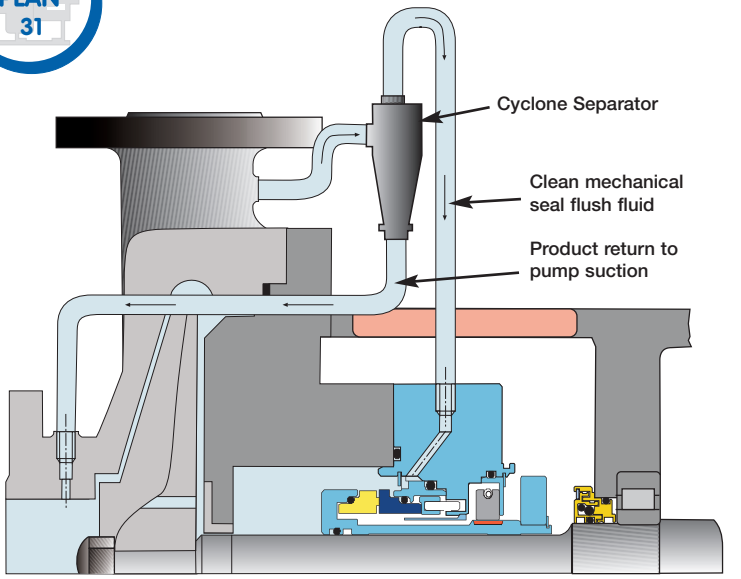
Use

1. In hot and clean services e.g. in boiler feed water and hot hydrocarbon services.

Caution

1. Maintain maximum 0.5m horizontal distance from seal chamber to heat exchanger.
2. Vent valve required at highest point of piping system.
3. Ensure that pump has a close clearance throat bush.
4. Ensure that the seal outlet connection is in the top half of the gland.
5. Ensure that the cooler is mounted above the pump centre line.
6. Vent the system fully before start up.

API PLAN 31


Cyclone Separator
Clean mechanical seal flush fluid
Product return to pump suction

API PLAN **31**

Description

Product recirculation from discharge through a cyclone separator, which directs clean fluid to the seal and solids back to pump suction.

Features

1. Removes entrained solids from the mother liquor.
2. Particles from cyclone separator are returned to suction.

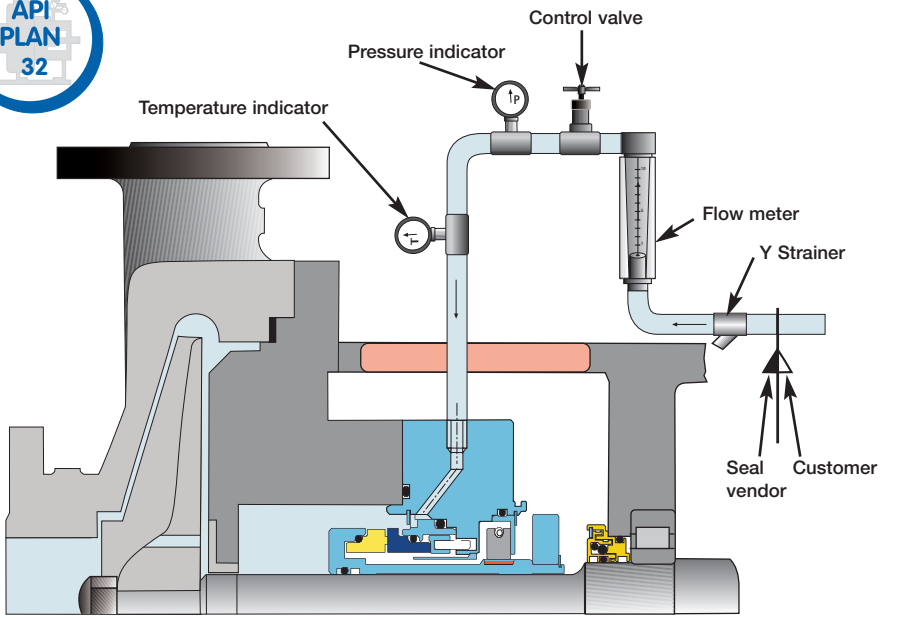
Use

1. Used in media with suspended solids.

Caution

1. Pump throat bushing is recommended.
2. Ensure use for services containing solids with specific gravity twice or more than that of process fluid.

API PLAN 32


Control valve
Pressure indicator
Temperature indicator
Flow meter
Y Strainer
Seal vendor
Customer

API PLAN **32**

Description

Injection of clean or cool liquid from external source into the seal chamber.

Features

1. Reduces flashing or air intrusion across seal faces by providing a positive flush.
2. Maintains vapor pressure margin.
3. Always provided at a pressure greater than seal chamber pressure.
4. If maintained properly the best of all single seal plans (subject to acceptance of contamination).

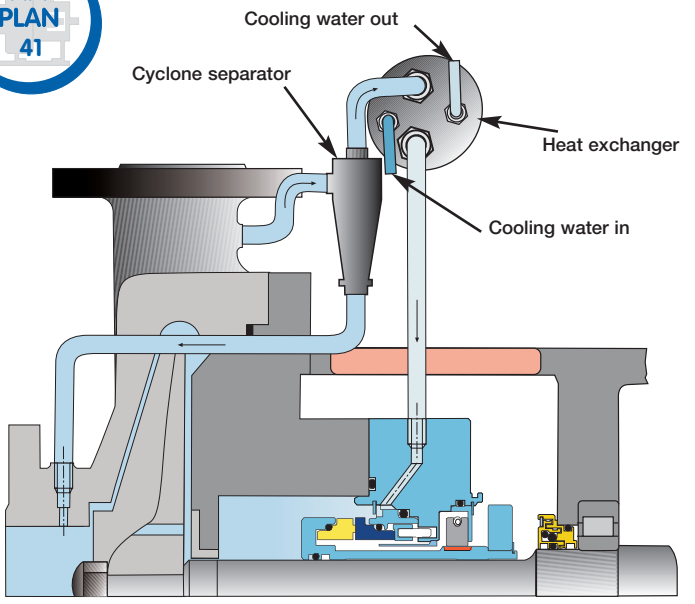
Use

1. Dirty or contaminated fluids.
2. High temperature applications.
3. Polymerising and oxidising fluids.
4. Media with poor lubrication properties.

Caution

1. External source should be continuous and reliable at all times, even during start up & shut down.
2. Flush fluid must be compatible with process fluid due to product contamination.
3. Product degradation can occur.
4. Ensure use with close clearance throat bushing to maintain pressure in stuffing box & control the rate of contamination of pumped media.
5. Careful selection of flush fluid required to ensure that it does not vaporise on entering the seal chamber.

API PLAN 41


Cooling water out
Cyclone separator
Heat exchanger
Cooling water in

API PLAN **41**

Description

Product recirculation from discharge through a cyclone separator and a heat exchanger to seal chamber.

Features

1. Improves pressure margin to vapor pressure.
2. Improves temperature margin to meet secondary sealing element limits, to reduce coking or polymerising & to improve lubricity.
3. Removes entrained solids from the mother liquor
4. Particles from cyclone separator are returned to suction.

Use

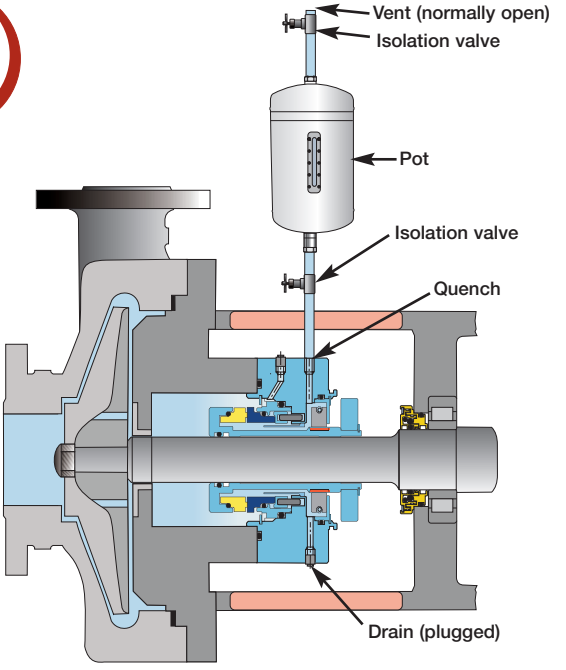
1. In hot services containing suspended solids.

Caution

1. Pump throat bushing is recommended.
2. Ensure use for services containing solids with specific gravity twice or more than that of process fluid.
3. Cooler duty is high leading to fouling on waterside.

SECONDARY FLUSH PLANS

API PLAN 51


Vent (normally open)
Isolation valve
Pot
Isolation valve
Quench
Drain (plugged)

API PLAN **51**

Description

External reservoir providing a dead-ended blanket for fluid to the quench connection of the gland.

Features

1. No direct process leakage to atmosphere.
2. No need to maintain pressure system as in plan 53A.

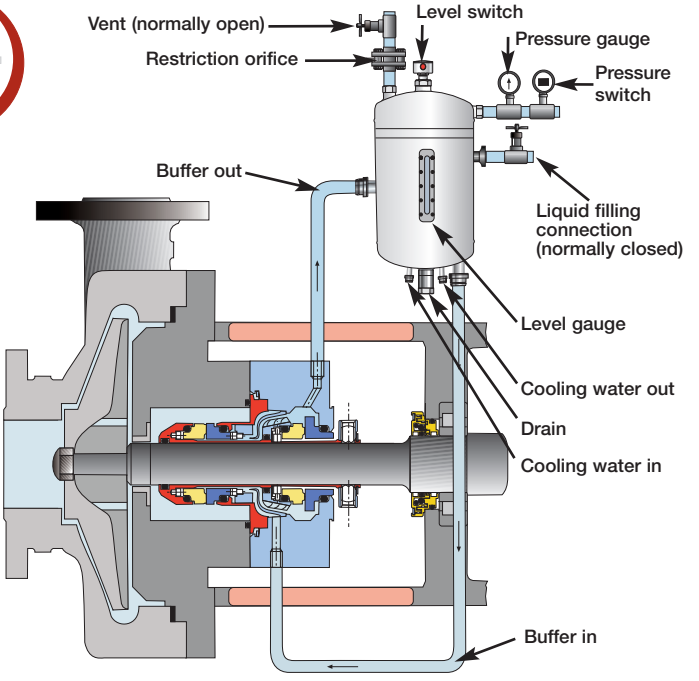
Use

1. Preferred for clean, non-polymerising media with vapor pressure higher than buffer fluid pressure.

Caution

1. Keep pot vent continuously open, which is necessary to maintain buffer fluid pressure close to atmospheric pressure & vent the vapor's to flare.
2. Should not be used in dirty of polymerizing products.
3. Never run the system with level in the sealant vessel being at low level as marked on the level gauge.
4. Vent the system properly before start up.

API PLAN 52


Vent (normally open)
Restriction orifice
Level switch
Pressure gauge
Pressure switch
Buffer out
Liquid filling connection (normally closed)
Level gauge
Cooling water out
Drain
Cooling water in
Buffer in

API PLAN 52

Description

Depressurized buffer fluid circulation in outboard seal of a dual seal configuration through a seal support system. Circulation is maintained by using pumping ring in running condition and by thermosyphon effect in stand still condition.

Features

1. No process contamination.
2. No direct process leakage to atmosphere.
3. No need to maintain pressure system as in plan 53A.

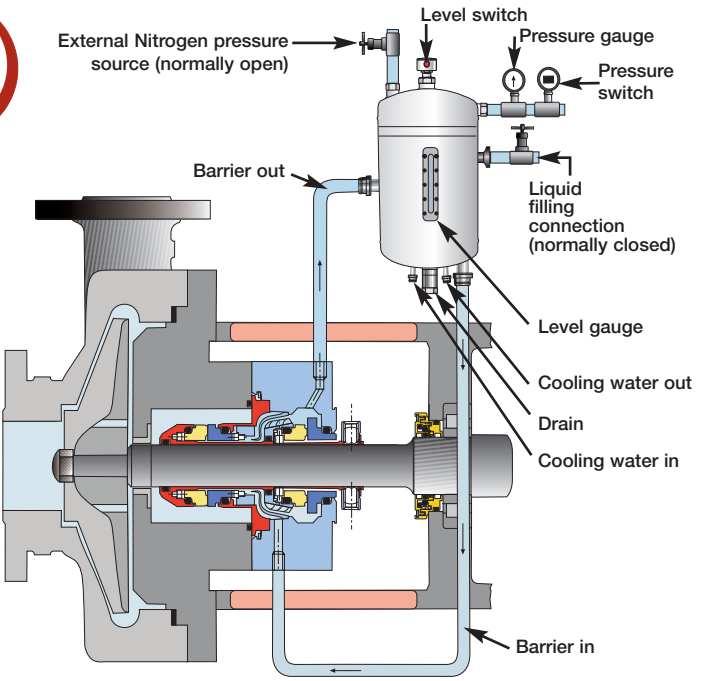
Use

1. For media where product dilution is not allowed but leakage to atmosphere in diluted form may be allowed.
2. Preferred for clean, non - polymerising media with vapor pressure higher than buffer fluid pressure (Is also used for lower vapor pressure media).

Caution

1. Keep the sealant vessel vent continuously open, which is necessary to maintain buffer fluid pressure close to atmospheric pressure & vent the vapors to flare.
2. Should not be used in dirty or polymerizing products.
3. A restriction orifice is necessary in vent line to maintain back pressure in pot and facilitate quick release of vapors to flare.
4. Pressure switch setting should be done above minimum flare back pressure in order to avoid false alarms.
5. Never run the system with level in the sealant vessel being at low level as marked on the level gauge.
6. Check for temperature difference in inlet and outlet lines to ensure that circulation is on.
7. Vent the system properly before start up.

API PLAN 53A


External Nitrogen pressure source (normally open)
Level switch
Pressure gauge
Pressure switch
Barrier out
Liquid filling connection (normally closed)
Level gauge
Cooling water out
Drain
Cooling water in
Barrier in

API PLAN **53A**

Description

Pressurized barrier fluid circulation in outboard seal of dual seal configuration through a seal support system. Circulation is maintained by using pumping ring in running condition and with thermosyphon effect in stand still condition.

Features

1. In no case media leakage to atmosphere (Provided the seal support system pressure is not lost).
2. Clean fluid film formation between the inboard seal faces gives better seal life.
3. Works as a Plan 52 arrangement if barrier fluid pressure is lost.

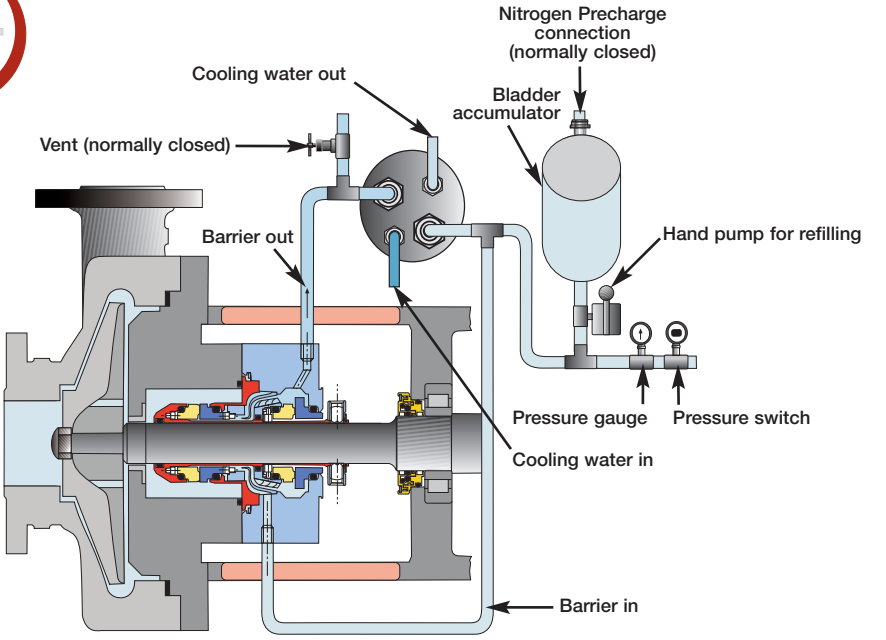
Use

1. Applications where no leakage to atmosphere can be tolerated e.g. hazardous, toxic, inflammable media.
2. For dirty, abrasive or polymerising products where media is unsuitable as a lubricant for inboard seal faces.

Caution

1. There will always be some leakage of barrier fluid in to the product. Check compatibility of barrier fluid with product.
2. Always ensure that the pressure source maintains higher pressure at the seal support system so that process does not dilute the barrier fluid.
3. Vent the system properly before start up.
4. In certain cases the inert gas can dissolve in the barrier media.
5. Product quality can deteriorate due to barrier fluid contamination.

API PLAN 53B


Nitrogen Precharge connection (normally closed)
Cooling water out
Bladder accumulator
Vent (normally closed)
Barrier out
Hand pump for refilling
Pressure gauge
Pressure switch
Cooling water in
Barrier in

API PLAN **53B**

Description

Pressurised barrier fluid circulation in outboard seal of dual seal configuration. Circulation is maintained by using pumping ring in running condition and with thermosyphon effect in stand still condition. The pressure is maintained in the seal circuit by a bladder accumulator.

Features

1. Keeps barrier fluid and pressurised gas (inert gas) separate by using a bladder.
2. Heat is removed from the circulation system by an air-cooled or water-cooled heat exchanger.
3. Being a stand-alone system does not rely upon a central pressure source. Hence much more reliable than a Plan 53A.
4. In no case media leakage to atmosphere.
5. Clean fluid film formation between the inboard seal faces gives better seal life.

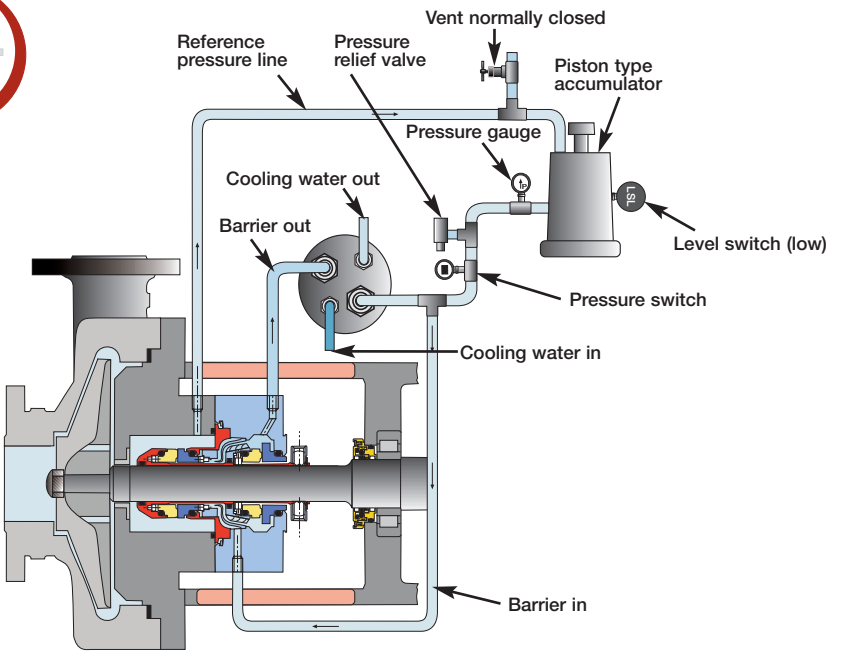
Use

1. Applications where no leakage to atmosphere can be tolerated e.g. hazardous, toxic, inflammable media.
2. For dirty, abrasive or polymerising products where media is unsuitable as a lubricant for inboard seal faces.

Caution

1. There will always be some leakage of barrier fluid in to the product. Check compatibility of barrier fluid with product.
2. Low volume of barrier fluid in system, hence heat dissipation is totally dependent on cooler efficiency.
3. Always recharge bladder to 0.9 times the working pressure.
4. Vent the system properly before start up.
5. Product quality can deteriorate due to barrier fluid contamination.
6. Can not be used where seal chamber pressure varies. Use Plan 53C for such applications.

API PLAN 53C


Vent normally closed
Reference pressure line
Pressure relief valve
Piston type accumulator
Pressure gauge
Cooling water out
Barrier out
LSL
Level switch (low)
Pressure switch
Cooling water in
Barrier in

API PLAN **53C**

Description

Pressurised barrier fluid circulation in outboard seal of dual seal configuration. Circulation is maintained by using pumping ring in running condition and with thermosyphon effect in stand still condition. The pressure is maintained and fluctuations are compensated in the seal circuit by a piston type accumulator.

Features

1. There will always be some leakage of barrier fluid in to the product. Check compatibility of barrier fluid with product.
2. Vent system properly before start up.
3. Heat is removed from the circulation system by an air-cooled or water-cooled heat exchanger.
4. In no case media leakage to atmosphere.
5. Clean fluid film formation between the inboard seal faces gives better seal life.

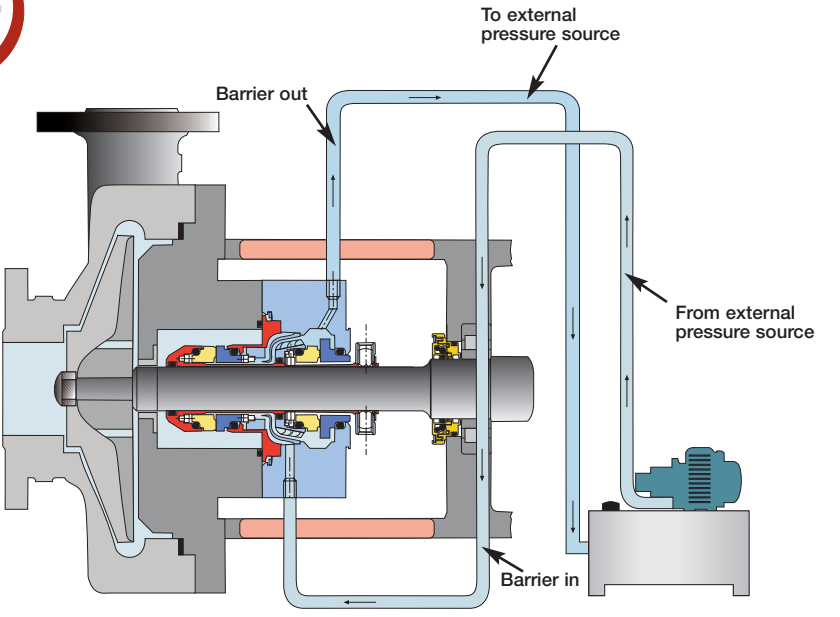
Use

1. Applications where no leakage to atmosphere can be tolerated e.g. hazardous, toxic, inflammable media.
2. For dirty, abrasive or polymerising products where media is unsuitable as a lubricant for inboard seal faces.
3. Where pump pressure varies during operation needing an auto setting of barrier fluid pressure, thus maintaining the same differential throughout.

Caution

1. Always connect reference pressure line from seal chamber to accumulator and keep it open.
2. There will always be some leakage of barrier fluid in to the product. Check compatibility of barrier fluid with product.
3. Vent the system properly before start up.
4. Product quality can deteriorate due to barrier fluid contamination.

API PLAN 54


To external
pressure source
Barrier out
From external
pressure source
Barrier in

API PLAN **54**

Description:

Pressurized external barrier fluid circulation from a central pressure source or by a stand alone pumping unit (e.g. AESSEAL® PUMPPAC™).

Features:

1. Ensures higher flow rate, better heat dissipation & positive circulation of barrier fluid.
2. If maintained properly, is the most reliable pressurised plan for dual seals as compared to Plan 53 A/B/C.
3. Can also be given as a stand alone unit per pump.

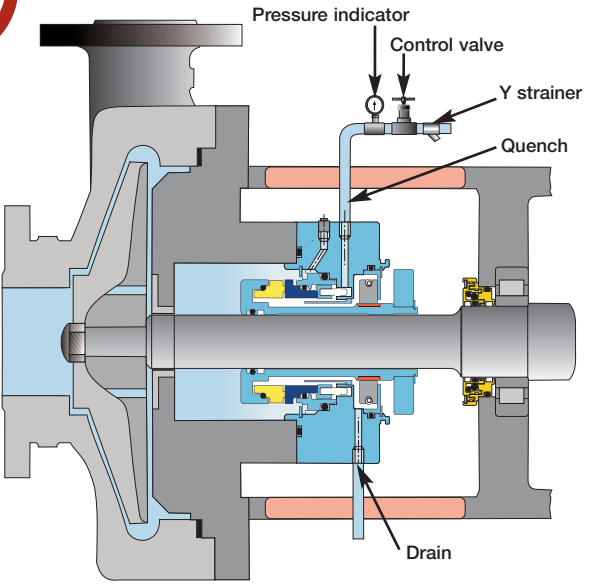
Uses:

1. Applications where no leakage to atmosphere can be tolerated e.g. hazardous, toxic, inflammable.
2. For dirty, abrasives or polymerising products where media is unsuitable as a lubricant for inboard seal faces.
3. For media with high pressure and/or high temperature and/or high heat generation between faces.
4. Wherever Plan 53 A/B/C circulation is insufficient to dissipate heat.

Caution:

1. Carefully consider the reliability of barrier fluid source, if a central source is used.
2. Expensive system, proper engineering required.
3. Circulating system must be pressurised at least 1.5 bar greater that the pressure in the seal chamber.
4. Product contamination does occur. Barrier fluid selected should be compatible with the process fluid.
5. Always check filter/strainer in the system for any possible blockages.
6. Loss of pressure in system can lead to entire barrier liquid contamination.
7. Product quality can deteriorate due to barrier fluid contamination.

API PLAN 62



API PLAN 62

Description

An external fluid stream is brought to atmospheric side of the seal faces using quench and drain connections.

Features

1. The quench fluid acts as barrier in between atmosphere and process fluid.
2. The quench fluid reduces oxidation and cocking of product & also cools seal faces.
3. Flushes away undesirable material build up under seal faces.
4. Can be used with water, steam or an inert gas.

Use

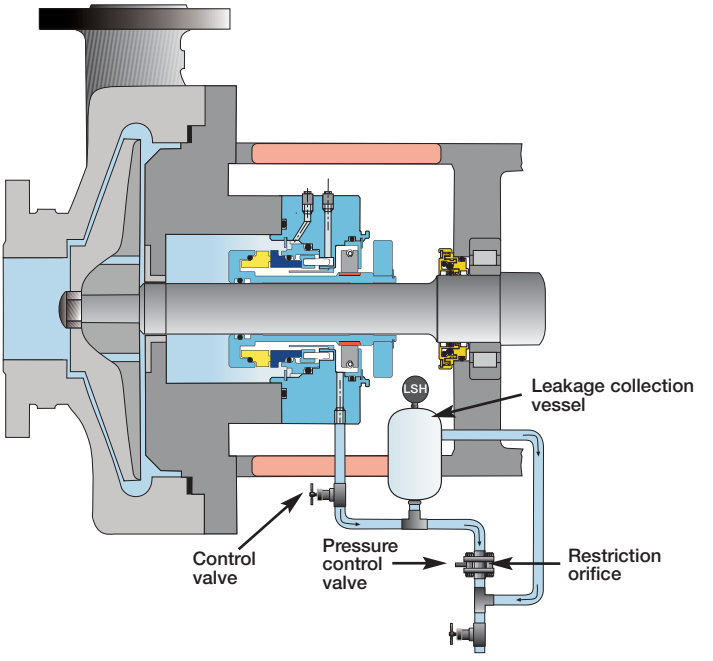
1. In caustic or crystallising fluids.
2. In oxidising fluids or hot hydrocarbons.
3. Can be used to purge steam in hot applications especially for stationary bellows to avoid coking.

Caution

1. Ensure availability of continuous supply of low-pressure quench fluid limited to maximum 1bar.
2. Use of throttle bushing on atmosphere side is mandatory.
3. Use proper bearing isolators to ensure that the quench fluid does not enter the bearings.

CONTAINMENT SEAL PLANS

API PLAN 65


LSH
Leakage collection vessel
Control valve
Pressure control valve
Restriction orifice

Description

Leakage from seal faces is collected via the drain port & directed to a liquid collection system via a vessel equipped with a high-level alarm.

Features

1. The quench fluid acts as barrier in between atmosphere and process fluid.
2. The quench fluid reduces oxidation and cocking of product & also cools seal faces.
3. Flushes away undesirable material build up under seal faces.
4. Can be used with water, steam or an inert gas.

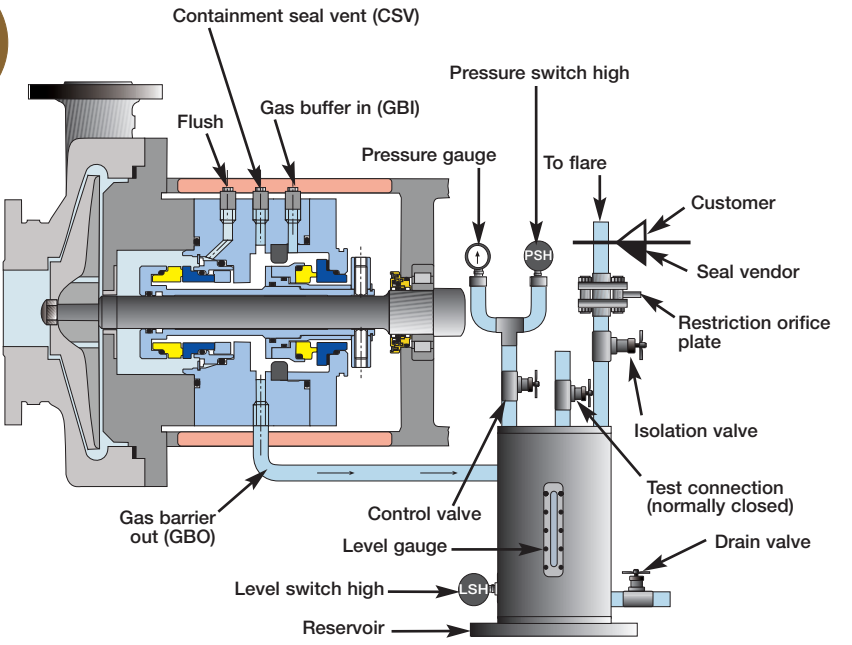
Use

1. In services where seal leakage is condensing.
2. Used for single seals.

Caution

1. Vent connection should always be plugged.
2. Orifice downstream of the level switch should be located in vertical piping leg to avoid accumulation of fluid in drain piping.
3. Shut down the pump as soon as high-level alarm is activated & attend the seal.

API PLAN 75


Containment seal vent (CSV)
Pressure switch high
Flush
Gas buffer in (GBI)
Pressure gauge
To flare
Customer
PSH
Seal vendor
Restriction orifice plate
Isolation valve
Test connection (normally closed)
Gas barrier out (GBO)
Control valve
Level gauge
Drain valve
Level switch high
LSH
Reservoir

Description

Leakage of process liquid from inboard seal of a dual containment seal is directed to a liquid collector.

Features

1 Can be used with Plan 72 with buffer gas or with Plan 71 without buffer gas systems.
2. Collection can be redirected to process fluid by using separate pumping device.
3. Can be used in single containment seal also.
4. Test connection is provided to check the inner seal by closing the block isolation valve while pump is in operation and noting the time/pressure build-up relationship in the collector.

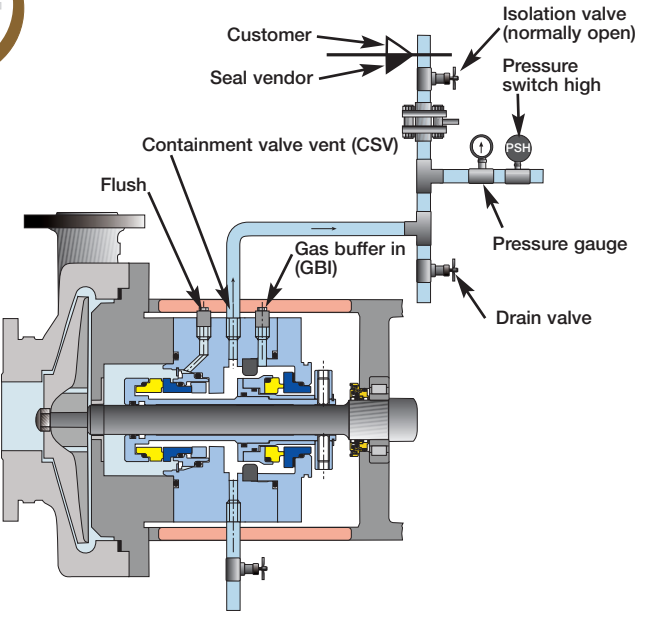
Use

1. Duties with condensing leakages.
2. Hazardous, toxic fluids.
3. May also be used for non condensing leakages. In such cases, the collector can help in collecting condensate from the vapor recovery system.

Caution

1. Ensure that collection system is located below the seal drain with sloping pipelines.
2. Drain port should be at bottom of containment seal to allow the leakage to flow to the collection system.
3. Collection system should always be vented releasing vapors of process liquid to vapor recovery system.
4. Valves that are installed should be accessible to operator relative to ground clearance and other obstructions.
5. A flow control orifice is required to create back pressure on collection system and to have effective condensation of vapors.
6. Pressure switch should be set at a gauge pressure of 0.7 bar.

API PLAN 76


Customer
Seal vendor
Isolation valve (normally open)
Pressure switch high
PSH
Containment valve vent (CSV)
Flush
Gas buffer in (GBI)
Pressure gauge
Drain valve

API PLAN **76**

Description

Vapor leakages from inboard seal of dual containment seal are directed to a vapor recovery system via a vent connection.

Features

1. Can be used with Plan 72 with buffer gas or with Plan 71 without buffer gas system.
2. Vapor leakage collection ensures zero to very low process emissions from out board containment seal.

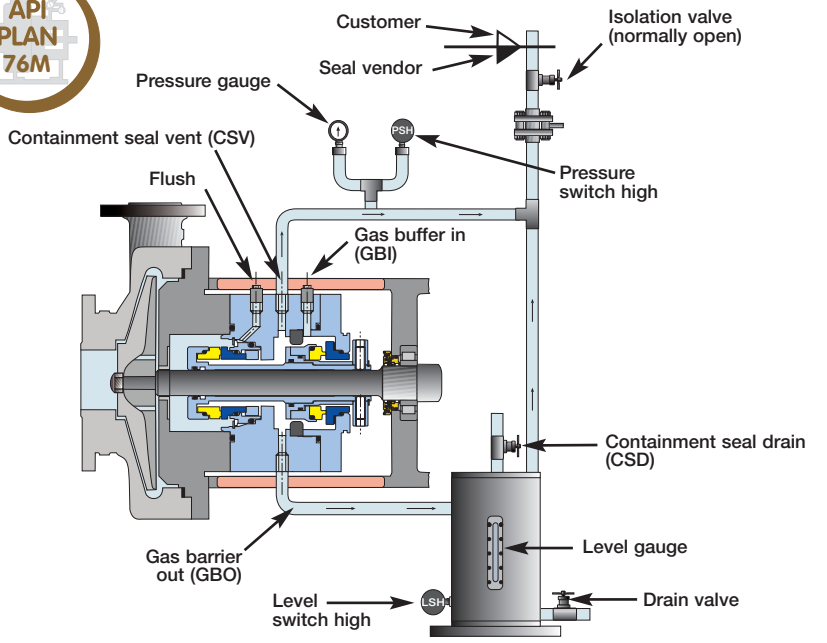
Use

1. For high vapor pressure fluids, light hydrocarbons
2. In hazardous or toxic media

Caution

1. Do not use for condensing media.
2. Ensure continuous vent to low pressure vapor recovery or flare system.
3. Tubing shall be 13mm (1/2”) minimum diameter and shall rise continuously from the CSV connection to the piping/instrumentation harness.
4. A flow control orifice is required to generate back pressure.
5. Ensure proper support to harness piping.
6. Ensure a low point drain in the piping loop.

API PLAN 76M


Customer
Isolation valve (normally open)
Seal vendor
Pressure gauge
PSH
Containment seal vent (CSV)
Pressure switch high
Flush
Gas buffer in (GBI)
Containment seal drain (CSD)
Level gauge
Gas barrier out (GBO)
Level switch high
LSH
Drain valve

API PLAN **76M**

Description

It is a combination of Plan 75 and Plan 76. Leakage of process liquid from inboard seal of a dual containment seal is directed to a liquid collector. At the same time, any vapor leakages from inboard seal of dual containment seal are directed to a vapor recovery system via a vent connection.

Use

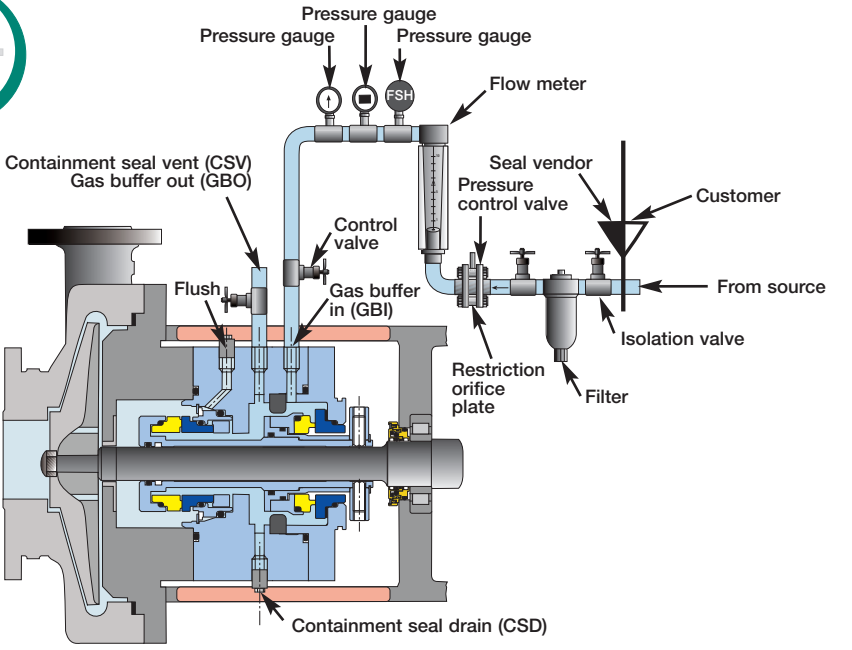
1. Whenever the vapor pressure of the media is in between minimum and maximum flare back pressures & so the leakage can either be condensing or non condensing

Caution

1. Use only after verifying vapor pressure of fluid and limits of Flare back pressure.

GAS SEAL PLANS

API PLAN 72


Pressure gauge
Pressure gauge
Pressure gauge
FSH
Flow meter
Containment seal vent (CSV)
Gas buffer out (GBO)
Seal vendor
Pressure control valve
Customer
Control valve
Flush
Gas buffer in (GBI)
From source
Isolation valve
Restriction orifice plate
Filter
Containment seal drain (CSD)

API PLAN **72**

Description

Buffer gas is circulated in the containment seal chamber to sweep inner seal leakage away from outer seal to a collection system and/or dilute the leakage so that the emissions from the containment seal are reduced.

Features

1. Used in conjunction with API Plan 75 and/or 76.
2. Nitrogen provides cooling to seal faces.
3. Nitrogen blanket reduces the explosion hazard in high vapor pressure liquids.
4. This plan is used in conjunction with Plan 75 and 76.

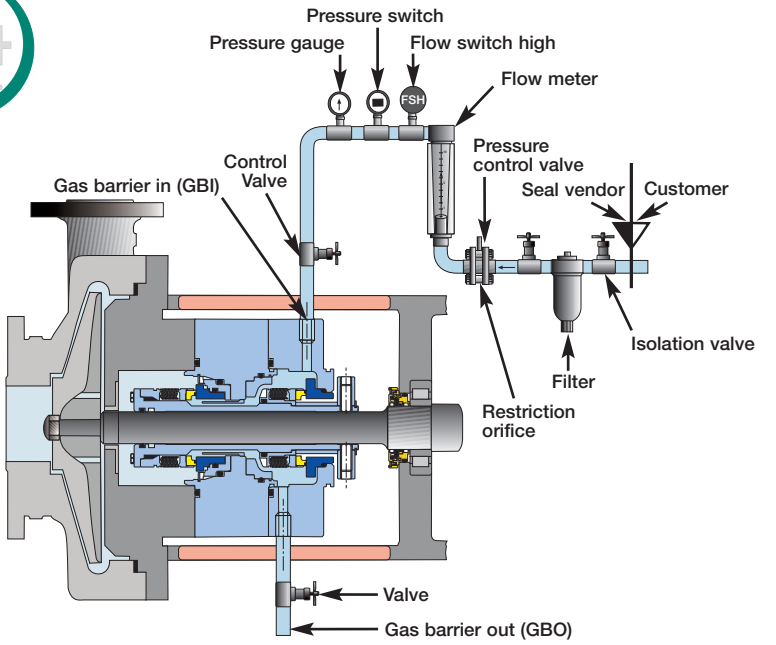
Use

1. For flashing hydrocarbons

Caution

1. Always ensure that buffer gas pressure is less than seal chamber pressure.
2. Set the forward pressure regulator at min 0.4 bar above flare back pressure.

API PLAN 74


Pressure switch
Pressure gauge
Flow switch high
FSH
Flow meter
Pressure control valve
Seal vendor
Customer
Control Valve
Gas barrier in (GBI)
Isolation valve
Filter
Restriction orifice
Valve
Gas barrier out (GBO)

API PLAN **74**

Description

Externally pressurized barrier gas through gas control system to a dual seal arrangement. An inert gas is used as a barrier gas.

Features

1. Media leakage to atmosphere is eliminated.
2. Obtain very high reliability, as solids or other materials, which can lead to premature seal failure cannot enter the seal faces.

Use

This plan is intended to be used for dual pressurised non contacting gas seals.

1. Used in services which are not hot (within elastomer temperature limit) but which may contain toxic or hazardous material whose leakage to atmosphere can not be tolerated.
2. In case of solids or other material present in sealing media.
3. Where process contamination is allowed but process liquid leakage to atmosphere is not allowed.

Caution

1. Always ensure barrier gas pressure is higher than seal chamber pressure.
2. Causes media contamination due to high-pressure nitrogen entering the pump.
3. Back pressure regulator should be set at least 1.7 bar greater than the seal chamber pressure.
4. Carefully consider the reliability of barrier pressure source, if central pressure issued.
5. Always check filter for any possible blockage
6. Do not use for sticking or polymerising media.