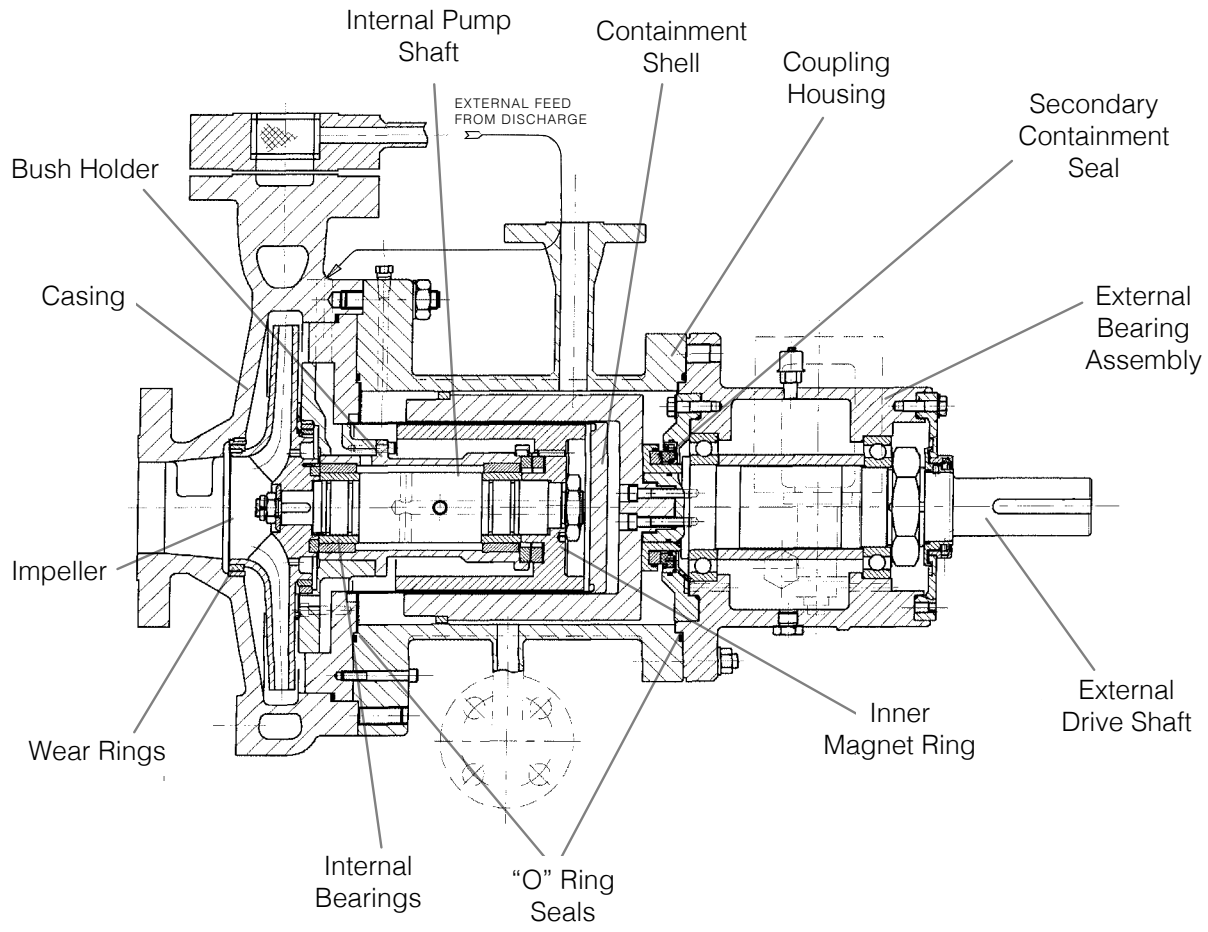
Recommendations for
Sundyne Magnetic Drive Sealless Centrifugal Pumps
for Hydrofluoric Acid Service

The purpose of this document is to outline the design recommendations for pumps used for hydrofluoric acid service. This document is intended as a guide and is based on the API 685 compliant GSP Pump ranges (frame 1 to frame 3).

This document covers the following design aspects:

- The Sundyne API 685 GSP Magnetic Drive Pump – Components
- Liquid Contact Materials of Construction – UOP Requirements
- Liquid Contact Materials of Construction – HMD Alloy C276
- Internal Bearing Feed Systems
- Pressure Temperature Profile
- Secondary Containment System
- Instrumentation Options
- Other Design Considerations

The Sundyne API 685 GSP Magnetic Drive Pump – Components



Since pioneering the technology over 65 years ago, Sundyne HMD Kontro sealless magnetic drive centrifugal pumps have become synonymous with reliability and safety. Pumps featuring failure-prone mechanical couplings and seals can leak harmful process fluids, negatively impacting employee health, the environment and productivity. Sundyne sealless pumps do not leak. Additionally, their streamlined modular design means maintenance can be performed quickly and easily, maximizing uptime and minimizing repair costs over the lifecycle of the pump.

Built to meet exacting ASME / ANSI B73.3 and ISO 2858 chemical process pump standards, Sundyne sealless pumps are the easy upgrade option for fluid handling professionals interested in replacing their standard mechanically sealed pumps. With over 100,000 pumps in operation today backed by our global service network, Sundyne sealless magnetic drive pumps are the ideal choice for handling the extreme temperatures, high viscosities and acute pressures inherent to the petroleum, chemical and gas production industries.

Liquid Contact Materials Of Construction In Accordance With UOP Specifications

The following material specification is designed to follow the UOP Centrifugal Pumps Specification 5-11-8 Section 4.3 as far as is applicable to magnetic drive pumps.

Pump Component	Material	API Material Class S-9 (see note 5)	Material Specification
Pressure Casing Casting	Cast Steel / Monel Cladding	A216 Gr. WCB (see note 1)	UNS J03002
Impeller	Monel	A 494 Gr. M-35-1	UNS N24135
Impeller Nut and Key	Monel	B 865 UNS N05500	UNS N05500
Casing Wear Rings	Monel	A 494 Gr. M-35-1 (see note 2)	UNS N24135
Impeller Wear Rings	Monel	A 494 Gr. M-35-1 (see note 2)	UNS N24135
Internal Pump Shaft	Monel	B 865 UNS N05500	UNS N05500
Casing Studs	Carbon Steel	A 193 Gr. B7M	G41400
Casing Nuts	Carbon Steel	A 194 Gr. 2HM	UNS K04002
Bush Holder (See note 4)	Monel	A 494 Gr. M-35-1	UNS N24135
Internal Bearings (See note 4)	SiC	Silicon Carbide	
O rings (See note 4)	Viton		
Inner Magnetic Ring (See note 4)	Alloy C276 Clad	B 575 UNS N10276 and B 574 UNS N10276	UNS N10276
Containment Shell (See note 4)	Alloy C276	B 575 UNS N10276 and B 574 UNS N10276	UNS N10276
Casing Gasket	Monel/Graphite	Monel/Graphite (see note 3)	
Coupling Housing (See note 4) (Secondary Containment Hsg)	Cast Steel	A216 Gr. WCB	UNS J03002

Notes:

(1.) The casing carbon equivalent, C.E., shall be 0.43 Max.

(2.) Casing wear rings shall be Monel with Colmonoy 5 hard surfacing. Monel with a minimum differential hardness of 50 BN per API 685 is also acceptable. The casing wear rings will be tack welded.

(3.) Gaskets shall be fully confined.

(4.) Specific to magnetic drive pumps.

(5.) Equivalent international material grades may be supplied.

Monel Cladding

Mating (static) cast steel surfaces will be overlaid with Monel to a minimum finished thickness of 3.2mm. An initial pass of pure nickel shall be applied. The initial pass of pure nickel shall not leave any nickel metal edges. Surfaces to be overlaid are those sliding fits where HF contact can cause a build up of corrosion products, cementing the parts together. Surface to be Monel overlaid are:

1. Casing location diameter for the containment shell flange (or casing plate).
2. Casing gasket surfaces.
3. Casing are behind the case wearing rings (wear ring locations).

Surfaces that are Alloy C276 shall not be overlaid. Monel overlay will not be supplied on suction and discharge flanges. Monel overlay will not be applied to secondary containment components.

Liquid Contact Materials of Construction – HMD Alloy C276

Sundyne standard material offering for HF service is Alloy C276 per the following material specification. Sundyne has standardized on these materials based on previous experience.

**Additional details to support this material selection criteria are available on request.*

Pump Component	Material	API Material Class H-2	Material Specification
Pressure Casing Casting	Alloy C276	B 575 UNS N10276	UNS N10276
Impeller	Alloy C276	B 575 UNS N10276	UNS N10276
Impeller Nut and Key	Alloy C276	B 575 UNS N10276	UNS N10276
Casing Wear Rings	Alloy C276	B 575 UNS N10276	UNS N10276
Impeller Wear Rings	Alloy C276	B 575 UNS N10276	UNS N10276
Internal Pump Shaft	Alloy C276	B 575 UNS N10276	UNS N10276
Casing Studs	Stainless Steel	BS4882 B8MX	
Casing Nuts	Stainless Steel	BS4882 8MX	
Bush Holder	Alloy C276	B 575 UNS N10276	UNS N10276
Internal Bearings	SiC	Silicon Carbide	
O rings	Viton		
Inner Magnetic Ring	Alloy C276 Clad	B 575 UNS N10276 and B 574 UNS N10276	UNS N10276
Containment Shell	Alloy C276	B 575 UNS N10276 and B 574 UNS N10276	UNS N10276
Casing Gasket	Alloy C276/ Graphite		
Coupling Housing (Secondary Containment Hsg)	Cast Steel	A216 Gr. WCB	UNS J03002

Internal Bearing Feed Systems

There are several different options of internal bearing feed configuration depending upon the amount of particulate present in the pumped liquid. The capability of these systems is indicated below:

Configuration	Capability (Note 2)	Equivalent schematic in Annex D of API 685 (Note 1.)
Feed system without filtration	2.5% wt/wt up to 250 microns	Plan 11-S
External Feed with In-line Filter	5% wt/wt up to 250 microns	Not listed
External Sacrificial Flush	8% wt/wt up to 250 microns	Plan 32-S

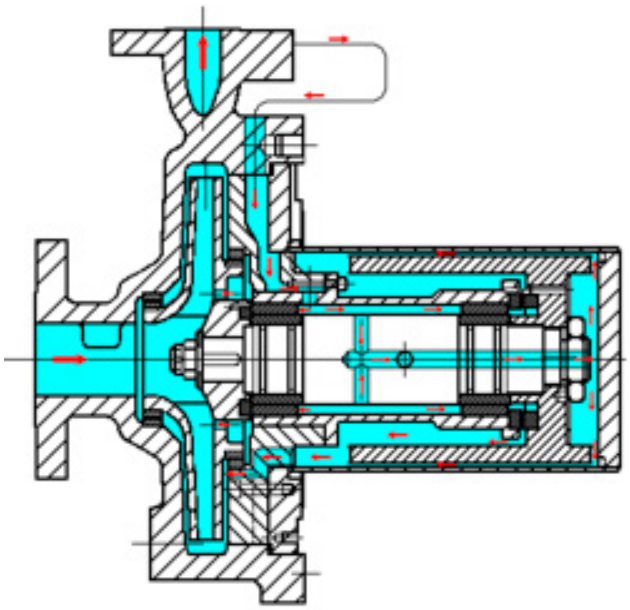
Notes

1. API 685 Annex indicates return feed to suction. All Sundyne GSP pumps feature discharge to discharge feed systems, therefore reducing the possibility of product vaporisation.

2. Synchronous pumps are not suitable for pumping liquids containing ferritic or magnetic particles as they will become attached to the IMR and will progressively block the internal flow passages. If only a small amount of magnetic particles are present, a cartridge filter with a magnetic element in the strainer basket can be used.

Feed System Without Filtration

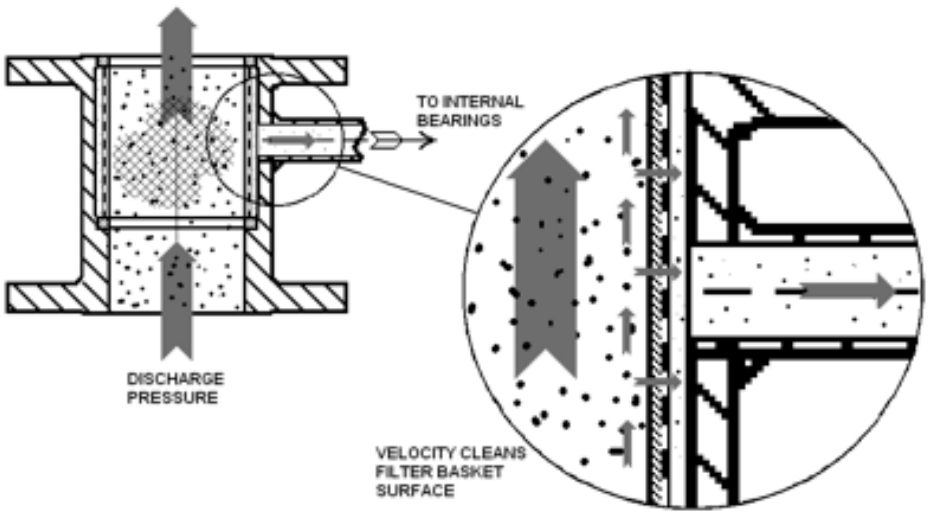
The internal bearings are lubricated and the containment shell cooled by redirecting a stream of pumped liquid from the pump discharge area. The flow enters the space between the two radial bearings before splitting in three directions. The main flow passes via holes in the pump shaft to the rear of the containment shell before passing between the shell and the inner magnetic ring. It then flows towards the impeller and exits behind the impeller outside the rear neck ring at a pressure slightly below pump discharge pressure. The front bearing flow passes between the front radial bearing and sleeve, over the surface of the front thrust washer and into the area behind the impeller inside the rear neck ring. It then returns to the pump suction via the thrust balance holes in the impeller. The rear bearing flow passes between the rear radial bearing and sleeve, over the face of the rear thrust washer and into the space between the bush holder and the inner magnet ring. It then flows towards the impeller, mixes with the main coupling flow and exits behind the impeller outside the rear neck ring.



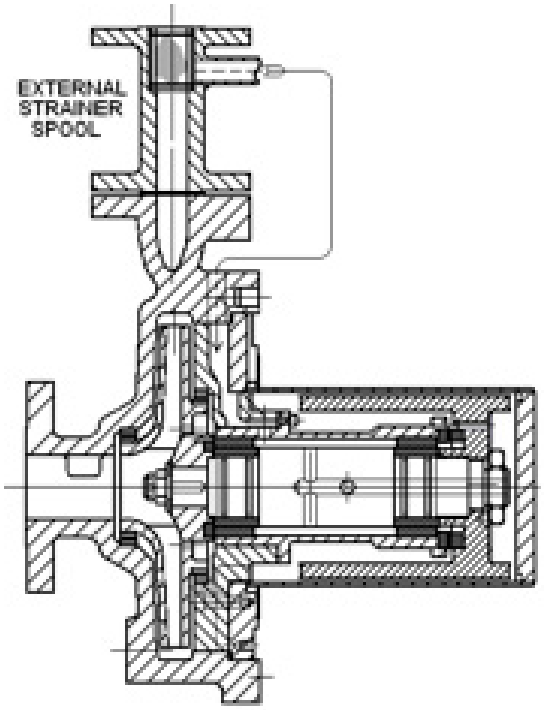
The diagram above visually indicates this flow path.

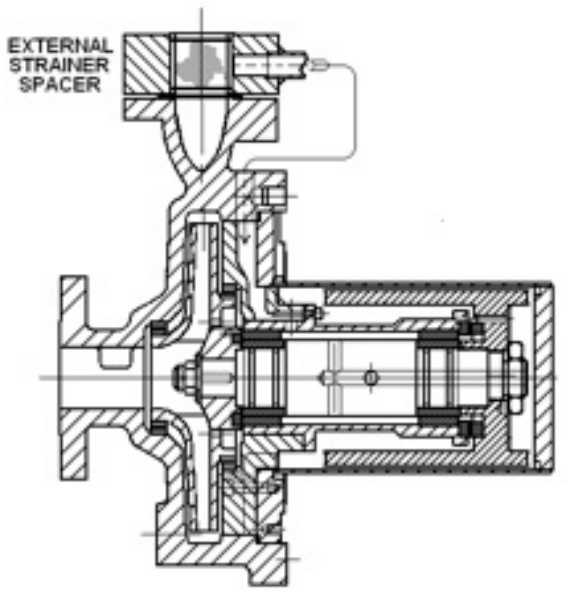
External Feed With In-line Filter System

The In-line self-cleaning filter works on the principle that discharge velocity of the pumped liquid cleans any particulate arresting on the surface of the filter mesh. The filtered liquid is then circulated around the internal bearings providing lubrication and cooling. The filter mesh aperture size is 0.185mm (0.007”) and is supported by a back-up ring comprised of 20 SWG (0.9mm thick) material with apertures of diameter 3mm (0.12”).



Depending upon the size of pump, the strainer basket may be located in a spool or a spacer as shown below. On some pump sizes the strainer basket can be recessed within the pump discharge flange.

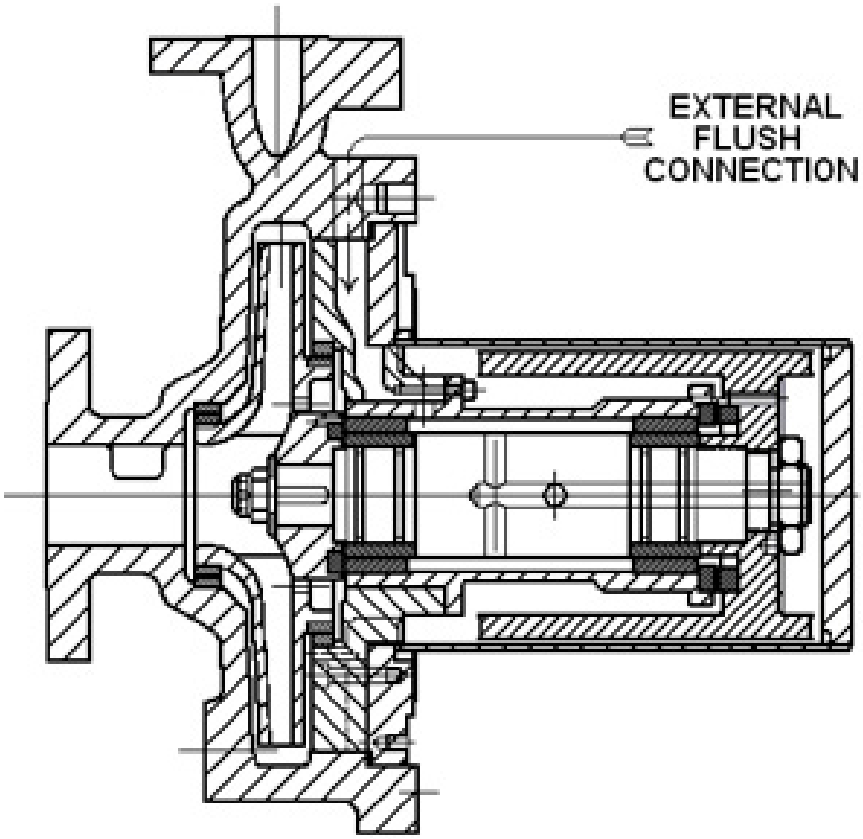




External Sacrificial Flush System

This system uses a clean fluid stream (compatible with the pumped product e.g. Isobutane) that is connected to the external feed connection. The system is a total loss system - what passes through the internal bearing feed path will return to the casing area via the return feed hole, impeller balance holes and radial bearing grooves, to mix with the bulk flow going through the pump casing, and then into the process via the discharge flange connection.

The pressure and flow rate of the flush is dependent upon pump size and operating parameters. As guidance, the pressure of the flush system needs to be slightly higher than the suction pressure plus differential pressure at the minimum continuous flow rate of the pump.



Pressure Temperature Profile

A pressure temperature profile calculation is a means of establishing the temperature rise of the pumped liquid as it travels from the point at which it enters the pump to the point at which it exits the pump. The calculated pressure temperature profile establishes the bulk rise in temperature (that is, the overall temperature rise from suction to discharge) and the rise in temperature across the magnetic coupling.

Purpose

Liquids that are pumped that are close to their boiling point (i.e. liquids with a low vapor pressure) need to be checked to ensure that the temperature rise in the pumped liquid is not sufficient to allow the liquid to change its state to a gas.

API 685 Applications

API requires pump vendors to provide an application, pressure temperature profile at the proposal stage. This should be issued with the quotation, provided that sufficient information is forwarded with the enquiry to ensure such a calculation can take place and will be checked to ensure that the temperature rise in the pumped liquid is not sufficient to allow the liquid to change its state to a gas.

Information Needed

The following is the minimum information required to carry out a pressure temperature profile calculation:

1. Vapor pressure characteristics or curve for the pumped liquid, ranging from the minimum pumping temperature, to the maximum pumping temperature, plus 20°C (70°F)
2. The Suction Pressure (or range of suction pressures) the pump will be operating at.
3. The Specific Heat of the liquid.
4. The Specific Gravity of the liquid.

Secondary Containment System

The scope and definition of secondary control and secondary containment systems are both explained in API 685. For HF Service, Sundyne recommends a secondary containment system be utilised.

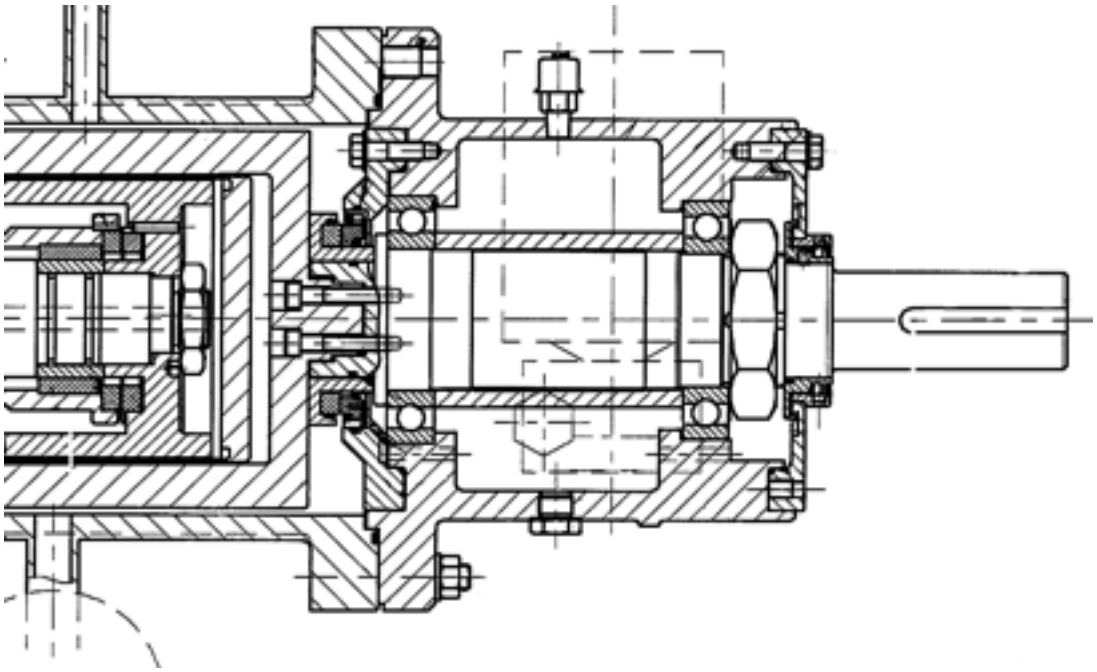
Purpose

The purpose of a secondary containment system is to contain any leakage that may occur in the event of the primary pressure containment shell failure. Once contained safely, the leaked product should have a means of being drained away from the secondary containment area in a safe and controlled manner whereby it can be dealt with appropriately and the system can then be flushed of product residue, so that the pump is safe to work on.

Construction

A dry running gas seal is fitted to the external bearing housing front cap to prevent the release of the pumped product into atmosphere in the event of a containment shell failure. If the seal was not fitted the natural path for leakage to propagate would be through the external bearing assembly.

The coupling housing has been designed to withstand internal pressures up to 40 Bar (580 psi) and is sealed at the flange location on both ends to prevent product release. The dry running gas seal is rated for 40 bar (580 psi).



Seal Specification

Design	Non-contacting dry running gas seal
Materials of Construction	Seal Body: Stainless Steel Static Facing: Impregnated Carbon Dynamic Face: Silicon Carbide 'O' Rings: Fluorocarbon or Perfluoroelastomer
Pressure Rating	40 Bar (580 psi)
Application Temperature (Liquid)	-40°C to 260°C (-40°F to 500°F)
Maximum Speed	3500 rpm

Installation And Operation

The coupling housing must be fitted with a flanged drain to allow any leakage to be drained. A pressure switch is then used to shut the pump down and signal an alarm in the event of a containment shell failure. Alternatively, a liquid sensing probe can be connected into the lowest point of the coupling housing to detect leakage and perform the same shut down and alarm operations. As soon as the pump comes to a standstill, the normally non-contacting gas seal faces become contacting and contain any leakage from the shell failure.

It is recommended that a lockable valve (locked in the closed position) is fitted to the coupling housing drain connection point. This will keep the secondary system closed and will allow pressure build up for the pressure switch to operate with in the event of a containment shell failure.

The coupling housing drain should be connected to a suitable drainage system. If the system is not open to atmosphere and is pressurised, details should be forwarded to Sundyne to ensure suitability of operation.

Once the pump has been shut down and isolated the drain valve can be opened and the coupling housing secondary containment system drained and dealt with appropriately.

Instrumentation

Recommended instrumentation systems for HF Service are:

- Power Control Monitor – measures the power being absorbed by the unit and is used to ensure the unit does not dry run or run out of its design envelope.
- VapourView non-intrusive gas in liquid detector for sealless magnetic drive centrifugal pumps – for real time detection of entrained gas, cavitation or gas formation within the pump internal feed system. This non-instrusive device is mounted externally.
- RTD device located on Containment Shell – Measures the external temperature of the containment shell. An increase in temperature at this point can indicate partial dry running or internal feed problems.
- Pressure-sensing device – located on the top flanged coupling housing connection and used to detect the increase in pressure in the unlikely event of a primary containment shell breach. Alternatively, a liquid sensing probe – located at the bottom of the coupling housing and used to detect the presence of liquid in the unlikely event of a primary containment shell breach.
- HF Acid / Gas sensor located in secondary coupling housing (optional).

Other Design Considerations

Consideration should also be given to any client's specific, or licensee-based specifications relating to Sundyne Centrifugal Pumps for HF service.

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PUMPS

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