Plan 52 Buffer Plan

Double Seal, Unpressurized

Plan Overview:

API Plan 52 supports **Arrangement 2** seals, specifically contacting wet containment seals **(2CW-CW)**. It utilizes an **unpressurized** buffer fluid to **contain** and **minimize** process leakage to the atmosphere, ensuring the process fluid remains **uncontaminated**. This plan is also suitable for applications where the process fluid may **solidify** upon atmospheric exposure or where additional **heat removal** from the inboard seal is required.

An external reservoir **(Thermosyphon Pot)** maintains the buffer fluid at a pressure **lower than** the seal chamber pressure and **2.8 bar (40 psi)**, continuously supplying cooled liquid with the aid of the mechanical seal's **pumping ring** and the **thermosyphon effect.**

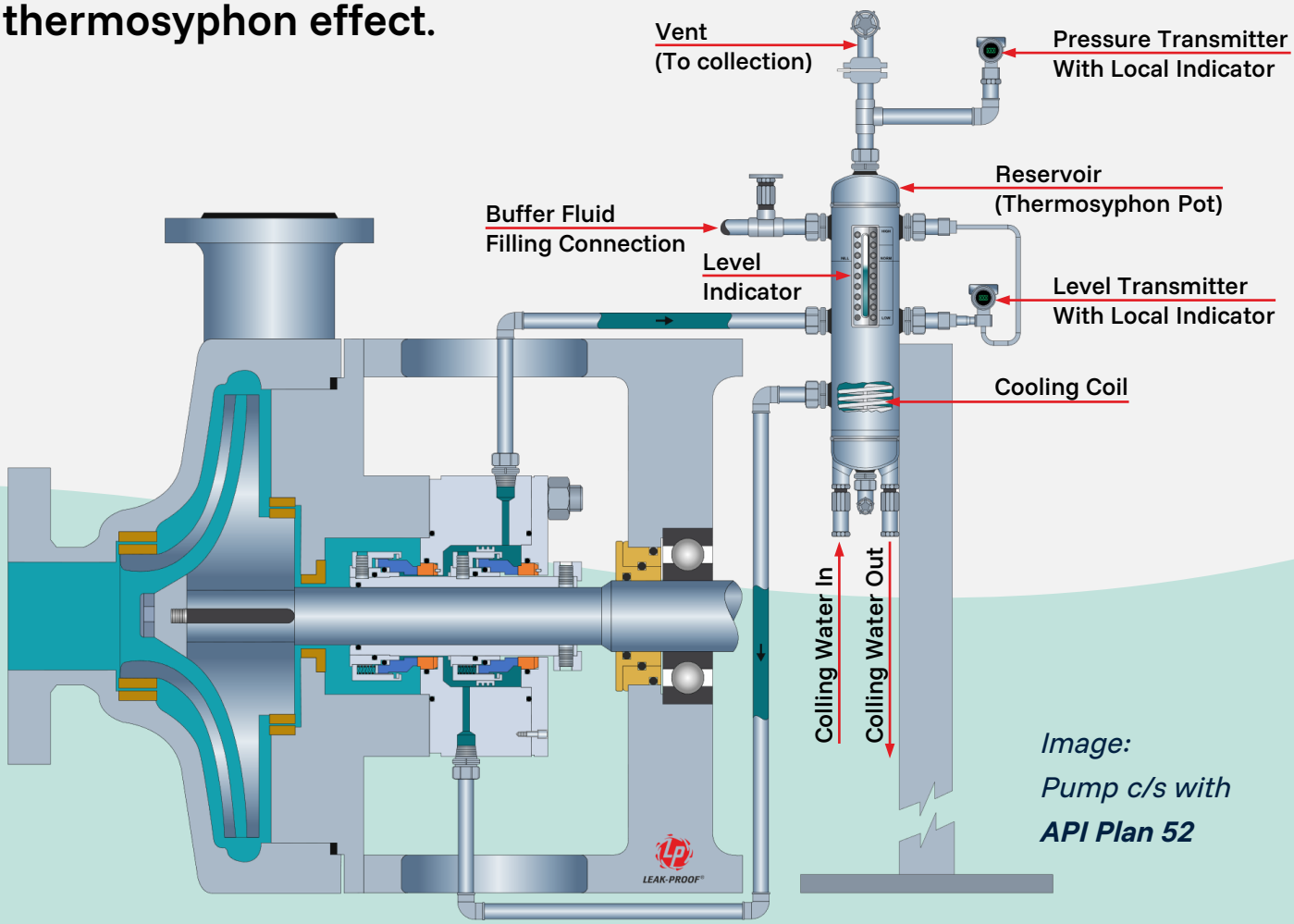

Image:
Pump c/s with
API Plan 52

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Features

1. **Prevention of Process Contamination:** Since Plan 52 operates with an unpressurized buffer fluid, there is **no reverse flow** into the process, ensuring that the process fluid remains **uncontaminated**. This makes it an ideal plan for applications where preventing process fluid contamination is a **necessity**.
2. **Unpressurized System:** The buffer fluid remains at a pressure lower than the seal chamber pressure and does not exceed **2.8 bar (40 psi)**, allowing controlled process leakage into the buffer fluid. Unlike pressurized systems, it operates without an external pressure source, simplifying system design and reducing maintenance requirements.
3. **Heat Dissipation:** The **cooled** buffer fluid circulates between the mechanical seal and the external reservoir through the **combined action** of the **thermosyphon effect** and the mechanical seal's **pumping ring**. This continuous flow efficiently removes heat from the seal faces, preventing **thermal distortion**, **excessive wear**, and **premature failure**.
4. **Leakage Monitoring:** Plan 52 enables **real-time** seal performance monitoring through fluid level indicators in the reservoir. Since process leakage migrates into the buffer fluid, a **sudden rise** in fluid level indicates excessive inboard seal leakage, allowing **early fault detection** and preventive maintenance.

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5. **Pressure Monitoring:** Plan 52 is equipped with a pressure indicator to monitor abnormal **pressure buildup** within the buffer system. A rise in pressure may indicate gas accumulation caused by process leakage or insufficient venting. Regular monitoring of the pressure level ensures proper system function and helps prevent **vapor lock**.

6. **Vapor Venting & Gas Removal:** Plan 52 includes a vent line to remove accumulated gases from the reservoir, preventing vapor lock and ensuring continuous buffer fluid circulation. Without proper venting, trapped vapors can disrupt the thermosyphon effect, reducing cooling efficiency and accelerating seal face wear.

Applications

1. Recommended for applications where atmospheric emission control is required but:
    A. Product **dilution** is not acceptable.
    B. The process fluid is **clean**, **non-polymerizing**, **non-toxic**, **non-hazardous**, and provides adequate **lubrication**.
2. Suitable for applications where:
    A. Venting is required to manage vapor buildup in fluids such as **high vapor pressure** or **flashing** liquids.
    B. Fluids tend to **solidify** upon contact with the atmosphere.

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Precautions

1. **Fluid Suitability:** Plan 52 should not be used for fluids containing suspended solids, polymerizing substances, contaminants, hazardous properties, or poor lubrication characteristics, as these can compromise seal performance and system reliability. For such demanding applications, consider a pressurized barrier plan like **Plan 53A**, **53B** or **53C**, based on process requirements and operating conditions.
2. **Buffer Fluid Selection & Compatibility:** The buffer fluid must be **chemically compatible** with the process fluid to prevent unwanted reactions. Since the **lubrication** of outboard seal faces depends entirely on the buffer fluid, it should have good lubricating properties to **minimize wear**. Fluids with a tendency to **polymerize** should not be used, as they can clog the system and lead to premature seal failure.
3. **Fluid Level Monitoring:** Always monitor the buffer fluid level on the reservoir level indicator before startup and throughout system operation.
    A. Operating with a **low buffer fluid level** should be avoided, as it can lead to inadequate lubrication and cooling.
    B. A **sudden rise** in fluid level indicates inboard seal leakage, requiring inspection and maintenance.
    C. An unexpected **drop** in fluid level suggests outboard seal leakage, which may require corrective action.

4. **Venting Management:**

   A. The piping between the seal and reservoir should be designed for **self-venting** to prevent gas pockets that could interfere with fluid circulation.

   B. The reservoir vent must remain **continuously open** to maintain buffer fluid pressure **close to atmospheric** and allow vapors to escape to the flare.

   C. A restriction orifice in the vent line helps maintain controlled **back pressure** and facilitates the quick release of vapors.

   D. Before startup, the system should be properly vented to remove trapped air and ensure stable operation.

5. **Pressure Management:**

   A. The pressure of the buffer fluid must remain lower than the seal chamber pressure and below **2.8 bar (40 psi)** for proper operation.

   B. The pressure switch should be set **above** the minimum flare back pressure to **prevent** false alarms and unnecessary system shutdowns.

   C. An **increase** in reservoir pressure is an indication of **inboard seal leakage**, requiring inspection and corrective action.

6. **Reservoir Design & Operation:**

   A. The reservoir must be positioned with its **normal liquid level (NLL)** at least **1 meter (3 feet)** above the gland plate to ensure proper fluid circulation.

   B. The reservoir should be equipped with a level transmitter and a **low-level alarm (LLA)** to prevent operation under insufficient fluid conditions. When specified, a **high-level alarm (HLA)** should also be included for enhanced monitoring.

   C. The reservoir volume at **NLL** should be at least **12 liters (3 U.S. gallons)** for shaft diameters up to **60 mm (2.5 in.)** and **20 liters (5 U.S. gallons)** for larger shaft sizes to maintain effective cooling and lubrication.

   D. Overfilling the reservoir can reduce the **thermosyphon effect** and cause improper circulation, negatively impacting heat dissipation and seal performance.

7. **Flow Rate Requirements:** The internal circulating device **(Pumping Ring)** must ensure the required flow rate of the specified buffer fluid under all **operating** and **start-up** conditions to maintain effective cooling and lubrication.

   A. Precise flow rate calculation is essential to prevent **overheating** and ensure stable seal performance. Flow rates depend on fluid properties such as **viscosity**, which changes with temperature.

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A. When the required flow rate exceeds **8 L/min (2 U.S. gal/min)**, the connecting lines between the buffer fluid system and the mechanical seal must have a minimum diameter of **20 mm (3/4 in.)** to minimize flow **resistance** and ensure adequate circulation.

Buffer Fluids

Selecting an appropriate buffer fluid is crucial for ensuring optimal seal performance and system longevity. Factors such as viscosity, thermal stability, heat transfer efficiency, and environmental impact should be considered alongside chemical compatibility. The fluid must also support effective heat dissipation and circulation within the system while maintaining stable properties under varying operating conditions. Below is a table of recommended buffer fluids along with their applications and temperature limits.

Table: Recommended Buffer Fluids – Applications & Temperature Limits

Fluid Family	Fluid / Solution / Grade	Application	Temp Limit °C (°F)
Water	-	Low Duty, Water, Food Processing, Pharma	5 to 70 (40 to 160)
Alcohols	Methanol, Propanol	Cryogenics	-110 to 20 (-165 to 65)
Glycol Solutions	50% Ethelene Glycol + 50% Water	Light Hydrocarbons	-35 to 100 (-30 to 210)
Hydrocarbons	Kerosene or Diesel	Light Hydrocarbons & Medium Duty	-10 to 80 (15 to 175)
Lubricating Oils	Below ISO Grade 32	General Purpose & Heavy Duty	-20 to 150 (-5 to 300)
Synthetic Oils	ISO Grade 5 to Grade 20	General Purpose & Heavy Duty with High Temp.	-30 to 250 (-20 to 480)
Heat Transfer Fluids	Therminol VP-1, Dowtherm A or Equivalent	Very High Temperature	-30 to 400 (-20 to 750)