What is a Secondary Pressure Drainer?

The Fluid Controls Institute (FCI) defines a Secondary Pressure Drainer (SPD) as "A vessel which collects and discharges liquid by alternately pressurizing and depressurizing through a given valve arrangement, utilizing a secondary compatible vapor or gas pressure as the motive source." Collection and discharge of liquid is accomplished using an operating mechanism, which FCI defines as a "sensing and valving arrangement of the SPD that alternately provides and relieves pressure from a secondary motive source in accordance with predetermined fluid levels within the SPD." (for a glossary of terms, see Appendix A)

Another way to describe a Secondary Pressure Drainer is to say it consists of a vessel (tank), inlet and outlet check valves to control the direction of fluid flow, a liquid level sensing device, and a valve arrangement that allows for entrance and exhaust of a motive pressure into and out of the vessel. The purpose of an SPD is to transfer a liquid from point A to point B using a vapor such as steam, air, or a compatible inert gas under positive pressure to push the liquid out of the vessel and into the discharge line. Steam is the preferred motive medium due to its suitability over a wide range of applications. While steam is used most often as the motive medium, other compatible inert media may be used. It is important that manufacturers be consulted in such cases.

Secondary Pressure Drainers can be used on either vented or non-vented systems, with the most common use being the collection and pumping of steam condensate. As steam gives up its heat energy, it turns into condensate, which should ultimately flow to a condensate return station. Secondary Pressure Drainers (SPDs) are one method of returning condensate, often replacing electric centrifugal pumps. This discussion focuses on the use of steam as the motive medium to pump steam condensate.

How Does a Secondary Pressure Drainer Work?

A complete SPD cycle comprises three stages, as follows:

Fill Stage (See Figure A)

Condensate flows by gravity from the receiver, through the inlet check valve, into the SPD. During this stage the motive pressure valve is closed and the vent valve is open to permit equalization of pressure between the receiver and SPD, which allows condensate to fill the SPD. The outlet check valve is generally held closed by the condensate return system pressure (or atmospheric pressure in cases where SPD is draining a vacuum system). The fill stage ends once the condensate level reaches the predetermined high level and the level sensing device activates the motive and exhaust valve arrangement simultaneously.

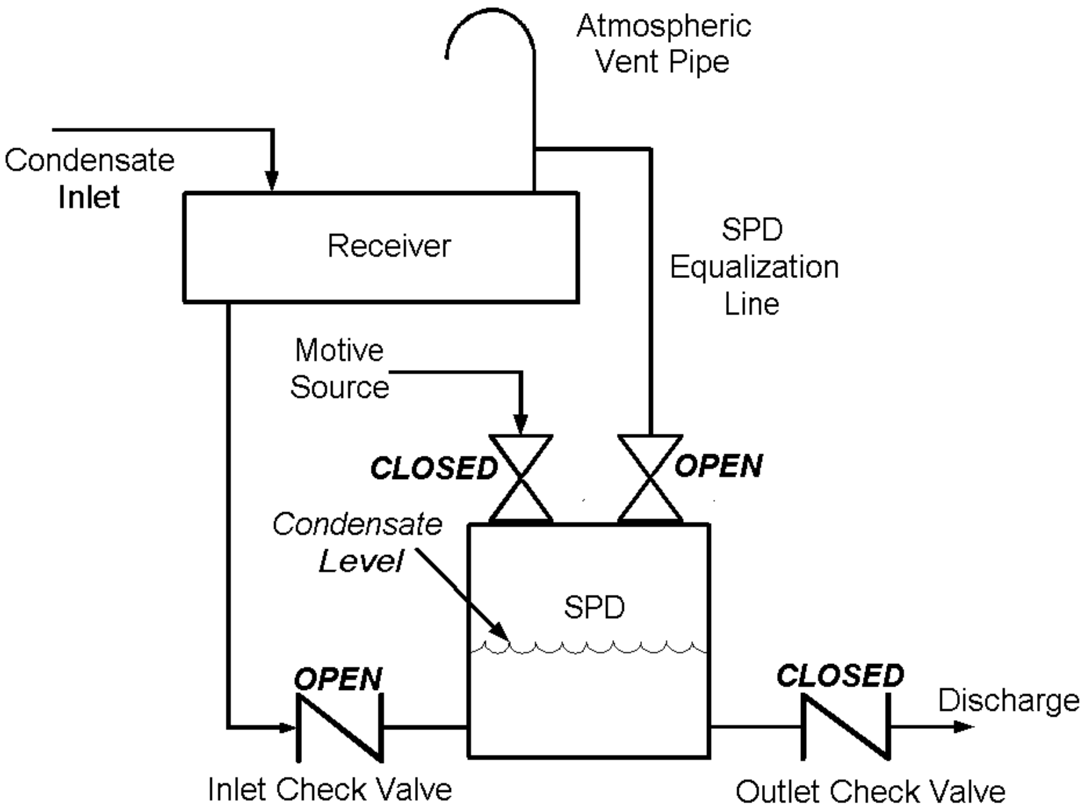

Fig. A Fill Stage

Discharge Stage (See Figure B)

When the motive pressure valve opens and the exhaust valve simultaneously closes, motive pressure to enable discharge enters the vessel and builds. Once the motive pressure in the SPD exceeds the condensate return line pressure, the condensate in the SPD is discharged into the return line through the outlet check valve. The inlet check valve is held closed by the motive pressure. Condensate will continue to be discharged until the predetermined low condensate level is reached. The discharge stage ends once the condensate reaches the predetermined low level, and the level sensing device activates the motive and exhaust valve arrangement.

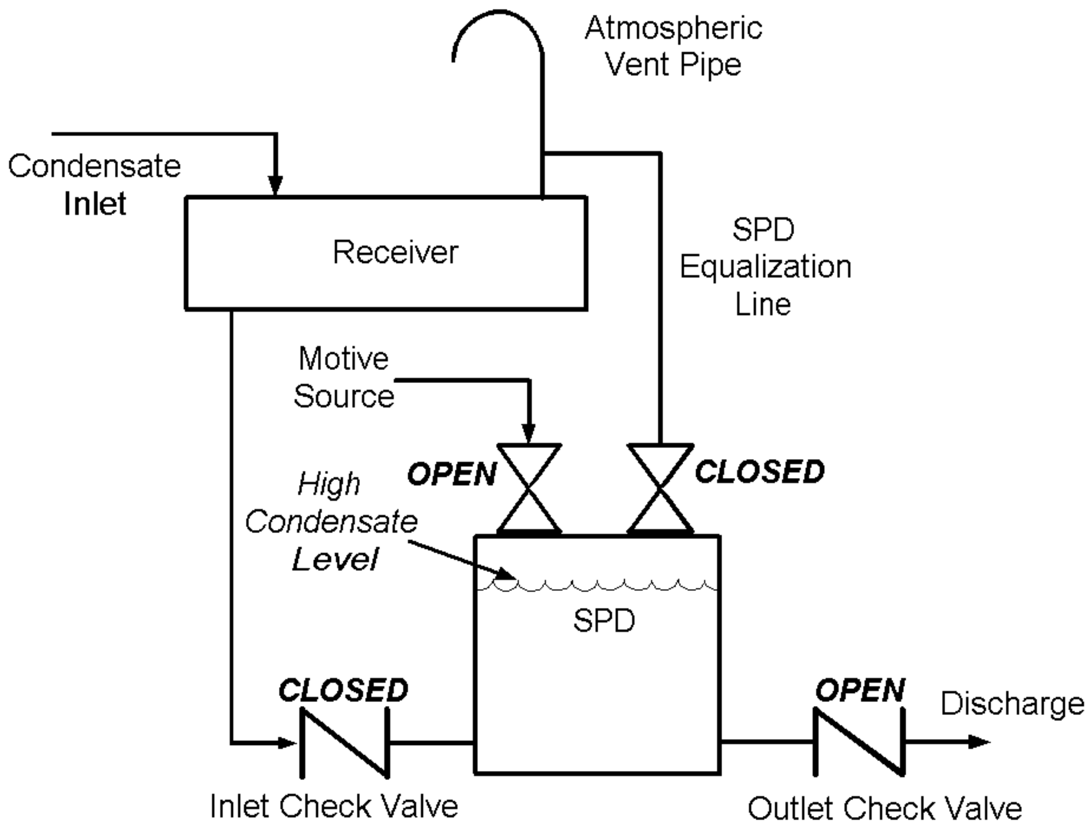

Fig. B Discharge Stage

Equalization Stage (See Figure C)

Activation of the motive and exhaust valve mechanism simultaneously closes the motive pressure valve and opens the exhaust valve, allowing the vessel pressure to equalize with the receiver. Once the pressure in the SPD is equalized with the receiver, the equalization stage ends allowing the complete SPD cycle to repeat itself. NOTE: The equalization and fill stages occur with the motive pressure and exhaust valves in the same position.

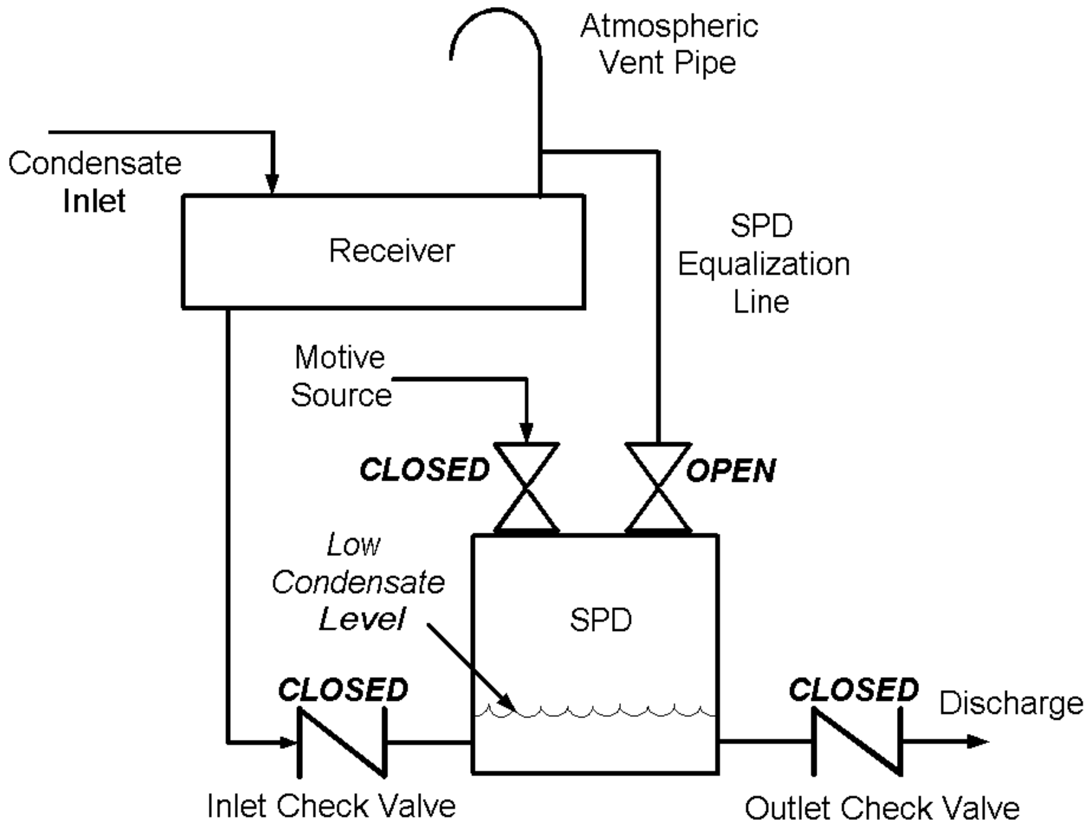

Fig. C Equalization Stage

Types of Systems

Atmospheric

If the condensate is being collected from steam traps draining multiple sources (such as steam-using equipment, steam mains, or tracers), normally a Type 1 SPD is used, and both the SPD and its receiver are vented to atmosphere. (see Figure D).

Proper vent pipe and receiver sizing are important design requirements. If the sizing of the atmospheric vent pipe is correct, the maximum pressure in the receiver and SPD vessels will be zero psig. If the vent line is too small and/or the receiver is too small, the receiver can become pressurized and condensate can either be unsafely discharged through the vent line, or back up into the steam-using equipment. Unsafe hot condensate discharge through the vent can cause harm to personnel near the vent opening, and back up into steam-using equipment can lead to wide temperature fluctuations, frozen steam coils, water hammer, thermal shock, erosion and/or corrosion of the equipment and downstream piping, and an array of other problems.

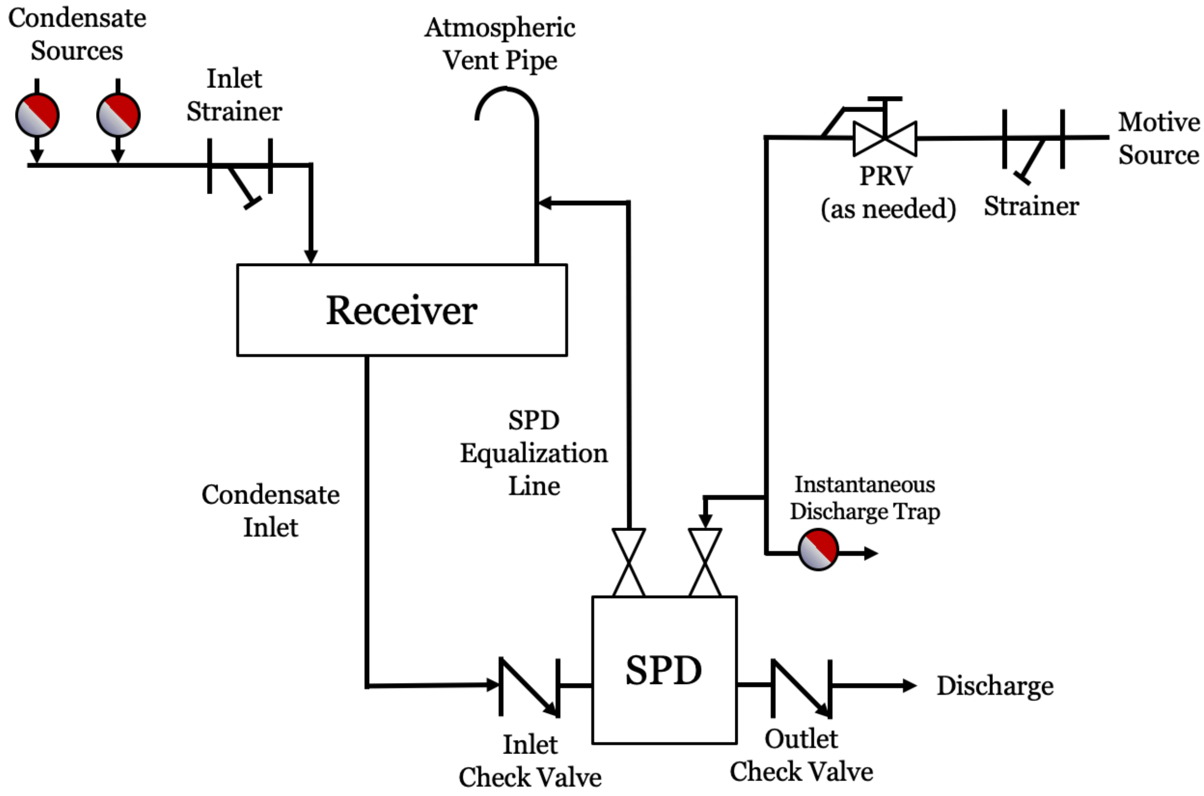

Fig. D. TYPE 1 SPD – Pumping Condensate from Atmospheric Systems

Sub-Atmospheric

An SPD can be closed to atmosphere and allow condensate to be drained and returned from a vacuum condition steam source under the correct set of conditions.

Sub-Atmospheric SPD installations require careful design to discharge into a condensate return line with a higher pressure than inside the steam space being drained. In certain instances, the installation can use a Type 1 SPD arranged similar to Figure E. The equalization line from the SPD connects to the reservoir. The equipment equalization line connects the reservoir to the steam-using equipment to provide free flowing vapor space. Incondensable vapor such as air may collect in the reservoir, which needs a vacuum removal capability for continuous SPD operation.

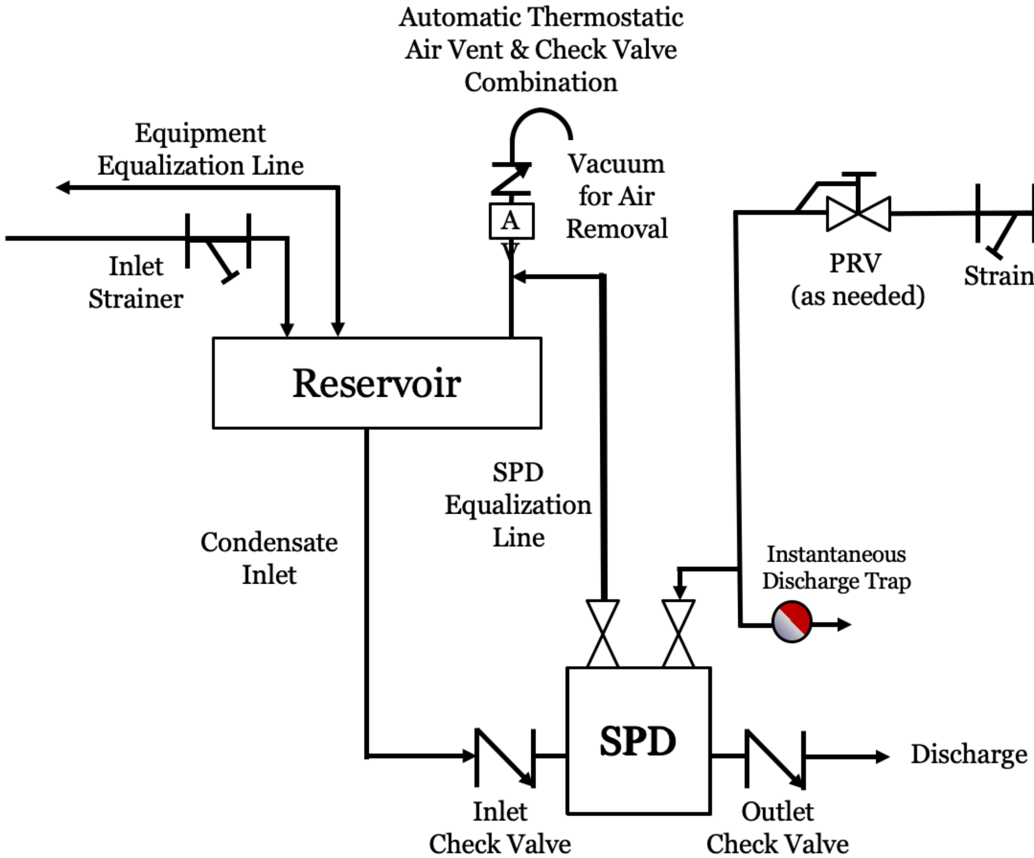

Fig. E. TYPE 1 SPD – Pumping Condensate from Sub-Atmospheric Sources

Non-Atmospheric

An SPD can be closed to atmosphere and allow condensate to be drained and returned from steam-using equipment with varying internal pressure that can at times be either higher or lower than the condensate line back pressure.

This type installation can use a Type 2 SPD arranged similar to Figure F. In this example, a separate automatic discharge valve is installed on the outlet side of the SPD. The valve can be installed either internal or external to the SPD. The automatic discharge valve is designed to allow only liquid to discharge and to prevent loss of steam.

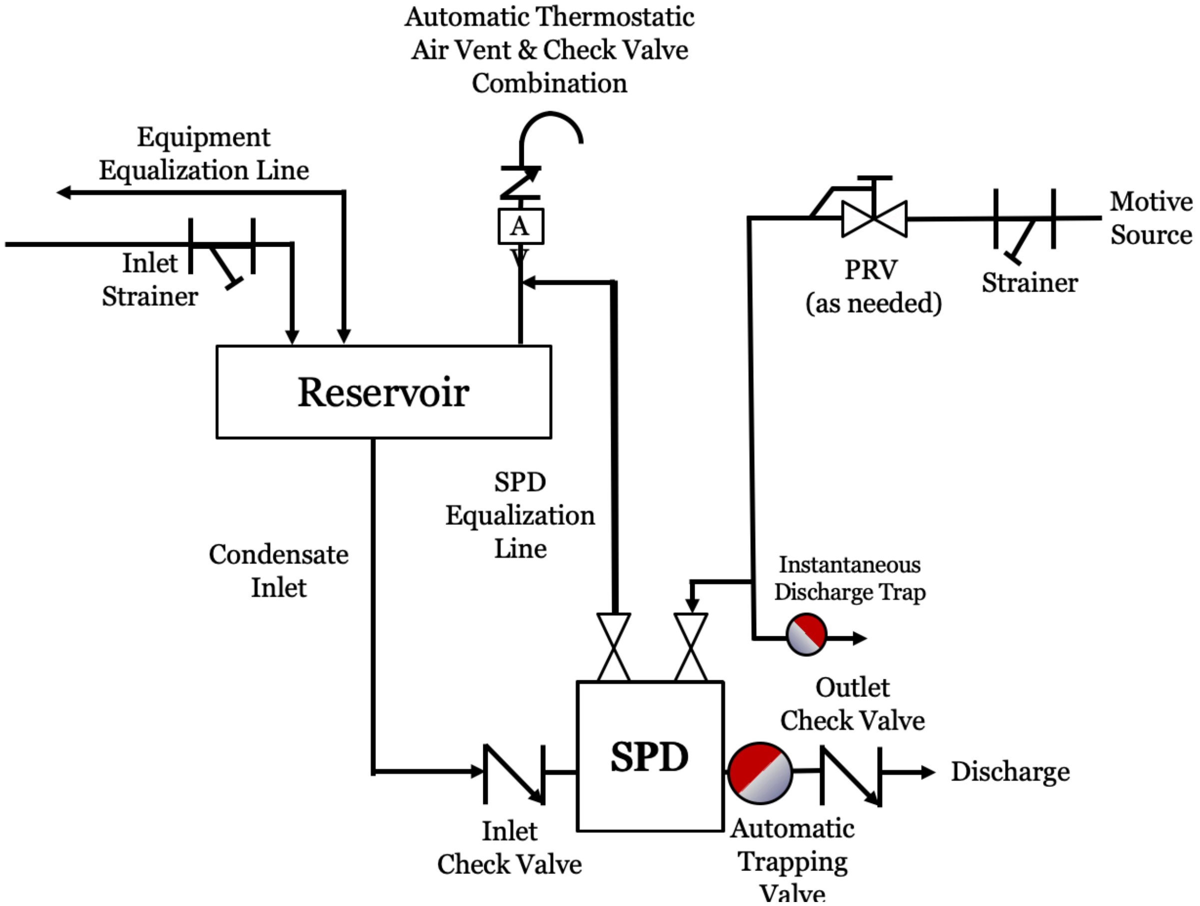

Fig. F. TYPE 2 SPD – Pumping Condensate and Preventing Steam Loss from Steam-using Equipment with Varying Internal Pressure

Installation Considerations

Fill velocity of incoming condensate can be increased by the distance the receiver/reservoir is above the SPD. This is known as "fill head." The pumping capacity of an SPD will change as the fill head changes. If all other factors remain the same, the higher the receiver is above the SPD, the faster it can fill. This can increase the maximum pumping capacity of the SPD. There is a limit as to the maximum fill head before no appreciable additional increase in capacity is achieved.

While the SPD is discharging condensate, the inlet check valve is held closed and the SPD cannot accept additional condensate during the discharge stage. However, more condensate may be generated during this stage, and this condensate must be collected, necessitating a receiver/reservoir of a size sufficient to hold this volume. This receiver/reservoir will keep the condensate out of the steam-using equipment (such as a heat exchanger), allowing for the best possible heat transfer. Further eliminating condensate backup minimizes water hammer, corrosion, and thermal shock.

Check valves are critical system components, and the selection of appropriate check valves is essential for proper operation of SPDs. Always use manufacturer's recommended check valves to ensure proper operation.

A high-quality motive medium, such as steam or air, is essential to proper operation. It is important for designers to exercise care in the proper straining of debris and draining of any liquid that might be present in the motive supply. A steam trap that instantaneously discharges condensate is recommended.

A Pressure Reducing Valve installed to reduce pressure in the motive supply may be useful to improve SPD operation. Consult manufacturer for design recommendations specific to the SPD selected.

Future articles will discuss the advantages of Secondary Pressure Drainers and typical applications. For typical use of Type 1 and Type 2 SPDs, refer to the following chart:

SPD Selection Guide Chart

Application		SPD Type
Condensate Recovery		Type 1
Equipment Drainage		
	Stall ≤ 150 psig	Type 2
	Stall > 150 psig	*Consult Manufacturer*

Appendix A

Glossary of Terms

Receiver - A properly sized fabricated tank or pipe used to collect condensate in atmospheric systems.

Reservoir - A properly sized fabricated tank or pipe used to collect condensate in non-atmospheric systems.

Atmospheric Vent Pipe - A properly sized and designed vent to handle flash steam.

Automatic Thermostatic Air Vent - An automatic valve to discharge air.

Stall - A condition in steam using equipment where the pressure differential from the steam using equipment outlet to the condensate return line has become negative. For further discussion of stall, see **FCI Tech Sheet # SPD 202**

SPD vs. Electric Centrifugal Condensate Pumps

	Comparison Topics	Electric Centrifugal Pumps		SPD Type	
	The following items are important system characteristics to compare when selecting from a choice of condensate drainage, pumping, or recovery product options	1750 RPM Pumps	3500 RPM Pumps	SPD I Pumps	SPD II Pump / Traps
DESIGN	Sizing Requirements	2 - 3x	2 - 3x	1x	1x
	Less sensitive to TDH variation		√	√	√
	Less filling height / static head required	√		√	√
	Relatively less sensitive to NPSHA			√	√
	Easily used in wet, hazardous & explosive external environments			√	√
	Sump Applications	√	√	√	√
	Hot condensate sump application			√	
	Most can operate without electricity			√	√
	Most can operate during localized electrical outages.			√	√
	Readily self adjusts to variations in back pressure.			√	√
	May require 240 / 480 volt electricity	√	√		
	Many units temperature limited to less than 200 ºF		√		
	Standard models capable of operating 212ºF & above			√	√
INSTALLATION	Generally single building trade required			√	√
	Can be insulated			√	√
	Flexibility in application/sizing			√	√
	Utilizes steam, air and inert gas – less expensive than electricity			√	√
	No seals, no motors, no impellers or electric components which frequently fail.			√	√
	Long life – less maintenance required.			√	√
	Can easily drain heat exchangers in a non-flash (closed loop) system.				√
	Lower spare part inventory required.			√	√
	Minimal assemblies required for spare parts – lower maintenance costs.			√	√
	Handles flash condensate			√	√
	Suitable motive pressure may not be available			√	√

	Comparison Topics	Electric Centrifugal Pumps		SPD Type	
	The following items are important system characteristics to compare when selecting from a choice of condensate drainage, pumping, or recovery product options	1750 RPM Pumps	3500 RPM Pumps	SPD I Pumps	SPD II Pump / Traps
	Discharge piping may require installing back pressure valve	√	√		

Tech Sheet #SPD 201

	Comparison Topics	Electric Centrifugal Pumps		SPD Type	
		1750 RPM Pumps	3500 RPM Pumps	SPD I Pumps	SPD II Pump / Traps
MAINTENANCE & OPERATION					
	Efficient operation through recycling of motive energy				√
	Generally low profile when properly installed	√		√	√
	Installed low cost option			√	√
	Very accepted in industries	√	√	√	√
	High level of repair knowledge required (high maintenance required)	√	√		
	Low NPSH pumps	√		√	√
	Replacement impellers	√	√		
	Requires sufficient NPSH	√	√		
	Extremely NPSH sensitive		√		
	Extremely TDH sensitive	√			
	Extensive requirements for NEMA VII / XII environments	√	√		
	Special requirements for high temperature environments	√	√		
	Requires sufficient fill height for gravity drainage			√	√
	Additional cooling may be required	√	√		
	Flash tank is always required	√	√	√	
	Requires two building trades – minimum	√	√		
	Don't insulate pump/receiver	√	√		
	Sized for specific narrow range of specific conditions (less flexibility)	√	√		
	Generally higher maintenance required	√	√		

* Check valves are critical system components related to capacity ratings, and the selection of appropriate check valves is essential for proper operation of SPDs. Always use manufacturer's recommended check valves to ensure proper operation.

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