PyroPure Multiple-Effect Stills

The Mueller PyroPure P6000 Series is Built to Last

Mueller PyroPure multiple-effect stills (MES) are the simplest, most reliable means of producing pyrogen-free water-for-injection (WFI) that meets all U.S. Pharmacopoeia requirements. The MES is designed with efficiency in mind. Because the system recovers the latent heat of vaporization occurring within its own process to heat feedwater and uses feedwater as its primary source of cooling, the MES is an energy and money-saving model of ingenuity. Due to the absence of moving parts, the PyroPure MES requires less maintenance and is much quieter than mechanical compression stills. Multiple-effect stills also lack the seal and associated oil supply required by mechanical compression stills; therefore, there is no danger of contamination due to seal breakdown associated with mechanical compression. The PyroPure MES is manufactured according to FDA current Good Manufacturing Practices (cGMPs) and ASME-BPE requirements.

Each PyroPure MES is designed to minimize operating costs associated with production of WFI by minimizing the required utility steam and coolant consumption. This is accomplished by utilizing sources of energy within the various process streams to preheat the feedwater and thus use the feedwater as a cooling source. Using the feedwater as a coolant source also reduces the utility steam consumed to elevate the temperature of the feedwater. The feedwater ultimately enters the tubes of the first effect evaporator where utility steam is applied to the shell to evaporate the feedwater. The resulting steam produced is then directed to the separation column where a tangential inlet produces centrifugal force that separates the entrained water droplets away from the pure steam. This pure steam is then used as the heating source for the subsequent effect.

Simple Design, Reliable Operation

- External evaporators access for inspection and preventative maintenance on critical o-rings and gaskets.
- The separation columns contain no internal components that require inspection or periodic maintenance.
- All maintenance, including replacement of critical components, can be performed with only 24" of space on all sides (including the top) of the equipment.
- ASME-BPE certified fittings are used throughout.
- WFI condensers have removable tube bundles for easy cleaning and inspection of product contact surfaces.
- Minimal instrumentation is required upon operation of the equipment. Only two control loops are needed which minimizes the calibration required as well as the potential for downtime.
- All elastomers in contact with feedwater and product are provided with USP Class VI certifications.
- All components are fully drainable including the optional feedwater pump.

As the pure steam is condensed in the shell side of the subsequent evaporator, the resulting WFI flows through feedwater preheating devices and to the WFI condenser for subcooling to the required product temperature. Only pure steam discharged from the last effect of the still is condensed in the product condenser. The final product as well as the feedwater supplied to the still is measured for conductivity to ensure compliance with specifications.

Control of the multiple-effect still is accomplished by two control loops. The first control loop monitors the first effect temperature and manipulates the plant steam control valve as needed to maintain the specified temperature. The second control loop monitors the product temperature and manipulates a coolant control valve to maintain the specified product temperature. Level switches in the separation columns provide control for the feedwater supply and provide alarm capabilities to ensure that all effects are operating correctly. The control and operational simplicity results in a design that requires no rotating equipment, flow measurement devices or pressure transmitters.

Models are available with 3 to 6 effects to provide the best solution for your application. Additional effects will result in further reduced utility consumption while a minimum of effects will provide the lowest capital cost solution and occupy the smallest footprint. All product contact surfaces are polished to 20 Ra maximum and electropolished. Surfaces in contact with feedwater are polished to 25 Ra maximum. All surfaces in contact with feedwater and product are manufactured from 316/316L stainless steel.

System Components

Condenser. PyroPure condensers have a double-tube-sheet design that provides users with the efficiency of heat exchange and at the same time ensures that pure vapor and distillate will never come into contact with feedwater and coolant. To facilitate maintenance, all PyroPure condensers are mounted at an angle to allow full drainage of the pure distillate through the distillate outlet port installed at the lowest point of the vessel. The condenser is designed to allow the removal of the U-tube bundle, making it easy for the user to inspect the critical pure distillate contact surfaces.

Controls. The standard control system is an Allen Bradley PLC with an Allen Bradley operator interface mounted in a NEMA rated panel. Ethernet is provided on the standard control system to facilitate communications with adjacent equipment or data archiving systems. Mueller can also provide other Allen Bradley control components, as well as control systems from Siemens and Mitsubishi. Control and electrical panels are supplied with a UL 508a label.

Steam Separator. Mixture of water and vapor leaves the evaporator at high velocity and enters the separator through a tangential port, a natural vortex is formed. The centrifugal force of the vortex separates water droplets and contaminants out of the spiraling vapor. Pure vapor rises up through the steam separator and out of the port at the top of the separator. The steam separator has no baffles or demister, there are no auxiliary surfaces for condensation to collect and stagnate. Concerns over the potential for bacterial growth are eliminated.

Preheaters. Each still is equipped with a preheater for each effect to provide for maximum energy recovery and efficiency. As the water flows under pressure from each effect to the next the pressure of the water is reduced which will result in “flashing” of the water into steam. The preheater recovers this energy into the feedwater to reduce the overall plant steam consumption.

Evaporator. The natural circulation design of the PyroPure evaporator ensures maximum surface wetting, eliminating the hot, dry areas that lead to the stress-cracking associated with other designs. The tube bundle creates a large heat transfer surface which vaporizes feedwater on contact. The PyroPure multiple-effect still has fully drainable external evaporators, eliminating the need for the excess headroom required for evaporator removal with other designs. The evaporator on the first effect of the multiple-effect still is double tube-sheet to prevent cross-contamination. All other effects have single-tubesheet evaporators.

Options

Feedwater Pump System. The feedwater pump system enhances feedwater pressure and is required if feedwater supply pressure is not equivalent to the plant steam pressure. When purchased, the feedwater pump system will be installed on the MES framework.

Pure Steam Option. Multiple-effect stills can be configured to produce pure steam from the first effect. Simultaneous WFI and pure steam production is also available.

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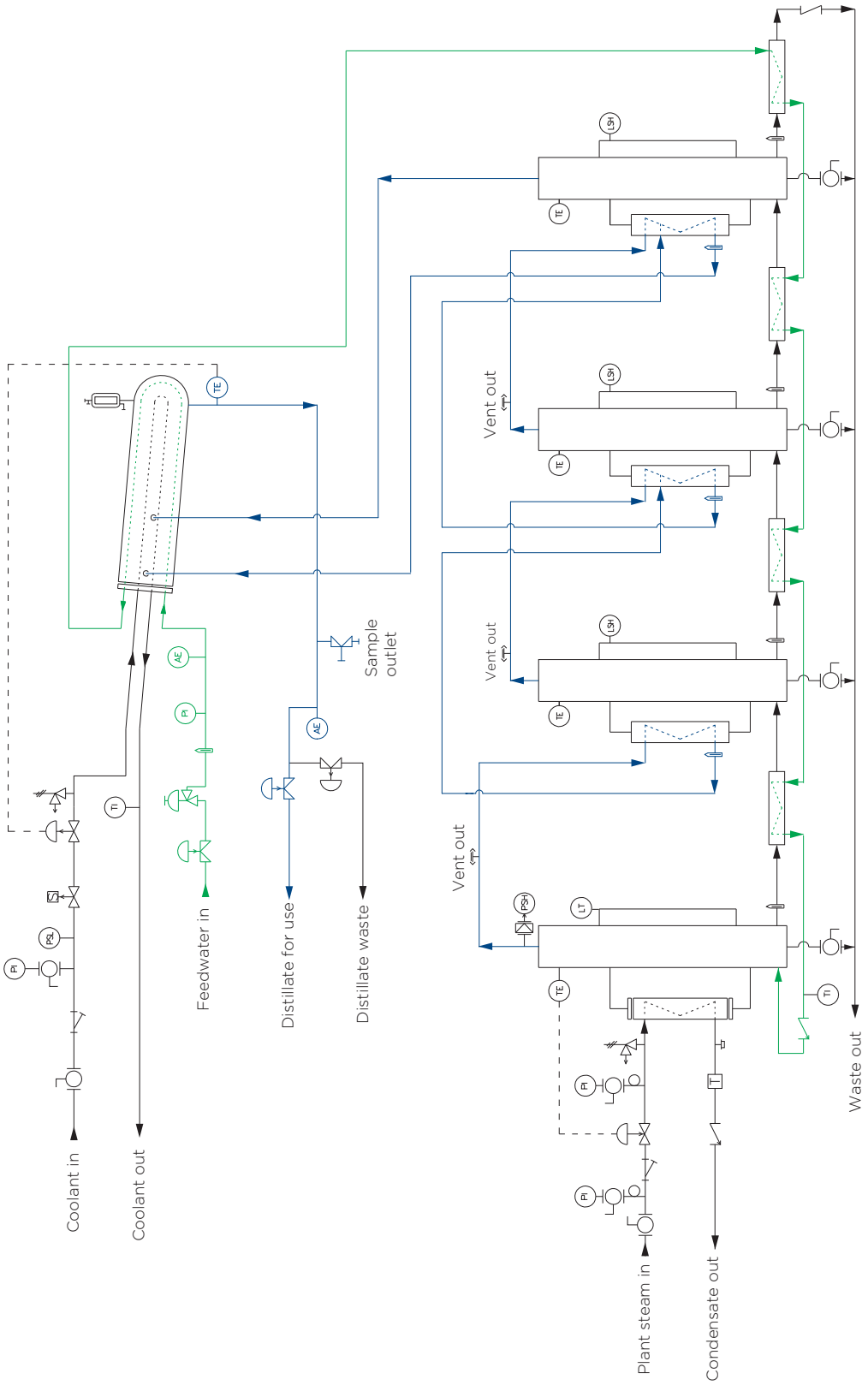
Schematic of Operation



Specifications

Plant Steam (psig): 110 • Distillate (°F): 190 • Feedwater (°F): 75 • Coolant Inlet (°F): 60

	Capacity[1]		Supply Steam[2]		Coolant Supply[3]		Approximate Dimensions		Distillate Outlet Ht		Est. Weight	
Model	gph	lph	lb/hr	kg/hr	gph	lph	HxWxD (in)	HxWxD (cm)	in	cm	lb	kg
MES 6009-3	90	341	345	156	214	810	113x62x40	287x157x102	90	229	2,500	1,135
MES 6015-3	165	625	625	283	424	1,604	114x62x40	290x157x102	89	226	3,050	1,385
MES 6015-4	150	568	467	212	267	1,011	114x75x40	290x191x102	89	226	3,200	1,453
MES 6015-5	140	530	382	173	185	702	114x88x40	290x224x102	89	226	3,350	1,521
MES 6032-4	305	1,154	958	435	569	2,155	112x80x45	284x203x114	85	216	3,600	1,635
MES 6032-5	275	1,041	753	342	382	1,447	112x94x45	284x239x114	85	216	4,100	1,861
MES 6032-6	240	908	593	269	256	969	112x108x45	284x274x114	85	216	4,600	2,088
MES 6040-5	400	1,514	1,060	481	544	2,059	112x94x45	284x239x114	85	216	4,400	1,998
MES 6040-6	390	1,476	922	418	408	1,544	112x108x45	284x274x114	85	216	4,800	2,542
MES 6064-4	630	2,385	1,926	874	1,169	4,425	128x100x52	325x254x132	102	259	4,900	2,225
MES 6064-5	600	2,271	1,554	705	811	3,070	128x119x52	325x302x132	102	259	5,600	2,543
MES 6064-6	500	1,893	1,198	543	542	2,052	128x138x52	325x351x132	102	259	6,300	2,860
MES 6076-5	690	2,612	1,811	822	945	3,578	131x119x52	333x302x132	102	259	6,800	3,087
MES 6076-6	660	2,498	1,557	706	706	2,671	131x138x52	333x351x132	102	259	7,500	3,405
MES 6110-5	1,100	4,163	2,393	1,085	1,896	7,176	136x147x53	345x373x135	107	272	12,100	5,494
MES 6110-6	1,070	4,050	2,055	932	1,558	5,897	136x168x53	345x423x135	107	272	15,000	6,810
MES 6140-6	1,300	4,921	2,467	1,119	1,877	7,105	151x184x58	384x467x147	117	297	16,400	7,446
MES 6175-6	1,810	6,852	3,423	1,553	2,642	10,001	180x184x58	457x467x147	145	368	16,800	7,620
MES 6200-6	3,200	12,112	6,126	2,779	4,797	18,157	155x209x64	394x531x163	113	287	34,500	15,649
MES 6300-6	3,700	14,004	7,060	3,202	5,547	20,994	188x192x64	478x488x163	87	221	56,500	25,628

[1] Distillate 170°F (77°C) to 190°F (88°C) (customer determined). Gravity flow.

[2] Plant steam 110 to 125 psig (7.6 to 8.6 bar) dry and saturated (capacity based on 110 psig).

[3] Coolant water at 32°F to 100°F (0°C to 38°C) at 40 psig (2.8 bar) (flow rates based upon a distillate outlet temperature of 190°F [88°C] and cooling water inlet temperature of 60°F [16°C] and cooling water outlet temperature of 160°F [71°C]).

Additional requirements:

- *Feedwater: Feedwater supply 10 percent over distillate capacity. If feedwater pressure is less than plant steam pressure, a feedwater booster pump may be required. (Max. of 1 ppm silica or total hardness. No chlorine, chlorides, or amines.)*
- *Electrical Service (Standard): Without pump: 115 VAC, single phase, 60/50 Hz; with pump 460 VAC, 3 phase, 60Hz.*