



CONTROL FACTORS

Steam & Filtration Specialists

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Maxi-Therm's principal design revolves around the utilization of uncontrolled high-pressure steam within a vertical flooded u-tube heat exchanger (HX), where water flows through the tubes and steam in the shell. This innovative idea offers several advantages:

1. **Elimination of Pressure Reducing Valve Stations and Safety Relief Valves:** By leveraging high-pressure steam directly into the flooded HX, there's no need for steam pressure reducing valve stations or safety relief valves with vents to the roof. This simplifies the system architecture and reduces maintenance requirements.
2. **Prevention of Flash Steam losses:** The flooded HX is meticulously sized to ensure it remains flooded even during full load operation, maintaining the condensate outlet temperature below 200°F. This eliminates the occurrence of flash steam and negates the necessity for a flash tank with a vent.
3. **Precise Control with Electric Actuated Condensate Control Valve:** Our system incorporates an electric actuated condensate control valve to modulate the condensate flood level within the HX, based on the temperature of the hot water outlet. This ensures optimal heat transfer efficiency and provides at or below +/- 2 Degrees of set point.
4. **Efficient Heat Extraction:** The interface between steam and water inside the HX allows for precise control over the exposure of the tube bundle to live steam. This enables efficient extraction of both latent heat from steam as it changes phase and sensible heat from the condensate, resulting in maximized BTU extraction per pound of steam.
5. **Motive Force for Condensate Return:** The high-pressure steam within the HX generates a motive force on the sub-cooled condensate return line, overcoming any backpressure and facilitating the lift of condensate back to the boiler plant or condensate receiver without the need for condensate pumps.
6. **Condensate Mixer for Simplified Return Line:** Additionally, our system includes a condensate mixer, enabling connection of high-pressure steam (HPS) drip legs within the mechanical room to the sub-cooled condensate return line for a single line return setup.
7. **Prevention of Corrosion:** Operating on a flooded basis ensures that the system never operates under a vacuum. This reduces the amount of oxygen exposure, which is known to produce carbonic acid and contributes to corrosion on condensate return lines. Furthermore, the flooded HX design reduces thermal stress on the tube sheet, extending the lifespan of the HX.

In essence, our principal design not only streamlines system architecture and maintenance but also enhances efficiency, control, and longevity while mitigating corrosion risks, providing a comprehensive solution for steam to hot water applications.

◆ Operation Sequence:

Upon initial startup or a return to normal operation due to shut down, the unit follows a systematic sequence:

1. **Valve Positioning and Flow Verification:**
 - All valves start in the closed position.
 - The water flow sensor awaits confirmation of meeting the minimum flow requirement.
2. **Steam Introduction:**
 - Once flow is confirmed, the small steam bypass valve opens, equipped with an orifice plate to regulate the steam flow.
 - The steam, upon entering the HX, rapidly condenses due to the cold water flowing through the tubes, initiating the filling of the HX with condensate.

3. **Condensate Level Monitoring:**

- As condensate accumulates, surpassing the top of the tubes within the HX, it reaches the drip trap line equipped with a thermostatic trap, akin to an end-of-main drip.
- Pressure begins to build within the HX between the condensate level and the closed main steam butterfly valve.

4. **Transition to Main Steam Operation:**

- Once the pressure within the HX approaches that of the main steam line, the small bypass valve closes.
- Simultaneously, the main steam butterfly valve opens, initiating the transition to main steam operation.
- The condensate control valve commences modulation to maintain the outlet hot water set point selected for optimal system operation.

5. **Ramp Mode Activation:**

- The system initiates in ramp mode to gradually elevate the heating system's temperature.
- This gradual approach ensures uniform warming of the piping throughout the entire building, optimizing system performance.

6. **Dual System Configuration for Complete Redundancy:**

- Our DMCU dual skid setup ensures unparalleled reliability by offering redundant heat exchangers (HXs), condensate control valves, stabilizing lines, and control panels. This design philosophy guarantees operational continuity even in the event of component failure.
- Under normal circumstances, water circulates through a single heat exchanger at any given time. The system includes automatic isolation valves, allowing for the selection of the active heat exchanger. The primary heat exchanger can be switched either manually (both locally and remotely) or automatically at predetermined intervals (set by default to every 7 days), with the timing of the next switch clearly indicated on the Lead/Lag module interface. The current operational status (Lead or Stand-by) is prominently displayed.
- Should the currently active Lead heat exchanger experience a malfunction for a continuous period of 10 minutes, an automated transition will initiate, either activating the Stand-by unit or reverting to the previous Lead unit, thereby ensuring uninterrupted operation.
- The system is designed to activate the Lag Assist feature under two specific conditions, enabling the Stand-by HX to support the Lead HX when needed: 1) The CV1 Condensate Valve remains over 80% open for 10 or more minutes, indicating excessive demand, or 2) The liquid flow through the Heat Exchanger approaches 90% of its maximum designed capacity.

By following this meticulously planned sequence, the system ensures smooth and efficient operation, while also safeguarding against potential issues during startup or normal operation.

◆ **Energy Savings:**

- Maxi-Therm excels in conserving energy by optimizing steam utilization for any required BTU load. Leveraging the latent heat of steam, which increases at lower pressures, alongside the sensible heat of condensate, our system delivers exceptional efficiency. For instance, comparing a 10-psi system to a 100-psi system reveals a substantial difference: the 10-psi system utilizes 953 Btu/lb while the Maxi-Therm system only requires 1019 Btu/lb, resulting in a notable 7% increase in efficiency.
- Furthermore, our design minimizes losses associated with flash steam generation. Traditional systems typically lose 3% of condensate as flash steam at 10 psi, necessitating water makeup and heating. By discharging condensate directly into the main return line, Maxi-Therm eliminates this need, avoiding additional energy consumption and treatment costs.
- Moreover, our system's design ensures that condensate remains uncontaminated by air, as it is not exposed to vented receivers or vacuum breakers. This not only eliminates the need for additional treatment but also results in significant savings in boiler treatment chemicals, tailored to each site's requirements.
- The Maxi-Therm unit guarantees precise temperature stability within $\pm 2^{\circ}\text{F}$ of the setpoint, preventing wasteful temperature overshooting or hunting by control valves, thus optimizing energy usage.
- Additionally, our innovative Maxi-Therm Condensate Mixer eliminates vent losses from steam traps, enabling efficient recovery of flash steam from both working and failed traps. This recovery mechanism significantly

contributes to energy savings, as demonstrated by quantifiable examples, such as recovering flash steam from high-pressure drip traps. Overall, these energy-saving features make a substantial impact on operational efficiency and cost reduction.

◆ **Maintenance Savings:**

- The Maxi-Therm system significantly reduces the need for maintenance and equipment replacements. Without the need for a Pressure Reducing Valve Station, the common maintenance issues associated with it—such as failed pilots, dirt accumulation, wear and tear on the seat and plug, diaphragm replacements, pilot replacements, wire drawing, noise issues, leaking isolation valves, leaks at fittings, safety valves malfunctions, and the logistical challenges of scheduling shutdowns for repairs, not to mention the inventory of spare parts—are all avoided. This simplification results in direct maintenance budget and inventory savings.
- Additionally, Maxi-Therm eliminates the need for a condensate pump station, sidestepping the typical issues that come with such systems. These include pump wear, overheating of condensate, seal leaks, potential room humidification from vents, improper disposal of condensate by maintenance staff, lack of maintenance on parts, and the costs and logistics of expedited shipping for replacements. The maintenance headaches and expenses associated with both duplex and pressure motive pumps, from mechanism malfunctions to costly rebuild kits, are effectively removed from the maintenance budget.
- The Maxi-Therm unit's tube bundle is designed for ease of maintenance and durability. With heavier gauge copper tubes (0.049" wall), our units are resistant to water hammer damage that often plagues standard heat exchanger units. This design choice not only ensures longevity but also facilitates easy maintenance or tube replacement when necessary. The static steam flow and saturated steam/condensate interface in a Maxi-Therm unit prevent the common damages seen in conventional systems, such as water hammer impact and damage at the steam entry points.
- Maxi-Therm opts for a minimalistic approach by using a single, small-sized ½" to ¾" fail-safe control valve on the condensate side instead of multiple steam control valves. This valve is not only smaller and less prone to issues like wire drawing but also contributes to longer-lasting condensate piping, as it avoids exposure to carbonic acid and oxygen pitting. This thoughtful design further reduces maintenance requirements and extends the system's lifespan, leading to additional savings.

◆ **Streamlined Design:**

- By eliminating steam Pressure Reducing Valve (PRV) stations, Safety Relief Valves (SRV) vented to the roof, Heat Exchanger (HX) controlling valves, flash tanks with vents, condensate pumps, and associated piping, valves, and traps in the mechanical room, our design simplifies your infrastructure. This reduction in components decreases complexity and lowers overall yearly equipment maintenance requirements.

◆ **Optimized Space Utilization:**

- Experience a significant reduction in mechanical room size, leading to minimized space requirements and lower construction costs. This makes our solution ideal for retrofitting existing systems and integrating into new installations.

◆ **Efficient Operation:**

- Our system operates efficiently by utilizing smaller pipe sizes and fewer components, which reduces material costs and installation time while maximizing energy efficiency. The small ½" condensate control valve, serves as the sole modulating part in our system, with all other valves either fully open or closed. This design minimizes maintenance requirements, and we offer a 5-year warranty on this valve for added assurance.

◆ **Cost-Effective Solution:**

- Benefit from annual energy savings over the equipment's lifespan, with great Return on Investment (ROI) potential compared to standard conventional systems. The efficiency gains achieved with Maxi-therm flooded heat exchangers translate into substantial cost savings, reducing operating costs in the long term.

◆ **Simplified Installation:**

- Our skid systems come factory pre-wired and tested prior to shipment, requiring only five connections for installation. This reduces labor hours, materials costs, and commissioning expenses.

◆ **Advanced Safety Features:**

- Our state-of-the-art design emphasizes safety without compromising efficiency. We offer tailored skid systems to accommodate specific pressure and temperature needs, even for applications involving superheated steam.
- Our heat exchanger (HX) boasts ASME Code stamping and TEMA rating, showcasing 90/10 CuNi tubes with a .049" wall thickness, backed by a comprehensive 10-year warranty.
- Furthermore, our skid systems can include full skid UL stamping and Seismic certifications upon request.
- Automatic condensate shut-off valve activates if condensate temperature reaches the flash point, ensuring heightened safety measures. This comprehensive offering provides building operators with unparalleled peace of mind.

◆ **Seamless Integration:**

Our system features pre-programmed and pre-wired touch screen controls, ensuring effortless integration into your building automation system. The user-friendly touchscreen interfaces facilitate easy monitoring and control, with BACnet IP or MSTP built-in, alongside hard-wired control points. We provide the HMI graphics files to be used to build the remote interface at your BMS for easier integration.

The NEMA 4 UL approved control panel is pre-programmed to handle start-up, shut down procedures, and alarm management. It includes:

- A programmable controller with an optimal Lead/Lag control sequence exclusive to Maxi-Therm.
- Factory wiring to all sensors and valves.
- Color HMI with an intuitive, user-friendly graphic interface offering different user access levels.
- Access via the building automation system to all parameters for remote monitoring and control.
- Availability of communication protocols such as BACnet (IP and MSTP), LON, Modbus (MTU and TCP).
- Secure remote access capabilities (ISO 27001 and ISECOM STAR certified), with internet connectivity requiring an ethernet cable provided by the customer for remote troubleshooting and monitoring.
- Continuous display and data logging of crucial parameters like temperatures, pressures, flow rates, valve positions, and heat transfer rates.
- Pre-programmed and adjustable alarms for various conditions such as liquid outlet high/low temperatures, condensate outlet high temperature, high/low liquid flow, and high steam pressure. Standard sensor/valve failure alarm is also included.
- An outside disconnect switch allows local power shutdown before opening the panel door.
- Integral network switch and 120V power supply receptacle for easy laptop connection for tech support. The laptop can be plugged in with the control panel door closed for enhanced safety.
- Automatic return to the last known state after a power outage ensures uninterrupted functionality.

◆ **Data-driven Insights:**

- Track flow, temperature, valve position, and BTU consumption with detailed data logging and analysis capabilities. This enables informed decision-making and optimization of system performance.

◆ **Reliability Guaranteed:**

- UPS power backup and electrical surge protection as standard features, ensure uninterrupted operation and system reliability even during power surges.

◆ Minimized Environmental Impact:

- Maxi-therm is dedicated to sustainability, placing it at the core of our mission. Through enhanced energy efficiency, our heat exchangers actively lower greenhouse gas emissions, assisting organizations in reaching their environmental objectives with clean and eco-conscious technology.
- By gradually integrating flooding design throughout the entire campus, you'll establish a 100% steam and condensate closed loop. This initiative significantly diminishes surface blowdown, reduces chemical costs, and minimizes water treatment needed for boiler operation, potentially eliminating the necessity for a deaerator altogether.

Maxi-Therm units not only deliver cost savings in conventional applications but also play an integral role in what we regard as the most advanced and energy-efficient steam plant concept ever developed.

- Recently, Maxi-Therm submitted its sixth patent application for a groundbreaking 95% steam generation system coupled with a 100% steam and condensate closed-loop distribution design. The cornerstone of this system lies in the capability of Maxi-Therm heat exchangers to generate cool condensate. Beyond just eliminating flash steam losses, this cool condensate can be effectively utilized within the boiler room to harness waste heat.
- In alignment with recommendations from the U.S. Department of Energy (energy.gov), we adhere to guidelines to preheat combustion air for feeding high-efficiency natural gas burners, recover heat from steam vents and blowdown, and incorporate a two-stage condensing boiler stack economizer. This economizer, cooled by low-temperature condensate, enables us to achieve an outstanding overall boiler efficiency exceeding 95%. Remarkably, all of these advancements are achieved using well-established, existing equipment in the central plant.
- We encourage you to explore the implementation of our distinctive and dependable concept in your facility. We eagerly anticipate collaborating with you and your engineering and contracting partners to assess the potential return on investment achievable through Maxi-Therm and steam compared to traditional steam or hot water systems.

High Efficiency Closed-Loop Steam System

