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RENEWABLE SOLUTIONS



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Aqua GWPrime HP

Modular CO2 Heat Pump for Heating and Domestic Hot Water

Specifications - V1.0

Specification

General

1. The chiller shall be designed to operate with R744 (CO_2) refrigerant, a natural refrigerant with low Global Warming Potential (GWP), to meet environmental and regulatory standards.
2. The chiller shall be capable of providing hot water output up to 180°F with a temperature differential of up to 60°F, enabling it to support high-temperature applications.
3. The chiller shall be able to provide simultaneous cooling and heating, allowing the production of both chilled water and domestic hot water (DHW) as required.
4. The chiller shall be capable of providing simultaneous variable heating and cooling capacities, allowing flexible performance based on the building's demand.
5. The chiller shall support multiple operating modes, including:
    a) **Cooling-Preferred Mode:** In this mode, the chiller prioritizes cooling capacity to achieve maximum Energy Efficiency Ratio (EER) while simultaneously providing hot water for either space heating or domestic hot water applications.
    b) **Heating-Preferred Mode:** In this mode, the chiller maximizes heating capacity and efficiency (COP) to meet high heating demand while also producing chilled water to support cooling applications as needed.
    c) **Domestic Hot Water (DHW) Mode:** In this mode, the chiller shall operate at maximum capacity and efficiency to produce domestic hot water while also providing chilled water for cooling applications.

Mechanical

1. The chiller shall utilize Flanged or grooved-type water connections that allow for the quick connection of valves and accessories, enabling faster installation and maintenance.
2. The chiller shall include fast-acting valves on the evaporator and gas cooler heat exchangers. These valves shall modulate within 40 seconds or less in response to the chiller controller to maintain precise temperature control while safeguarding

compressor security. The valves shall also function as the first stage of compressor envelope protection.

3. The chiller shall be equipped with temperature sensors on the inlet and outlet piping of the hot and chilled water circuits to monitor return and supply temperatures and accurately control water temperatures.

4. As a safety feature, the chiller shall have flow switches installed on both the chilled water and hot water circuits. The flow switches shall prevent the compressor from operating unless both switches are activated, ensuring adequate water flow and protecting the system from potential damage.

Refrigeration

1. Compressor Configuration:

    a) The chiller shall feature two tandem CO_2 semi-hermetic transcritical reciprocating compressors to handle high-pressure refrigerant demands.

    b) The lead compressor shall operate with variable speed control, modulating between 100% and 50% capacity to provide precise cooling and heating control. Additional compressors shall operate at fixed speeds to maintain efficiency and load flexibility.

2. Heat Exchangers:

    a) The chiller shall have a brazed plate gas cooler, subcooler, and evaporator for efficient heat exchange performance.

    b) All brazed plate heat exchangers shall be constructed from 316 stainless steel for corrosion resistance and durability.

    c) The heat exchangers shall be designed, tested, and stamped in accordance with UL 60335-2-40 and rated for a working pressure of 1830 psig to meet the high-pressure requirements of CO_2 refrigerant.

3. The chiller shall include an electric expansion valve (EEV) to provide precise refrigerant flow control, optimizing efficiency and performance in varying load conditions.

4. Each refrigeration circuit shall operate independently, allowing the chiller to continue running even if one or more circuits fail. This redundancy ensures continuous operation and increases system reliability.

5. The chiller shall be equipped with comprehensive protection and safety features, including:
    a) High and low-pressure protection to prevent operation outside safe pressure limits.
    b) Temperature sensors and pressure transmitters at key points in the refrigeration circuit for accurate temperature monitoring.
    c) Crankcase heaters to prevent refrigerant migration and maintain proper oil temperature during low-ambient conditions.
    d) Anti-short cycling protection to avoid frequent compressor restarts and extend compressor life.
    e) Phase loss and reverse phase protection to prevent damage from electrical anomalies.
    f) Suction accumulator to prevent liquid refrigerant from entering the compressor.
    g) Liquid receiver for storage of excess refrigerant during varying operating conditions.
    h) Shut off valves to isolate the compressor assembly for maintenance purposes.
    i) Schrader valves on various parts of the refrigeration circuit for pressure measurement and servicing.
6. The chiller shall incorporate an oil separator and a comprehensive oil management system for all compressor assemblies, ensuring consistent oil distribution and return, especially under variable load conditions.
7. The chiller shall have factory-tested refrigeration circuits, and quality control reports shall be available to verify performance and integrity upon request.

Electrical

1. The chiller shall be ETL listed in accordance with UL Standard UL 60335-2-40 for safety in heating and cooling equipment applications.
2. The chiller shall be factory-wired and control-tested before delivery, ensuring that all electrical and control connections meet manufacturer standards and function correctly.
3. The chiller shall be factory-charged with R744 refrigerant and undergo comprehensive testing to verify system performance and leak integrity before shipping.
4. The chiller shall be designed for a three-phase power supply (e.g., 480V/3-phase/60Hz or 575V/3-phase/60Hz) with voltage and frequency specifications customized to meet project requirements.
5. The chiller shall include a factory-installed control circuit transformer to step down the primary power supply voltage to the control circuit voltage, ensuring the safe and reliable operation of the control system.
6. The chiller shall be equipped with internal overcurrent protection for each compressor, fan motor, and auxiliary component, ensuring protection against electrical overload and compliance with safety standards.
7. The chiller shall include a lockable main power disconnect switch that isolates the unit from the power source, providing a secure method for maintenance personnel to shut off power safely during service operations.

Controls

1. Each chiller shall have an advanced controller capable of monitoring, calculating, controlling, and reporting key parameters to ensure efficient and safe operation. The controller shall provide real-time data and control over the following:

    a) Suction Temperature, Pressure, and Superheat: Monitors suction conditions to ensure optimal refrigerant vapor intake and prevent compressor damage.

    b) Discharge Temperature, Pressure: Controls discharge parameters to maintain system efficiency and protect compressor integrity under varying load conditions.

    c) Liquid Temperature, Pressure, and Subcooling: Manages liquid line conditions to enhance refrigerant subcooling, improving cooling capacity and overall system performance.

d) Evaporator Outlet Temperature, Pressure, and Superheat: Monitors evaporator conditions to ensure stable refrigerant flow and prevent liquid refrigerant from entering the compressor.

2. The chiller controller shall monitor and control the gas cooler pressure through an intelligent sequencing algorithm that optimizes compressor efficiency. The controller shall enhance overall performance and energy savings by adjusting gas cooler pressure based on system demands and ambient conditions.
3. The chiller shall feature subcooler superheater control to maximize system efficiency and safety, prevent excess refrigerant vapor, and ensure efficient refrigerant usage.
4. Flash gas controls shall be included to manage refrigerant expansion, optimize efficiency, and maintain stable operation across different operating conditions.
5. Compressor Staging, Modulation, and Envelope Protection:

    a) The controller shall manage compressor staging and modulation to balance load demand and maximize efficiency. Based on load requirements, it shall determine the optimal number of compressors to activate, ensuring energy-efficient operation and reducing wear on individual compressors.

    b) Compressor envelope protection shall be integrated to prevent operation outside safe pressure and temperature limits, protecting compressor components from potential damage.

6. Capacity Sequencer for Multi-Chiller Systems:

    c) In installations with multiple chillers, the main chiller shall include a capacity sequencer to manage all compressors across all circuits, ensuring optimal system-wide efficiency, redundancy, and load balancing.

    d) The sequencer shall provide lead-lag functionality to distribute compressor usage evenly, preventing overuse of any single compressor and extending the lifespan of each unit.

    e) The capacity sequencer shall dynamically adjust capacity across the system to meet fluctuating demand, reducing energy consumption during partial load conditions while ensuring sufficient capacity during peak demand.

7. The chiller/heater shall feature a standalone controller with embedded Modbus and BACnet communication protocols for flexible connectivity. Modbus communication shall be prioritized for internal sensor-to-controller data exchange, ensuring efficient and accurate data flow within the chiller system.

8. The chiller shall have a 10’’ Human Machine Interface (HMI) for real-time monitoring and control. The HMI shall display readable data accessible to all users, while writable data (for control and configuration) shall be password-protected to allow only authorized personnel to make changes.
9. A BACnet communication port shall be provided for seamless integration with third-party Building Management Systems (BMS). The chiller controller shall communicate directly with the BMS via a wired BACnet network, enabling centralized monitoring and control of the chiller system as part of a larger facility management solution.

Safety

1. The chiller/heat pump shall provide low refrigerant pressure monitoring with automated shut-off to protect the compressor and other critical components if refrigerant pressure falls below safe operating levels.
2. The chiller/heat pump shall have high refrigerant pressure monitoring to protect the system from excessive pressures. The controller shall trigger a safety shutdown if pressure exceeds designated thresholds, preventing equipment damage.
3. The system shall include flow switches on the chilled water and hot water circuits to detect adequate water flow. If insufficient or no flow is detected, the chiller shall prevent compressor operation, ensuring the safety and longevity of the equipment.
4. The chiller/heat pump shall monitor the evaporator and gas cooler's inlet and outlet temperatures. The system shall have low- and high-water temperature protections to prevent operation outside safe temperature ranges, ensuring stable performance and avoiding damage from extreme conditions.
5. The system shall include envelope protection to prevent the compressor from operating outside its designed pressure and temperature limits, safeguarding it from damage due to abnormal operating conditions.
6. The chiller/heat pump shall provide phase loss protection to detect any loss of electrical phase in the power supply. In phase loss, the system shall shut down to protect electrical components from damage.
7. The system shall include a refrigerant leak sensor to monitor potential leaks. If a leak is detected, the chiller shall trigger an alarm and initiate appropriate safety protocols to mitigate equipment and environmental risks.
8. The chiller/heat pump shall include reverse rotation protection to prevent compressors from operating in the wrong direction. This feature protects the

compressor from damage in case of incorrect wiring or phase reversal in the power supply.

9. The chiller shall enforce minimum compressor run time and off-time settings to prevent excessive cycling. This protection minimizes compressor deterioration, enhancing reliability and extending operational life.
10. The system shall feature a power phase monitor to detect issues with phase balance, voltage imbalances, or abnormal frequency. This monitor shall protect the equipment from damage due to unstable power conditions.
11. Automatic Reset After Power Failure: The chiller/heat pump can be configured to automatically reset and restart after a power failure, with built-in delays to protect the compressor during restart.

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