MHRC2 CHILLER

INSTALLATION MANUAL

MHRC2

with MCS MAGNUM Controls

Rev.41816

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Multiaqua Chiller Manual

The Multiaqua Chiller System is the only air conditioning/refrigeration system of its kind in the world today offering the degree of application flexibility described in the following manual.

The Multiaqua Chiller System is not only unique in its application flexibility; it is unique in superior quality, rated capacities, and rugged durability. When installed in accordance with these instructions, the system will deliver years of trouble free service.

Proper equipment sizing, piping design, and installation are critical to the performance of the chiller. This manual is meant to be an introduction to piping and installing the Multiaqua Chiller System.

RECOGNIZE THIS SYMBOL AS AN INDICATION OF IMPORTANT SAFETY OR INSTRUCTION RELATED INFORMATION.

Website information addresses are supplied throughout this manual for piping and accessory information. The plumbing industry also has pressure drop information on ferrous and copper piping systems.

The following sections will describe each component and how it functions within the system. Installation information is supplied where appropriate. The piping design section will explain the design and layout the piping system. Following the examples provided will enable the installer to determine the correct accessory sizing, as well as equipment location. It is important to know before installation if the proposed system will operate correctly. That determination can be made by doing a formal layout of a new application or a review of an existing piping system.

The chiller circulates a solution of water and Propylene Glycol. Throughout this manual the term “liquid solution” is used in place of a water and glycol mixture.

It is essential to operate the system with a minimum of 10% glycol, or more, as required by your climate zone. DO NOT OPERATE THIS SYSTEM USING WATER ALONE.
For proper liquid solutions mix ratios, refer to page 16 or the glycol manufacturer’s recommended mix ratios.

System Description





The Multiaqua Heat Recovery Chiller is a self-contained, air-cooled outdoor coil, coupled with two brazed plate heat exchangers. One heat exchanger is used as an evaporator for cooling and the other as a condenser for heating water. The system utilizes a scroll compressor to circulate refrigerant between the outdoor coil and heat exchanger. The refrigerant is metered into the heat exchanger with an electronic expansion valve. Protecting the system in conjunction with the MCS control package are a high-pressure switch as well as liquid solution flow switches.

Liquid solution (water and Propylene Glycol) is circulated through the heat exchangers by the pumps (externally mounted). The liquid solution flows through the heat exchangers to the system's supply piping and on into the air handlers or components.

A solenoid-operated, motorized valve (or circulator) controls the flow of the chilled liquid solution through the air handlers. The valves, or circulators, can be actuated by a variety of different control schemes.

Liquid solution temperatures are controlled by a chiller-mounted MCS control package. A system sequence of operation, individual control description, troubleshooting information, and a schematic are included in the Operation Manual.

It must be recognized that ferrous pipe may cause accelerated deterioration of the brazed plate heat exchanger and could void the heat exchanger warranty.

Cooling Load Diversity

Equipment sizing for a chilled liquid solution system can utilize Cooling Load Diversity. Diversity is described as the actual amount of cooling needed (heat load) by various sections of a structure at a given time. Conventional air conditioning systems are designed for the highest structure heat load. The conventional system determines and selects equipment based on the peak heat load demanded by the structure. A system sized to take advantage of diversity would determine the heat load by the time of day, building exposure, and usage. As an example, the sections of a structure facing west demand more cooling in the afternoon than sections facing east. The opposite of this is true in the morning where the east section is exposed to a higher heat load requiring more cooling. Utilizing diversity, the chiller system would adapt to the needs of each side of the structure during peak demand by delivering more cooling to that area and less to the areas that do not need it. A structure utilizing a conventional DX system that requires 8 tons of cooling at peak load could utilize a much smaller capacity system (potentially 4 or 5 tons) if the system installed could take advantage of load diversity. Load diversity would supply the necessary amount of cooling to the space when or as needed instead of keeping a total larger capacity available at all times.

Cooling Load Diversity

Continued

Cooling load diversity can best be determined by referring to the ACCA (Air Conditioning Contractors of America) Manual "J". Refer to the appendix A-2:Multi-Zone Systems. ACCA's Internet address is http://www.acca.org/

Due to load diversity, a Multiaqua Chiller can serve more total air handler tonnage than the actual total chiller capacity. For example, a 10 ton chiller may be delivering chilled liquid solution to 13 tons or more of air handler capacity. Thus, with cooling load diversity in use, the building does not need equal amounts of cooling in each area at the same time.

Electrical and Physical Data

The information contained in this manual has been prepared to assist in the proper installation, operation, and maintenance of the chiller. Improper installation or installation not made in accordance with these instructions can result in unsatisfactory operation and/or dangerous conditions which can void the related warranty.

Read this manual and any instructions included with all additional equipment that is required to make up the system prior to installation. Retain this manual for future reference.

Separate and independent power supplies and disconnects must be provided.

All power to the chiller must be turned off prior to opening cabinet and/or servicing.

Failure to properly ground chiller can result in death.

Disconnect all power wiring to chiller before any maintenance or service work. Failure to do so can cause electrical shock resulting in personal injury or death.

All wiring must be done in accordance with NEC (National Electric Code), as well as state and local codes, by qualified electricians.

Product warranty does not cover any damages or defect to the chiller caused by the attachment or use of any components, accessories, or devices (other than those authorized by the manufacturer) into, onto, or in conjunction with the chiller. You should be aware that the use of unauthorized components, accessories, or devices may adversely affect the operation of the chiller and may also endanger life and property. The manufacturer disclaims any responsibility for such loss or injury resulting from the use of unauthorized components, accessories, or devices.

Electrical and Physical Data

(Continued)

Upon receiving the chiller and components, inspect for any shipping damage. Claims for damage, either apparent or concealed, should be filed immediately with the shipping company.

No liquid, other than the liquid solution mixture of water and Propylene Glycol, shall be used in the piping system and must be mixed in accordance with table 6 on page 16.

Corrosive environments may subject metal parts of the chiller to rust and deterioration. The oxidation could shorten the chiller's useful life. Corrosive elements include salt spray, fog or mist in sea coastal areas, sulfur or chlorine from lawn watering systems, and various chemical contaminants from industries such as paper mills and petroleum refineries.

If the unit is to be installed in an area where contaminates are likely to be a problem, special attention should be given to the equipment location and exposure.

- **Avoid having lawn sprinklers spray directly on the chiller cabinet.**
- **In coastal areas, locate the chiller on the side of the building away from the waterfront.**
- **Elevate the chiller adequately to ensure that it does not sit in standing water or where water can contact with the cabinet base.**
- **Regular maintenance will reduce the build-up of contaminants and help protect the cabinet finish.**
- **In severe locations, having the chiller coated with an "epoxy" or other coating formulated for air conditioning systems located in coastal areas may be necessary.**

Consult local building codes or ordinances for special installation requirements. When selecting a site to locate the chiller, consider the following:

- **A minimum clearance of 36" on the service access ends of the cabinet, 36" on the coil air inlet sides and nothing above fan discharge clearance.**
- **The chiller must be located outdoors. No ductwork can be connected to the chiller's outdoor coil or condenser fans.**
- **If a concrete slab is used, do not connect the slab directly to any building's foundation or structure in order to prevent sound transmission.**
- **Locate the slab on a level surface that is above grade to prevent ground water from entering the chiller cabinet.**

When the system is first filled with liquid solution and the pump is started, expect the system to cycle off as the flow is interrupted by air in the piping. This will continue until all of the air is purged from the piping system..

High Pressure Switch Opening: Should the compressor discharge pressure go high enough to open the high-pressure switch; the compressor inverter will shut down on fault. Check for a dirty condenser coil, inoperable fan motor(s), or the recirculation of condenser air before resetting switch.

Refrigeration System Operation

The refrigeration system is a closed loop system consisting of one compressor, single circuit, brazed plate heat exchanger (evaporator), brazed plate heat exchanger (condenser), metering device (EXV's), and an outdoor coil. The refrigerant circulated is R410a. Depending upon mode, hot gas is pumped from the compressors to either the outdoor coil where a condenser fan pulls air across the coil or to the heating heat exchanger where heat is transferred to the liquid solution condensing and sub-cooling the hot gas into liquid refrigerant. The liquid refrigerant flows through the liquid lines to either of the electronic expansion (EXV) valves depending upon mode. From that point the refrigerant pressure drops causing the refrigerant to boil at a much lower temperature (34°- 40°F). The refrigerant leaves the expansion valve and swirls through the plates of the brazed plate heat exchanger absorbing heat from the circulating liquid solution when water chilling is needed. During dedicated heat mode, another EXV is directed to the outdoor coil to absorb heat from the air. This operation is similar to a heat pump.

The cooling heat exchanger is designed to operate with a 10°- 20°F superheat. The outdoor coil is designed to condense the refrigerant and sub-cool it to 10°F below condensing temperature.

The heating heat exchanger is designed to heat water to temperatures as high as 120° F. Hot refrigerant gas is condensed in this heat exchanger transferring heat to circulating liquid solution and sub-cooling liquid refrigerant.

Description of Piping Components

Supply Storage Tank: A supply storage tank must be used in a system with less than 100 gallons for a 4 pipe system or 25 gallons for a 2 pipe system. The tank prevents rapid cycling of the compressors and acts as a reservoir for chilled liquid solution.

Part Number: WX202H (20 Gallon)
ERTG42S (42 Gallon)

Supply storage tank must be insulated in the field.

Expansion Tank and Air Scoop: The expansion tank and air scoop assembly is used to compensate for the expansion and contraction of liquid solution in the system. The air scoop eliminates air entrained in the liquid solution.

Part Number: 1500/1" (2.2 Gallon)
EX-3000-125 (4.4 Gallon)

Liquid Solution Bypass Valve: The liquid solution bypass valve relieves system pressure from the liquid solution supply line to the return line as the system air handler controls are cycled off.

Part Number: D146M1032 (3/4")
D146M1040 (1 1/4")

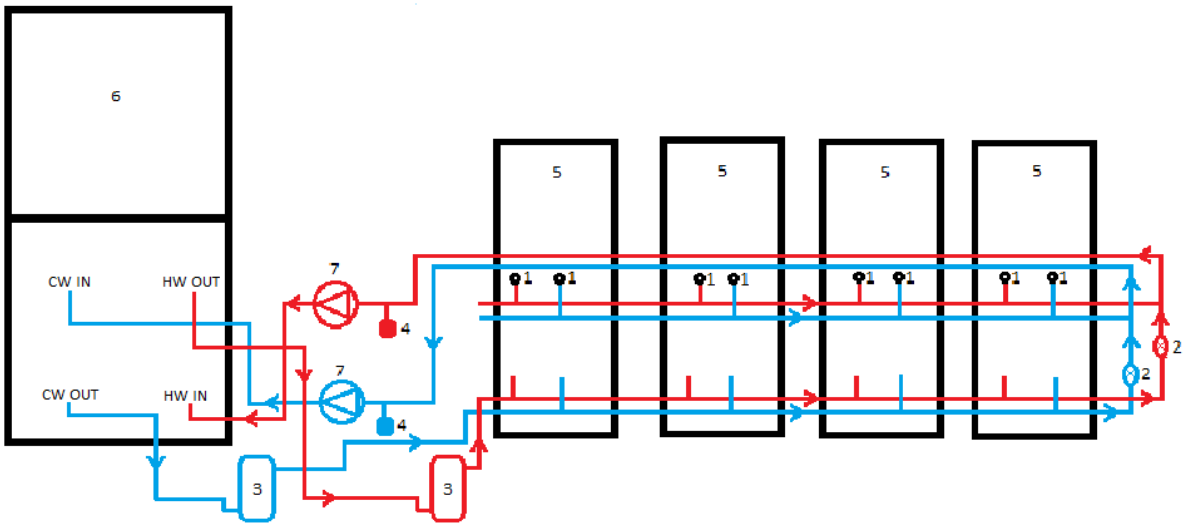
Motorized Valve: The air handler motorized zone valve controls the flow of liquid solution to the systems air handlers. Each air handler in the system should have a motorized valve.

Part Number: MZV524E-T (1/2" 2-Way Zone Valve)
MZV525E-T (3/4" 2-Way Zone Valve)
MZV526E-T (1" 2-Way Zone Valve)
VT3212G13A020 (1/2" 3-Way Zone Valve)
VT3212G13A020 (3/4" 3-Way Zone Valve)

Composite Piping Layout and Design

Understanding the function and friction loss of each part of the piping system is important to the layout and successful installation of a chilled liquid solution system.

FOUR PIPE SAMPLE LAYOUT:



1– 2 Way Liquid Solution Control Valve
2– Bypass Valve
3– Storage Tank
4– Expansion Tank
5– Fan Coil Unit
6– Chiller
7– Pump

The circulation pump is the key performer in the piping system. The pump must circulate the liquid solution through the heat exchanger and piping system to the air handlers. Pumps are designed to deliver a flow rate measured in gallons per minute (GPM). The pump must be able to overcome the resistance to flow (pressure drop) imposed by the chiller components, piping system, and air handlers while maintaining the necessary flow rates in gallons per minute.

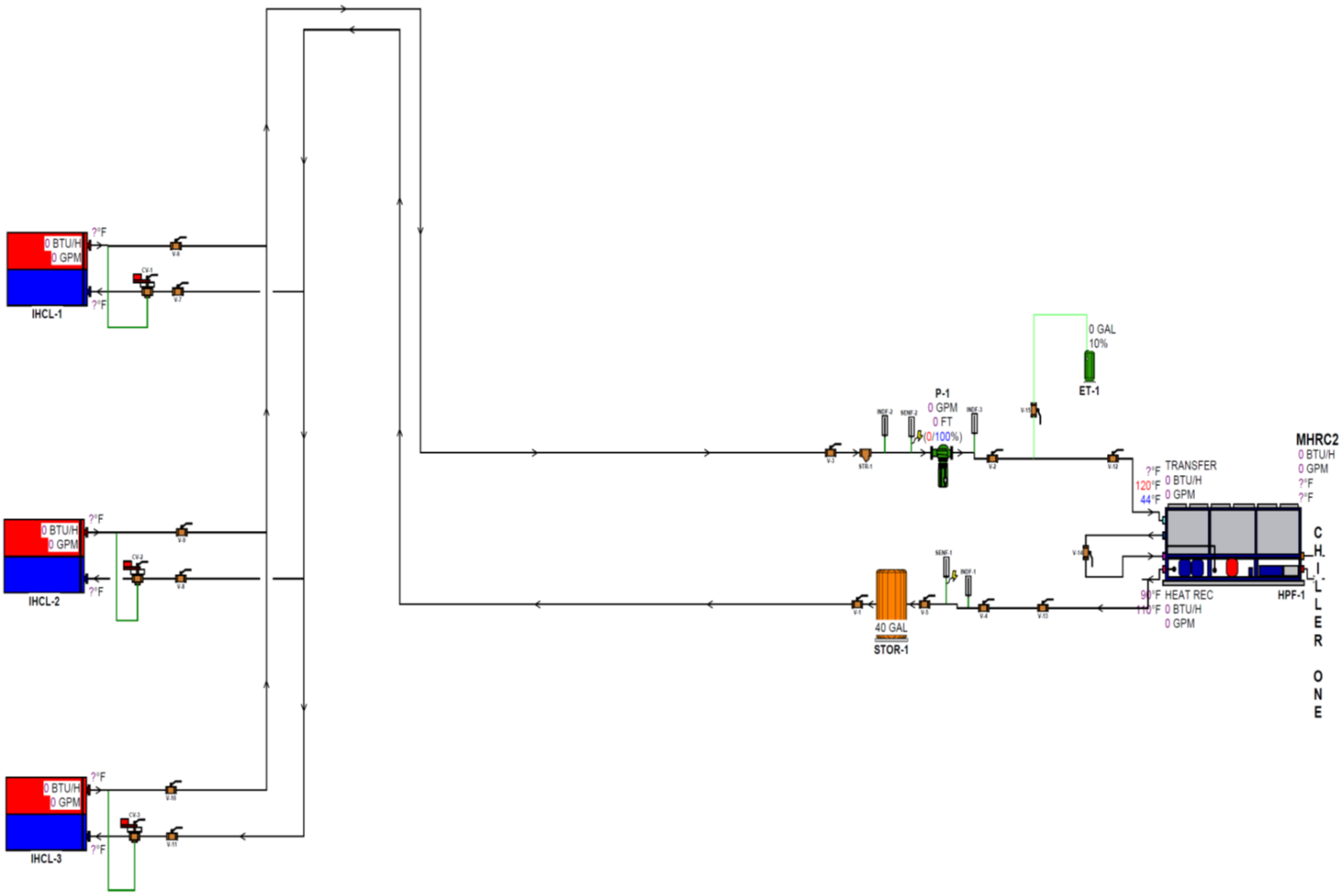
An adjustable valve or balancing valve must be used to throttle the discharge liquid solution flow rate to appropriate levels based on capacity and glycol mix percentages.

ALL PIPING SYSTEMS SHOULD HAVE A MINIMUM OF 10% PROPYLENE GLYCOL IN THE SYSTEM EVEN IN CLIMATES WITH NON-FREEZING AMBIENT TEMPERATURES.

TWO PIPE SAMPLE LAYOUT:

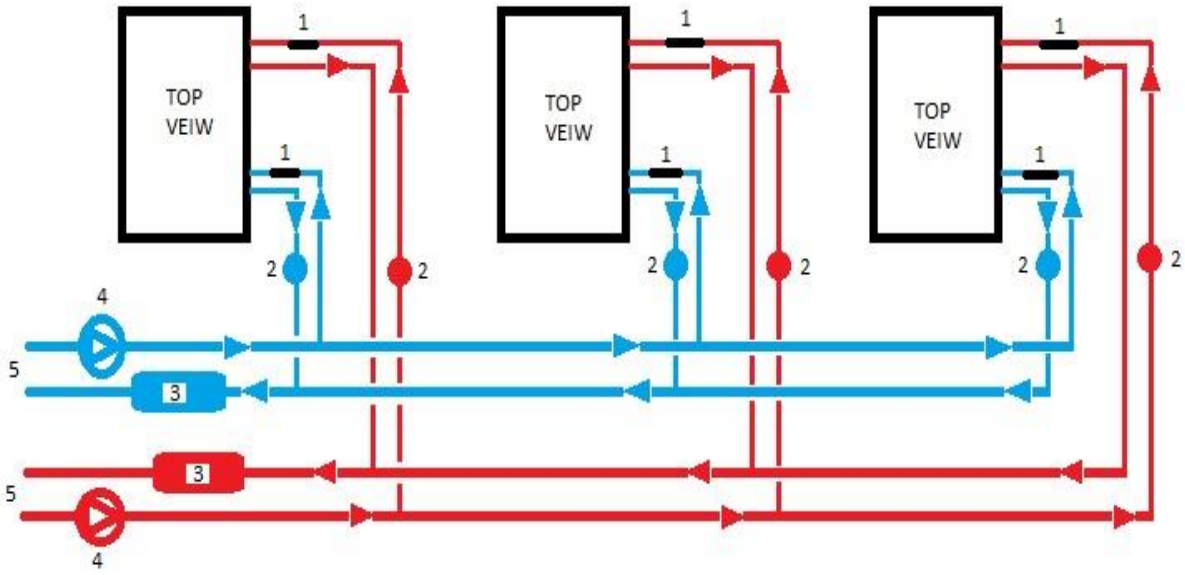
Heat Recovery Chiller # MHRC2 used in the two pipe application:
Liquid Solution Flow Sequence,

1. The two pipe system will be piped to the chiller.
2. The two heat exchangers will be piped in series.
3. When in the cooling mode, the liquid solution will travel through both the cooling and heating heat exchangers.
   Only the cooling heat exchanger will be active.
   The heat created will be rejected through the evaporator/condenser coil and fan.
4. When in the heating mode, the liquid solution will travel through both the cooling and heating heat exchangers.
   Only the heating heat exchanger will be active.
   The cooling created will be rejected through the evaporator/condenser coil and fan.



Banked Chiller Configuration

FOUR PIPE BANKED CHILLER SAMPLE

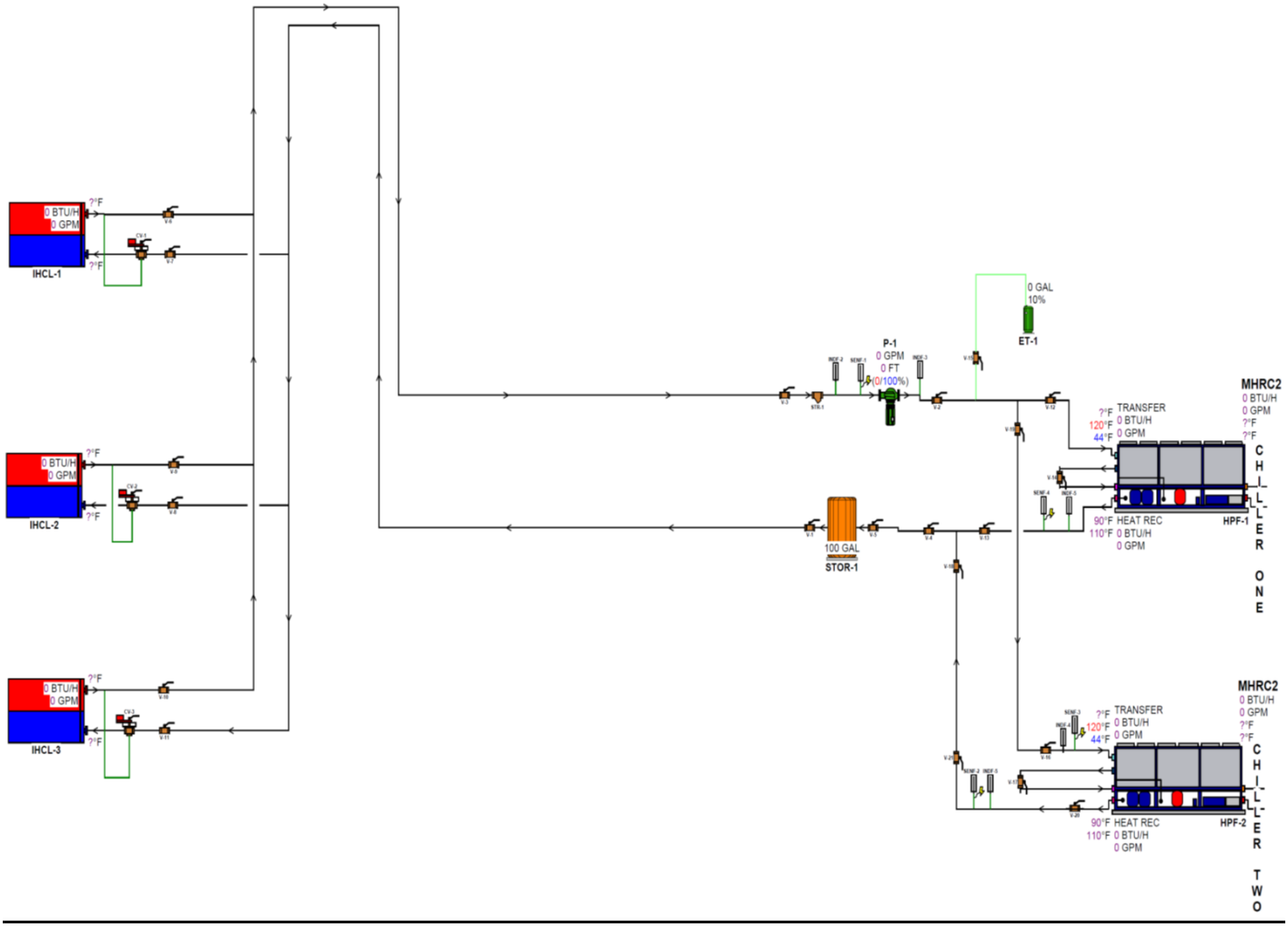


Number	Description
1	"Y" STRAINER
2	EXPANTION TANK WITH AIR SCOOP AND PURGE
3	STORAGE TANK
4	SOLUTION PUMP
5	SOLUTION LOAD TO THE BUILDING

ALL PIPING SYSTEMS SHOULD HAVE A MINIMUM OF 10% PROPYLENE GLYCOL IN THE SYSTEM EVEN IN CLIMATES WITH NON-FREEZING AMBIENT TEMPERATURES.

Installing Multiaqua chillers in parallel is recommended. Piping chillers in series is not recommended.

TWO PIPE BANKED CHILLER SAMPLE:



Rapid Defrost:

In applications where the MHRC2 will be running in primarily one mode all winter season, a Rapid Defrost configuration is recommended. In this set up auxiliary heat is added to the chilled water loop for use in defrost. If the chilled water loop temperature drops below 40° F, it is recommended that a heating element or hot water valve be modulated to maintain temperature.

Electric heating elements that can fit into plumbing are readily available and can be sourced locally. The elements are used in spas and are available in different sizes. Tankless on demand heaters can also be used if a fuel source is readily available.

Piping can be configured in such a way to use the heat from the hot water loop. The drawing below illustrates an example of how to set this up. It is recommended that a pump be installed to maintain water exchange between the two loops.

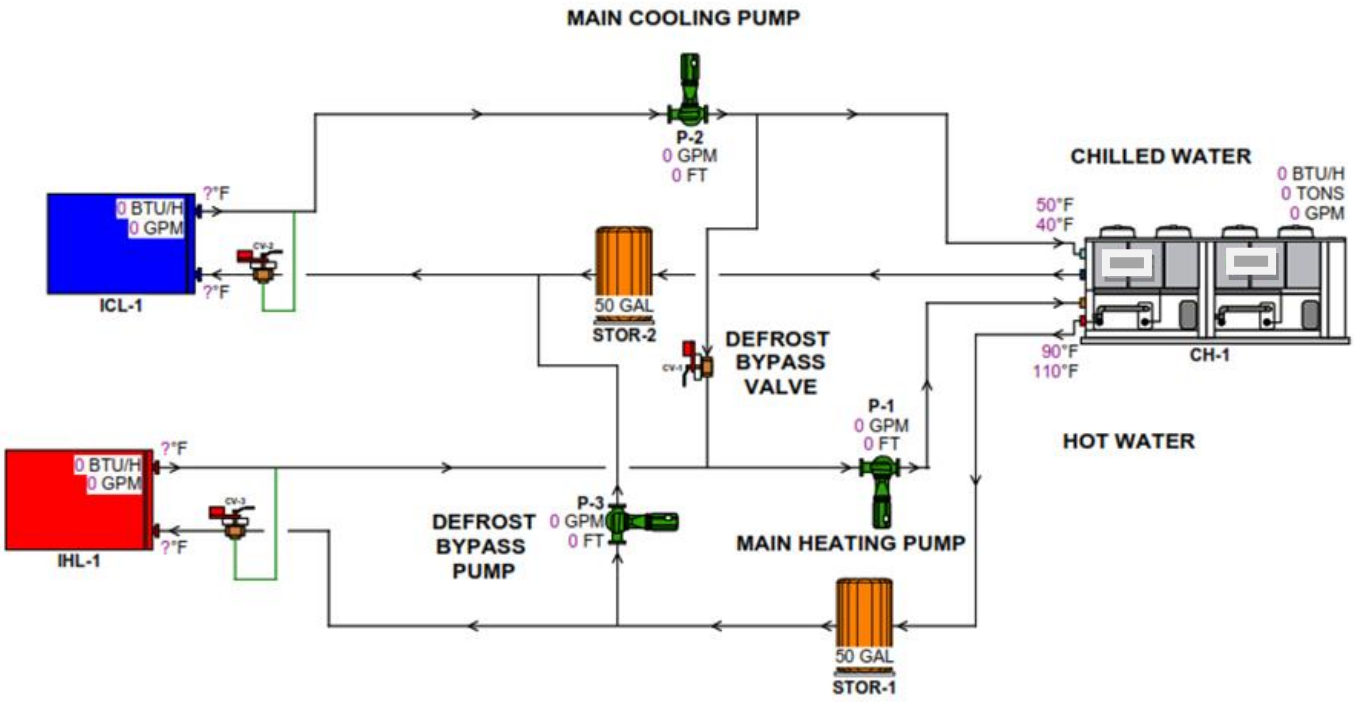


Table 1 Chiller System Data

MHRC2-060-VS-01 Product Specifications

	4 Pipe Configuration	2 Pipe Configuration
Compressor	Copeland Variable Speed (VS) Scroll	Copeland Variable Speed (VS) Scroll
Refrigerant	R410a	R410a
Heat Exchanger (Cooling)	Brazed Plate	Brazed Plate
Heat Exchanger (Heating)	Brazed Plate	Brazed Plate
Max. Flow Rate (Cooling)	14.4 gpm	14.4 gpm
Min. Flow Rate (Cooling)	12 gpm	12 gpm
Max. Flow Rate (Heating)	14.4 gpm	14.4 gpm
Min. Flow Rate (Heating)	12 gpm	12 gpm
Supply Water Temp (Cooling)	44°F (Adjustable)	44°F (Adjustable)
Return Water Temp (Cooling)	54°F (Adjustable)	54°F (Adjustable)
Minimum Supply Water Temp (Cooling)	28°F*	28°F*
Minimum Return Water Temp (Cooling)	38°F*	38°F*
Maximum Supply Water Temp (Heating)	120°F*	120°F*
Maximum Return Water Temp (Heating)	110°F*	110°F*
Minimum System Solution Content (Cold Side)	100 Gallons	25 Gallons
Minimum System Solution Content (Hot Side)	100 Gallons	25 Gallons
Expansion Tank Size	3% of Total System	3% of Total System
Water Connections (4)	1.00" MPT Supply & Return	1.00" MPT Supply & Return

* Compatible with Thermal Storage (TS) systems.

MHRC2-060-VS-01 Cooling Brazed Plate Heat Exchanger

Differential Pressure

	H2O	10% PG	20% PG	30% P.G	40% PG	50%PG
Flow (Gpm)	dP psi	dP psi	dP psi	dP psi	dP psi	dP psi
12	1.77	1.77	1.86	2	2.25	2.52
12.5	1.9	1.92	2.01	2.15	2.42	2.71
13	2	2.06	2.16	2.3	2.59	2.9
13.5	2.1	2.22	2.32	2.46	2.77	3.1
14	2.26	2.44	2.49	2.62	2.95	3.3
14.5	2.42	2.54	2.66	2.8	3.14	3.51

H2O = Water, PG = Propylene Glycol, GPM = Gallons Per Minute, DP = Differential Pressure, PSI – Pounds Per Square Inch,

MHRC2-060-VS-01 Heating Brazed Plate Heat Exchanger

Differential Pressure

	H2O	10% PG	20% PG	30% P.G	40% PG	50%PG
Flow (Gpm)	dP psi	dP psi	dP psi	dP psi	dP psi	dP psi
12	0.9	0.9	1.7	2.0	2.4	2.8
12.5	0.9	0.9	1.7	2.1	2.5	3
13	1.0	1.0	1.9	2.3	2.7	3.2
13.5	1.1	1.1	2.0	2.4	2.9	3.4
14	1.1	1.1	2.1	2.5	3	3.6
14.5	1.2	1.2	2.3	2.7	3.2	3.9

H2O = Water, PG = Propylene Glycol, GPM = Gallons Per Minute, DP = Differential Pressure, PSI – Pounds Per Square Inch,

Installation Notes:

Piping such as PEX, steel, copper, or PVC can be used with the Multiaqua system. Check local building codes for material conformation. Care must be taken when using PVC as the presence of propylene glycol may destroy plastics. Pressure drop data for the selected piping material is readily available and should be used. Should the Multiaqua chiller be installed using an existing steel (ferrous metal) piping system, dielectric fittings must be used at the chiller and air handler. The factory supplied wye strainer will capture particles of rust and sediment inherent with steel piping and should be checked and cleaned after initial start up. The strainer should be inspected and cleaned as part of regular maintenance during the life of the chiller.

Any piping used to conduct liquid solution must be insulated in accordance with local and national mechanical codes. Information on insulation installation and application can be obtained from Armacell web site at www.armacell.us/home. For future servicing of the chiller and air handlers, it is suggested that shut-off ball valves be installed at the chiller and air handler(s). If ball valves are used, they can double as balancing valve (s) in the supply piping at each chiller and air handler. Chiller shut-off valves should be attached at the chiller connections with unions.

The air handlers are to be controlled with electrically operated, slow-opening valves, circulators, or motorized zone valves. A thermostat can operate the valves.

Bypass valves, should be installed between the supply and the return chilled liquid solution supply pipes at a convenient location to the installation. The bypass valve operates to bypass liquid solution between the supply and return chilled liquid solution lines. In the event air handler valves shut down, the bypass valve is set to open and bypass liquid solution between the supply and return lines relieving pressure and thereby eliminating the possibility of pump cavitations. To adjust the valve, run the system with one air handler solenoid actuated. De-energize the solenoid valve (at this point no liquid solution will be flowing through the air handlers), and adjust the bypass valve to relieve pressure between the supply and return piping.

Bleed ports will be factory installed on all Multiaqua air handlers. Bleed ports are opened to eliminate air trapped in the air handlers after filling the system with the liquid solution and before chiller operation. **The field installation of an additional air bleed port at the highest point in the system is also recommended.**

The minimum liquid solution storage content in the 5 ton chiller system is 100 U.S. gallons for a 4 pipe configuration or 25 U.S. gallons for a 2 pipe configuration. Estimate the system liquid solution content. The tank stores enough chilled liquid solution to prevent frequent chiller compressor cycling at light load conditions. It also prevents chilled liquid temperature swings at higher load conditions when the chiller compressor is waiting to cycle on the time delay control.

Cold ambient mitigation is mandatory. Failure to do so will result in the damage to components, property damage, and void warranty.

Installation Notes: (continued)

Propylene Glycol must be added to the water used in the system. Propylene helps prevent freeze-ups due to low ambient temperature conditions and low chilled liquid solution temperatures. In comparison to water, Propylene Glycol slightly lessens the temperature exchange in the chiller's heat exchanger. However, that is offset by the increased flow of liquid solution through the piping system enabled by the Propylene Glycol. To determine the Propylene Glycol content for various ambient temperatures, refer to Table 6.

In no instance should a Multiaqua chiller be installed with less than 10% Propylene Glycol content in the piping system. **Using less than the recommended Propylene Glycol percentage content voids equipment warranty**.

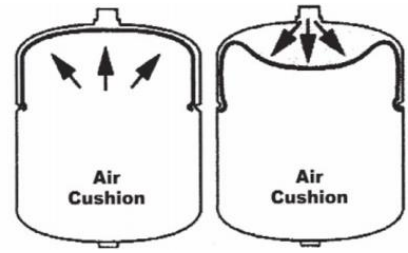
Table 6

Percent of Propylene Glycol to Water Content				
Propylene Glycol %	Water Flow	Capacity	Min. ambient Temperature	GPM Adjustment = 100 % Capacity
10%	x 1.020	x .99	26°F	x 1.01
20%	x 1.028	x .98	18°F	x 1.03
30%	x 1.036	x .98	8°F	x 1.07
40%	x 1.048	x .97	-7°F	x 1.11
50%	x 1.057	x .96	-29°F	x 1.16

Ethylene Glycol is environmentally hazardous and not recommended. Inhibited Propylene Glycol (typical automotive coolant) is not to be used in a Multiaqua Chiller under any circumstances. Dow Chemical's "Ambitrol" Glycol-based coolant of food grade Propylene Glycol is suggested. Information on Ambitrol is available from Dow at www.dow.com, search word "Ambitrol"

Estimated Propylene Glycol Adjustment Factors:		
Percent of Propylene Glycol	Capacity adjustment Multiply TONS by:	Pressure Drop adjustment Multiply PD by:
10%	0.995	1.02
15%	0.992	1.04
20%	0.986	1.08
25%	0.972	1.13
30%	0.96	1.21
35%	0.95	1.26
40%	0.928	1.47
50%	0.878	2.79

Expansion Tanks



Liquid solution expansion and contraction within the closed system must be compensated for with an expansion tank. The expansion tank used with the Multiaqua system is a steel tank with a rubber bladder internally attached. There is air pressure on one side of the rubber bladder that keeps the bladder pushed against the sides of the tank before the system is filled with liquid solution (illustration above). As the liquid solution heats up, the bladder will be pushed further away from the tank walls allowing for expansion and contracting as the liquid solution temperature changes. By flexing, the bladder controls the system pressure adjusting to temperature variations of the chilled liquid solution system.

It is critical that the expansion tank's air bladder pressure be less than the system solution pressure. Air pressure can be measured with an automotive tire gauge at the Schrader valve port on the expansion tank. Bleeding air out of the bladder or increasing the pressure with an air pump will adjust the pressure.

Filling System with Liquid Solution

Before filling the system with liquid solution (Propylene Glycol and water), pressure test the piping system with compressed air. **Testing should be done at a maximum of 50 PSI**. The system should hold air pressure for a minimum of one (1) hour with no leakage.

Concentrations of Propylene Glycol in excess of 50% will destroy o-rings in fittings and pumps. Water should be added to the system first or a solution of diluted Propylene Glycol mix.

System that contains 50 or more U.S. gallons should have a tee fitting with a stop valve installed in the return line close to the chiller. The stop valve can be opened and attached to a hose with a female by female hose fitting. In the open end of the hose section (1 - 1.5 feet long) insert a funnel and pour the liquid solution mixture or add water first and then the appropriate quantity of Propylene Glycol (refer to Table 6). After adding the liquid solution mixture, proceed to add enough water to the system to achieve 15 PSI gauge pressure. To measure system pressure, shut off the stop valve, remove hose, and attach a water pressure gauge. Open the stop valve and read system pressure. Systems that use a chilled liquid solution storage tank should be filled at the tee/stop valve fitting in the outlet fitting of the storage tank.

Air Elimination

Once the system is filled, start the pump and continue bleeding air from the system any air left in the system must be eliminated. Briefly open each bleed valve at the air handler(s) and allow trapped air to escape. This will eliminate much of the air left in the system. **A field installed air bleed port at the highest point in the piping is recommended to speed up the air elimination process.**

If you continue having air entrapment issues, it will be necessary to install a micro bubble remover device.

ALL PIPING SYSTEMS SHOULD HAVE A MINIMUM OF 10% PROPYLENE GLYCOL IN THE SYSTEM EVEN IN CLIMATES WITH NON-FREEZING AMBIENT TEMPERATURES.

USING LESS THAN THE RECOMMENDED PROPYLENE GLYCOL PERCENTAGE CONTENT VOIDS EQUIPMENT WARRANTY.

Liquid solution control valves (solenoid or motorized valves), should be selected for low pressure drop.

Notes:

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