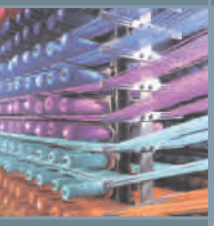


THERMAX

Hot Water Driven
Vapor Absorption Machine

Cogenie

ProChill™

With you always,
in your quest to preserve nature.

Contents

Company Profile

Thermax is an engineering major providing energy-environment solutions, systems and products in global markets. The US $ 800 million Thermax is featured in the Forbes List of 'Best Under a Billion' Companies in the Asia Pacific. It offers business - to - business solutions to industrial and commercial establishments in the areas of heating, cooling, captive power, water treatment, air pollution control, waste management & resource recovery, and chemicals. It supports a wide spectrum of industry in over 50 countries of South East Asia, Japan, Africa and Middle East, CIS countries, USA, South America and Europe.

In the energy business, Thermax executes projects in the areas of process heat, captive power and waste heat recovery. The company also offers a range of boilers and thermal oil heaters, energy efficient machines and customized products such as waste heat and exhaust gas boilers. Thermax's integrated expertise in energy has helped it to offer its customers Combined Heating Power and Cooling (CHPC) projects.

Thermax offers industry its expertise over a hundred fuels -- oil, gas and a wide variety of solid fuels including biomass. Through diverse installations in several countries, it has also developed reliable project

management capabilities. Leveraging its leadership position in electricity saving vapor absorption technology, Thermax offers process industries and commercial establishments like hotels, shopping malls and offices vapor absorption machines a boon in power-starved areas. These eco-friendly, energy efficient equipments have found prestigious customers such as BBC, Mercedes Benz, Audi, Bosch, Panasonic, Henry Ford Museum.

In the environment area, Thermax offers waste management expertise for solid, liquid and air pollution. Thermax provides solutions from pre-treatment to waste water treatment and chemical conditioning of water for boiler and cooling water systems. Water recycling is a thrust area for Thermax. Hi-grade ion exchange resins from Thermax have found niche customers in US and Europe, MBA, SEA, China markets.

Thermax has an extensive international marketing network. Headquartered in Pune (Western India), Thermax's 17 international offices are located in South East Asia, Middle East, Africa, Russia, UK and the US. Its overseas subsidiaries--Thermax Europe Ltd (UK) and Thermax Inc (USA) play a significant role in business development.

The Thermax group's manufacturing facilities spread over 14 plants, measuring a covered area of over 700,000 sq. ft are ISO 9001, ISO 14001 and OHSAS 18001 accredited. Thermax manufactures to international standards like ASME, BS, DIN, and GOST. Lloyds, Bureau Veritas, SGS, and TUV have inspected the facilities.

Thermax's business is inspired by the conviction that 'Improving your business is our business.'

Introduction

Refrigeration is a process of extracting heat from a low temperature medium and transferring it to a high temperature heat sink. Refrigeration maintains the temperature of the heat source below that of its surroundings while transferring the extracted heat to a heat sink. This operation finds applications in many industries ranging from process, engineering, manufacturing, medical, dairy and confectionery, to beverage, hospitality, education and commercial establishments.

Absorption chillers, instead of using electricity (high grade energy), use heat as energy source which is low grade energy. The energy source may be steam or hot water, or it may even be waste heat like in exhaust gases from an engine (gas or oil based). Thermax offers a wide range of solutions for each of these sources of energy representing a major advance in the Absorption Chilling Technology. Hot water absorption chillers are eco-friendly and help in reducing CO_2 emissions because these use heat input from low grade sources like engine jacket cooling water or water from solar heaters etc.

Cogenie and ProChill Vapor Absorption Chillers derive energy from hot water to provide the desired chilling effect. These Cogenie - Vapor Absorption Chillers are available in 70 to 740 KW and the ProChill (Twin Design) - Vapor Absorption Machines are available in 844 to 4043 KW. These chillers can achieve chilled water temperature down to 3.3°C by making use of low temperature hot water (70°C - 110°C).

The Cogenie and ProChill Series' product range represents a culmination of Thermax's global expertise in energy and environment, continuous innovation through focused Research and Development, world-class manufacturing capabilities, efficient and responsive service and a deep commitment to quality and reliability. Testimony to this is provided by over 4000 installations in the last 15 years across 40 countries, appreciation from our customers and several prestigious awards and honors.

Salient Features Of Cogenie and ProChill

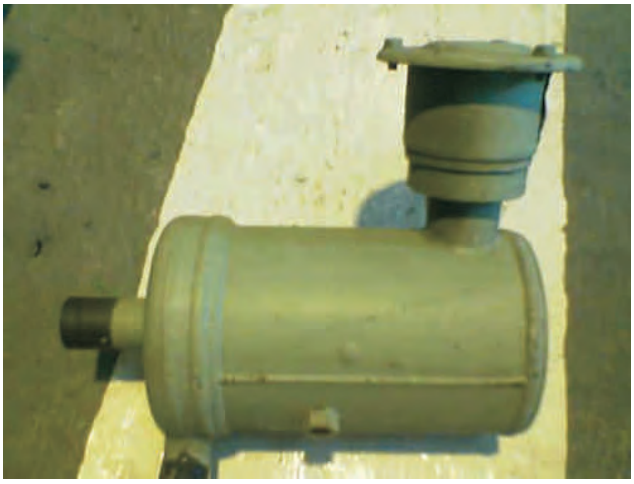
- **Part load performance:** For loads ranging from 10 - 100 % of the design capacity, the 3-way diverting valve automatically varies the hot water flow to maintain a uniform temperature of the chilled water leaving the chiller.
- **Gravity feed system:** Gravity feed of refrigerant and absorbent enhances heat transfer efficiency and overcomes the problems of wear and tear and clogging of nozzles, which use pressurized spraying techniques. Feed trays are of **Stainless Steel.**
- Machines are designed and supplied based on the low temperature (67°C - 110°C) hot water.
- **Effective corrosion inhibitors:** The corrosion inhibitor minimizes the rate of copper and ferrous metal corrosion on the solution side of the unit. The corrosion inhibitor used - Lithium Molybdate - is non-toxic and does not generate ammonia, thus protecting the copper tubes in the machine. Use of Lithium Molybdate is more effective than conventionally used corrosion inhibitors.
- The evaporator, condenser and absorber tubes are made of **Copper/ Cupronickel/ AISI-316L/ Titanium** depending on the available water quality.
- Factory mounted **on-line purging system** maintains low vacuum in the shell and ensures consistent performance. Any non-condensable gas, generated inside the machine during operation, is purged continuously into the storage tank, thus eliminating the need for a replaceable palladium cell.
- **PLC based control panel**, user-friendly interface and data-logging system ensure easy and smooth operation. Branded PLC enhances the reliability of the machine.
- Cooling water flows first through the condenser and then through the absorber.
- Use of Non-Welded Pumps: In Thermax Absorption Chillers, the absorbent and refrigerant pumps are in bod construction (except for 20 frame small chillers) so that if required, bearing and filters can be cleaned after few years of operation. In case of welded pumps, replacement of the entire pump is the only solution.

Isolation valves

Isolation valves are provided on the pumps of higher models of **Cogenie** (LT 10C and LT 21C) and for all **ProChill** models facilitating on-line pump maintenance without loss of vacuum in the system due to the exposure to air.

- **Double protection**, in terms of differential pressure switch and flow switch, is provided for freeze protection.
- **Optional Features** include electrical control valve, VFD control for part load conditions, standby canned motor pumps, flameproof construction, high pressure headers, online bearing monitoring, special tube material for Evaporator, Absorber, Condenser, multi-sectional shipment and Factory Performance Test.
- **Service:** A global network, powered by over 100 highly trained service personnel, ensures quick response and delivers the right solution to customers. Also on offer are value-added services such as 'e-reach' - remote access for chillers, preventive maintenance contracts, operations and manning and localized customer training programs

Bolted CANNED Motor Pump



Welded CANNED Motor Pump

What is a Canned Motor Pump?

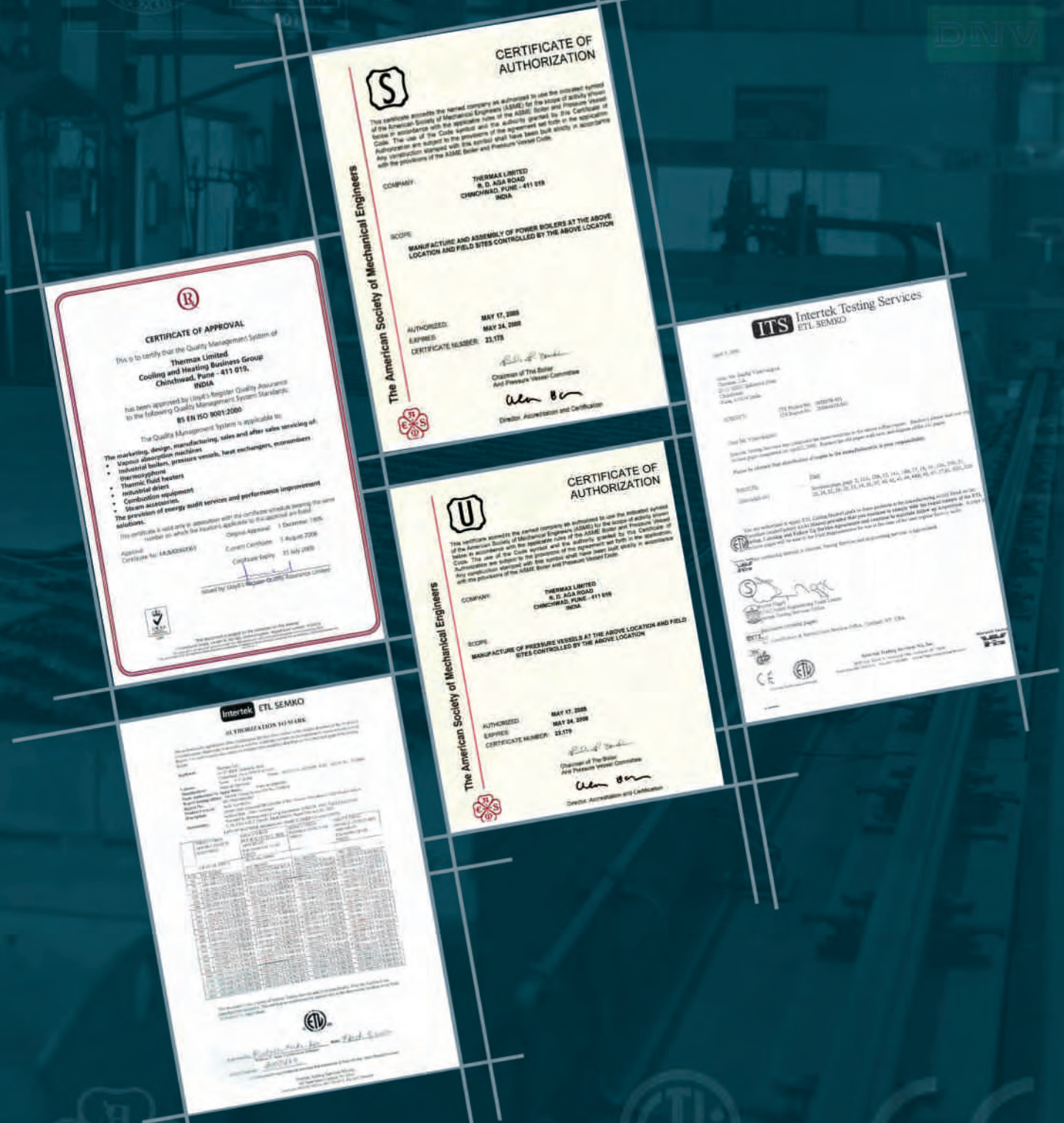
CANNED motor pump is some times misinterpreted as a pump similar to hermetically sealed compressor of a window air-conditioner.

CANNED motor pump is a single unit of a pump and a motor, and has no shaft seal. Shaft seal is a moving joint and cannot pass through stringent helium leak test.

In the CANNED motor pump, the pumped liquid is used for cooling motor as well as lubrication of bearings. Hence, the pumped liquid enters the motor section, and in order to keep the liquid away from the motor coil and the rotor, the motor coil and the rotor are sealed with CANS, which are thin metal cylinders.

Bolted canned motor pump, bit costly though, offer advantage like replacement of parts, which may be needed after many years of service. Only non-moving parts are bolted and hence they offer excellent leak proof properties while offering maintainability simultaneously.

Certificates



CERTIFICATE OF AUTHORIZATION

The American Society of Mechanical Engineers

COMPANY: THERMAX LIMITED
R. D. AGA ROAD
CHINCHWAD, PUNE - 411 019
INDIA

SCOPE: MANUFACTURE AND ASSEMBLY OF POWER BOILERS AT THE ABOVE LOCATION AND FIELD SITES CONTROLLED BY THE ABOVE LOCATION

AUTHORIZED: MAY 17, 2005
EXPIRES: MAY 24, 2008
CERTIFICATE NUMBER: 23,175

Chairman of The Boiler And Pressure Vessel Committee

Director, Accreditation and Certification

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of
Thermax Limited
Cooling and Heating Business Group
Chinchwad, Pune - 411 019,
INDIA

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standards:
BS EN ISO 9001:2000

The Quality Management System is applicable to:

The marketing, design, manufacturing, sales and after sales servicing of:
- Vapour absorption machines
- Industrial boilers, pressure vessels, heat exchangers, economisers
- Thermosyphons
- Thermic fluid heaters
- Industrial driers
- Combustion equipment
- Steam accessories.

The provision of energy audit services and performance improvement solutions.

Original Approval: 1 December 1995
Current Certificate: 1 August 2006
Certificate Expiry: 31 July 2009

Issued by: Lloyd's Register Quality Assurance Limited

ITS Intertek Testing Services
ETL SEMKO

Intertek ETL SEMKO
AUTHORIZATION TO MARK

CERTIFICATE OF AUTHORIZATION

The American Society of Mechanical Engineers

COMPANY: THERMAX LIMITED
R. D. AGA ROAD
CHINCHWAD, PUNE - 411 019
INDIA

SCOPE: MANUFACTURE OF PRESSURE VESSELS AT THE ABOVE LOCATION AND FIELD SITES CONTROLLED BY THE ABOVE LOCATION

AUTHORIZED: MAY 17, 2005
EXPIRES: MAY 24, 2008
CERTIFICATE NUMBER: 23,175

Chairman of The Boiler And Pressure Vessel Committee

Director, Accreditation and Certification

Working Principle

The boiling point of water is directly proportional to pressure. At atmospheric pressure, water boils at 100°C. At a lower pressure, it boils at a lower temperature. At 6 mm Hg absolute pressure, the boiling point of water is 3.9°C.

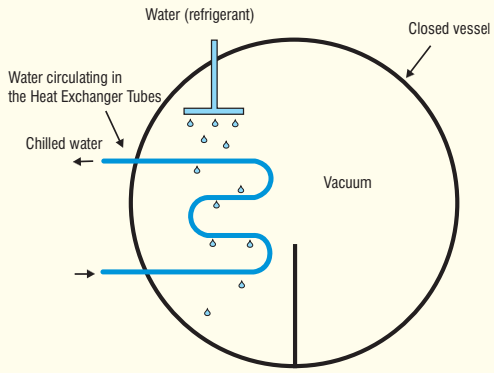
To change water from liquid to vapor it has to be heated. The water absorbs the applied heat and its temperature starts rising, until it reaches the boiling point. At boiling point, the temperature remains constant but liquid water vaporizes. The heat required to change the phase of a liquid to vapor is called the Latent heat of Vaporization. Similarly the heat rejected by the vapors during condensation is called the Latent Heat of Condensation.

For the LiBr-water system, the absorption varies directly in proportion with the solution concentration and inversely with the solution temperature. Lithium Bromide (LiBr) is a water soluble chemical, and LiBr - water solution (used as refrigerant) has an inherent property to absorb water due to its chemical affinity.

Also, there is a large difference between vapor pressure of LiBr and water. This means that when the LiBr water solution is heated, the water will vaporize but the LiBr will stay in the solution and become more concentrated.

Absorption Cycle Overview:

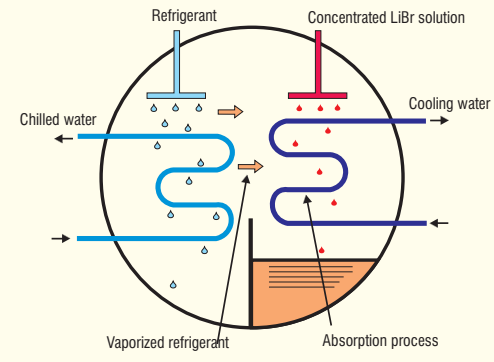
1



When maintained at high vacuum, water will boil and flash cool itself.

Absorption systems use heat energy to produce a refrigerating effect. In these systems the refrigerant, i.e. water, absorbs heat at a low temperature and low pressure during evaporation and releases heat at a high temperature and high pressure during condensation.

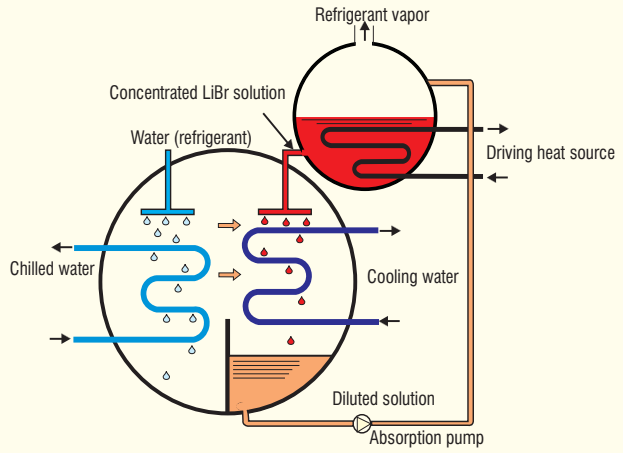
2



Concentrated Lthium Bromide solution has affinity towards water. The solution absorbs vaporized refrigerant water.

LiBr solution, which acts as the absorbent, is used to absorb the vaporized refrigerant. The evaporation of the refrigerant takes place at a low pressure. The diluted solution, which contains the absorbed refrigerant vapor, is heated at a higher pressure.

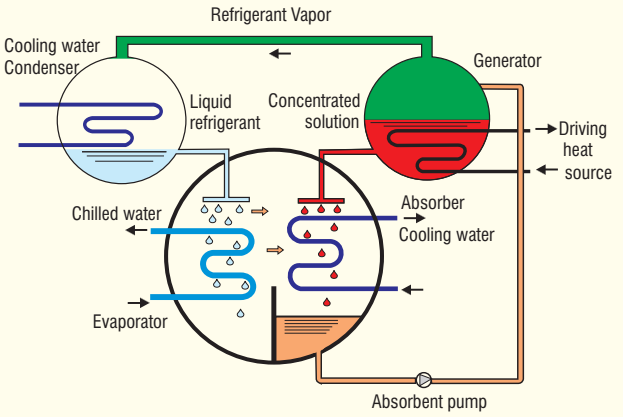
3



As Lithium Bromide becomes dilute it loses its capacity to absorb water vapor. It thus needs to be reconcentrated using a heat source.

This leads to the vaporization of the refrigerant and thus the solution is restored to its original concentration. The cycle keeps repeating itself to give the desired chilling effect.

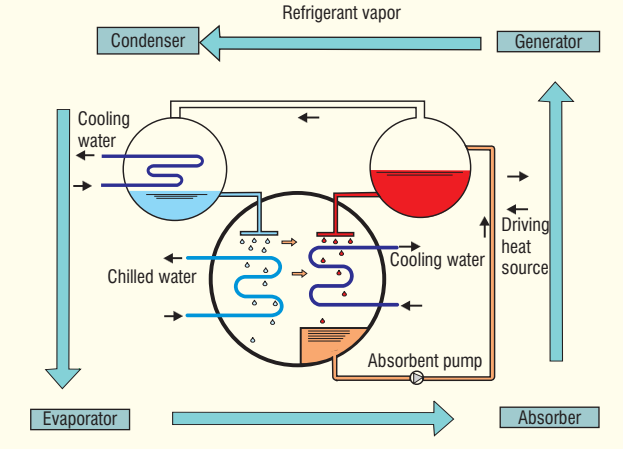
4



This heat causes the solution to release the absorbed refrigerant in vapor form. This vapor is cooled in a separate chamber to become liquid refrigerant.

In ProChill (twin design) absorption machines, the hot water first passes through high pressure generator and then through low pressure generator to enhance the efficiency of the cycle.

5



The basic operation cycle of the single effect vapor absorption chiller.

The refrigerant goes through a series of processes to complete the refrigerating cycle. These are namely evaporation, absorption, pressurization, vaporization, condensation, throttling and expansion. During this cycle, the refrigerant absorbs heat from a low temperature heat source and releases it to a high temperature sink.

Refrigeration Cycle

Cogenie

Evaporator

The Evaporator consists of a tube bundle, an outer shell, distribution trays, and a refrigerant pan.

A refrigerant pump is used to circulate the refrigerant from the refrigerant pan into the distribution trays. From these trays, the refrigerant falls on to the evaporator tubes.

The evaporator shell pressure is maintained at a low pressure. At this low pressure, the refrigerant evaporates at a low temperature (~ 3.89 °C) (for its evaporation the refrigerant extracts the required heat from the water, being circulated through the evaporator tubes.) As a result, the water in the tubes becomes chilled.

Absorber

The Absorber consists of a tube bundle, outer shell (common with the evaporator), distribution trays.

The Generator is housed in the upper shell, just above the Absorber. From the Generator, a concentrated absorbent solution is fed into the distribution trays, which falls on to the absorber tubes.

On the other hand, the vaporized refrigerant from the Evaporator is absorbed by the concentrated absorbent; leading to its dilution. Due to this absorption, the vacuum in the shell is maintained at a low pressure, leading to the desired chilled water temperature. During this process, the 'Heat of Dilution' is generated. The cooling water circulating through the absorber tubes removes this heat. As the absorbent solution loses its heat to the cooling water, it is able to absorb more refrigerant vapor, and gets further diluted. The diluted absorbent collects at the bottom of the shell.

Heat Exchanger

The absorbent pump sends the diluted absorbent to the Generator.

It passes through a Regenerative Heat Exchanger, where it absorbs heat from the concentrated absorbent before entering the Generator.

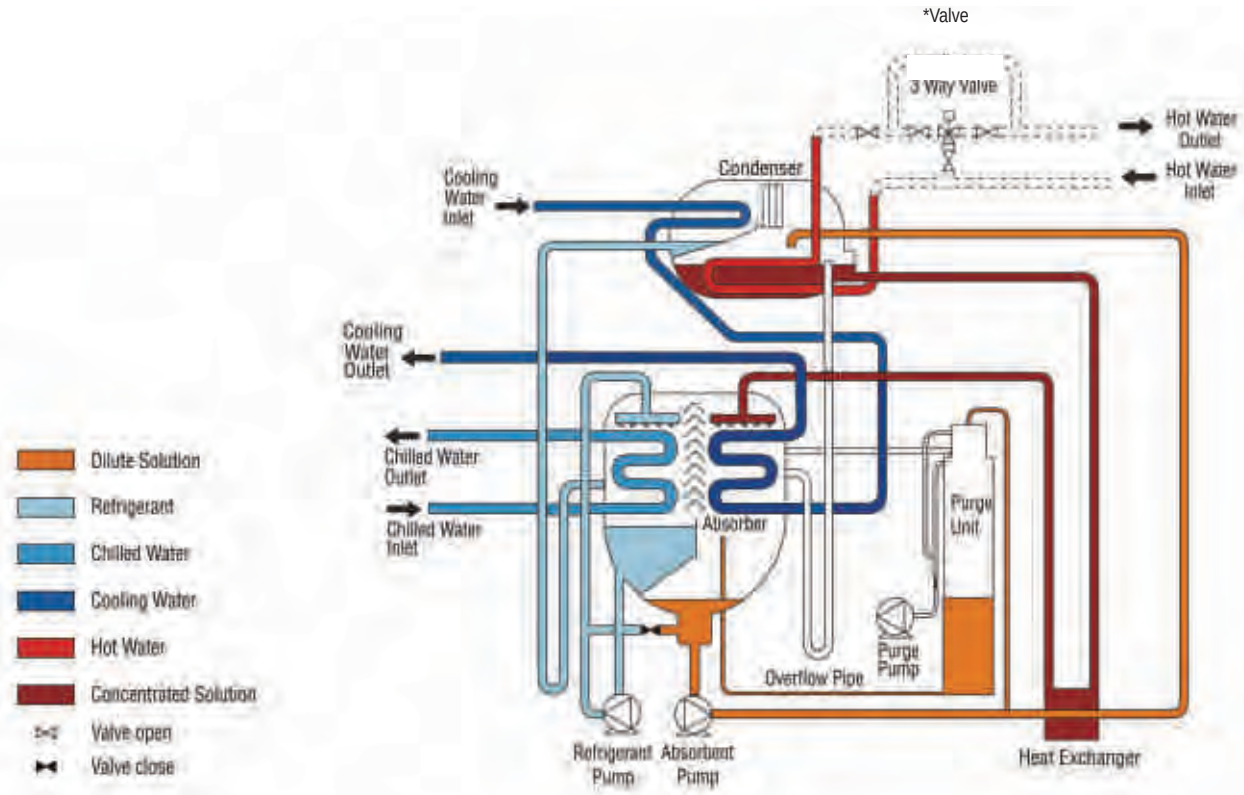
Because the heat exchanger heats up the cool absorbent solution before it enters the Generator for reheating, it reduces the heat input required in the Generator and increases the efficiency of the cycle.

Generator and Condenser

The generator and condenser tube bundles are enclosed in the upper shell. Hot water flows into the generator tubes, heats the absorbent flowing outside the tubes and, finally, condenses to drain out of the unit. The refrigerant vaporized from the absorbent, passes through the Eliminators to the Condenser. Here, the cooling water, circulating inside the condenser tubes cools it down. The refrigerant vapor condenses on the outside of the condenser tubes and collects at the bottom of the Condenser. The condensed refrigerant, from the Condenser, flows into the Evaporator. The absorbent, which has become concentrated in the Generator, drains into the Absorber through the Heat Exchanger, to begin a new absorbent cycle.

Cycle diagram

Cogenie

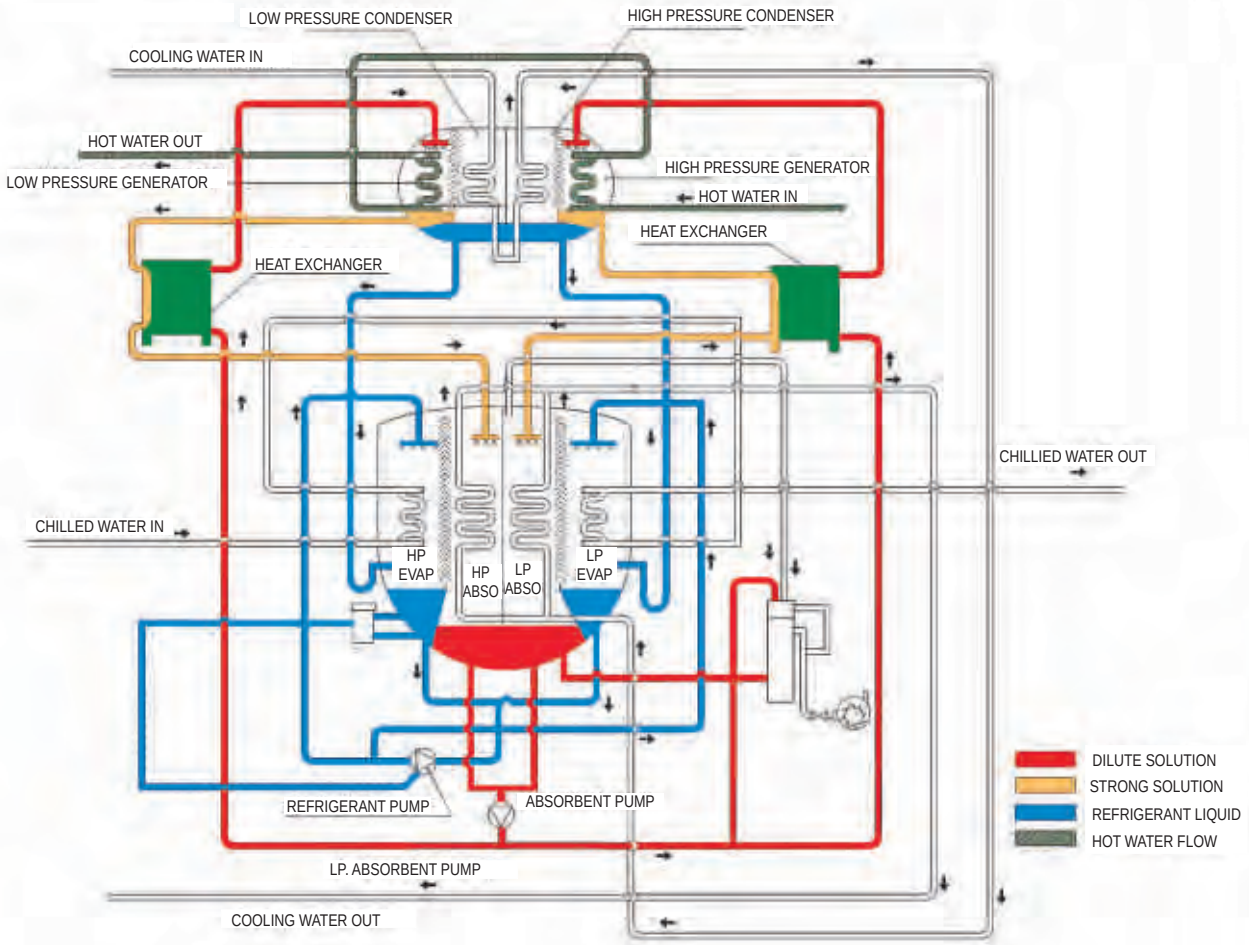


* 3 way hot water valve

The 3 way hot water valve is suggested as Thermax is concerned with Customers problems. For the chiller two way valve is more than adequate. When the flow rate required is very low and if pump is dedicated to Absorption machine closing of two way valve may lead to reduce flow lower than minimum recommended by the pump maker. In such a case pump life will be in danger. We normally not only worry about our chiller, but we do consider the problems faced by the customer, and hence, 3 way hot water valve is suggested.

Cycle diagram

ProChill



ProChill (Twin Design)

High Pressure Evaporator

The High Pressure Evaporator consists of a tube bundle, an outer shell, distribution trays, and a refrigerant pan.

Chilled water flows inside the tubes. A refrigerant pump is used to circulate the refrigerant from the refrigerant pan into the distribution trays. From these trays, the refrigerant falls on to the evaporator tubes.

Evaporator shell pressure is maintained at ~7.62 mm Hg (a). At this low pressure, the refrigerant evaporates at a low temperature and extracts latent heat of evaporation from the water being circulated through the evaporator tubes. As a result, water gets chilled and then passes through the low pressure evaporator tubes.

High Pressure Absorber

The High Pressure Absorber consists of a tube bundle, an outer shell (common with the high pressure evaporator), distribution trays and an absorbent collection sump.

Concentrated absorbent solution from the Low Pressure Generator is fed into the distribution trays. This solution falls on the high pressure absorber tubes.

On the other hand, the vaporized refrigerant from the High Pressure Evaporator is absorbed by the concentrated absorbent, leading to its dilution. Due to this absorption, the vacuum in the shell is maintained at a low pressure, leading to the desired chilled water temperature. During this process, 'Heat of Dilution' is generated. The cooling water, circulating through the high pressure absorber tubes, removes this heat. As the absorbent solution loses its heat to the cooling water, it is able to absorb more refrigerant vapor and gets further diluted. This diluted absorbent collects at the bottom of the shell.

Low Pressure Evaporator

The Low Pressure Evaporator consists of a tube bundle, an outer shell, distribution trays and a refrigerant pan.

The heat source i.e. chilled water from High Pressure Evaporator, flows inside the tubes. A refrigerant pump is used to circulate the refrigerant from the refrigerant pan into the distribution trays. From the trays, the refrigerant falls on to the evaporator tubes.

The shell pressure is maintained at a low pressure. At this low pressure, the refrigerant evaporates at a low temperature and extracts latent heat of evaporation from the water being circulated through the Evaporator tubes. As a result, heat is extracted from the water and it becomes chilled to the required temperature.

Low Pressure Absorber

The Low Pressure Absorber consists of a tube bundle, an outer shell (common with the Low Pressure Evaporator), distribution trays and an absorbent collection sump.

Concentrated absorbent solution from the High Pressure Generator is fed into the distribution trays. This solution falls on to the Low Pressure Absorber tubes.

On the other hand, the vaporized refrigerant from the Low Pressure Evaporator is absorbed by the concentrated absorbent, leading to its dilution. Due to this absorption, the vacuum in the shell is maintained at a low pressure, leading to the desired chilled water temperature. During this process, 'Heat of Dilution' is generated. The cooling water, circulating through the low pressure absorber tubes, removes this heat. As the absorbent solution loses its heat to the cooling water, it is able to absorb more refrigerant vapor and gets further diluted. This dilute absorbent collects at the bottom of the Low Pressure Absorber.

High Pressure Heat Exchanger

An absorbent pump is used to send the diluted absorbent to the High Pressure Generator through the High Pressure Heat Exchanger. The High Pressure Heat Exchanger heats up the absorbent solution before its entry into the High Pressure Generator for regeneration. The diluted absorbent gets heated up due to the strong solution coming from the High Pressure Generator. As a result the required heat input in the High Temperature Generator is very low, thereby increasing the efficiency of the cycle.

Low Pressure Heat Exchanger

An absorbent pump is used to send the diluted absorbent to the Low Pressure Generator through the Low Pressure Heat Exchanger. The Low Pressure Heat Exchanger heats up the absorbent solution before its entry into the Low Pressure Generator for regeneration. The diluted absorbent gets heated due to the strong solution coming from the Low Pressure Generator. As a result, the heat input required in the Low Pressure Generator is very low, thereby increasing the efficiency of the cycle.

High Pressure Generator and Condenser

The High Pressure Generator and Condenser tube bundles are enclosed in a shell and are separated by an insulation plate.

The hot water, at rated inlet conditions, passes through the tubes of the High Pressure Generator and boils the diluted solution coming from the High Pressure Absorber to form the refrigerant vapors. The cooling water flowing through the tube side of Condenser cools these vapors. The condensed refrigerant thus formed gets collected at the bottom of the Condenser. The absorbent, now concentrated in the Low Pressure Generator, drains to the Low Pressure Absorber to begin a new cycle.

Low Pressure Generator and Condenser

The Low Pressure Generator and Condenser tube bundles are enclosed in a shell and are separated by an insulation plate.

The hot water, coming from the High Pressure Generator, flows through the tubes of the Low Pressure Generator and boils the dilute solution to form refrigerant vapors. The cooling water flowing through the tube side of Condenser cools these vapors. The condensed refrigerant thus formed collects at the bottom of the condenser. The absorbent, now concentrated in the Low Pressure Generator, drains to the high pressure absorber to begin a new cycle.

Constructional Features And Mechanical Design Considerations

Cogenie and ProChill chillers can be designed to conform to the codes and standards given below. Whenever no specific standard is applicable, the design is according to good and proven Thermax engineering standards.

■ ETL ■ CE ■ PED ■ TUV ■ DNV ■ ASME ■ GOST

The lower shell houses two shell and tube heat exchangers: the Absorber and Evaporator. This shell is fabricated from formed carbon steel plates with fusion welded seams. Carbon steel tube sheets are drilled and reamed to accommodate absorber and evaporator tubes, and the tube ends are expanded to ensure no leakages between the shell and tube side. The support plates inside the shell are also fabricated from carbon steel plates. Enhanced copper tubes are used in the Absorber and Evaporator. The maximum allowable working pressure on the tube side is 8 bar . Gravity feed spraying technology is applied to spray the solution in the Absorber and Evaporator. The solution in the spraying tubes sprays downward to ensure good film thickness and better heat transfer. The Absorber and Evaporator are separated by an Eliminator that prevents the carryover of LiBr from Absorber to Evaporator, while allowing the water vapor from Evaporator to cross over to the Absorber. The lower shell is mounted on the base frame.

The upper shell comprises of the Generator and Condenser. This shell is also fabricated from carbon steel plates. Smooth copper tubes are used in the Condenser and finned stainless steel tubes in the Generator. Gravity feed spraying technology is applied to spray the solution in the Absorber and Evaporator. An Eliminator, that prevents the carryover of LiBr from the Generator to Condenser, separates these two. Hot water passes through the generator tubes.

In a twin design chiller, the upper shell comprises of the High Pressure Generator and Condenser separated from Low Pressure Generator and Condenser separated by a partition plate. This shell is also fabricated from carbon steel plates. Smooth copper tubes are used in Condensers and finned carbon steel tubes in Generators. The lower shell houses the High Pressure Absorber and Evaporator separated from the Low Pressure Absorber and Evapoator by a partition plate. Gravity feed spraying technology is applied to spray the solution in the Absorber and Evaporator. An Eliminator, that prevents the carryover of LiBr, separates each Generator and Condenser and also each Evaporator and Absorber. The upper shell rests on the lower shell.

The Regenerative Heat Exchangers increase the efficiency of the cycle by utilizing the heat within the system.

For lower Cogenie models (LT-2 to LT-8), canned motor pumps are in welded construction.

For higher models of Cogenie (LT-10C to LT-21C) and for all ProChill models, canned motor pumps are in bolted construction to facilitate maintenance. Isolation valves are also provided to ensure that the machine vacuum is not disturbed as it is not exposed to air during maintenance.

Non condensable gases are removed from the chiller by operating the vacuum pump and opening the manual purge valves. Service valves are provided for N2 charging, sampling and for connecting the Manometer.

The Purge System

Supply List And Scope Of Work

Cogenie

Sr. No.	Description	Remarks
A	**Lower Shell**	
1.	Evaporator	Common Shell and
2.	Absorber	Tube sheets, separate level boxes
3.	Base Frame	
B	**Upper Shell**	
4.	Generator	Common Shell and Tube sheets,
5.	Condenser	separate level boxes
C	**Heat Exchangers**	
6.	Heat Exchanger	Plate Heat Exchanger
D	**Pumps and Motors**	
7.	Absorbent Pump and Motor	Canned Motor Pump Set
8.	Refrigerant Pump and Motor	Canned Motor Pump Set
9.	Purge Pump and Motor	Vacuum Pump Set
E	**Purge System**	For Separation of Non-condensable gases from Absorbent and its Storage
F	**Piping**	Interconnecting Piping
G	**Instrumentation***	2/ 3-way Hot Water Flow Control Valve Control Panel, Field Instruments, Cabling
H	**Electricals**	Starters, Circuit breakers, Wiring within Battery Limits
I	**Documents**	Operation and Maintenance Manual, Packing List

Note: * indicates that the scope of work is optional

■ Prochill

Sr. No.	Description	Remarks
A	**Lower Shell**	
1.	High Pressure Evaporator	Common Shell and Tube sheets, separate level boxes
2.	High Pressure Absorber	
3.	Low Pressure Evaporator	
4.	Low Pressure Absorber	
5.	Base Frame	
B	**Upper Shell**	
6.	High Pressure Generator	Common Shell and Tube sheets, separate level boxes
7.	High Pressure Condenser	
8.	Low Pressure Generator	
9.	Low Pressure Condenser	
C	**Heat Exchangers**	
10.	High Pressure Heat Exchanger	Plate Heat Exchanger
11.	Low Pressure Heat Exchanger	Plate Heat Exchanger
D	**Pumps and Motors**	
12.	Absorbent Pump and Motor	Canned Motor Pump Set
13.	Refrigerant Pump and Motor	Canned Motor Pump Set
14.	Purge Pump and Motor	Vacuum Pump Set
E	**Purge System**	For Separation of Non-condensable gases from Absorbent and its Storage
F	**Piping**	Interconnecting piping
G	**Instrumentation***	3-way Hot Water Flow Control Valve, Control Panel, Field Instruments, Cabling
H	**Electricals**	Starters, Circuit breakers, Wiring within Battery Limits
I	**Documents**	Operation and Maintenance Manual, Packing List

Note: * indicates that the scope of work is optional

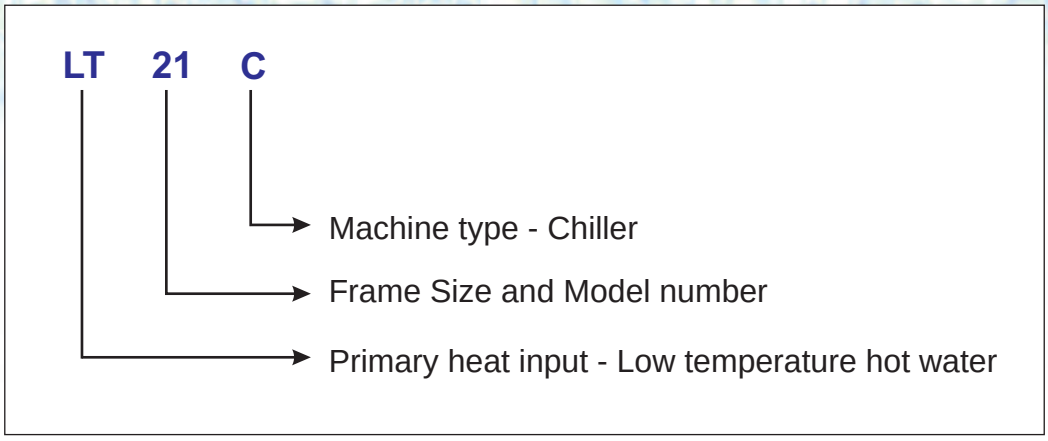
■ Distribution of Scope of Work - Manufacturing, Transportation and Installation

Item / Activity	Thermax	Customer	Remarks
Chiller			
Chiller Manufacture with accessories	✓		Refer to Supply List.
Testing			
Factory Testing	✓		Thermax Optional Feature.
On-site Erection		✓	
Supervision of Commissioning	✓	✓	Customer to assist, Thermax Representative will supervise the commissioning.
Transportation			
Loading at Thermax Factory	✓		
Factory to Port	✓		
Port in India to Port of Destination*		✓	Optional
Port to Job-site		✓	
Unloading at Job-site		✓	
Storage at Job-site		✓	If required.
Construction and Installation			
Handling at Job-site		✓	Rigging, Shifting to actual location.
Civil Foundation		✓	
Piping outside Battery Limits		✓	Refer to Supply List.
Butterfly valve in the cooling water line		✓	If required. (Refer to Safety Functions under Instrumentation and Safety Features.)
Chiller Insulation*		✓	
Piping Insulation outside Battery Limits		✓	Refer to Supply List.
Electrical Connections outside Battery Limits		✓	Refer to Supply List.
Assembly and On-site Connections		✓	For Multi-Sectional Shipment (Optional).
Operation and Maintenance			
Training of Customer's Operators during commissioning (maximum period of 7 days)	✓		
Operation		✓	

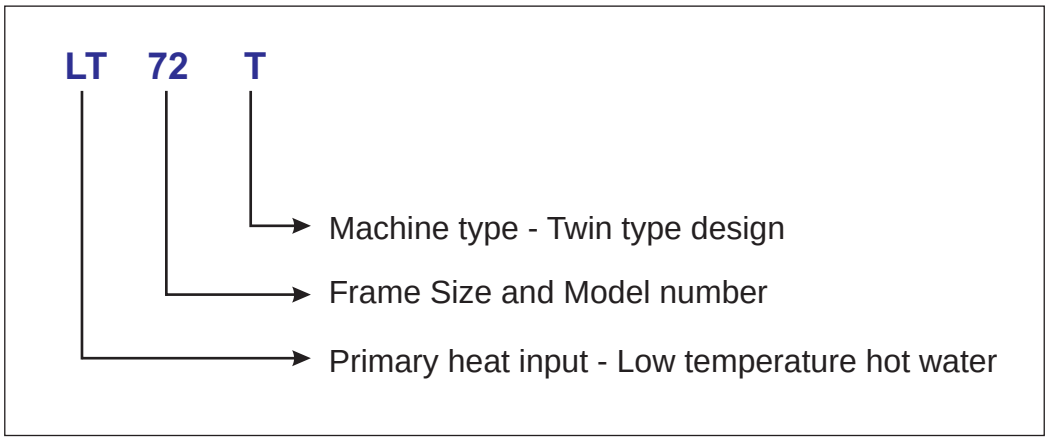
NOTE: * Indicates that the scope of supply can also be included by Thermax, as an option.

Thermax Nomenclature And The Prochill B4k Product Basket

LT 21 C



LT 72 T



Utility Requirements

Chilled Water: The chiller's design ensures in delivering the desired cooling capacity. The chilled water flow rate to the machine is kept constant. Hence its capacity is proportional to the difference in the temperatures of the inlet and the outlet chilled water.

Cooling Water: Cooling water is used to remove heat of absorption and condensation. The chiller can be designed to suit rated cooling water temperature of 25° - 36°C.

Energy Source: The chiller is designed according to the available hot water temperature. The hot water operating temperatures can be from 75 to 120°C.

Air: Compressed air is required for pneumatic operation of the Hot Water Control valve. The Air supplied should be moisture free and the required pressure is 6.9 bar (g). Air is not be required if 2 way electric valves (size: up to 6 inch) are provided.

Electricity: The power supply to the chiller shall be strictly as per the voltage and frequency rating given on chiller name plate.

To avoid scaling and corrosion, we recommend maintaining water quality as given here. If the water quality at the installation site is different, the chiller can be designed to adjust to it.

Chilled Water and Cooling Water Treatment

Treatment of the chilled and cooling water is important to get desired chiller performance and for its long life.

If the water quality is bad, it shows a scaling and/or corrosion tendency. Sludge and scale can adhere to the inside of the tubes. This impedes heat transfer between the chilled water and refrigerant and between the cooling water and LiBr solution. Consequently, there can be an increase in the respective temperatures of the LiBr solution and the condensed refrigerant, leading to an increase in the fuel consumption and thus hampering the capacity and efficiency of the chiller. In cases of prolonged corrosion, the tubes will require maintenance or, in some cases, they may even have to be replaced.

As the cooling water circuit is open, the salts get concentrated due to evaporation taking place in the cooling tower. This can be adjusted by controlling cooling water blow-down and make-up. Moreover, exposure to sunlight favors biological growth. Slime is more detrimental to heat transfer than scale. Dosing biocides during cooling water treatment can minimize these adverse effects.

Unlike the cooling water circuit, which is always open, the chilled water circuit may be open or closed. Due to the lower temperature, chilled water circulating in an open circuit does not have severe consequences. Soft water is recommended for use in this circuit.

■ JIS recommends the following water quality for copper tubes:

Sr. No.	Items	Units	Allowable Range		
			Chilled Water	Cooling Water	
			(Circulating)	(Circulating)	(Make-up)
1	pH (25°C)		6.5 - 8.0	6.5 - 8.0	6.5 - 8.0
2	Electric Conductivity (25°C)	μs/cm	500 max	800 max	200 max
3	M Alkalinity	ppm	100 max	100 max	50 max
4	Chloride Ion Cl -	mg/l	100 max	200 max	50 max
5	Sulphuric Acid Ion SO4 --	mg/l	100 max	200 max	50 max
6	Total Hardness as CaCO3	mg/l	100 max	200 max	50 max
7	Total Iron Fe	mg/l	1.0 max	1.0 max	0.3 max
8	Sulphur Ion S --	mg/l	Not detected		
9	Ammonium Ion NH4 +	mg/l	0.5 max	1.0 max	0.2 max
10	Silica	mg/l	50 max	50 max	30 max
11	Turbidity	NTU	10 max	20 max	5 max
12	Suspended solids	mg/l	10 max	20 max	5 max
13	Free Carbonic acid	mg/l	10	-	-
14	Biological Oxygen Demand (BOD)	ppm	Below 160	-	Below 160
15.	Chemical Oxygen Demand (COD)	ppm	Below 160	-	Below 160

Sr. No.	Description	Unit	Specifications	
			Cooling Water	Make-up Water
1	pH at 77°F		6.5 - 8.5	6.5 - 8.5
2	Electrical Conductivity (max.)	μs/cm	800	200
3	M Alkalinity (max.)	ppm	100	50
4	Total Hardness (max.)	mg $CaCO_3$/lit	200	50
5	Chloride ion (max.)	mg Cl/lit	200	50
6	Sulphate ion (max.)	mg SO_4/lit	200	50
7	Total Iron (max.)	mg Fe/lit	1	0.3
8	Sulphide ion	mg S/lit	Not detected	
9	Ammonium ion (max.)	mg NH_4/lit	1	0.2
10	Silica ion (max.)	mg SiO_2/lit	50	30
11	Suspended solids (max.)	mg/lit	20	5
12	Turbidity	NTU	20	5
13	BOD / COD (max.)	mg/lit	160	160

Selection Criteria And Procedure

Selection Criteria

The following factors govern model selection

- **Hot water temperature:** Capacity of the chiller is sensitive to hot water temperature. If hot water temperature is lower than the rated temperature, capacity of the chiller tends to reduce and vice-versa.
- **Chilled and cooling water temperature:** Capacity of the chiller varies based on chilled water outlet temperature and cooling water inlet temperature. The chiller is capable of delivering higher than its rated capacity if chilled water temperature is higher than the rated temperature or cooling water temperature is lower than the rated temperature. Conversely, the chiller capacity is likely to be reduced if chilled water temperature is lower and cooling water temperature is higher than their respective rated temperatures. Thermax has designed and installed chillers for chilled water temperatures ranging from 3.5°C to 21°C and cooling water temperatures varying from 10°C to 36°C.
- **Chilled and cooling water circuit pressure:** Thermax's standard product range is designed for a maximum pressure of Cogenie - 5 bar (g), Prochill - 8 bar (g) in the chilled and cooling water circuits. Thermax also offers special design for higher pressures.
- **Size:** For ease of operation, Thermax design ensures sufficient distance between various parts of the chiller. However, on special requirement, compact chiller can be manufactured to fit within the available space at the existing site. Moreover, if the openings available at site are smaller than the machine size, the chiller can be transported in multiple sections and assembled at site.
- **Optional features:** These include tube material of construction, frequency drive for double effect absorbent pumps, flame proof construction, cladded tube sheets and special electronics and instrumentation.

Selection Procedure

Absorption is a complex phenomenon involving heat and mass transfer. The chiller consists of multiple interlinked heat exchangers. In such a complex mechanism, deration factors and two-dimensional graphs can lead only to approximation. At Thermax, every selection is done with the help of a computer program that does detailed heat and mass transfer calculations for each Heat Exchanger and accurately determines performance of the chiller. When using media other than water or for non-standard fouling factors, the selection considers appropriate properties to evaluate overall heat transfer coefficient. The program optimizes the energy and the fuel consumption, the chilled and the cooling water flow rates and the pressure drops.

The following document provides performance data and the dimensional data for all the standard models.

Dimensional Data

Specifications - Low temperature hot water fired Single effect chillers - MKS

Model Number		UNIT	LT2	LT3	LT5	LT6	LT8
Cooling Capacity		kW	70	106	176	229	281
Chilled Water Circuit	Flow Rate	m^3/hr	11.0	16.5	27.4	35.7	43.9
	No. of passes (Evaporator)	#	6	4			
	Friction Loss	kPa	18.6	16.7	19.6	17.7	24.5
	Connection Diameter	mmNB	50	65	80	100	
Cooling Water Circuit	Flow Rate	m^3/hr	20	30	50	65	80
	Outlet temperature	^0C	37.1	36.8	36.8	36.8	36.8
	No. of passes (Absorber	#	6	4			
	No. of passes (Condenser)	#	2				
	Friction Loss	kPa	39.2	45.1	77.5	46.1	54.9
	Connection Diameter	mmNB	65	80		125	
Hot Water Circuit	Flow Rate	m^3/hr	17	24	40	52	64
	No. of passes (Generator)	#	8	4			
	Friction Loss	kPa	76.5	17.7	17.7	15.7	17.7
	Connection Diameter	mmNB	50	65	80	100	
Overall Dimensions	Length (L)	mm	2150	2350	2350	2550	
	Width (W)	mm	1105	1275	1350	1540	
	Height (H)	mm	2350	2100	2350	2490	
Operating Weight		$x10^3$ kg	2.5	3.0	4.0	5.5	5.8
Maximum Shipping Weight		$x10^3$ kg	2.2	2.5	3.5	4.2	4.5
Clearance for Tube Removal		mm	1500	2200			
Electrical data	Absorbent Pump	kW (A)	1.1(3.4)				
	Refrigerant Pump	KW (A)	0.1(0.55)			0.3(1.4)	
	Purge Pump	kW (A)	0.75(1.8)				
	Total power consumption	kVA	5.1			5.7	
	Power Supply		415V(±10%), 50 Hz (±5%), 3 Phase+N				

Notes:
1) Model Nos. : LT X - Low Temperature Hot water fired Single effect Chillers
2) Chilled water inlet/outlet temperature- 12.2/6.7^{0}C
3) Cooling water inlet temperature = 29.4^{0}C
4) Hot water inlet / outlet temperature = 90.6 / 85^{0}C
5) Minimum Chilled water outlet temperature is 3.5^{0}C
6) Minimum Cooling water inlet temperature is 20^{0}C
7) Ambient condition shall be between 5 to 45^{0}C
8) Maximum Allowable pressure in chilled / cooling / hot waler system = 4.9 bar (g)
9) Control panel Electric Input = 1 kVA
10) All Water Nozzle connections to suit ASME B16.5 Class 150
11) Technical specification is based on JIS B 8622 : 2002

ProChill - (LT 24 T to LT 115 T)

Specifications - Low temperature hot water fired Single effect chillers - MKS

Model Number		UNIT	LT10C	LT12C	LT14C	LT16C	LT18C	LT21C
Cooling Capacity		kW	352	422	492	563	633	739
Chilled Water Circuit	Flow Rate	m^3/hr	54.9	65.8	76.8	87.8	98.7	115.2
	No. of passes (Evaporator)	#	2					
	Friction Loss	kPa	18.6	19.6	31.4	31.4	63.7	66.7
	Connection Diameter	mmMB	150					
	Flow Rate	m^3/hr	100	120	140	160	180	210
Cooling Water Circuit	Outlet temperature	^0C	36.6	36.6	36.6	36.6	36.6	36.6
	No. of passes (Absorber	#	2					
	No. of passes (Condenser)	#	1					
	Friction Loss	kPa	34.3	38.2	56.9	61.8	35.3	38.2
	Connection Diameter	mmNB	150				200	
Hot Water Circuit	Flow Rate	m^3/hr	76	91	107	121	137	159
	No. of passes (Generator)	#	4			3		
	Friction Loss	kPa	43.1	43.1	30.4	30.4	56.9	59.8
	Connection Diameter	mmNB	150					
	Length (L)	mm	4100		4700		5800	
Overall Dimensions	Width (W)	mm	1500					
	Height (H)	mm	2520					
Operating Weight		x 10^3 kg	6.0	6.3	7.1	7.3	8.2	8.6
Maximum Shipping Weight		x 10^3 kg	5.3	5.5	6.1	6.2	7.1	7.3
Clearance for Tube Removal		mm	3200		3800		4800	
Electrical data	Absorbent Pump	kW(A)	1.5 (5.0)					
	Refrigerant Pump	kW(A)	0.3(1.4)					
	Purge Pump	kw(A)	0.75(1.8)					
	Total power consumption	kVA	6.9					
	Power Supply	415 V(±10%), 50 Hz (±5%), 3 Phase+N						

1) Model Nos: LT XX C Low Temperature Hot wafer fired Single effect Chillers
2) Chilled waler inlet /outlet temperature = 12.2/6.7 ^0C
3) Cooling water inlet temperature = 29.4^0C
4) Hoi water inlet / outlet temperature = 90.6 / 85^0C
5) Minimum Chilled waler outlet temperature is
6) Minimum Cooling water inlet temperature is
7) Ambient condition shall be between 5 to 45^0C
8) Maximum Allowable pressure in chilled / cooling / hot water system = 7.8 bar (g)
9) Control panel Electric Input = 1kVA
10) All Water Nozzle connections to suit ASMEB16.5 Class 150
11) Technical specification is based on JIS BBG22 : 2002

ProChill™

Performance Data

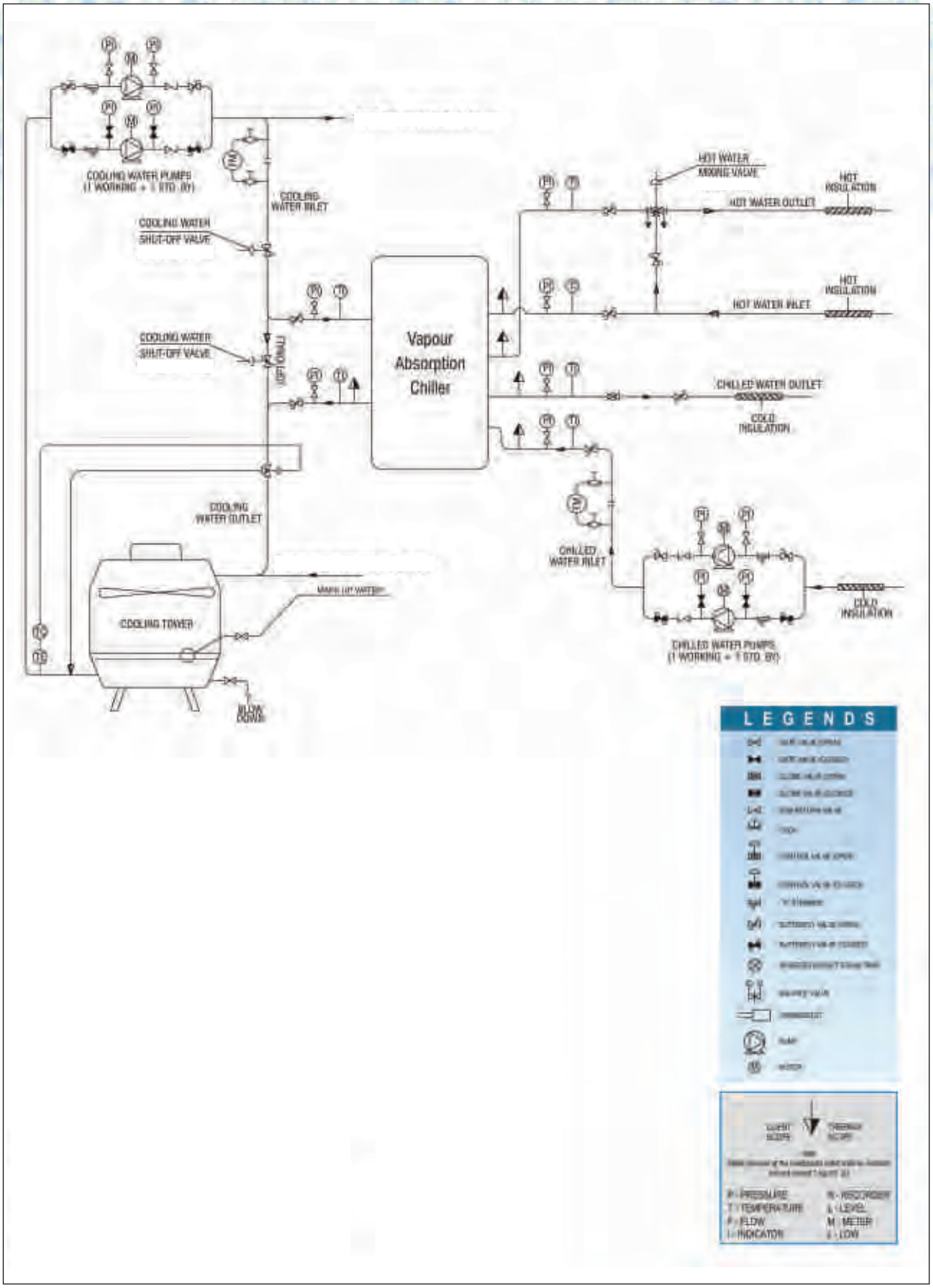
Specification - Low temperature hot water fired Twin type absorption chillers - MKS

Model Number		UNITS	LT24T	LT27T	LT31T	LT34T	LT38T	LT42T	LT47T	LT52T	LT60T	LT65T	LT72T	LT77T	LT85T	LT95T	LT105T	LT115T
Cooling Capacity		kW	844	950	1090	1196	1336	1495	1653	1846	2110	2286	2532	2708	2989	3341	3693	4044
Chilled Water Circuit	Flow rate	m^3/hr	131.6	148.1	170.0	186.5	208.4	233.1	257.8	288.0	329.1	356.5	394.9	422.4	466.2	521.1	575.9	630.8
	No. of passes (Evaporator)	#	1+1															
	Friction loss	kPa	30.4	25.5	27.5	28.4	25.5	26.5	38.2	41.2	71.6	72.6	65.7	64.7	51.0	56.9	88.3	93.2
	Connection Diameter	mmNB	150		200		250										300	
Cooling Water Circuit	Flow rate	m^3/hr	240	270	310	340	380	425	470	525	600	650	720	770	850	950	1050	1150
	Outlet Temperature	^{0}C	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4	36.4
	No. of passes (absorber)	#	2 , 2															
	No. of passes (condensor)	#	1+1															1,1
	Friction loss	kPa	61.8	53.9	56.9	59.8	53.9	57.9	67.7	71.6	122.6	121.6	120.6	122.6	107.9	111.8	98.1	1059
	Connection Diameter	mmNB	200		250				300				350			400		
Fuel Circuit	Flow rate	m^3hr	176	198	227	249	279	312	345	385	440	477	528	565	623	697	770	843
	No. of passes (Generator)	#	1 + 1															
	Friction Loss	kPa	24.5	16.7	17.7	186.6	21.6	23.5	38.2	43.1	67.7	70.6	60.8	62.8	59.8	63.7	100.0	101.0
Overall Dimen-sions	Connection Diameter	mmNB	150					200					250			300		
	Length (L)	mm	5130		5460		5660		6810		8050		8200		8390		9700	
	Width (W)	mm	2200		2350		2400		2525				2875		3200			
	Height (H)	mm	3180		3380		3520		3560				4360		4940			
Operating Weight		x 10^3 kg	12.0	14.4	15.0	15.4	18.8	19.4	23.6	24.2	27.2	28.2	35.6	36.6	46.4	48.6	53.6	55.6
Maximum Shipping Weight		x 10^3 kg	10.3	12.4	12.8	13.0	15.7	16.2	19.8	20.1	22.7	23.4	30.2	30.9	39.0	40.7	45.2	46.6
Clearance for Tube Removal		mm	4000						5250		6500						7900	
Electric Supply	Absorbent Pump	kW (A)	1.5(5)		3(8)		3.7(11)		5.5(14)				6.6(17)		4.5(13)		7.5(20)	
	Refrigerant Pump	kW(A)	0.3(1.4)								1.5(5.0)							
	Purge Pump	kW(A)	0.75(1.8)															
	Total Electric Input	kVA	6.9		9.1		11.2		13.4		16.0		18.1		15.2		20.3	
	Power Supply		415 V(±10%), 50 Hz (±5%), 3 Phase+N															

Notes:

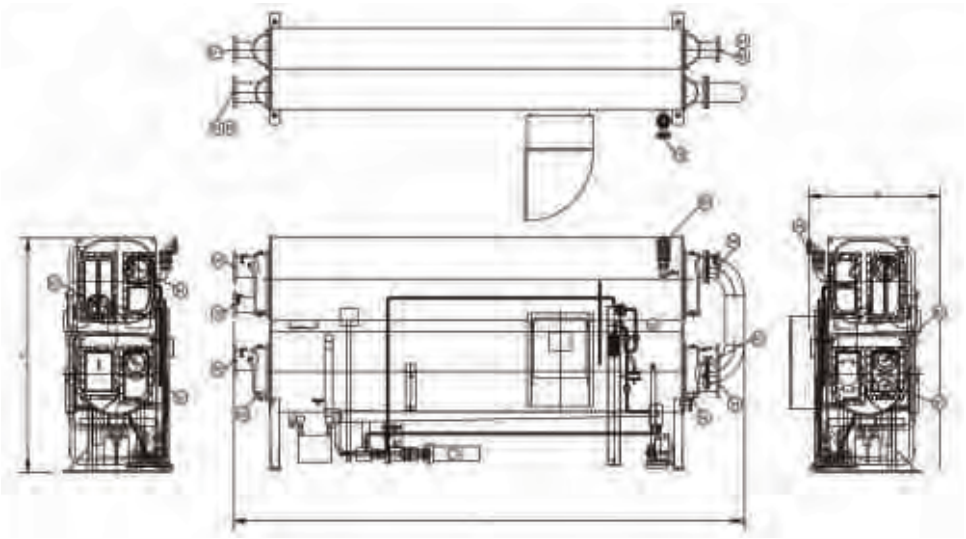
1) Model Nos. : LT XX -T Low Temperature Hot water fired Twin type Chillers
2) Chilled water inlet / outlet temperature = 12.2 / 6.7^{0}C
3) Cooling water inlet temperature = 29.4^{0}C
4) Hot water inlet / outlet temperature = 90.6 / 85^{0}C
5) Minimum chilled water outlet temperature is 3.5^{0}C
6) Minimum Cooling water inlet temperature is 200C
7) Ambient condition shall be between 5 to 450C
8) Maximum Allowable pressure in chilled/ cooling/ hot water system = 7.8 bar (g)
9) Control panel Electric Input = 1kVA
10) All Water Nozzle connections to suit ASME B16.5 Class 150
11) Technical specification is based on JIS B 8622 : 2002

Typical System P&I Diagram



Typical General Arrangement Drawings

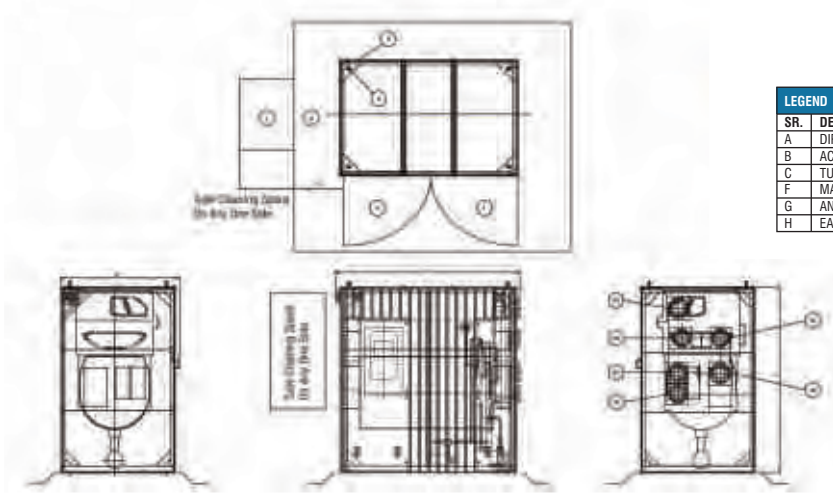
LT 10 C to LT 21 C



NOZZLE	DESCRIPTION
N1	CHILLED WATER INLET
N2	CHILLED WATER OUTLET
N3	CHILLED WATER DRAIN PLUGGED
N4	COOLING WATER INLET
N5	COOLING WATER OUTLET
N6	COOLING WATER DRAIN PLUGGED
N7	HOT WATER INLET
N8	HOT WATER OUTLET
N9	RUPTURE DISK

MODEL NUMBER		UNIT	LT10C	LT12C	LT14C	LT16C	LT18C	T21C
NOMINAL REFRIGERATION CAPACITY		NTR	100	120	140	160	180	210
DIMENSIONS	Length (L)	mm	4100		4700		5800	
	Width (W)	mm	1500					
	Height (H)	mm	2520					
Operating Weight		x 1000 kg	6	6.3	7.1	7.3	8.2	8.6
Maximum Shipping Weight		x 1000 kg	5.3	5.5	6.1	6.2	7.1	7.3
Cleaning For Tube Removal		mm	3200		3800		4800	

LT-2 to LT-8



LEGEND	
SR.	DESCRIPTION
A	DIRECT SPACE
B	ACCESS DOOR FOR CONTROL
C	TUBE CLEANING SPACE
F	MAINTENANCE SPACE (DOOR SPACE)
G	ANCHOR BOLT LOCATION
H	EARTH TERMINAL/ELECTICAL WIRING OPENING

NOZZLE SCHEDULE	
SR.	DESCRIPTION
N1	CHILLED WATER INLET
N2	CHILLED WATER OUTLET
N3	CHILLED WATER DRAIN PLUGGED
N4	COOLING WATER INLET
N5	COOLING WATER OUTLET
N6	COOLING WATER DRAIN PLUGGED

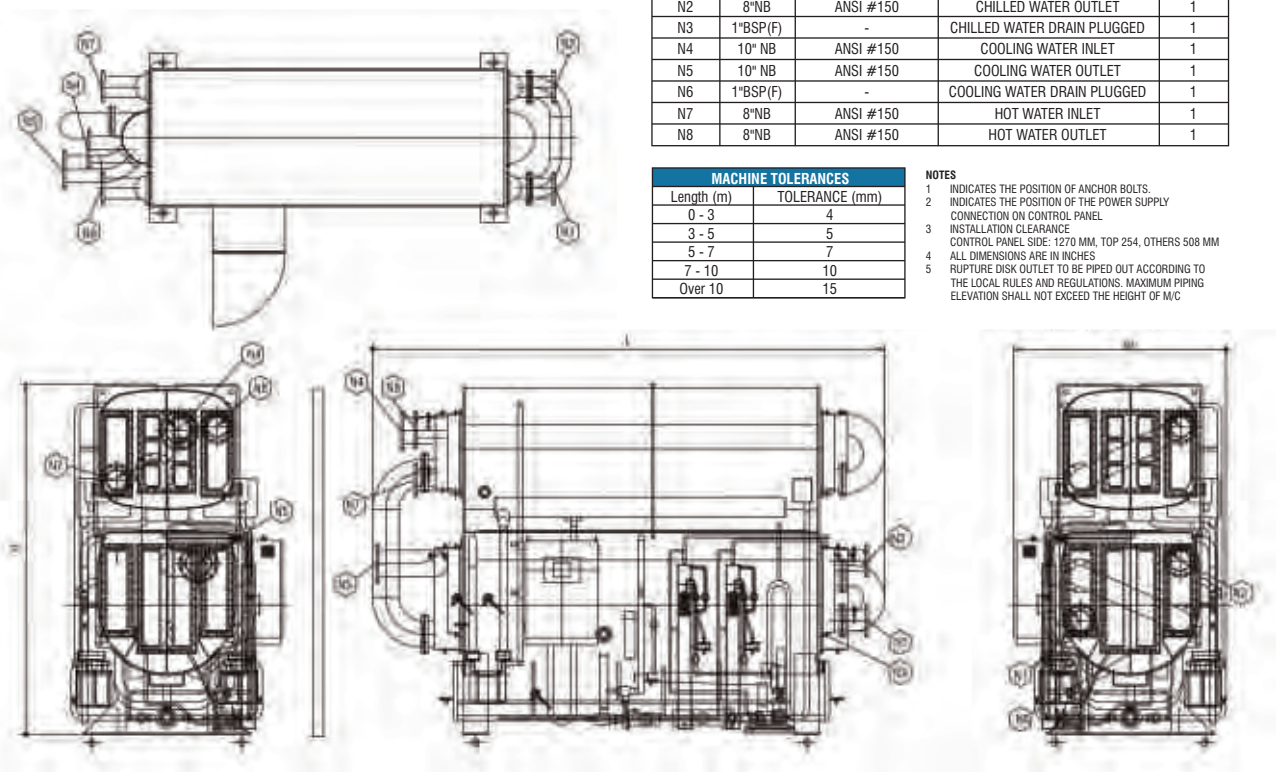
MODEL NUMBER		UNIT	LT2	LT3	LT5	LT6	LT8
NOMINAL REFRIGERATION CAPACITY		NTR	20	30	50	60	80
DIMENSIONS	Length (L)	mm	2150	2350	2350	2550	2550
	Width (W)	mm	1105	1275	1350	1540	1540
	Height (H)	mm	2350	2100	2350	2490	2490
Operating Weight		x 1000 kg	2.5	3	4	5.5	5.8
Maximum Shipping Weight		x 1000 kg	2.2	2.5	3.5	4.2	4.5
Cleaning For Tube Removal		mm	1500	2200			

LT 24 T to LT 115 T

NOZZLE SCHEDULE				
NOZZLE	**SIZE**	**NOZZLE FL. RATING**	**DESCRIPTION**	**QTY**
N1	8"NB	ANSI #150	CHILLED WATER INLET	1
N2	8"NB	ANSI #150	CHILLED WATER OUTLET	1
N3	1"BSP(F)	-	CHILLED WATER DRAIN PLUGGED	1
N4	10" NB	ANSI #150	COOLING WATER INLET	1
N5	10" NB	ANSI #150	COOLING WATER OUTLET	1
N6	1"BSP(F)	-	COOLING WATER DRAIN PLUGGED	1
N7	8"NB	ANSI #150	HOT WATER INLET	1
N8	8"NB	ANSI #150	HOT WATER OUTLET	1

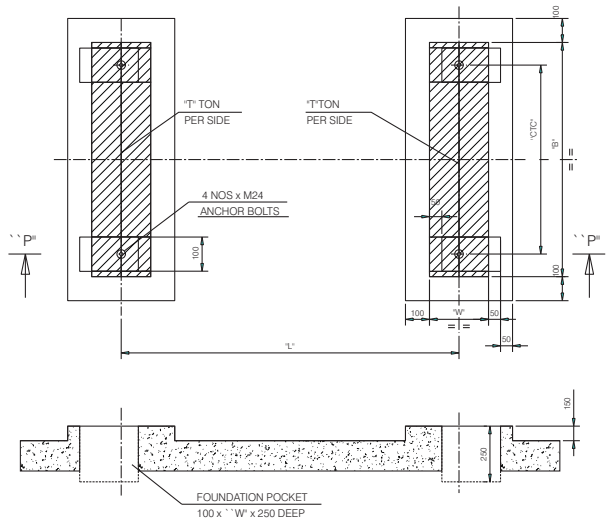
MACHINE TOLERANCES	
Length (m)	TOLERANCE (mm)
0 - 3	4
3 - 5	5
5 - 7	7
7 - 10	10
Over 10	15

NOTES
1. INDICATES THE POSITION OF ANCHOR BOLTS.
2. INDICATES THE POSITION OF THE POWER SUPPLY CONNECTION ON CONTROL PANEL
3. INSTALLATION CLEARANCE
   CONTROL PANEL SIDE: 1270 MM, TOP 254, OTHERS 508 MM
4. ALL DIMENSIONS ARE IN INCHES
5. RUPTURE DISK OUTLET TO BE PIPED OUT ACCORDING TO THE LOCAL RULES AND REGULATIONS. MAXIMUM PIPING ELEVATION SHALL NOT EXCEED THE HEIGHT OF M/C

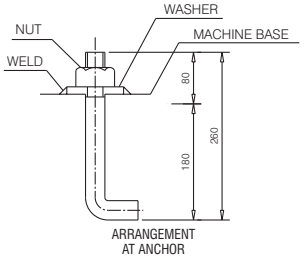


Foundation Drawings

LT 24 T to LT 115 T



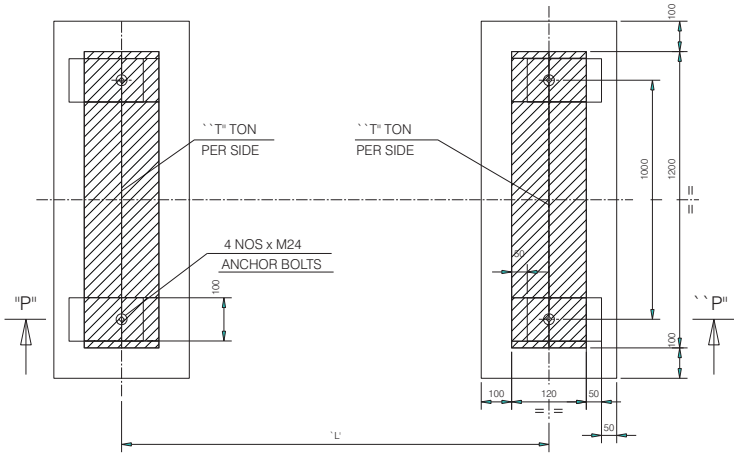
MODEL	"L"	"W"	"B"	"CTC"	"T"
	mm	mm	mm	mm	TON (1000 kgs)
LT24T	3424	270	1580	1380	6.0
LT27T	3424	270	1740	1540	7.2
LT31T	3424	270	1740	1540	7.5
LT34T	3424	270	1740	1540	7.7
LT38T	3374	320	1975	1760	9.4
LT42T	3374	320	1975	1760	9.7
LT47T	4592	320	1975	1760	11.8
LT52T	4592	320	1975	1760	12.1
LT60T	5826	320	1975	1760	13.6
LT65T	5826	320	1975	1760	14.1
LT72T	5726	420	2412	2272	17.8
LT77T	5726	420	2412	2272	18.3
LT85T	5726	420	2660	2520	23.4
LT95T	5726	420	2660	2520	24.3
LT105T	6976	420	2660	2520	26.8
LT115T	6976	420	2660	2520	27.8

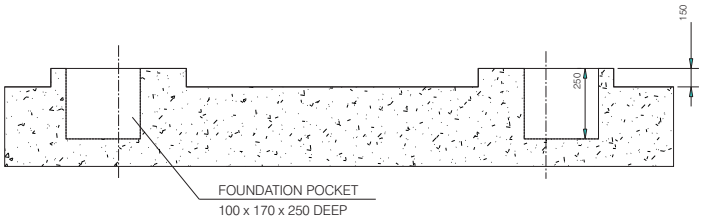


INDICATES THE BASE OF MACHINE

Note:-
The above drawing indicates the dimensions of the equipment base frame and foundation bolt pockets and suggested size of the footings. The foundation shall be designed to suit the soil conditions and other design considerations at site.

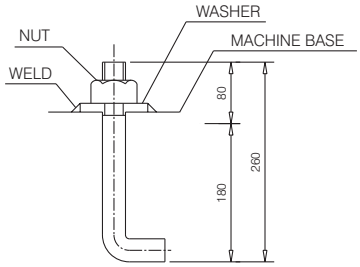
LT 10 C to LT 21 C





SECTION "P - P"

MODEL	"L"	"T"
	mm	TON (1000 Kgs)
LT6C	1946	2.5
LT8C	1946	2.6
LT10C	2966	3.0
LT12C	2966	3.2
LT14C	3574	3.5
LT16C	3574	3.6
LT18C	4574	4.1
LT21C	4574	4.3

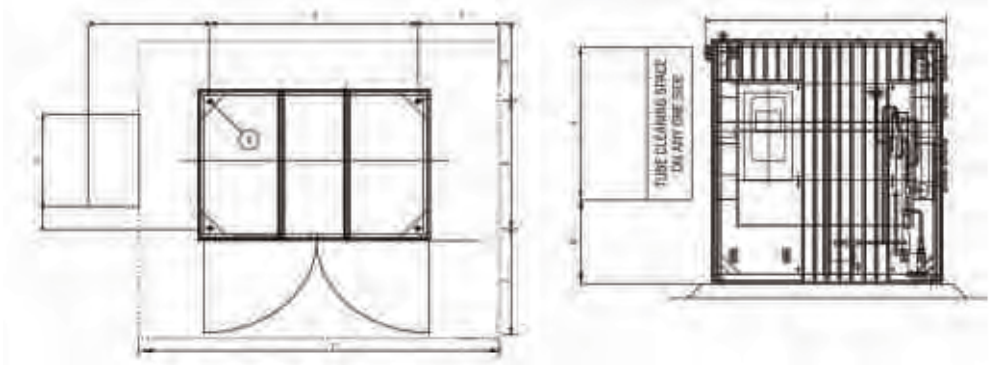


ARRANGEMENT
AT ANCHOR

INDICATES THE BASE OF MACHINE

Note:-
The above drawing indicates the dimensions of the equipment base frame and foundation bolt pockets and suggested size of the footings. The foundation shall be designed to suit the soil conditions and other design considerations at site.

LT-2 to LT-8



UNIT	MM									
MODEL	A	B	C	D	E	F	G	J	K	M
LT-1	1250	1140	1100	635	1125	3449	851	274	1049	599
LT-2	1250	1140	1100	635	1125	3449	851	274	1049	599
LT-3	1872	940	1120	620	1219	4112	625	211	1120	681
LT-5	1981	1046	1125	620	1300	4234	696	249	1349	701
LT-6	2169	1341	1100	599	1283	4364	879	279	1397	968
LT-8	2169	1295	1100	599	1283	4364	879	277	1397	968

TUBE CLEANING SPACE ON ANY ONE SIDE

1. There should be a drain ditch around the foundation.
2. Anchor bolts should be fixed in the foundation prior to the chiller installation.
3. Anchor bolts (anchor bolts, nuts & washers) are supplied with the chiller.
4. Be sure to weld the washer as shown in above detail.
5. The floor surface should be made water proof for ease of maintenance work.

Instrumentation And Safety Features

Control Logic

The control panel includes the following components:

- Programmable Logic Controller (PLC)
- Panel view operator interface
- Power circuit for pumps
- Panel mounted instruments

The total heat extracted from the chilled water defines the cooling capacity of a machine. The chilled water inlet flow- rate is kept constant. Hence the cooling capacity is proportional to the difference in the temperatures of the chilled water at inlet and outlet chilled water.

Load changes are reflected in the rise or fall of the temperature of the inlet chilled water. The outlet chilled water temperature varies with the inlet chilled water temperature. An RTD sensor notes this change in temperature. This temperature signal is fed to the PLC.

An inbuilt software PID control loop processes this signal with respect to the chilled water set point. A control output signal of 4 to 20 mA is sent to the I/P converter.

The I/P controller converts the 4 to 20 mA electrical signal to a 0.2 (g) to 7.0 (g) bar pneumatic signal, which controls the position of the hot water control valve. As the load increases, the hot water control valve also opens, and vice-versa, thus regulating the quantity of hot water entering the machine.

Safeties

Safety devices are provided to protect the machine from reaching abnormal conditions, to safeguard it from damage and to ensure continued availability.

■ Safety devices are:

- Machine mounted safeties, located on the machine
- Panel mounted safeties, on the control panel and
- Field Interlocks passing signals from the field to the machine

■ Machine mounted

- Chilled water flow switch

  - Paddle type device mounted on the chilled water outlet nozzle

- Chilled water differential pressure (DP) switch

  - Connected to the inlet and outlet chilled water nozzles

- Chilled water Antifreeze thermostat

  - Capillary thermostat mounted on the chilled water outlet nozzle

- Refrigerant level electrodes

  - Mounted in the refrigerant level box

■ Panel Mounted

- Refrigerant level controller
- Absorbent pump overload relay/ AC Drive
- Refrigerant pump overload relay
- Purge pump overload relay

■ Field interlocks

- Chilled water pump interlock
- Cooling water pump/ butterfly valve interlock

Safety Functions

The safety functions of the machine protect it against abnormal conditions. The various safety functions are:

■ **Thermal shock protection:** To protect the machine from a thermal shock, the hot water control valve is opened gradually for the first 10 minutes after machine start up. At this moment, the generator temperature is less than 70°C. After the slow opening duration is over, the control automatically switches over to the chilled water temperature.

■ **Antifreeze protection:** To prevent the chilled water from freezing in the evaporator tubes, there are various safety functions to stop the machine like:

- L-cut: The refrigerant pump is switched off in case the chilled water outlet temperature drops below the L-cut set point, and the hot water control valve closes fully. This safety prevents a further drop in the chilled water temperature. The refrigerant pump will restart after the chilled water outlet temperature rises above the L-cut set point plus the hysterisis set point.
- Antifreeze: If the chilled water outlet temperature drops below the antifreeze set point, the machine trips and the 'TOTAL SHUTDOWN' alarm sequence is carried out. The alarm should be reset only after the chilled water outlet temperature rises above the antifreeze set point plus the hysterisis set point.
- Chilled water pump interlock: Chilled water flow is a prerequisite for machine operation. A potential free contact is wired from the chilled water pump motor starter to VAM/c panel to sense chilled water pump ON/ OFF/ TRIP status. The machine starts only when the chilled water pump is ON. If the chilled water pump stops/ trips during operation, the 'TOTAL SHUTDOWN' alarm sequence is carried out.
- Cooling water pump interlock: Cooling water flow should be stopped immediately when the chilled water flow stops in the machine. So, the cooling water pump should be started through the start permissive of cooling water pump.
- Chilled water flow switch: If the chilled water flow drops below 50% of the rated value, 'TOTAL SHUTDOWN' alarm sequence is carried out.
- Chilled water differential pressure switch: If the chilled water flow drops below 50% of the rated value, 'TOTAL SHUTDOWN' alarm sequence

is carried out.

- Butterfly control valve in cooling water line: If all the cooling water pumps can be stopped electrically when the differential pressure switch or flow switch shows less or no flow, automatically operated butterfly valve is not required. However, when such arrangement can not be ensured, auto butterfly valve needs to be provided by the customer to stop the cooling water based on differential pressure switch/ flow switch signal.

■ **Crystallization prevention:** If the concentrated absorbent solution, while returning to the Absorber from the Generator is excessively cooled, it crystallizes in the Heat Exchanger thus affecting the operation of the machine. Crystallization either occurs when the concentration of the absorbent (related to its temperature) becomes too high or its temperature drops excessively.

The following safety functions prevent the machine from crystallizing:

- Generator high temperature safety: If the generator temperature exceeds the generator high temperature set point, the 'DILUTION CYCLE' alarm sequence is carried out. The machine goes into the dilution cycle. The generator high temperature alarm can't be reset until the generator temperature drops below the set point minus the hysterisis set value.

- Cooling water low temperature safety: If the cooling water inlet temperature drops below the cooling water low temperature set point, the 'DILUTION CYCLE' alarm sequence is carried out. The machine goes into the dilution cycle immediately. The alarm can't be reset until the cooling water inlet temperature rises above the cooling water low temperature set point plus the hysterisis set value.

■ Cavitation protection of refrigerant pump: The refrigerant pump starts to cavitate when the refrigerant level in the evaporator pan falls below set level. The level of the refrigerant is controlled to ensure a minimum acceptable suction pressure. This is done by means of three level electrodes, and a level relay.

■ The three electrodes are mounted in the refrigerant level box assembly, on the lower shell (Evaporator electrode of the smallest length, the pump starts. The pump stops when the level goes below the electrode of intermediate length. It will restart again only when the level reaches the smallest electrode. When the level goes below the intermediate electrode, a delay of 20 seconds is provided before the pump can be switched off.

■ **Motor protection.**

- Absorbent pump overload relay: If the absorbent-pump motor draws more than its rated current, this overload relay trips. The 'DILUTION CYCLE' alarm sequence is carried out. The alarm can't be reset until the overload relay/ AC drive is reset.

- Refrigerant pump overload relay: If the refrigerant-pump motor draws more than its rated current, this overload relay trips. The 'DILUTION CYCLE' alarm sequence is carried out. The alarm can't be reset until the overload relay is reset.

- Purge pump overload relay: If the purge-pump motor draws more than its rated current, this overload relay trips. The alarm can't be reset until the overload relay is reset.

Machine Room Layout Considerations

- **Location:** Unlike conventional electric chillers, absorption chillers are characterized by silent operation and simpler foundation. Owing to this, they can be located in basements or on terraces of buildings; the location being ultimately decided by space availability and ease of installation and maintenance.

- **Room Size:** The machine room size should be decided according to the chiller's dimensions. A minimum of 1m clearance space should be kept on all sides of the machine. In addition, provision for tube removal space should be made on either sides of the machine. A clearance of 1 m is recommended on the panel side of the machine and a clearance of 214 mm is recommended on the top of the machine. For more details, please refer to the Dimensional Data given in this document.

- **Ambient Temperature:** Temperature in the machine room should be between 5 and 45°C.

- **Humidity:** The humidity of the machine room should be less than 85%. High humidity can result in corrosion and failure of equipment failure. The machine room should be adequately ventilated.

- **Drainage:** All discharge pipes and overflow pipes should be routed to the drains. The drains should be kept covered. In case the machine room is built in the basement, a water tank and pump is required for proper drainage.

Piping Guidelines

- Hot water piping should be designed and installed to meet the safety standards prescribed for the hot water pressure. Pipe sizing should be as per the required flow rates.
- In the connecting lines, field instruments should be installed adjacent to the chiller. Pipe design and its routing should provide easy access to the field instruments (for e.g. during maintenance).
- The crossover piping from the Absorber to the Condenser is a standard feature of Thermax absorption chiller.
- The piping should be adequately supported to prevent any strain on the machine nozzles and connecting flanges.
- Check whether air-vent valves, drain valves and pressure gauges are provided on the chilled water, cooling water, hot water and drain piping. The drain connections should be at the lowest point, whereas the air-vents should be at the highest point on the piping.
- The inlet chilled, hot water line and inlet cooling water line to the chiller should be flushed clean, before connecting these to the chiller.
- Check the connective direction of the chilled water, cooling water and hot water piping.
- Check the valve positions on the chilled water piping, cooling water piping and hot water piping.
- Make sure that strainers are provided in the water circuits.
- If cooling water pump is not dedicated to individual chiller, auto-operated butterfly valve is necessary in the cooling water circuit.

Electrical Guidelines

- All field wiring should be in accordance with applicable codes.
- Use Copper conductors only.
- All wiring should be checked regularly for any damage and all terminal connections tested for tightness.
- The power supply specifications should match with those given on the unit nameplate. Voltage must be

within 15% of the nameplate value.

- For minimum circuit ampacity and maximum fuse size, see the unit nameplate.
- Wiring to chiller control panel should be proper.
- Proper wiring should be provided from the chiller control panel to the control valve.
- Proper interlocking of chilled water and cooling water with the chiller control panel should be provided.

■ Insulation Guidelines

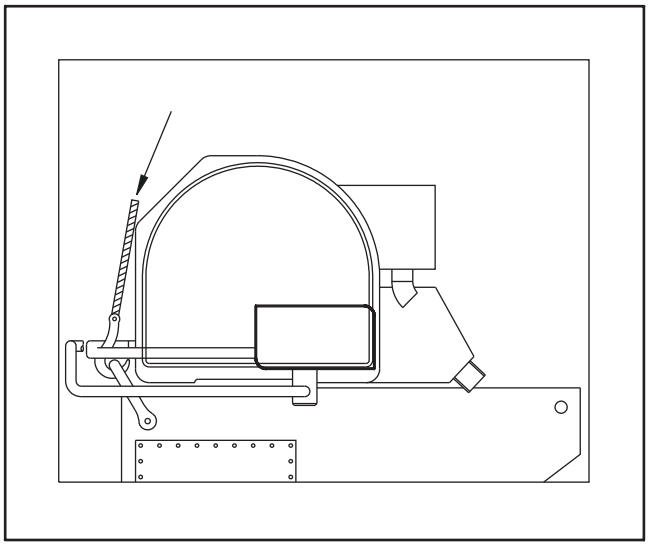
- Use adhesive agents, iron wires and bounds to mount insulation material. These should not be fixed/ mounted using tapping screws or rivets.
- Use non-combustible insulation material. This could be wool or polystyrene foam in case of cold surfaces, and glass wool in case of hot surfaces.
- The insulation should not cover the cap of the damper, sight glass, handle of the refrigerant blow down valve, refrigerant pump motor, refrigerant level electrode box cover, generator level electrode level box cover and the service valves.
- For effective in-tube cleaning, the evaporator header should be removable.
- To assist in-tube inspection, the insulation for high temperature generator headers (known as 'Generator' in single effect chiller) should be removable.
- In addition, the following components should also have removable insulation:
  - Chilled water flow switch
  - Chilled water freeze protection thermostat
  - Chilled water temperature sensor

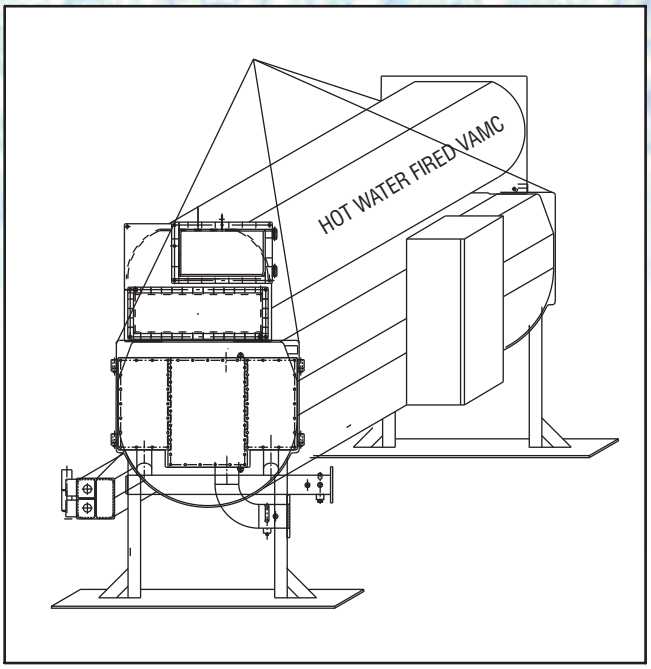
■ The chiller comes with a rust preventive paint.

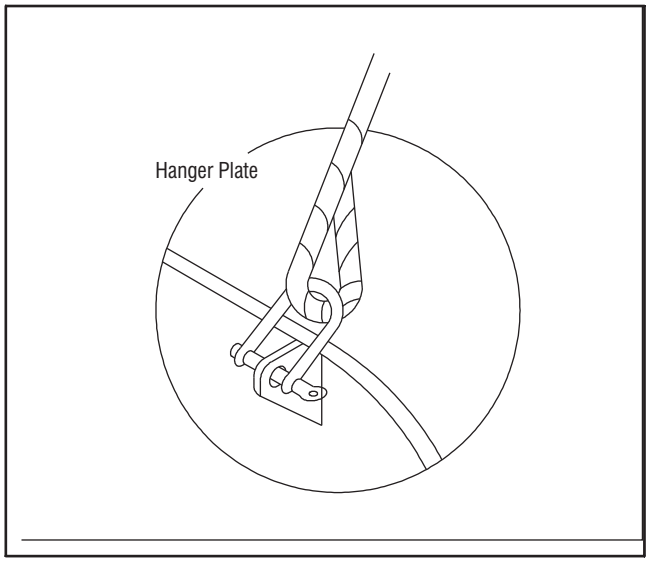
Site Unloading And Installation

Unloading instructions

- For unloading purposes, use lifting shackles provided on the machine. Rigging from any other point on the machine can damage the unit and cause personal injury.
- Use proper sized hooks/ slings and approved methods for lifting the machine.
- Lift the machine simultaneously from all four corners, while keeping the unit leveled with the ground.
- Proper care should be taken while hooking up the shackles near the pipes. (Refer figure)
- Every care should be taken to prevent damage to interconnecting pipes, control panel and machine mounted panel.







Unloading & Installation of Machine (Single piece):

As a standard feature, the machine is shipped in a single piece. All piping should be adequately supported and fitted to prevent any strain on nozzles and connecting flanges. During installation, sizes of cooling and chilled water lines to the chiller should match with those of the connecting nozzles. Their inlet connections should be flushed clean, and electrical wiring should be verified. The sketch shown below, indicates the unloading of a single piece machine.

- Note: This is only a diagrammatic representation of the general appearance of the machine. The actual machine may be different than what has been shown here.

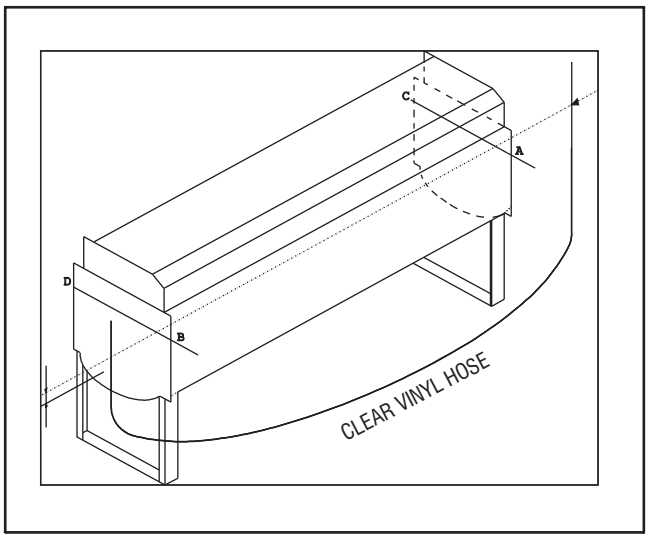
Rigging and Shifting to the foundation

To avoid any damage, the machine should be rigged with care to its ultimate location. A plate should be placed beneath the saddles of the machine, and castors or rollers placed below the plate. The machine should be pulled gradually from one side using a winch. The wire rope used for pulling should be tied to the saddle.

Leveling of machine:

Before hooking up the machine to the external piping, it is very important to level it based on the procedure given below. Proper leveling of the machine is essential to achieve the rated capacity of the unit. Allowable tolerance (both

- lengthwise and sidewise) is less than or equal to 1.6 mm per 1.5 meters.
- There are four leveling checkpoints provided on the chiller (Labeled as A, B, C and D in the figure below). These check points are designated by the three punch marks on the tube sheet or shell of the lower shell.
- **Procedure for leveling:** Fill a clear vinyl hose (diameter of the hose 9.5 mm) with water, ensuring that there are no air bubbles in it. Using point 'A' as a reference point, measure the difference in the water level at the other points (i.e. B, C and D).



Leveling calculations are as shown below:

A	B	C	D
0mm	mm	mm	mm

$$\frac{A-B}{L} \quad \frac{C-D}{L} \quad \frac{A-D}{L} \quad \frac{B-C}{L} \quad \frac{A-C}{W} \quad \frac{B-D}{W}$$

Where
L= Length of the heater
W= Width of the heater

In case the tolerance is not met, it can be achieved by inserting a metal shim between the machine frame and foundation. Metal shim size is approximately 50 mm width X 76 mm length.

After making adjustments, confirm the leveling of the chiller by taking a new set of readings.

- **Procedure for grouting**

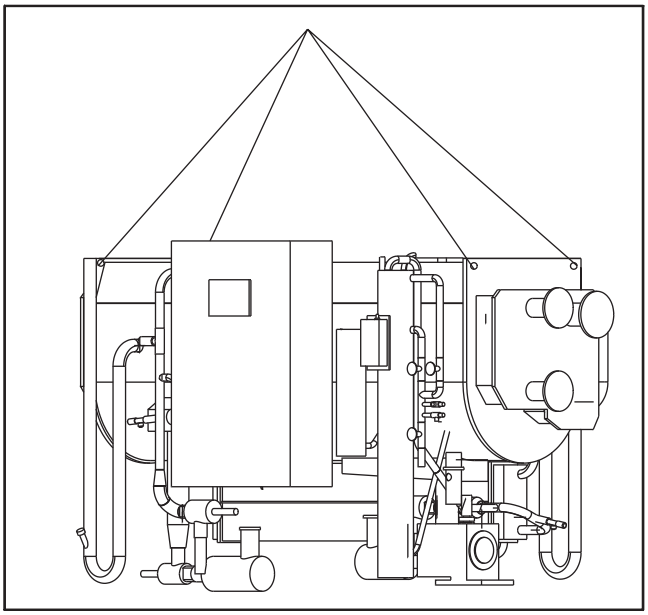
After the leveling of the chiller, it needs to be grouted before the external piping can be connected to it. This is done by fixing the anchor bolts, by welding the washer to the chiller frame and by tightening the bolts.

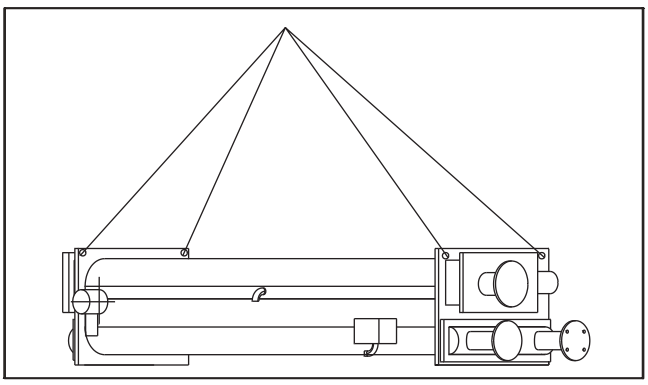
- **Storage of the unit**

In case the unit is not to be installed immediately, it should be kept covered until its installation. It is recommended to keep the machine indoors during this period to prevent any damage to. Nitrogen should not be removed from the chiller unit. All the accessories supplied along with the unit should be kept in the same place.

- **Optional Multi-sectional Shipment**

The chiller can be shipped in two sections viz. the lower shell assembly and the upper shell assembly. This is done when there are indications that the chiller's dimensions as a single piece may cause rigging problems (particularly during retrofit jobs).





Notes

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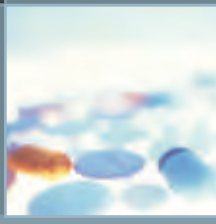

December 2008/ Revision