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1. WHAT’S LIQUID CHILLER?

Liquid Chiller cooling refers to cooling by means of the convection or circulation of a liquid. It is a method of heat removal from components and devices. As opposed to air cooling, liquid is used as the heat conductor. Usually, water is the best best heat conductor. Water cooling is commonly used for cooling precise instrument, laser, lab test. Recently, small water chiller also is used for various major components cooling. For example, it is applied to inside high-end personal computers such as CPU, GPU, and motherboards. The main mechanism for water cooling is convective heat transfer. It includes:

- Water cooling
- Liquid cooling for computers
- Cooling by convection or circulation of coolant
- Liquid Cooling and Body Vest Cooling
- Laser and Precise Instrument Cooling

2. WHAT’S RIGID LIQUID CHILLER MODULES?

RIGID liquid chiller module is an integrated cooling sub-system. It is specially used for small footprint cooling applications where space and weight are critical. The LCM includes Miniature Compressor, Driver Board, Condenser, Evaporator and other small cooling parts. It provides core cooling and refrigerant control mode is capillary tube. This subsystem is full charged with R134a and oil and ready to use. It allows end users to adapt to the coolant fittings for ultimate flexibility.

RIGID liquid chiller module is world’s lightest weight and very compact footprint. It particularly designed for small liquid circulatory cooling, such as laser manufacturers, laboratory, hospital lab, large end users and system integrators. RIGID patent mini dc compressor drives the refrigerant directly through the heat exchangers. This concept eliminates the need for a water cooling loop (water pump, reservoir and associated tubing) resulting in a greatly simplified cooling system.

The micro LCM serves as a source of chilled water for circulation through liquid pipes. The chilled water of the pipes has direct contact with the heat producing source to to take away the heat.

Pic. 1, At present, RIGID has developed 4 types of small cooling systems
3. WHY RIGID DEVELOP LIQUID CHILLER MODULE?

To meet the growing demand of small cooling systems, RIGID has developed compact liquid chiller modules for several customers. At first, these compact cooling modules are used for portable and compact water chiller and small device cooling. Later, They are widely used in medical, aesthetic, laboratory, military who expressed a need for a compact, lightweight liquid chiller, which would meet the environmental stresses of the harshest environments while still provided sufficient cooling or heating. The system has both heating and cooling capabilities and circulates thermally regulated (+/- 0.5°C) coolant to a customer cold plate or heat exchanger. The system has a built-in pump and reservoir to circulate the coolant, which allows system to function without the use of a fill kit. The system also has a communication port which allows the user to monitor the system performance and choose the operating temperature.

The compact design gives the user flexibility to design this chiller into their system or have is reside as a separate unit. Also, the cold plate, which ultimately removes heat from the payload, can exist remotely from the chiller and can be designed as appropriate.

The chiller has been designed to meet the requirements of mobile applications where it may be subjected to shock, vibration, and a variety of environmental conditions.

4. HOW MANY TYPES OF RIGID LIQUID CHILLER MODULES?

**Coil type:** Coil type evaporator is a traditional coiled tube configuration heat exchanger. Its main advantage is highly efficiency use of space, less pumping energy and lower cost.

RIGID Coil type chiller module Applications:
- Pure water cooling;
- Liquid cycling refrigeration;
- Portable & compact hospital equipments cooling;
- Precision instrument or PC or Laser Beam Cooling;
- Special types of work (Military, Firefighting, Body cooling etc);
- ... ... (Included above applications but not limited)

*Pic. 1, Liquid chiller with coiled tube evaporator*
**Plate type:** Plate type evaporator is a type of heat exchanger which uses metal plates to transfer heat between two fluids. One is R134A coolant liquid, the other is other liquids need to be chilled. It has a major advantage over a conventional heat exchanger. The fluids of plate type radiator are exposed to a much larger surface area because the fluids are spread out over the plates.

RIGID Plate type chiller module Applications:
- Body Cooling (Race car driver, firefighter...);
- Portable liquid cycling refrigeration device;
- Portable & compact hospital equipments cooling;
- Precision instrument or PC or Laser Beam Cooling;
- Special types of work (Military, Firefighting, Body cooling etc);
- ... ... (Included above applications but not limited)

*Pic. 2, Liquid chiller with plate & frame evaporator*

**Coaxial type:** Coaxial type liquid chiller use coaxial stainless steel evaporator. it is a latest type of heat exchanger consist of one spiral grooves inner tube and an outer tube. Two kinds of liquids flow in the inner and outer tube separately. This coaxial heat exchanger has extraordinary heat transfer capacity because the fluids are full contact with coolant.

RIGID Coaxial type chiller module Applications:
- Pure water cooling & freezing;
- Laser or precise instrument cooling;
- Medical & Aesthetic Liquid cycling refrigeration;
- Portable & compact hospital equipment cooling;
- Thermoelectric coolers refrigerant-based cooling system;
- Special types of work (Military, Firefighting, Body cooling etc);
- ... ... (Included above applications but not limited)
5. HOW RIGID LIQUID CHILLER MODULE WORKS?

RIGID specializes in the design of miniature refrigeration systems. We work directly with our customers to provide custom cooling solutions to meet their specific requirements. Rigid also provides solutions to meet client’s challenging cooling requirements. Many of cooling systems & modules which Rigid has designed, are very well-received by customers.

RIGID LCM compact chiller modules are compact, hermetically sealed refrigeration systems (including a miniature variable speed inverter compressor and drive board (patented sine wave), condenser, heat exchanger, capillary, filter drier, dc fan motor, and other small parts).

RIGID small cooling system is fully charged with R-134a, insulated and mounted to a baseplate to drop directly into the end application. The user connects their coolant loop to the evaporator and provides airflow over the condenser. The user can interface with the drive board to provide compressor speed control as desired.

**Features:**
1. Weight: 6.6 lbs / 3.0kgs;
2. 12V 24V 48V DC input;
3. Inverter brushless compressor;
4. 300Btu~1,600Btu cooling capacity.

**Key Benefits:**
1. Miniature DC compressor;
2. Stationary or portable available;
3. Minimize weight&footprint&noise;
4. Compact complete integrated for precise thermal control;
6. RIGID LIQUID CHILLER MODULE LCM PARAMETERS

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Liquid Chiller Modules</th>
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<tbody>
<tr>
<td>Chiller Types</td>
<td>Coaxial / Plate / Coil, 3 types</td>
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<tr>
<td>Application</td>
<td>Small &amp; Portable Device and Equipment Cooling</td>
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<tr>
<td>Refrigerant &amp; Oil</td>
<td>Included</td>
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<tr>
<td>Compressor Type</td>
<td>RIGID Mini DC Compressors, R134A</td>
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<tr>
<td>Compressor Displacement</td>
<td>1.4cc, 1.9cc and 3.25cc per revolution</td>
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<tr>
<td>ASHRAE Cooling Capacity</td>
<td>30W ~ 250W</td>
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<tr>
<td>Speed</td>
<td>Variable 2,000~6,500 rpm</td>
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<tr>
<td>Motor</td>
<td>Brushless, DC Motor</td>
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<tr>
<td>Nominal Input Voltage</td>
<td>12V, 24V or 48V DC</td>
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<tr>
<td>Maximum Current</td>
<td>10A, 8.5A and 4.2A respectively</td>
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<tr>
<td>Evaporator Temperature Range</td>
<td>-40 to +25 ºC</td>
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<tr>
<td>Other cooling parts</td>
<td>No Pumps and Reservoir</td>
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<tr>
<td>Cooling System Configuration</td>
<td>Hermetically sealed system, no oil leaks</td>
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<tr>
<td>Power Supply</td>
<td>Operate in battery, vehicle, grid or solar power</td>
</tr>
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7. RIGID LIQUID CHILLER MODULE SPECIFICATIONS

6.1 Cooling Capacity
This is usually defined as the specified nominal cooling capacity at normal working conditions of the system in watts, according to evaporating and condensing temperatures. The capacity is determined by the mass flow rate of refrigerant, which depends on the condensing unit compressor’s displacement, RPM, and volumetric efficiency. RIGID compact liquid chiller module refrigeration capacity ranges from 30W to 250W.

6.2 Refrigerant Type
Refrigerant selection can be made on the basis of availability, performance, and ecological considerations. RIGID liquid chiller module has been verified for use with R134a refrigerant.

6.3 Ambient Temperature
RIGID liquid chiller modules are usually intended for indoor use, and a minimum of +5°C is required in order for proper lubrication. In 2017, RIGID has successfully developed T-tropical series mini compressor, which is able to work in 52 degree ambient temperature.
6.4 Electrical Power Available

RIGID liquid chiller modules are used in mobile or portable refrigeration systems. Its DC power is produced by batteries, fuel cells, vehicle alternators, solar panels, or from an AC inverter power supply. The compressor must be selected for use according to the DC voltage available. RIGID compressors are available in 12V, 24V and 48V versions.

6.5 Size and Cooling

RIGID liquid chiller modules are extremely small, high-performance for end users direct refrigeration devices. Its size is only 7.85x6.3x6.7 inch and weighting only 6.6 lbs. Current models produce as much as 30W to 250W.
8. RIGID LIQUID CHILLER MODULE WORKING PRINCIPLE

Super Small & Compact Recirculating Liquid Chiller System
9. WHY CHOOSE RIGID LIQUID CHILLER MODULE?

Rigid circulatory liquid chiller modules are self-contained high-efficient refrigeration compressor with R134A coolant, smallest condenser and evaporator, filter drier and driver board etc. All these refrigeration parts are all well integrated in one unit, sophisticated design by our skilled engineers. It serves as a source of chilled water for circulation through the water pipes, and the unit has smallest footprint and weight make it portability.

- Extremely small, but high performance
- DC Rotary Variable speed running on 12V, 24V, 48V DC
- Compact & precise design providing reliable results to cooling and refrigeration
- Small & light weight configuration is ideal for a wide range of small refrigeration application
- Variable speed refrigerated dc compressor can operate in battery, vehicle, grid or solar power

RIGID Liquid Chiller Modules use miniature rotary dc compressor:

**Compact Liquid Chiller Module Application**

- Glycol Chiller, Custom Liquid Chiller
- CPU Cooler, Laser, Instrument Cooling
- Ice Maker, Liquid Chill Water Dispenser and Home & Commercial Compact Cooling Use
- Body cooling, Water cooled system
- Medical/Aesthetic Chiller
10. RIGID LIQUID CHILLER MODULE FOR DRIVER & BODY COOLING

RIGID compact & mobile cooling chiller module (also named Liquid Chiller Module), is also used for extreme hot environment and confined space, besides small cooling devices and equipment. After more than 8 years experience for small dc refrigeration system, RIGID has successfully engineered and developed sophisticated cooling systems to handle OEM and ODM project. In 2017, RIGID introduced a powerful and compact plate type liquid chiller, which meets market's need for personal cooling in the race car industry. Temperatures on the track can reach over 60°C (140°F) and the drivers need to operate their car precisely in these extreme conditions. The size of RIGID's compressor keeps the cooling system lightweight. The efficiency of a vapor-compression solution, yields a great advantage over thermo-electric personal cooling systems.

RIGID LCM can be installed within the car and gives the driver the ability to select the desired amount of cooling (up to 250W at the most extreme temperatures). The system keeps the driver’s core cool, which helps to prevent fatigue or cramps while racing.

*RIGID miniature dc compressor is also perfect for cooling vest, which allows users to increase productivity while reducing heat injuries and safe body cooling.*