RIGID HVAC CO., LTD

RIGID MINI COMPRESSOR

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1. WHAT'S COMPRESSOR?
Compressor is a key component to refrigeration and air conditioning applications. Compressors are the “heart” of such appliances, comparable to a car engine or even the human heart. A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. RIGID Technologies now presents the lightest, more compact and more efficient BLDC Inverter Compressor.

2. HOW TO SELECT COMPRESSOR?
The selection of a compressor should be considered the following factors:

   1. Evaporator Temperature
   2. Cooling Capacity
   3. Refrigerant Type
   4. Ambient Temperature
   5. Electrical Power Available
   6. Compressor and Drive Cooling

3. RIGID MINI COMPRESSOR FEATURES
   1. Super small volume: 56.5 x 78 mm (LxH)
   2. Super light weight: 720g (1.6lbs)
   3. Use brushless motor, 12V, 24V and 48V are available
   4. Driver board: variable speed ranges 1800 to 6500 rpm
   5. Low vibration with anti-vibration cushion
   6. High temperature working condition, can work under 52 degree ambient temperature.

4. RIGID MINI COMPRESSOR APPLICATION
The minimum evaporating temperature and the condensing temperature allows RIGID mini compressor apply to application (LBP, MBP, or HBP).

Low Back Pressure systems such as freezers have evaporator temperatures below -20°C (-4°F). Medium Back Pressure systems such as food coolers or beverage dispensers have evaporator temperatures higher than -20°C (-4°F). High Back Pressure systems such as chillers and air conditioners have evaporator temperatures higher than -5°C (+23°F).
# 5. RIGID MINI COMPRESSOR SERIES

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Application</th>
<th>Model</th>
<th>Displacement m³</th>
<th>Max Speed rpm</th>
<th>Max Capacity W</th>
<th>Max Current A</th>
<th>Cooling Type</th>
<th>Power Supply</th>
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<tr>
<td>R134a</td>
<td>LBP</td>
<td>QX1401VDL</td>
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<td>QX1402VDL</td>
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<td>24V</td>
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6. RIGID MINI COMPRESSOR PARAMETERS

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 compressor’s displacement, RPM, and volumetric efficiency. RIGID miniature compressor refrigeration capacity ranges from 100W to 550W.

6.2 Refrigerant Type
Refrigerant selection can be made on the basis of availability, performance, and ecological considerations. RIGID BLDC rotary compressors have been verified for use with R134a refrigerant.

6.3 Ambient Temperature
The compressor must be selected in order to ensure it’s suitable to operate at the highest expected ambient temperature. RIGID mini compressors 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 DC compressors 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 mini compressors are extremely small, high-performance rotary refrigeration compressors. Its size is only an adult's fist and weighting only 1.6 to 2.2 lbs. Current models produce as much as 100W to 550W of cooling under standard ASHRAE conditions, using a single cylinder configuration. Compatible with various refrigerants and running on 12, 24 and 48VDC, or AC power through a AC-DC conversion, the new compressors are starting a new trend in various compact mobile cooling systems as well as small foot-print countertop appliances with cooling or ice making capabilities.
RIGID Compressor Cooling Capacity and COP

![Cooling Capacity Graph]

- Cooling Capacity
- Evap. Temp
- 4000RPM
- 6000RPM

Note: Test Condition: Condenser Temp 38°C

![Compressor COP Graph]

- Compressor COP
- Evap. Temp
- 4000RPM
- 6000RPM

Note: Test Condition: Condenser Temp 38°C
7. WHY CHOOSE RIGID MINI COMPRESSOR?

The attached photo Table 1. shows the comparative sizes of RIGID miniature rotary compressor with a reciprocating DC compressor. RIGID mini dc compressor (right) is about 30 percent less size than that of traditional reciprocating compressor (left), which has been widely used around the world for a long time. It is almost inconceivable to most people at first glance that the small compressor on the right (1.5 lbs) actually has a 30 percent higher capacity than the larger compressor on the left (9.5 lbs)! Comparison of key performance parameters is also shown in Table 2. For appliance designers, an important but seldom used (since they were pretty much all the same!) parameter is that of cooling power density, both volumetric and weight.

Table 1.

<table>
<thead>
<tr>
<th>Compressor Type</th>
<th>Reciprocating Compressor (left)</th>
<th>RIGID’S Rotary Mini Compressor (right)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerant</td>
<td>R-134a</td>
<td>R-134a</td>
</tr>
<tr>
<td>Volume, cu.in</td>
<td>130</td>
<td>11</td>
</tr>
<tr>
<td>Displacement per revolution, cc</td>
<td>2</td>
<td>1.4</td>
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<tr>
<td>Weight, lbs</td>
<td>9.5</td>
<td>1.3</td>
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<tr>
<td>Speed, RPM</td>
<td>2,000–3,500</td>
<td>2,000–6,500</td>
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<tr>
<td>Capacity (ASHRAE), W(Btu)</td>
<td>252 (860)</td>
<td>390 (1230)</td>
</tr>
<tr>
<td>Volumetric Cooling Capacity Density, Btu/cu.in (ratio)</td>
<td>6.6 (1)</td>
<td>112 (17)</td>
</tr>
<tr>
<td>Weight Cooling Capacity Density, Btu/cu.in (ratio)</td>
<td>90.5 (1)</td>
<td>948 (10.5)</td>
</tr>
</tbody>
</table>
RIGID tiny compressor is a new type bldec rotary compressor. It has 17 times the cooling power for the same volume, and 10.5 times the cooling power for the same weight. An obvious conclusion to be drawn from this realization is that a large space and weight savings can be achieved using the miniature compressor. Such factors have historically been prized in mobile refrigeration systems only. Now, even though highly unusual for a DC-powered compressor, due to the weight and volume, the miniature compressors are being considered in various stationary applications, such as household countertop appliances; beverage dispensers; ice makers; ice cream machines, coffee machines, etc., where the small compressor size is highly desired to make the footprint of the appliance small.

When RIGID miniature compressor is used in a refrigeration system together with a high-performance condenser and evaporator, the complete refrigeration system can be incorporated within a package as small as 100 in3 (1.64 liter). This allows a major space reallocation in the cabinet, namely much less volume for the refrigeration system and considerably more volume for product storage space. There’s also a weight reduction of approximately 10 lbs (4.54 kg) just from the use of mini-compressors. But for the most part, the space savings are usually considered more important than weight savings in most refrigerated appliances.

A small vapor compression cooling system using RIGID miniature compressor would have even larger performance and efficiency advantages over thermoelectric coolers often used in various products in the absence of small compressors before. Above the cooling capacity range of 100W, the vapor compression based system will be far superior to the thermoelectric systems: ¼ to ½ the weight and volume, and 1/3 to ½ the power consumption compared to the thermoelectric systems.

Table 3. compressor types
8. RIGID MINI COMPRRESSOR APPLICATION

RIGID tiny compressor is very well-received by the market. Numerous refrigerated appliances can benefit from the size and weight reduction of a compressor. Some of the relevant refrigerated appliances are listed below:

- Water Dispenser
- Beer Dispensers
- Beverage Cooling
- Beverage Dispensers/Refrigerated
- Cabinets/Refrigerated
- Commercial Refrigerators/Freezers
- Cooled Display Cases
- Countertop Appliances/Refrigerated
- Drawers/Refrigerated
- Household Appliance
- Ice Cream Cabinets/Dispensers
- Ice Storage Bins/Chests
- Yacht Refrigerators
- Medical Product Storage
- Milk Coolers/Dispensers
- Mini Portable Air Conditioners
- Mini-Bars
- Overclocking of Personal computers
- Portable Spot Coolers
- Reach-In Freezers
- Refrigerated Buffet Units
- Solar-Powered A/C & Refrigerator
- Vaccine/Medical Transport
- Wine Coolers
- Yogurt/Smoothie/Slush Machines
PART OF APPLICATIONS:

- Firefighting & Military & Welding Miniature Refrigeration
- Portable Cooling System & Beverage Cooling
- Electric Car Aircon
- Vaccine Refrigerator
- Portable Refrigerator
- Yacht Freezer
- Ice Maker
- Water Dispenser
- Precision Equipments
9. RIGID MINI COMPRESSOR STORAGE AND HANDLING

RIGID’s compressors are built to order. Prior to installation, compressors should be stored in an upright position to prevent oil from entering the suction or discharge tubes. If compressors are to be stored in inventory for long periods of time, they should be stored in climate chambers or storage areas that can control both temperature and humidity.

RIGID compressors are built with high precision parts that are susceptible to chemical attack and corrosion from contaminants in ambient air. Compressors are always shipped with a low-pressure nitrogen blanket sealed with rubber plugs to maintain this pressure and prevent internal parts from exposure to moisture and other contaminants. If long shelf life is anticipated, it is important to maintain the inert atmosphere to prevent internal corrosion or chemical attack.

10. COMPRESSOR UNPACKING

All compressors shipped from RIGID are charged with 25cc of RL-32H oil, are evacuated, sealed with low-pressure nitrogen, and capped. In addition to the compressor, other system components should be internally dried, sealed, and stored in an inert atmosphere until installation, preferably no more than 15 minutes from assembling of components.

Remove the compressor from its packaging while keeping it in an upright position. Failure to keep the compressor upright can result in the flow of oil into the suction accumulator and process connections, which can cause brazing problems. The compressor must also remain upright while assembling the grommets in the mounting bracket to the base plate.

11. PREPARATION OF REFRIGERATION SYSTEM COMPONENTS

The cleaning and removal of solid substances and non-condensibles and the removal of moisture and other gas contaminants in all components of the refrigeration system are key to successful compressor operation and long life. In addition, the use of R134a with new polyolester oils has been accompanied by new stricter standards in comparison with CFC or HCFC refrigerants. Any non-compatible products that can contaminate these refrigerants and polyolester oils including chlorine compounds and non ester-based oils need to be eliminated. Other system components such as tubing, evaporators, condensers, receivers, valves, capillaries, and separators need to have these contaminants removed before the system is assembled.

RIGID recommends that all components remain sealed as long as possible before assembly, performing the brazing no more than 15 minutes after exposure to ambient.
It is important to avoid residual oil during brazing by blowing out components with nitrogen or dry air, with a dew point lower than -40°F. Internal oil on surfaces of the suction or discharge tubes can cause difficulty in brazing, and even more hazardous, it can introduce contaminants into the system from ‘cracking of oil’.

The filter drier needs to be protected from absorption of ambient humidity during assembly of the system components using the following practices:

(1) Remove protective caps just prior to brazing
(2) For filters supplied without protective caps in hermetic boxes, these must also be protected to avoid moisture absorption before brazing.

If the drier does not have complete water absorption in the molecular sieve, then moisture can circulate freely in the system with the following effects:

1. Ice Buildup: Reduces cross-sectional area of capillary tube or TX valve
2. Acid Buildup: Causes serious attack in compressor and to the molecular sieve in filter drier
3. Oil Contamination Acidification reduces lubrication, changes oil color, buildup of sludge, and poor lubrication of compressor

RIGID is not responsible for damage to its compressors from the introduction of such contaminants.

12. REFRIGERANT & OIL USE GUIDE

RIGID compressors have been designed and tested for operation with R134a refrigerant. Some users may want to employ other refrigerants or refrigerant blends, and other refrigerants may perform quite well. However, due to case design pressure considerations, refrigerants that have a maximum working pressure greater than 350 psi (24.13 bar) are not recommended. If other refrigerants are to be used, the compressor should be thoroughly tested and evaluated with those refrigerants to verify reliability with expected conditions in the intended application. Because of the wide differences in refrigeration systems with different working fluids, the reliability of all equipment should be evaluated for appropriate life through field tests.

Rotary compressors perform best when the pressure ratio between the high and low sides of the compressor is less than 8:1. When the pressure ratio exceeds this value, the compressor’s coefficient of performance (COP) is adversely affected. Good refrigeration practice requires that careful evaluation of the refrigeration system and evaporator conditions be specified, and that an appropriate refrigerant is selected to avoid excessive pressure differential.


12.1 R134a Refrigerant

R134a (tetrafluorethylene) is a replacement for R12 in applications with medium and high evaporator temperatures in Aspen’s compressors. Its physical properties are:
Molecular Weight – 102
Critical Temperature – 101.1°C
Critical Pressure – 40.6 bar
Boiling Point -26.5°C

This refrigerant also requires the exclusive use of polyolester oil (POE) as a lubricant. R134a refrigerant is associated with strict requirements for internal cleanliness of the cooling system. In addition to chlorine and water, solid residues must be carefully removed including dust, metal particles, etc., which can damage the compressor. The recommended lubricating oil is POE RL 68H. This lubricant is highly hygroscopic (water absorbing) which can cause the formation of acid residues. When present, these acid residues can create a blockage in the capillary tube and reduced lubricity in the compressor.

The level of moisture in the refrigeration system should be below 40 ppm. It is recommended that a filter dryer compatible with R134a and POE be installed with a capability to remove moisture from the system to below 20 ppm. The compressor and other components should remain sealed until they’re ready to use. The compressor and other system components should not be open to the ambient for more than 15 minutes. Good refrigeration practice also calls for system evacuation of both low and high sides, achieving a minimum vacuum level of 0.14 bar (100 !Hg).

12.2 Refrigerant Charge

Following the system evacuation, it must be charged with refrigerant. For a low capacity system, as little as 40 grams might be used, while as much as 120 grams might be used in a high capacity system. After refrigerant is pumped into the system, it is wise to wait 5-10 minutes before starting the compressor to allow refrigerant evaporation and avoid the ingestion of liquid into the compressor. For high charge levels, the system should be equipped with a liquid receiver. An accumulator should always be used with rotary compressors to minimize liquid intake in the compressor.

For each system, the optimum refrigerant charge should be determined by controlled testing in order to obtain the best working conditions, and to avoid the return of liquid refrigerant to the compressor. In order to evaluate system performance, instrumentation should be added at certain locations to record key data. Recommended data points to be recorded include the following:
12.3 OIL MANAGEMENT

Even the most experienced refrigeration technicians need to read these instructions carefully, since the quantity of oil used in RIGID compressors is much less than found in other types. Some lubricating oil will travel with the refrigerant in any refrigeration system. Thus, it is imperative that they be miscible and fully soluble in one another at all temperatures. This provides good oil return and lubricity for the compressor, while avoiding heat transfer losses in the evaporator. During the prototyping of the refrigeration system, it is vital that the proper amount of oil in the system be determined. RIGID compressors are all shipped with 25cc of POE RL 68H. This has been found to be adequate for many compact cooling systems.

There is no sight glass to visualize oil flow within the compressor. Therefore, the following procedures are highly recommended to ensure that adequate oil is present at all times. Keep in mind that oil entertainment occurs in all compressors, and typically is a function of compressor speed (RPMs). All RIGID cooling systems have been designed to be fully drainable with no traps in heat exchangers, and contain refrigerant refill valve where coolant or oil can recharge.
12.4 Oil Charging

Using a syringe (see photo below) load the compressor with adequate (RL 68H, Viscosity: 300SUS, recommended or equivalent) refrigerant oil through the discharge port. Make sure the syringe is inserted just far enough to reach inner chamber to allow air to purge but not to contact internal electrics, which might cause damage.

Note:
Syringe must have large enough ID to allow oil flow and a small enough OD to allow air to purge from canister.
13. COMPRESSOR SPECIFICATIONS

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<thead>
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<th>Refrigerant</th>
<th>R134a</th>
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<tbody>
<tr>
<td>Lubricating Oil</td>
<td>Polyol Ester</td>
</tr>
<tr>
<td>Compressor Type</td>
<td>Rotary Brushless Direct Current (Rolling Piston)</td>
</tr>
<tr>
<td>Displacement</td>
<td>1.4cc, 1.9cc and 3.25cc per revolution</td>
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<tr>
<td>ASHRAE Cooling Capacity</td>
<td>360, 460 and 550W respectively</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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<td>Evaporator Temperature Range</td>
<td>-18 to +25 °C</td>
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<td>Condenser Temperature Range</td>
<td>27 to 70 °C</td>
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<td>Maximum Compressor Ratio</td>
<td>8:1</td>
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<tr>
<td>Driver Board</td>
<td>Sine Wave</td>
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</table>

14. COMPRESSOR DRIVER BOARD

![Graph showing the relationship between voltage and RPM]
15. COMPRESSOR & DRIVER BOARD WIRE CONNECTION

Compressor Wire Connection

Compressor

Potentionmeter for speed adjusting

Driver Board

24V -