

FRIGID-X™ VORTEX TUBES

Produce cold air as low as minus 50°F (minus 46°C) from compressed air with no moving parts to spot cool or cool enclosures with no electricity

WHAT ARE THEY - REASONS TO USE

Vortex Tubes are devices that work on a standard compressed air supply. Air enters the vortex tube and is literally split into two parts - cold air at one end, and hot air at the other - all without any moving parts.

Vortex Tubes have an adjustable valve at the "hot" end which controls the volume of the air flow, and the temperature exiting at the cold end. By adjusting the valve, you control the "cold fraction" which is the percentage of total input compressed air that exits the cold end of the Vortex Tube. Our Vortex Tubes may also be supplied with a fixed preset "cold fraction" instead of an adjustable valve.

Inside is the interchangeable brass "generator" which can alter the air used in the Vortex Tube, and control the temperature ranges you wish to have at the cold and hot ends. There are several ranges of generators for compressed air capacity. There are also two basic types of generators - one to produce the extreme cold temperatures (maximum cold temperature out called the C generator) and one type to produce the maximum amount of cooling (maximum refrigeration called the H generator).



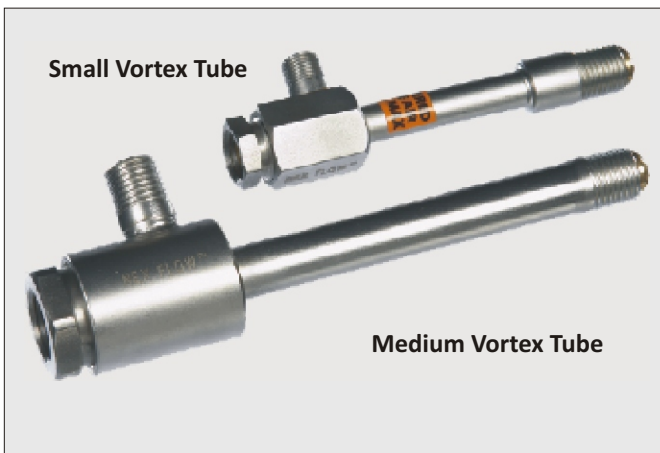
WHY THE FRIGID-X™ VORTEX TUBE OVER OTHERS:

The Frigid-X™ Vortex Tube is constructed of stainless steel and uses a generator and valve made of brass and sealed with viton o-rings to allow their use in the widest range of environments. This also allows for greater life and better consistency between Vortex Tubes made. In addition, it is usable in high temperature environments AS IT COMES with NO extra charge unlike many of our competitors.

Most competitors use plastic generators and standard Buna N O-Rings and charge extra for brass and high temperature-rings. The unique design and quality of materials used in Frigid-X™ products will deliver years of maintenance-free operation.

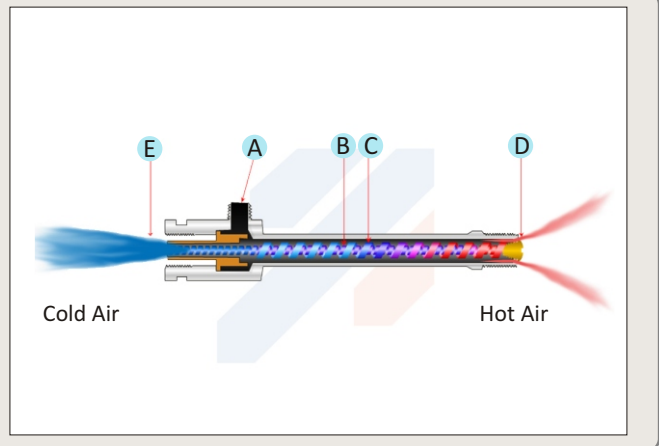
FRIGID-X™ VORTEX TUBE ADVANTAGES:

- ▶ No moving parts.
- ▶ Driven by air not electricity.
- ▶ Small and lightweight - portable.
- ▶ Low in cost compared to most others
- ▶ Superior design and performance
- ▶ Maintenance free operation
- ▶ Made of durable stainless steel and metal parts - no cheap plastic parts
- ▶ Adjustable temperature range
- ▶ Generators are interchangeable

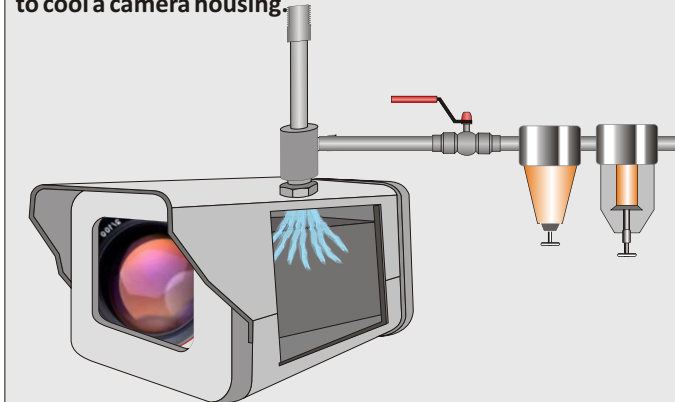


FRIGID-X™ VORTEX TUBE - HOW IT WORKS

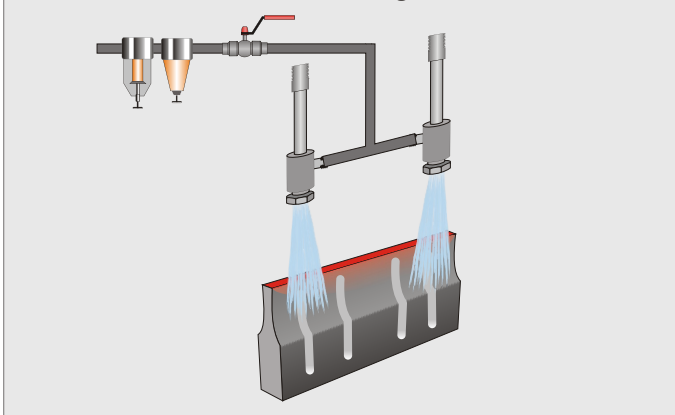
Compressed air enters at point (A). Inside the tube the compressed air is made to spin using a "generator". It travels in one direction along the small (hot end) tube and then back inside itself in the reverse direction creating one stream of air (B) and the second stream of air (C) in the opposite direction. The outside stream of air gets hot and exhausts at point (D). The center column of air gets cold and exists at point (E). Temperatures and capacities can vary by adjusting the hot end plug at (D) and by using different "generators"



Due to space limitation & the need to eliminate water cooling the camera, a Model 50025H Vortex Tube was used to cool a camera housing.

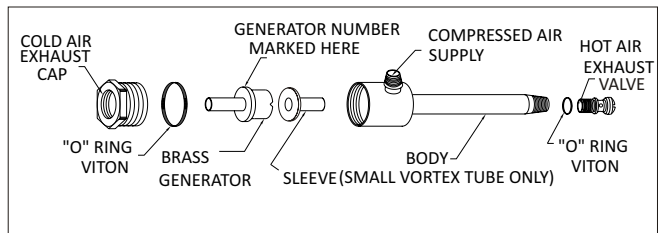


Two Vortex Tubes model 50030H with a Model 55002 Muffler cools an Ultrasonic Welding Horn.



FRIGID-X™ VORTEX TUBE EXPERIMENTAL KITS

Two Experimental Kits are available (small Vortex Tube kit and medium size Vortex Tube kit) which contains the appropriate Vortex Tube, all generators for that size, cold end muffler and filter with auto drain to do testing if you are not certain of what exact size you require.



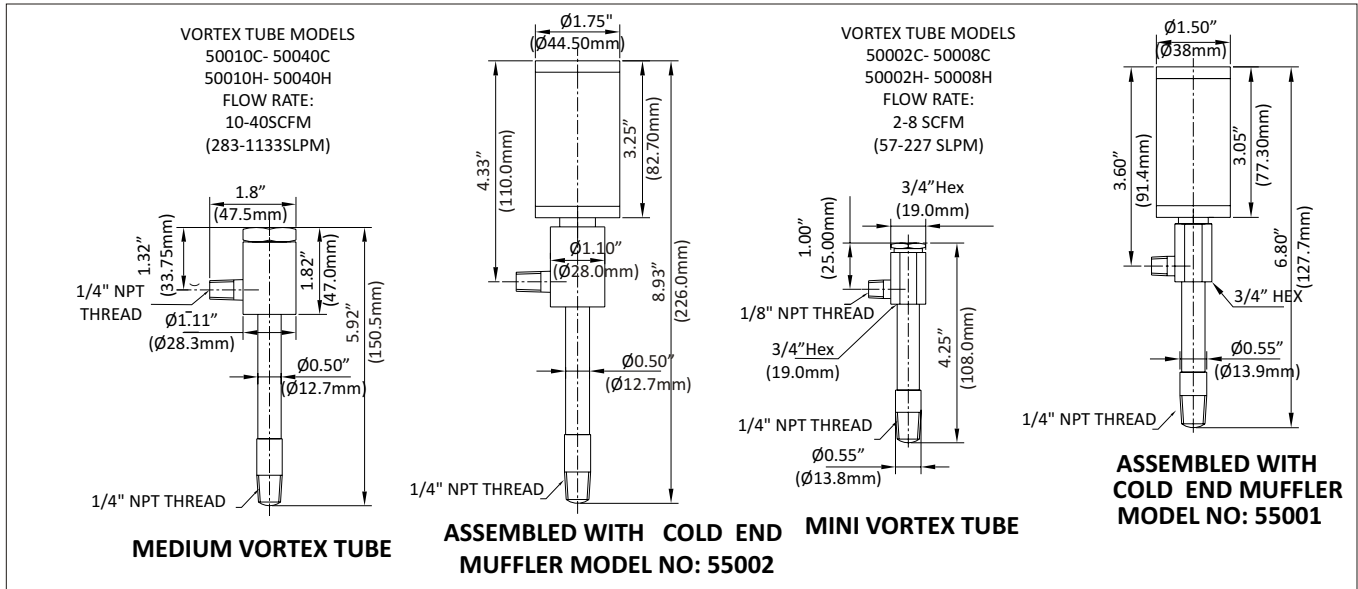
CONTROLLING THE FLOW RATE AND TEMPERATURE IN THE FRIGID-X™ VORTEX TUBE

The flow rate and temperature in a Vortex Tube are interdependent. When you open the adjusting valve at the hot end, the cold air flow decreases and the temperature drops. As you close the valve the cold air end flow increases and temperature rises. The percentage of the total input air that exits the cold end is termed the "cold fraction". Depending on inlet air temperature a cold fraction of between 60% and 80% produces the optimum combination of flow and temperature drop for maximum cooling effect, when using an H generator. Lower cold fractions produce colder air but do not cool as well because of reduced flow. Most industrial applications require the 60% to 80% setting and the H generator for optimal cooling.

In some instances such as cooling laboratory samples, testing circuit boards and other "cryogenic" applications, a 'C' generator is used which limits the cold end flow rate to lower levels and produces very cold temperatures.

To set the Vortex Tube to the desired temperature simply insert a thermometer at the cold end and adjust the hot end valve. The optimum cooling effect is achieved when the difference from the inlet air temperature and the cold air drops is 50° F (28° C) if the inlet air is relatively cool to 80° F (45° C) below compressed air temperature if the inlet air is relatively hot.

There are two basic physical sizes of Vortex Tubes used extensively in industry - the small and medium size. A larger version is available on special order. Frigid-X™ Vortex Tubes can be selected by required performance in cooling for the 'H' generator versions and where very cold temperature is required, the 'C' generators are used. However, even with 'C' generators, as expected, the higher the are flow rating the greater any cooling effect.



| H series Vortex Tubes (For Maximum Cooling) | | | | | |
|---|------|------|---------|-------|--------|
| MODEL NO. | SCFM | SLPM | BTU/Hr. | WATTS | SIZE |
| 50002H | 2 | 57 | 145 | 42 | small |
| 50004H | 4 | 113 | 290 | 85 | small |
| 50008H | 8 | 227 | 580 | 170 | small |
| 50010H | 10 | 283 | 730 | 214 | medium |
| 50015H | 15 | 425 | 1100 | 322 | medium |
| 50025H | 25 | 708 | 1800 | 527 | medium |
| 50030H | 30 | 850 | 2100 | 615 | medium |
| 50040H | 40 | 1133 | 2900 | 849 | medium |

| C series Vortex Tubes (For Maximum Cold Temperature) | | | | | |
|--|------|------|---------|-------|--------|
| MODEL NO. | SCFM | SLPM | BTU/Hr. | WATTS | SIZE |
| 50002C | 2 | 57 | N/A | N/A | small |
| 50004C | 4 | 113 | N/A | N/A | small |
| 50008C | 8 | 227 | N/A | N/A | small |
| 50010C | 10 | 283 | N/A | N/A | medium |
| 50015C | 15 | 425 | N/A | N/A | medium |
| 50025C | 25 | 708 | N/A | N/A | medium |
| 50030C | 30 | 850 | N/A | N/A | medium |
| 50040C | 40 | 1133 | N/A | N/A | medium |

NOTE:

1. SCFM and SLPM at 100 PSIG or 6.9 bar Inlet Pressure
2. BTU/hr and Watts is Cooling Capacity at 100 PSIG or 6.9 bar inlet pressure and with optimal cold fraction setting

NOTE:

1. SCFM and SLPM at 100 PSIG or 6.9 bar Inlet Pressure
2. BTU/hr and Watts not applicable as normally not used for air conditioning applications

Approximate temperature drops (and rises) from inlet air temperature produced by a Vortex Tube set at various cold fractions. Assume constant inlet pressure and temperature. Tests were conducted with a 15H generator in a medium size Vortex Tube (Model 50015H). Will vary with other sizes and capacities.

| PRESSURE SUPPLY | COLD FRACTION % | | | | | | |
|-----------------|-----------------|----------|----------|----------|----------|----------|-----------|
| | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| 20 (1.4) | 62 (34) | 60 (33) | 56 (31) | 51 (28) | 44 (24) | 36 (20) | 28 (16) |
| | 15 (8) | 25 (14) | 36 (20) | 50 (28) | 64 (26) | 83 (46) | 107 (59) |
| 40 (2.8) | 88 (48) | 85 (46) | 80 (42) | 73 (39) | 63 (34) | 52 (28) | 38 (20) |
| | 21 (11) | 35 (18) | 52 (28) | 71 (38) | 92 (50) | 117 (62) | 147 (80) |
| 60 (4.1) | 104 (57) | 100 (55) | 93 (51) | 84 (46) | 73 (40) | 60 (33) | 46 (25) |
| | 24 (14) | 40 (22) | 59 (33) | 80 (44) | 104 (57) | 132 (73) | 166 (92) |
| 80 (5.5) | 115 (63) | 110 (62) | 102 (56) | 92 (51) | 80 (45) | 66 (36) | 50 (28) |
| | 25 (14) | 43 (24) | 63 (35) | 86 (47) | 113 (63) | 143 (80) | 180 (100) |
| 100 (6.9) | 123 (68) | 118 (65) | 110 (61) | 100 (55) | 86 (48) | 71 (39) | 54 (30) |
| | 26 (14) | 45 (25) | 67 (37) | 90 (50) | 119 (66) | 151 (84) | 191 (106) |
| 120 (8.4) | 129 (72) | 124 (69) | 116 (64) | 104 (58) | 91 (50) | 74 (41) | 55 (31) |
| | 26 (14) | 46 (26) | 69 (38) | 94 (52) | 123 (68) | 156 (86) | 195 (108) |

Temperature drop of cold air, °F (°C) in blue

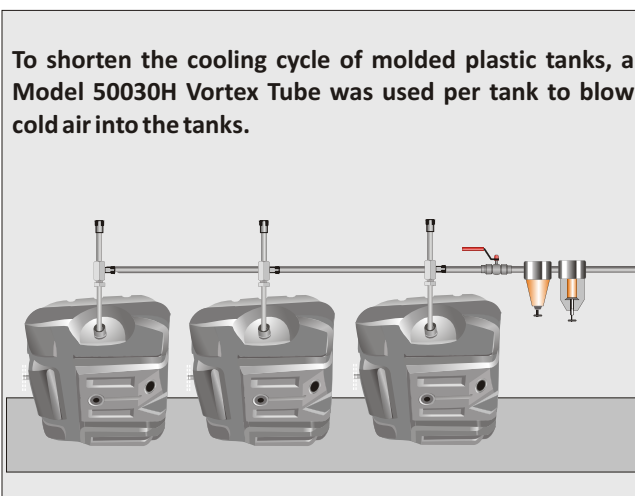
Temperature rise of hot air, °F (°C) in red

USING THE VORTEX TUBE :

Back pressures over 2 psig (0.1 bar) can reduce the performance of a Vortex Tube. Similarly it is important to use a minimum of 25 micron or less filtration to keep the air clean and dry. Vortex tubes alone without ducting can be noisy so mufflers are available for both the cold end and hot end. All of our Vortex Tubes are built to be used in even high temperature environments at no extra cost.

VORTEX TUBE THEORIES :

There are many theories of the Vortex Tube also known as the Ranque Vortex Tube, the Hilsch Tube, Maxwell’s Demon Tube, and the Ranque - Hilsch Tube. Invented in 1933 by French physicist Georges J. Ranque and improved upon by German physicist Rudolf Hilsch in a notable paper published in 1947, there is a great deal of information available on the internet.



FRIGID-X™ VORTEX TUBES & SPOT COOLING

FRIGID-X™ VORTEX TUBES

| Part No. | Description |
|----------|--|
| 50002H | Small Vortex Tube with 2H Generator for Maximum cooling Effect |
| 50004H | Small Vortex Tube with 4H Generator for Maximum cooling Effect |
| 50008H | Small Vortex Tube with 8H Generator for Maximum cooling Effect |
| 50010H | Medium Vortex Tube with 10H Generator for Maximum cooling Effect |
| 50015H | Medium Vortex Tube with 15H Generator for Maximum cooling Effect |
| 50025H | Medium Vortex Tube with 25H Generator for Maximum cooling Effect |
| 50025H | Medium Vortex Tube with 30H Generator for Maximum cooling Effect |
| 50040H | Medium Vortex Tube with 40H Generator for Maximum cooling Effect |
| 50002C | Small Vortex Tube with 2C Generator for Maximum Cold Temperature |
| 50004C | Small Vortex Tube with 4C Generator for Maximum Cold Temperature |
| 50008C | Small Vortex Tube with 8C Generator for Maximum Cold Temperature |
| 50010C | Medium Vortex Tube with 10C Generator for Maximum Cold Temperature |
| 50015C | Medium Vortex Tube with 15C Generator for Maximum Cold Temperature |
| 50025C | Medium Vortex Tube with 25C Generator for Maximum Cold Temperature |
| 50030C | Medium Vortex Tube with 30C Generator for Maximum Cold Temperature |
| 50040C | Medium Vortex Tube with 40C Generator for Maximum Cold Temperature |
| 55001 | Cold End Muffler for small Vortex Tube |
| 55002 | Cold End Muffler for Medium Vortex Tube |
| 55003 | Hot End Muffler for Small or Medium Vortex Tube |
| 51008K | Small Vortex Tube test Kit. Consists of Small Vortex Tube, Cold Muffler, Filter with auto drain, and Generators - 2C, 2H, 4C, 4H, 8C, 8H |
| 51040K | Medium Vortex Tube test Kit. Consists of Medium Vortex Tube, Cold Muffler, Filter with auto drain, and Generators - 10C, 10H, 15C, 15H, 25C, 25H, 30C, 30H, 40C, 40H |
| 59008K | Small Vortex Tube Generator Kit Generators - 2C, 2H, 4C, 4H, 8C, 8H |
| 59040K | Medium Vortex Tube Generator Kit Generators - 10C, 10H, 15C, 15H, 25C, 25H, 30C, 30H, 40C, 40H |

NOTE: The last two numbers in the part number indicate the SCFM consumption at 100 PSIG (6.9 Bar) - Example 50025C indicates 25 SCFM air consumption at 100 PSIG (6.9 Bar).

The PLCFC described in Section A is an effective means to control energy used by turning on and off the Vortex Tubes as required.



FRIGID-X™ VORTEX TUBES

| Part No. | Description |
|----------|--|
| 59002C | 2 SCFM Small Vortex Tube Brass Generator Only - Cold Temp. |
| 59004C | 4 SCFM Small Vortex Tube Brass Generator Only - Cold Temp. |
| 59008C | 8 SCFM Small Vortex Tube Brass Generator Only - Cold Temp. |
| 59002H | 2 SCFM Small Vortex Tube Brass Generator Only - Max. BTU/hr |
| 59004H | 4 SCFM Small Vortex Tube Brass Generator Only - Max. BTU/hr |
| 59008H | 8 SCFM Small Vortex Tube Brass Generator Only - Max. BTU/hr |
| 59010C | 10 SCFM Medium Vortex Tube Brass Generator Only - Cold Temp. |
| 59015C | 15 SCFM Medium Vortex Tube Brass Generator Only - Cold Temp. |
| 59025C | 25 SCFM Medium Vortex Tube Brass Generator Only - Cold Temp. |
| 59030C | 30 SCFM Medium Vortex Tube Brass Generator Only - Cold Temp. |
| 59040C | 40 SCFM Medium Vortex Tube Brass Generator Only - Cold Temp. |
| 59010H | 10 SCFM Medium Vortex Tube Brass Generator Only - Max. BTU/Hr. |
| 59015H | 15 SCFM Medium Vortex Tube Brass Generator Only - Max. BTU/Hr. |
| 59025H | 25 SCFM Medium Vortex Tube Brass Generator Only - Max. BTU/Hr. |
| 59030H | 30 SCFM Medium Vortex Tube Brass Generator Only - Max. BTU/Hr. |
| 59040H | 40 SCFM Medium Vortex Tube Brass Generator Only - Max. BTU/Hr. |

Accessories

| | |
|-------|--|
| 90001 | 3/8" NPT Filter with automatic drain - 65 SCFM (1841 SLPM) capacity |
| 90005 | 3/8" NPT Oil Removal Filter with automatic drain - 15 - 37 SCFM (425 - 1048 SLPM) capacity |
| 90006 | 3/4" NPT Oil Removal Filter with automatic drain - 50 - 150 SCFM (1415 - 4248 SLPM) capacity |

FRIGID-X™ VORTEX TUBES & SPOT COOLING