

Cooling large home theater installations

A previous paper (available for download on the technical info page at www.activethermal.com) describes several techniques for cooling mid-size enclosures. The great majority of enclosed home theater installations involve mid-size cabinets in the 10 to 30 cubic foot range.

Beyond these lie the large installations; the ones with several racks or many shelves full of equipment, located in cabinets, closets, or utility rooms. The enclosed volume of such installations ranges from the 50 cubic foot range (a converted coat closet measuring 3' x 2' x 8') to as much as 700 cubic feet (a large closet/small room with dimensions of 8' x 10' x 9'). In this paper, we'll confine our discussion to the 50 to 700 cubic foot enclosure.

Consuming thousands of watts in operation, systems of this size may dissipate hundreds of watts during standby periods, due to satellite and cable boxes, PVRs, whole-house amplifiers, telephone and security systems, and other "always-on" equipment. The amount of heat generated by such systems is normally too much to simply move into the theater; it has to go "somewhere else"...

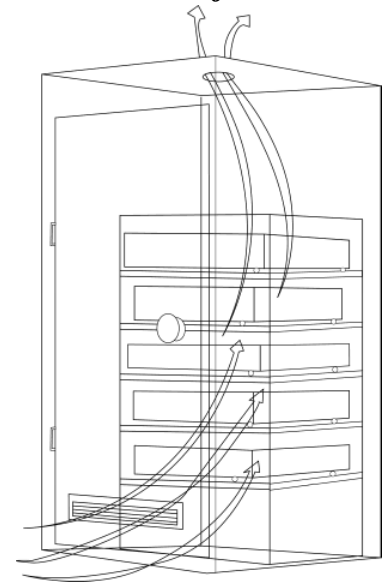
Depending on the location of the theater within the house, and the house's construction, "somewhere else" can be outdoors, an unfinished basement, crawl space, or attic. We are going to assume that heat being trapped within the rack is not a problem. (We know that may not always be true, and we'll deal with this issue a bit later. For now, we'll assume that a vent panel or two in the rack lets heated air escape INTO the closet, and we'll concentrate on getting that heat OUT of the closet.)

As important as removing heated air, of course, is providing fresh, or "makeup" air to the enclosure from which the heated air is being removed.

Three important points:

- 1. For every cubic foot of hot air that leaves the closet, an equal volume of fresh air has to enter. If the system can't "inhale", it can't "exhale" ...!*
- 2. The more easily air can move in and out of the enclosure, the less work a fan will have to do to provide ventilation and the slower the air will move. This translates directly into less fan ("motor") and air ("whoosh") noise.*
- 3. In almost every case, ventilation is accomplished most easily, quietly, and effectively by bringing fresh air in low at the front of the cabinet or closet, and removing heated air at the highest point, preferably at the rear. Special cases require special solutions (call us for situations you don't see here); snorkels to pull heated air downward, etc., but the simple "in low at the front, out high at the rear" technique is the preferred method 95% of the time.*

If the systems designer is given a free hand, and appearance is not a consideration (and we all know how often THAT happens...) effective ventilation is easily accomplished. As in the drawing to the right, a slot in the bottom part of the door, a fan in the ceiling, and - voila! - instant ventilation.



THE PROBLEMS: It's rarely that easy. Most clients don't want slots in their cabinet or closet doors, and fans in ceilings often make objectionable levels of noise. (Just think of bathroom fans...!)

We've also overlooked the matter of control; how - and when - does the fan turn on? When does it turn off? How do we handle situations (and there are more of them every day) in which much of the equipment is on, or partially on, all the time?

THE SOLUTIONS: The easiest way to overcome the noise and control issues is to use cooling devices that:

- ❖ are located away from the enclosure,

- ❖ turn slowly, and
- ❖ are controlled by the temperature within the enclosure.

Using products that have these characteristics minimizes both the level and duration of noise generated, and ensures that cooling will be provided only when needed.

Systems that simply turn on and off as the heat-producing equipment goes on and off turn on well before they're needed, and turn off while there's still residual heat flowing from the equipment into the enclosure.

Locating air movers away from a closet or other enclosure can be done by using the System 1 for really large installations, or the Cool-cube, for somewhat smaller enclosures and heat loads. The Cool-cube can move air up to 8 feet (using our 4" (inside diameter)/6" (outside diameter) flex tubing. This is more than long enough to allow a Cool-cube to be located a few feet above a closet in an attic, or in an adjacent utility room. In low speed, the Cool-cube can move 35 CFM; in high speed mode, it can move 70 CFM.



The Cool-cube

For larger enclosures, heat loads, or both, use the System 1. The System 1 can move 100 CFM short distances, and as much as 50 CFM with tubing lengths of up to 25 feet.



The System 1

Each of these Active Thermal Management air movers has its own accessory backdraft damper, also called a one-way valve, or “draft blocker”. These are simple gravity- or spring-activated doors that allow air to flow one way only, preventing drafts, odors, etc., from entering the client’s installation when the fans are not turning.



The Cool-cube is a temperature controlled system, and comes with a dual-element thermal switch which senses temperature rise, turning the fan on and selecting low or high speed automatically. It can be ordered with 6' of either

2" or 3" (i.d.), or 8' of 4"/6" (i.d./o.d.) tubing. The use of the largest diameter tubing that is possible in a given installation is highly recommended, as this maximizes air flow while minimizing noise.

The 2" and 3" tubing includes a small (4" x 3⁵/₈") "hot air collector", a funnel-like device that simplifies connecting the tubing to any flat surface.

The 4"/6" tubing includes a 6¹/₄" square hot air collector. Accessories available include backdraft dampers and diffusers (available in "new work" and "old work" models), used to trim the end of the tubing (4"/6" only) where it ends at a wall.

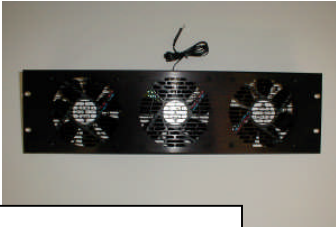
The System 1 is shipped as a kit consisting of the powerful centrifugal air handler, 8' of 4"/6" tubing, and a 6¹/₄" square hot air collector. Many optional accessories are available; 3 types of thermal switches, a speed control, tubing extension kits, "Y" fittings (to allow cooling 2 areas with one System 1), backdraft dampers, and diffusers.

In our "small closet/large closet" discussion, we've assumed that our rack was open enough that heat could freely escape from within it (even if it only escaped into the closet). We know that's not always the case. There may also be a need to move air through the rack itself, because it has so much equipment in it that air just doesn't circulate freely, or because it's tucked into a corner.... Whatever the reason, we have to get the heated air out of the rack and into the surrounding enclosure, whether closet or cabinet, so that the ventilating system can deal with it.



Active Thermal Management has several products in a "small, medium, large" assortment to stir things up in a rack.

To pull heat away from a specific piece of equipment, the Cool-stack I, a one-unit high cooler, is available in both exhaust and intake versions. Typically, an exhaust unit placed above an overheated amplifier will pull heated away, allowing cooler air to take its place. Alternately, an intake version (shown) can be placed below, blowing cool air up towards the hot component.



System 2 Rack Mount

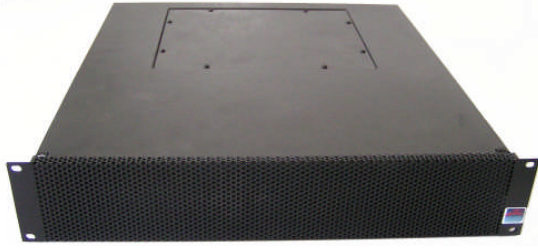
Another popular product is the three-unit high (but very shallow) System 2 Rack Mount. Only 2 ¾" deep, it's ideal for mounting on the rear rails of larger racks. Mounted behind hot audio/video equipment, it can pull hot air out of a rack, while a passive vent panel mounted on the front rails allows fresh air to enter.

Like other Active Thermal Management System 2 products, the Rack Mount's fans start and adjust their speed automatically, depending on the temperature sensed by its two remote thermistors.

For extreme situations in which very large racks have been placed in closets or cabinets, the Cool-stack II may be the answer. Only two units high but equipped with six 120 mm (4.7") fans, the Cool-stack II can move over 140 cubic feet of hot air per minute, *not only out of the rack, but also out of the closet*. It features three speeds, any two of which can be temperature-selected, and three exhaust ports, making it extremely flexible.

Placed at the top of a rack, the Cool-stack II pulls heated air up and expels it through its front panel, two rear, or a single top exhaust port. It is shipped with two 4' lengths of 2" tubing which fasten to the rear exhaust ports, and one 6' length of 4"/6" tubing (i.d./o.d.) which connects to the top exhaust port. Depending on the exhaust exit point(s) being used and fan speed, Cool-stack II can move between 50 and 140 CFM of heated air out of a rack and out of the enclosure the rack is in, through a side or rear wall, or up into a plenum or attic.

Active Thermal Management can be reached at 661-294-7999, 8:30-5:00 PST for additional information or applications assistance. Other white papers and specification sheets are available at www.activethermal.com.



Cool-stack II - front



Cool-stack II - rear