Innovations in Action

Advanced Cooling Technologies, Inc.

Energy Recovery Systems

ACT-HP-ERS/A-A Series Passive Air-to-Air Heat Pipe Heat Exchangers

Highly Recommended for Dedicated Outside Air Installations

Limited Lifetime Warranty

Start Saving Energy Today:

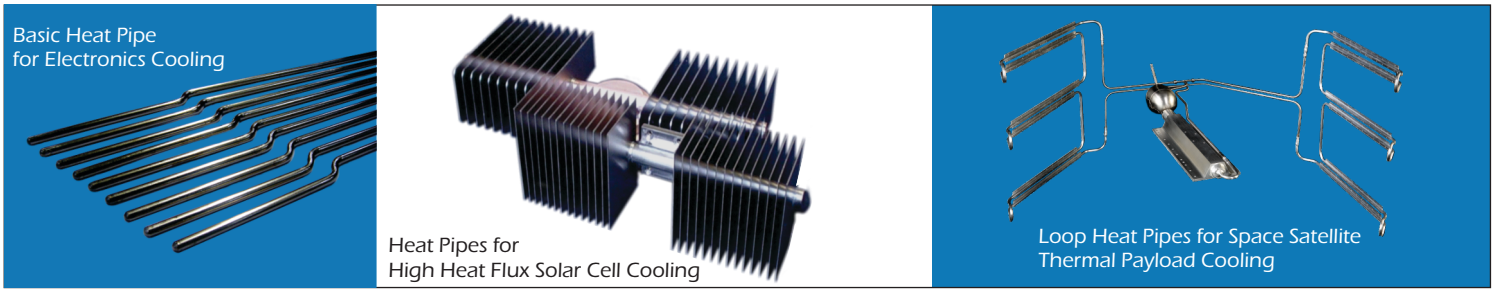
- Energy cost savings over 40%, cold or hot climates
- No cross-contamination between isolated airstreams
- Economically Improves Indoor Air Quality
- Quick return on investment from energy savings
- Reduce Heating or Cooling Requirements
- Totally passive, no moving parts or system maintenance
- Engineered efficient & compact design

Application & Specification Guide

ACT Energy Recovery Systems

ACT's Heat Pipe Core Thermal Competence

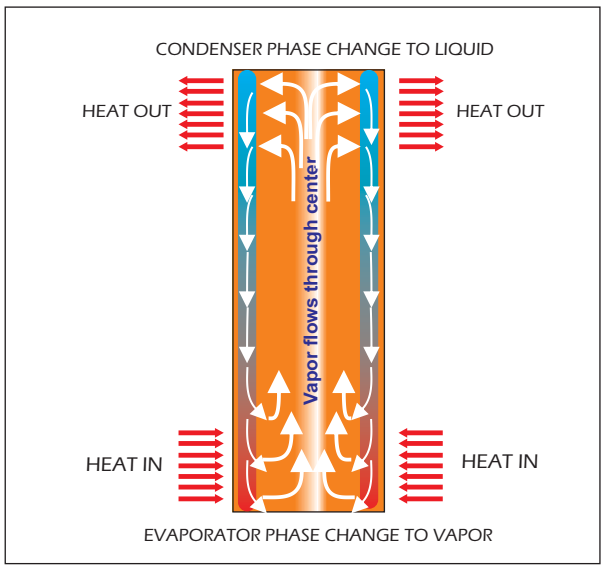
Thermal Expertise From Electronics to Space Flight



Heat pipes are a proven heat transfer technology with highly dependable operational performance in diverse applications including HVAC, industrial electronics, military and aerospace. ACT has over 100 years of accumulated engineering experience in the design, testing and manufacturing of heat pipes.

ACT-HP-ERS/A-A Air to Air Heat Exchangers Utilize High Performance Heat Pipes

Thousand Times Better Conductor Than Copper



Heat Pipe Operating Principle:

Heat pipes function by absorbing heat at the evaporator end of the cylinder, boiling and converting the fluid to vapor. The vapor travels to the condenser end, rejects the heat, and condenses to liquid. The condensed liquid flows back to the evaporator, aided by gravity.

This phase change cycle continues as long as there is heat (warm outside air) at the evaporator end of the heat pipe. This process occurs passively (no external electrical energy required). A typical ACT-HP-ERS/A-A moves thousands of Btu/hr. of heat between the supply air and exhaust airstreams.

ACT-HP-ERS/A-A Series Functionality and Performance

The ACT-HP-ERS/A-A Series Heat Pipe Heat Exchangers feature sensible heat transfer. Typical installations are placed across the supply and exhaust airstreams. ACT heat pipe technology allows passive bidirectional heat transfer to pre-cool or pre-heat airstreams depending upon the season. The system recovers energy in summer or winter without any mechanical adjustments. Installation requires side-by-side duct work. Static pressure drop is minimal. The intake and exhaust airstreams are completely sealed preventing cross contamination.

The ACT-HP-ERS/A-A Series Heat Pipe Heat Exchangers feature no moving parts, minimum cleaning (dust removal) and are hermetically sealed for lifetime operation. There are a variety of sizes and flow rates available.

Optimize Your Energy Efficiency With ACT Heat Pipe Heat Exchangers

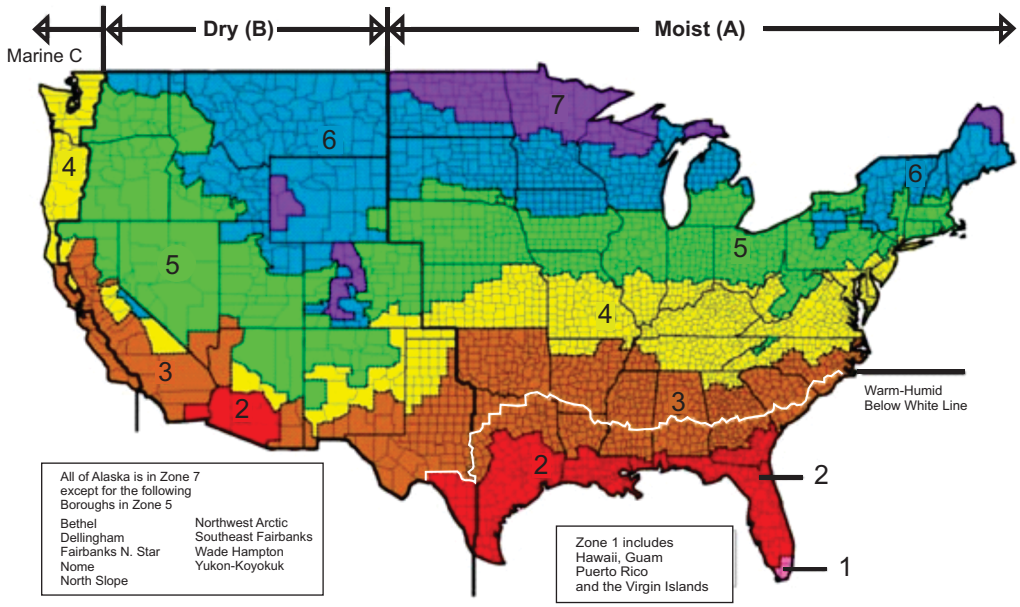


TABLE 6.5.6.1 Exhaust Air Energy Recovery Requirements

Zone	*% Outdoor Air* at Full Design Airflow Rate					
	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80
	Design Supply Airflow Rate (cfm)					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥5000	≥5000
1B, 2B, 5C	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥5500	≥4500	≥3500	≥2000	≥1000	> 0
7, 8	≥2500	≥1000	> 0	> 0	> 0	> 0

ANSI/ASHRAE/IES Standard 90.1-2010

Energy Recovery Example:

Just about every location in the United States can benefit from the transfer of energy from the building's exhaust air stream via an air-to-air heat pipe heat exchanger to either pre-cool or pre-heat the incoming outside air. Thousands of Btu/hr can be recovered to greatly reduce operating costs and in most cases down-size the initial air handling system. The ASHRAE Standard 90.1 specifically calls out where exhaust air energy recovery should be applied.

For example in Zone 5-A (Northern Climate) with an air handling system that is designed at ≥50% to <60% Outside Air, systems greater than 3,500 cfm should take advantage of energy recovery. Another example is Zone 2A (Southeastern Climate) where the direct outside airflow is ≥ 60% to <70%. In this application, systems greater than 2,000 cfm should utilize energy recovery. So, both warm and cold climates benefit.

ACT Energy Recovery Systems

ACT Heat Pipe Air-to-Air Heat Exchanger Performance & Solution Examples

Figure 1: Temperature Effectiveness (%) vs. Face Velocity (FPM)

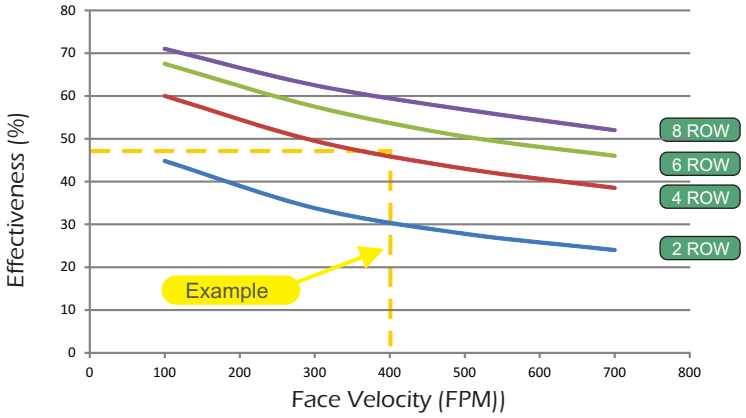
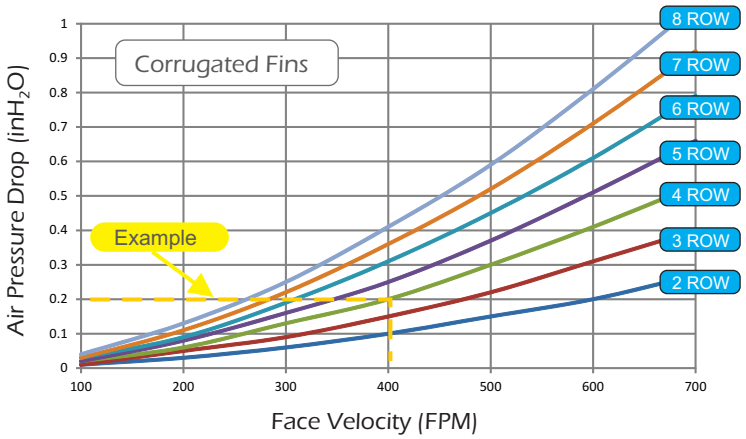
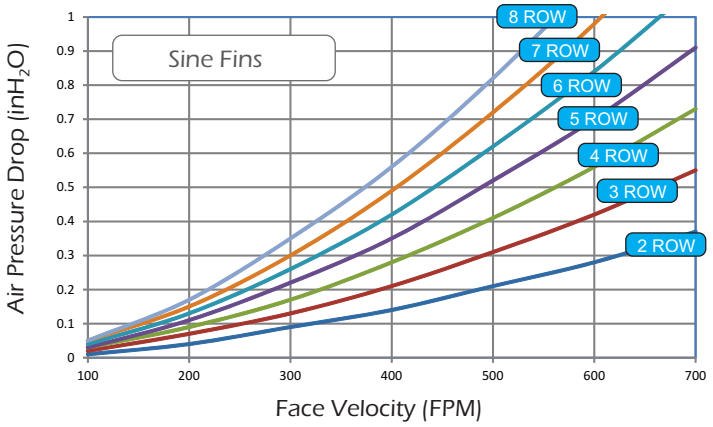


Figure 2: Air Pressure Drop vs Face Velocity (FPM)



(All examples are: 12 fins per inch, ½" heat pipes, aluminum fins .006" thickness)

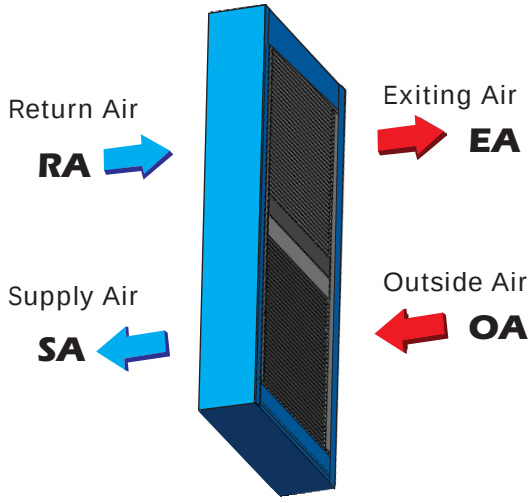
Figure 3: Air Pressure Drop vs Face Velocity (FPM)



(All examples are: 12 fins per inch, ½" heat pipes, aluminum fins .006" thickness)

Note: When performance is slightly less then required, a Sine Fin Pattern can often meet the Effectiveness requirement at a slightly higher Δ P versus adding another row of heat pipes.

AAHX Warm Climate Solution Example:



OA Outside Air = 2000 cfm at 95°F
RA Return Air = 2000 cfm at 74°F

Desired Δ T =10°F

Exhaust Air (EA) = RA + ΔT = 74°F + 10°F = 84°F
Supply Air (SA) = OA - ΔT = 95°F - 10°F = 85°F

Temperature Transfer Effectiveness (Eff.)

$$\text{Eff.} = \frac{\text{OA - SA}}{\text{OA - RA}} = \frac{95°\text{F - } 85°\text{F}}{95°\text{F - } 74°\text{F}} = \frac{10°\text{F}}{21°\text{F}} = 48\%$$

Calculate Face Area & Velocity

FH = 24 inches FL1= 30 inches

Face Area = 24"x30"/144sq.in. = 5.0 sq.ft.

$$\text{Face Velocity} = \frac{2000 \text{ cfm}}{5.0 \text{ sqft}} = 400 \text{ fpm}$$

Select Heat Pipe AAHX From Figure 1

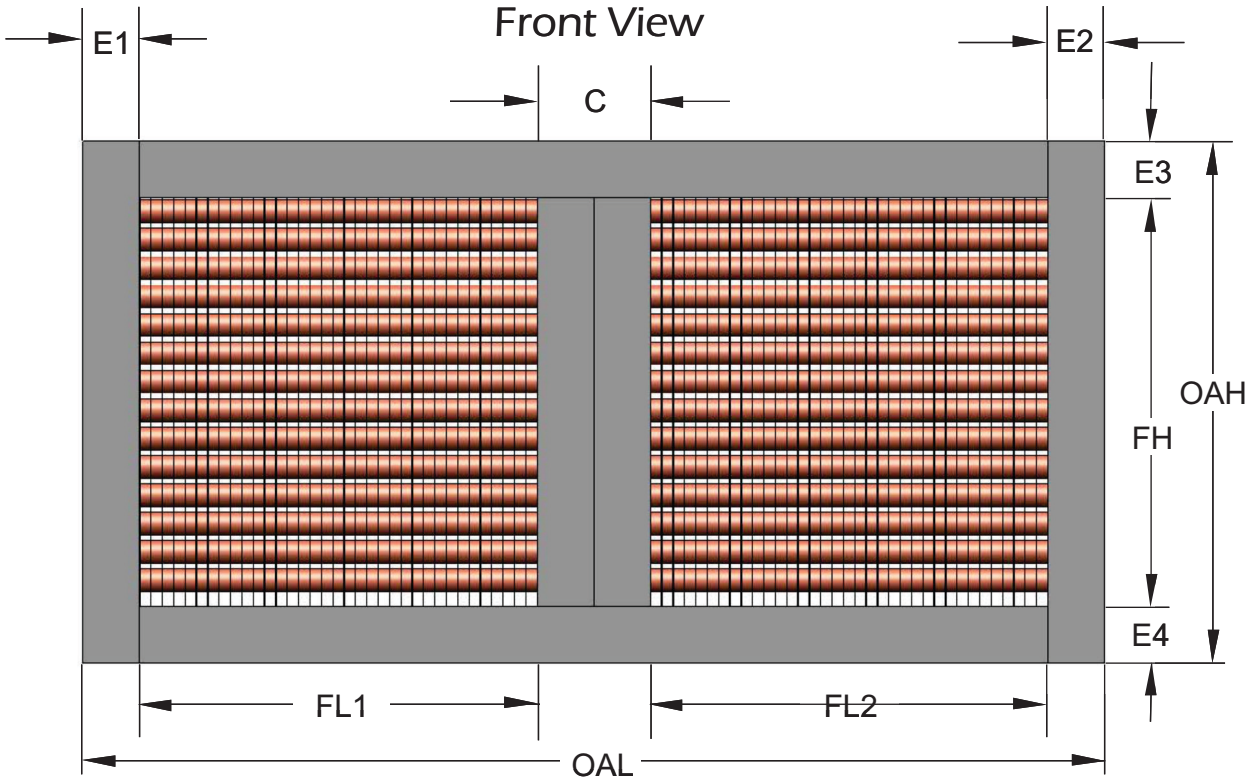
Eff. = 48% and Face Velocity at 400 fpm
Result: A 4 ROW will meet the requirement.

From Figure 2: Pressure Drop

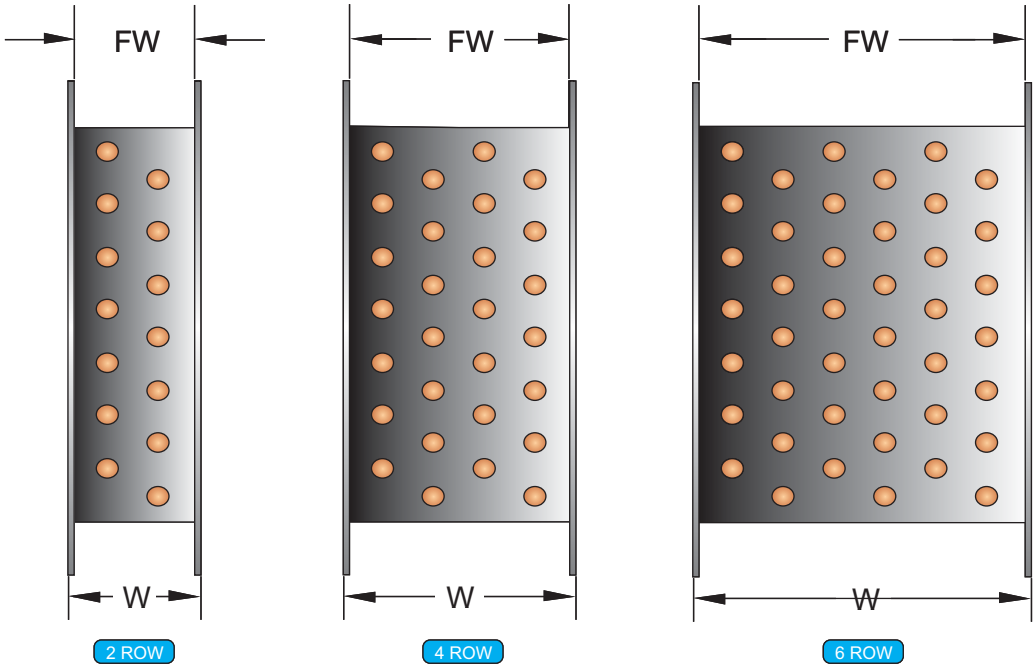
Face Velocity at 400 fpm and 4 ROW Air-to-Air

Results: Δ P = 0.20 inH_2O

Air-Air Heat Pipe Heat Exchanger Dimensional Specifications



Side View 2 - 4 - 6 Row Heat Pipe Heat Exchangers



Dimension Table
OAL: Overall Length
OAH: Overall Height
FH: Fin Height
FL1: Fin Length
FL2: Fin Length
C: Center Divider Width
E1 - E2: Side Flange Depth
E3 - E4: Top - Bottom Flange
W: Width
FW: Fin Width

ACT-HP-ERS/A-A Series Mechanical Specifications

The ACT Air-to-Air Heat Pipe Heat Exchanger (AAHX) shall be part number series ACT-HP-ERS as manufactured by Advanced Cooling Technologies, Inc. The heat pipe shall transfer heat between the outgoing and incoming airstreams in a counter flow arrangement, and shall be labeled for direction of airflow, noting inlets and outlets of exhaust and supply. The heat pipe heat exchanger shall be a passive device, requiring no other means for heat transfer, and shall be capable of operating at temperatures ranging from -50°F minimum to 180°F maximum.

Heat Pipe Heat Exchanger performance data is derived from laboratory testing in accordance with AHRI testing standards for Air-to-Air heat exchangers. Air-to-Air Heat Pipe Heat Exchanger performance shall be rated in accordance with applicable AHRI testing procedures.

Manufacturers of alternate equipment must be approved to bid via addendum, in writing by the specifying engineer, at least two weeks prior to bid time in order for their bid to be accepted by the contractor. If the equipment is not pre-approved then under no circumstances shall the contractor invest time or money in receiving submittals or considering the equipment.

The AAHX shall be installed vertically: with the warmer air stream under the cooler air stream. If the air stream at the top is warmer than the bottom, the AAHX will not transfer heat in reverse.

The AAHX shall be installed horizontally: with 1/8 to 1/4 inch per foot tilt angle with the warmer stream passing through the lowest end of the AAHX and the cooler stream passing through the highest end. With this type of installation, if the warmer stream changes to the highest end, the AAHX will not transfer heat in reverse.

The AAHX shall be installed horizontally: level to within 1/8 inch end-to-end for heat transfer in either direction depending on which stream is warmer.

Costs associated with dimensional, performance, or other deviations from the specified equipment, including engineering costs to evaluate such deviations, shall be paid by the contractor.

The manufacturer must have a quality management system in place, equal to the quality management system in accordance with ISO-9001-2008, for the design, manufacture, and service of heat exchangers. The manufacturer must also have a net worth greater than five times the value of the equipment being bid and must have been a manufacturer of heat pipes and heat pipe assemblies for at least five years prior to bid time. The heat pipe heat exchanger must be manufactured in the United States of America. The manufacturer shall have a LIFE TIME LIMITED WARRANTY on the performance and operation of the heat pipes in the heat exchanger.

DESIGN AND CONSTRUCTION FEATURES

1. Air-to-Air Heat Pipe Heat Exchanger:

Heat pipes shall be 0.5 inch outer diameter, seamless, internally rifled copper tubes. The finned tube coils shall have aluminum fins, 0.006" minimum thickness, with enhancement (corrugated wave, sine wave, or louvered) to meet the performance and pressure drop requirements. Fin density shall be 10-12 fins per inch. Heat pipes shall be a maximum of 1.25 inches on center in the face and shall be 1.08 inches on center row-to-row.

Heat pipes shall be individually processed, individually charged, and hermetically sealed. AAHX Heat Pipe Heat Exchangers shall be installed as shown on the manufacturer's submittal drawings.

2. Protective Heat Pipe Heat Exchanger Enclosure:

The heat exchanger frame shall be fabricated from minimum 16-gauge galvanized steel. The frame shall be supplied with a minimum of 1.50 inch wide flanges on all four sides, both front and back. Intermediate heat pipe supports and lifting points shall be furnished as required.

The heat exchanger shall be provided with a partition to isolate the outgoing and incoming airstreams; there shall be no cross contamination. The partition shall be fabricated from a minimum 16-gauge, galvanized steel and shall extend beyond the finned surface with a 3.0 inch mid-seal (1 ½ inches to supply side and 1 ½ inches to exhaust side).

End cover plates shall be provided to protect the heat pipe ends from possible installation damage. End plates shall be fabricated from minimum 16-gauge galvanized steel.

Note: Drain pans are recommended under all coils and are not included.

3. Working Fluid:

The Air-to-Air Heat Pipe Heat Exchanger working fluid refrigerant shall be selected on the basis of heat pipe operating temperature and compatibility with heat pipe tube material. Heat pipe heat exchanger refrigerant used shall be classified as ASHRAE safety group A1.

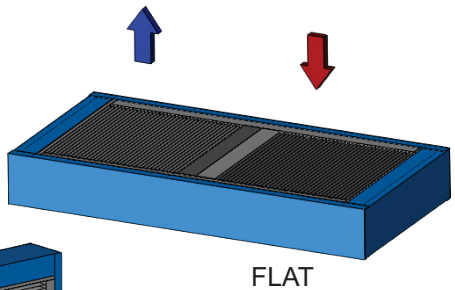
4. AAHX Protective Coating (When Specified):

E-Coat to protect against corrosion: Coating to be factory applied to entire unit after final fabrication.

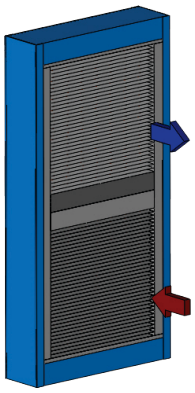
Optimize Your Dedicated Outdoor Air Installations

- Reduce Overall HVAC System Heating and Cooling Requirements: Size of the heating and/or cooling systems can be downsized based on our Air-to-Air heat pipe heat exchanger performance efficiency. Expensive heated or cooled air leaving a facility can now be safely recovered and passively transferred to boost HVAC systems performance.
- Meet Standards & Codes: ACT's Heat Pipe Heat Exchangers enable HVAC system designers to meet ASHRAE Standards 62.1 and 90.1, increasing building comfort while saving the building owner thousands of dollars per year.
- Easily Specified: ACT-HP-ERS/A-A Series Heat Pipe Heat Exchangers feature a thin planner profile construction. The slim profile provides ease of installation in new or existing AHU equipment, industrial or commercial energy applications. Multiple, individually sealed high capacity heat pipes offer reliable lifetime performance. Each installation is sized for optimized performance for the highest practical Btu/hr transfer between air streams.
- Care and Operational Costs: Since our Energy Recovery systems are totally passive (zero external electrical power to operate), your energy saving add up year after year. There are no periodic maintenance requirements are needed for typical operating conditions other than keeping the heat pipe coils free of dust and debris.

Air-to-Air Heat Pipe Heat Exchanger Installation Options:

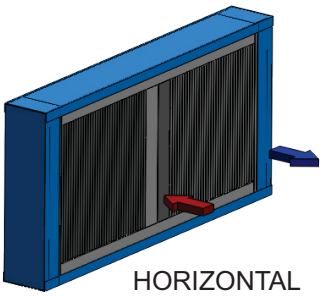


FLAT



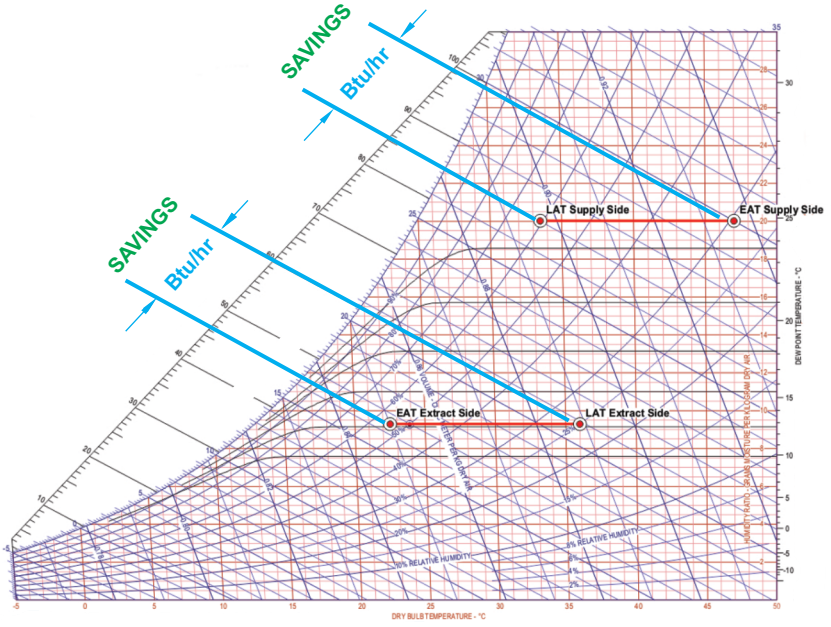
VERTICAL

The ACT Heat Pipe Heat Exchanger can be oriented to match the installed duct work.



HORIZONTAL

Air-to-Air Heat Pipe Heat Exchanger System Sensible Heat Transfer Performance



Every ACT Air-to-Air Heat Pipe Heat Exchange is designed to yield the optimal effectiveness in Btu/hr savings. Passive energy recovery transfer is custom engineered to each project to yield the best performance versus cost ratio.

Other Energy Recovery Products:

ACT-HP-WADX Wrap Around Dehumidification Systems

ACT-HP-WADX Enhanced Passive Dehumidification with Wrap-Around Heat Pipe Heat Exchangers offer engineered performance to enhance your systems efficiency and greatly reduce systems's operating costs.

ACT-HP-WADX Wrap-Around systems can be designed for all major AHU OEMs. For retrofitting existing systems, ACT can ship a pre-engineered unit, fully charged and ready to install. ACT offers onsite installation or units can be factory installed. Typical design build/install costs are recouped in a 1-2 year payback period.

ACT's Climate Test Chamber provides thermal performance testing of Wrap-Around Dehumidification and Air-to-Air Heat Pipe Heat Exchangers per AHRI specified test conditions.

General Specification:

- Fins	Copper or Aluminum
- System Working Fluid:	R-134a

Heat Pipe Systems Provide Benefits to help meet or Achieve:

- ASHRAE Standard 62.1 Ventilation for Acceptable Indoor air Quality
- ASHRAE Standard 90.1 Energy Standard for Buildings Except Low Rise Residential Buildings
- ASHRAE 189.1 Standard for the Design of High-Performance green Buildings
- Energy Policy Act 2005: Green Building Performance
- LEED Points possible for; Energy and Atmosphere, Indoor Environmental Air Quality, Innovation in design
- ISO 5000: Energy Management Standard: public and private sector organizations with management strategies to increase energy efficiency, reduce costs and improve energy performance.

Note: USDOE REFERERENCE: www1.eere.energy.gov/femp/technologies/eut_wraparound_pipes.html

Advanced Cooling Technologies, Inc.,
1046 New Holland Avenue
Lancaster, Pennsylvania 17601
Ph:717-295-6061, Fax:717-295-6064
www.1-ACT.com/HVAC
Mark.Stevens@1-ACT.com

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