Energy Recovery Ventilators Unitized to A/C Equipment

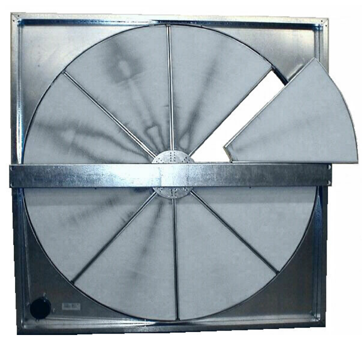
System Design Principles

Theory & Reality

Energy recovery COMPONENT certified to the ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program in accordance with ARI Standard 1060-2000. Actual performance in packaged equipment may vary.

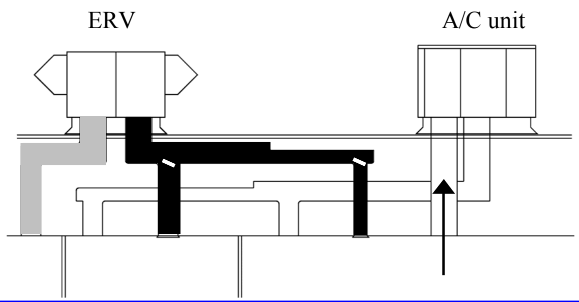
ROOFTOP SYSTEMS, INC.

Typical Energy Recovery Ventilator Configurations

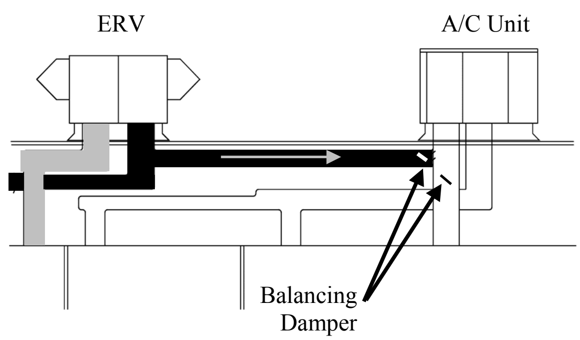


Energy Recovery Ventilators that incorporate a rotary heat recovery wheel have been used in applications for over 30 years. The recovery of energy from the exhaust air in large industrial applications has been a practical and cost effective practice during this time. With the advent of an increased amount of outdoor air to improve indoor air quality (IAQ), the practice of using Energy Recovery Ventilators (ERVs) for smaller commercial and residential applications has become more common. This requirement for improved IAQ has caused the volume of ERV equipment to grow substantially. This growth has made ERVs affordable while providing an improved environment and comfort level for the conditioned space. ERVs today are utilized in three basic configurations. They are listed below.

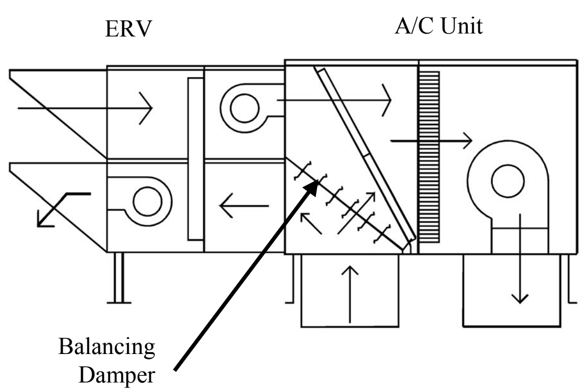
Stand-Alone System: The ERV in this system has a dedicated supply and return air duct. The ducts are not connected to any other duct system in the building. A balancing system must be provided along with a complete supply and return diffuser system.



Stand-Alone Coupled System: The ERV in this system has a dedicated return air duct, but has the supply air duct connected to the return air duct of an (or multiple) air conditioning system. This could be a packaged rooftop unit, a horizontal air handler, or an upflow furnace (etc.). By connecting to the return duct, the a/c system receives the benefit of the pretreated outside air. This system requires balancing dampers at each a/c unit and return grills.



Unitized System: The ERV in this system is attached directly to the air conditioning unit (rooftop, horizontal, upflow, etc.). In this configuration additional ductwork is not required, and the air conditioning equipment receives the benefit of the improved conditions of the entering outside air. ***A balancing damper is required and provided by RSI that installs in the a/c unit. Most ERV producers do not provide the balancing damper.*** When considering an alternative to the RSI ERV system, it should be verified how the ERVs are to be balanced with the air conditioning equipment.



The heart of an Energy Recovery Ventilator is the rotary Enthalpy Wheel. The enthalpy wheel is constructed of a polymeric material and is coated with silica gel through a proprietary process that permanently bonds the silica gel to the surface of the polymer substrate without adhesives. Silica gel desiccant has superior moisture handling capacity (see chart) in the working range above 30% R.H. as compared to other types of desiccants.

The wheel recovers energy from the exhaust air of the conditioned space as it is passed across the wheel. This occurs when the wheel media adsorbs both the sensible and latent heat of the exhaust air. As the wheel rotates into the outside air intake section of the ERV, the wheel exchanges this energy with intake air. When the outside air is cold, the released energy warms the outside air before it enters the building. When the outside air is hot energy is adsorbed cooling the outside air. In the graphic shown here, the treated outside air is termed the ***Tempered Outside Air (TA)***. TA is the condition of the air as it leaves the intake side of the enthalpy wheel. If the effectiveness (recovery percentage) of the wheel is known, the tempered air (TA) conditions can be calculated. Absolute humidity (grains of moisture/lbs of dry air) must be used for the latent TA_L. The formulas for TA_S and TA_L are as follows:

$$TA_S = ((RA_S - OA_S) * E_S) + OA_S$$
$$TA_L = ((RA_L - OA_L) * E_L) + OA_L$$

where

E_S = Dry Bulb (DB) Application Effectiveness
E_L = Absolute Humidity Application Effectiveness
OA_S = DB Outside Air Temperature
OA_L = Outside Air Absolute Humidity
RA_s = Return Air Dry Bulb Temperature
RA_L = Return Air Absolute Humidity
TA_S = Tempered Air Dry Bulb Temperature
TA_L = Tempered Air Absolute Humidity

Sensible Example: If the return air is 75°F, the outside air is 20°F, and the measured effectiveness is 70%, TA_S = 58.5°F.

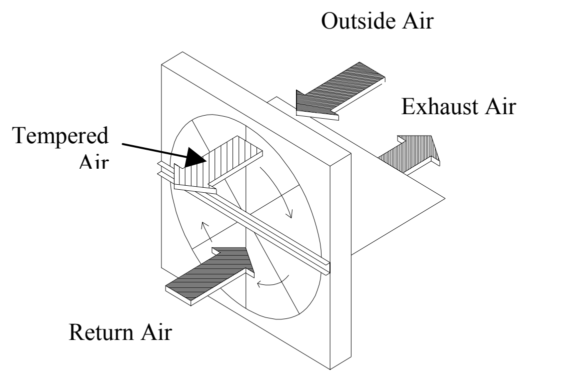
$$TA_S = ((75^\circ F - 20^\circ F) * 70\%) + 20^\circ F$$
$$TA_S = ((55^\circ F) * 70\%) + 20^\circ F = 58.5^\circ F$$

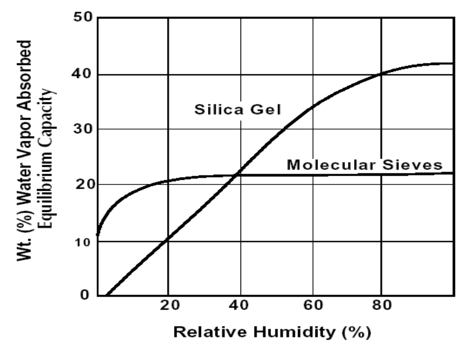
Latent Example: If the return air is 75°F - 50% rh and the outside air is 60°F - 90% rh, and the measured effectiveness is 70%, then TA_S = 70.5°F and TA_L = 66.36 gr/lb or 59.5% rh.

$$TA_L = ((64.92 - 69.7) * 70\%) + 69.7$$
$$TA_L = ((-4.78) * 70\%) + 69.7 = 66.36 \text{ gr/lb}$$

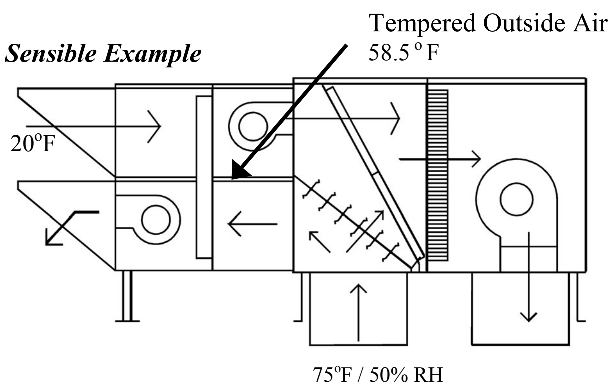
The formula for application (measured) effectiveness is as follows:

$$E_S = (TA_S - OA_S) / (RA_S - OA_S)$$
$$E_L = (TA_L - OA_L) / (RA_L - OA_L)$$

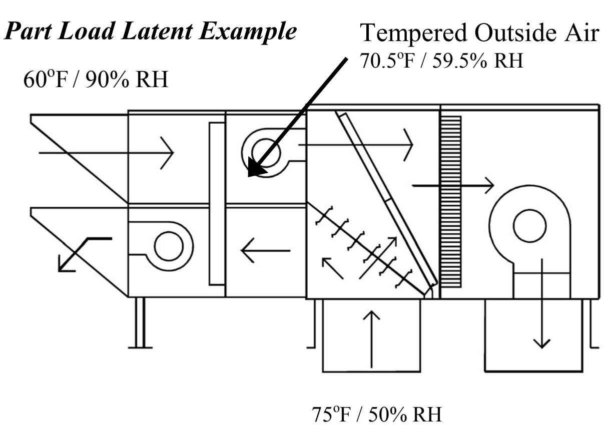




Sensible Example



Part Load Latent Example



Load Program Information

The **Tempered Outside Air** conditions replace the Outside Air entering air conditions in air conditioning load programs. The RSI performance modeling software provides tempered air conditions for both summer and winter design conditions. ***The software defines the TA as "Supply Air".*** In the latent example on the previous page the outside air entering air conditions would be 70.5^{o}F and 59.5% RH, not 60^{o}F and 90% RH. When entering the outside air load conditions always use information provided by the modeling software.

Entering Air is the mixed air conditions as it enters the evaporator coil or the heat exchanger of the a/c unit. The entering air temperature is a function of the percentage of outside air (either sensible or latent) to the percentage of air (either sensible or latent) supplied by the a/c unit. When using an ERV, the percentage of outside air is replaced by the percentage of **Tempered Air**. The formulas for sensible and latent entering air are as follows:

$$EA_S = (RA_S * RA_{\%}) + (TA_S * TA_{\%})$$
$$EA_L = (RA_L * RA_{\%}) + (TA_L * TA_{\%})$$

where

EA_S = Entering Air Dry Bulb Temperature
EA_L = Entering Air Absolute Humidity
RA_S = Return Air Dry Bulb Temperature
RA_L = Return Air Absolute Humidity
$RA_{\%}$ = Percentage of Return Air
$TA_{\%}$ = Percentage of Tempered Outside Air
TA_s = Tempered Air Dry bulb Temperature
TA_L = Tempered Air Absolute Humidity

Note: $RA_{\%} + TA_{\%}$ must add to 100%.

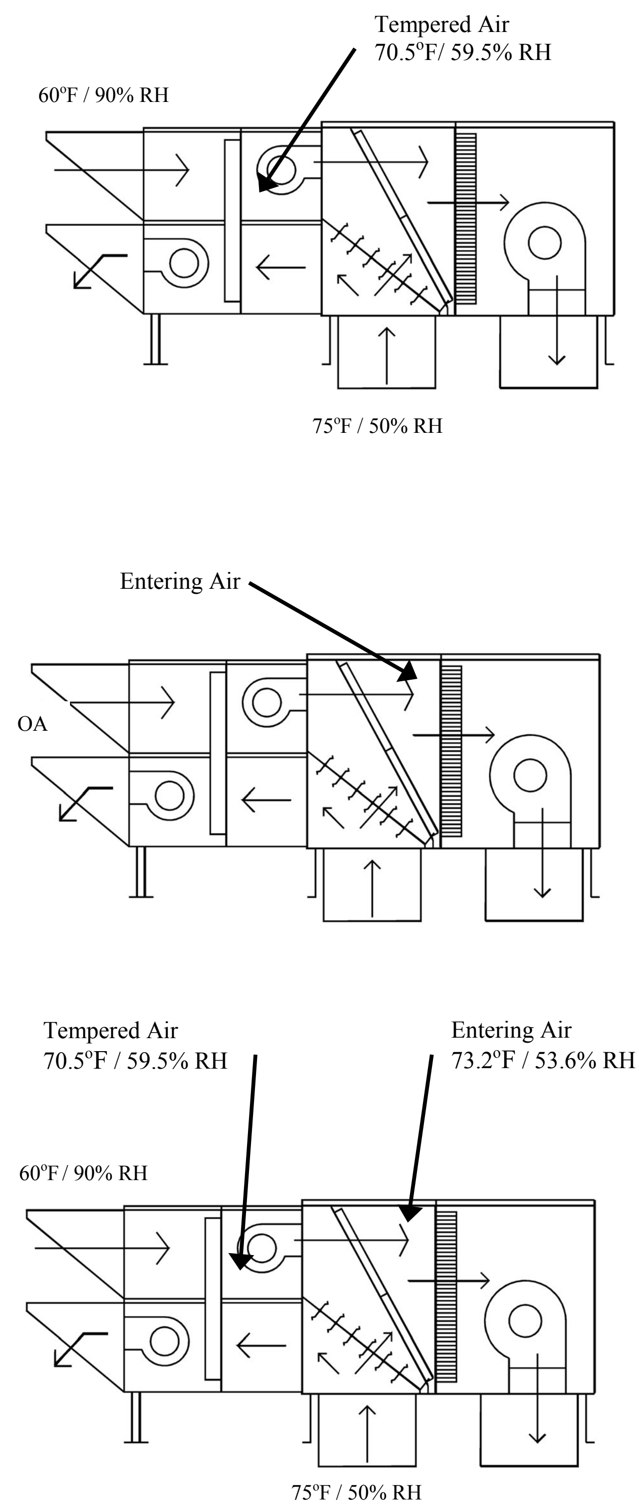
From the Previous Example: If the return air is 75^{o}F, the tempered air is 70.5^{o}F, and there is 60% return air, the entering air would be 73.2^{o}F.

$$EA_S = (75^{o}F * 60\%) + (70.5^{o}F * 40\%) = 73.2^{o}F$$

and

$$EA_L = (64.92*60\%) + (59.47*40\%) = 65.5 \text{ gr/lb}$$ or 53.6% rh at 73.2^{o}F.

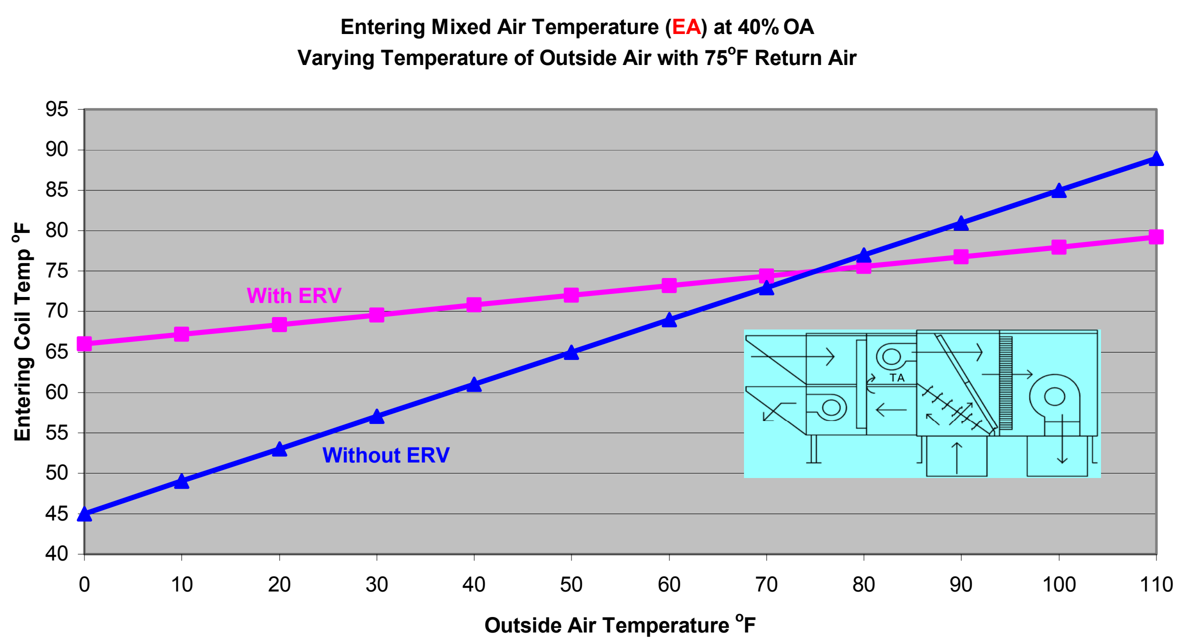
The Entering Air conditions are truly the most critical requirement needed to understand the tremendous positive effect that an Energy Recovery Ventilator has on an air conditioning system. In the winter it prolongs the heat exchanger life by raising the entering temperature. In the summer it allows the system to obtain greater moisture control due to lower latent content of the entering air.

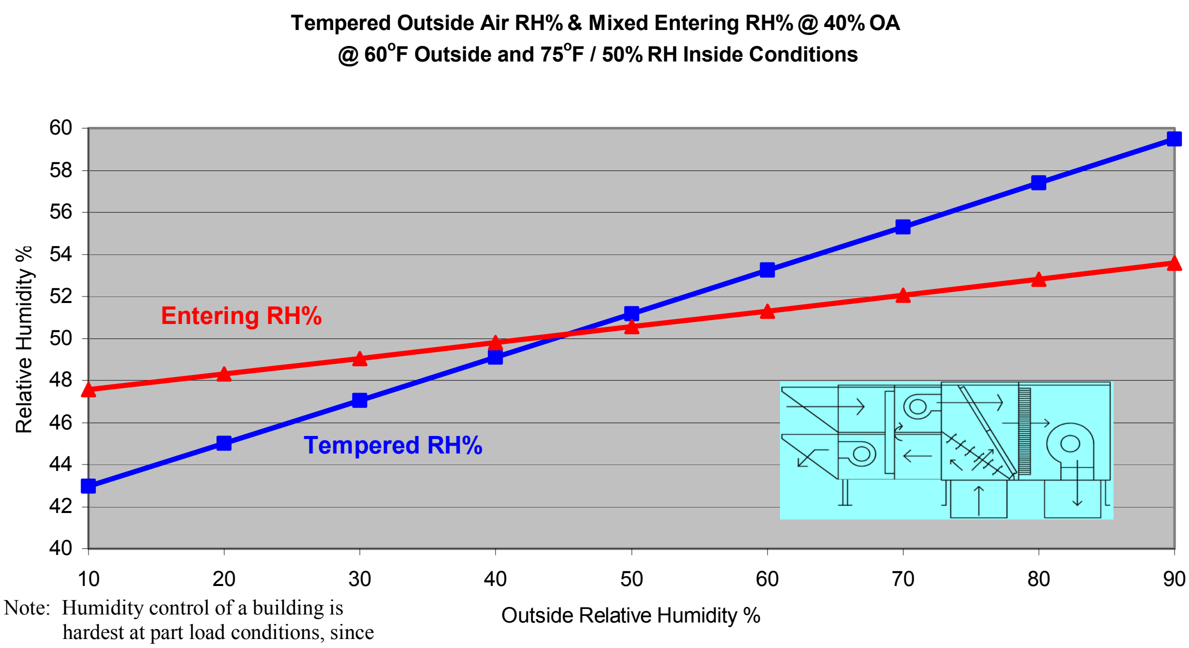


ERV Temperature & Humidity Example Charts

The following charts are based on the following conditions:

Return air temperature = 75°F
Return air humidity = 50% RH
Return air = 60% of a/c unit capacity cfm
Outside air = 40% of a/c unit capacity cfm





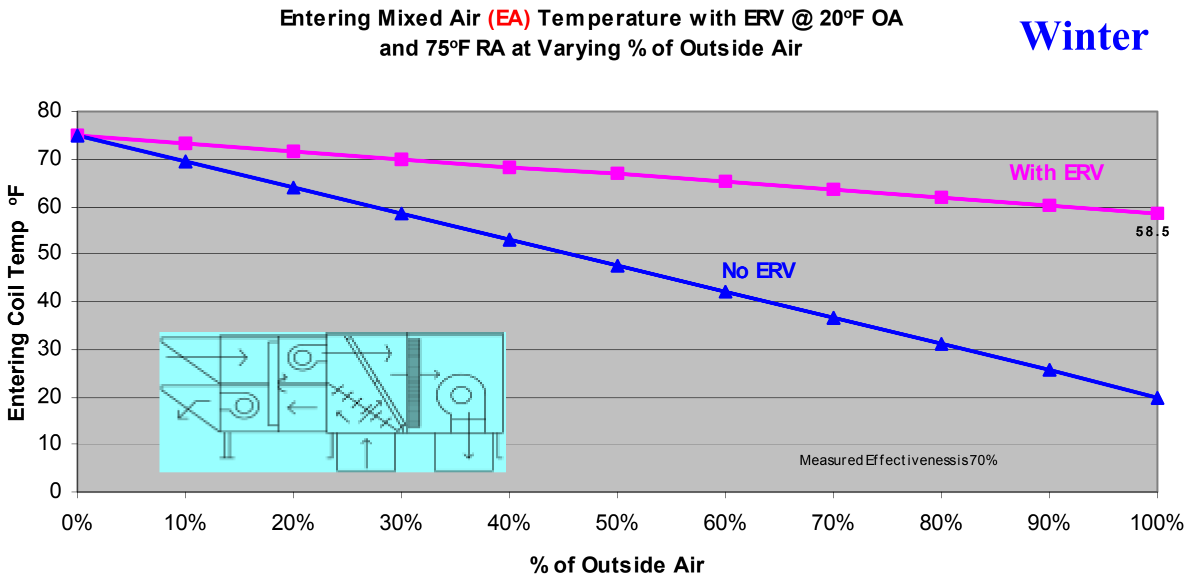
Note: Humidity control of a building is hardest at part load conditions, since compressor run time is minimized.

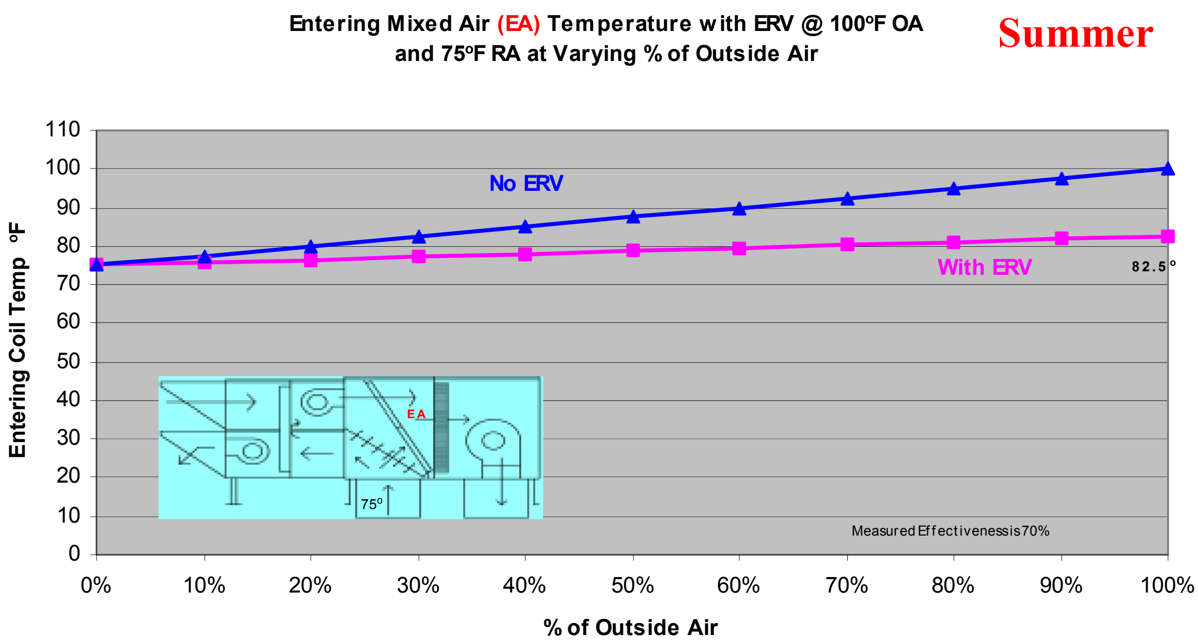
ERV Temperature at Varying % of Outside Air Example Charts

The following charts show the effect on the entering air temperature generated by different percentages of outside air at 20°F (Winter Conditions) and 100°F (Summer Conditions).

Return air temperature = 75°F

Effectiveness = 70%

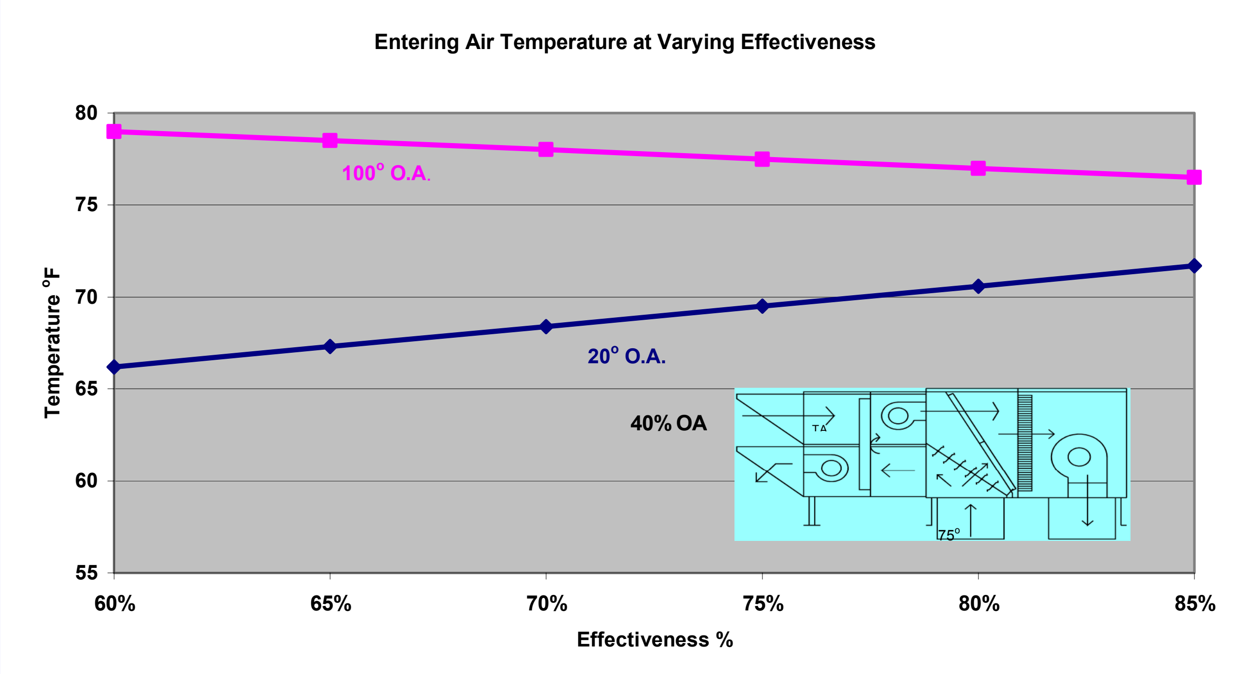




Effectiveness Relationship to Entering Air Temperature

The Effectiveness of an ERV is important in relationship to the overall energy recovered. The higher the effectiveness, the more energy is recovered. However, effectiveness is not always the key requirement in selecting Energy Recovery Ventilators. The combination of initial cost <u>and</u> energy savings should be considered when selecting an ERV. The cost of an ERV that is 80% effective versus a 70% effective unit may be considerable. This cost should be understood as part of the selection process. The difference in the effect on the entering air temperature may be minimal, thereby not justifying the added cost of the more effective ERV. ***When comparing ERVs manufactured by different companies, always compare the actual engineering data for each particular ERV at the specified CFM.*** The higher the CFM the higher the velocity is across the wheel. Higher CFM ranges result in lower effectiveness for all ERVs..

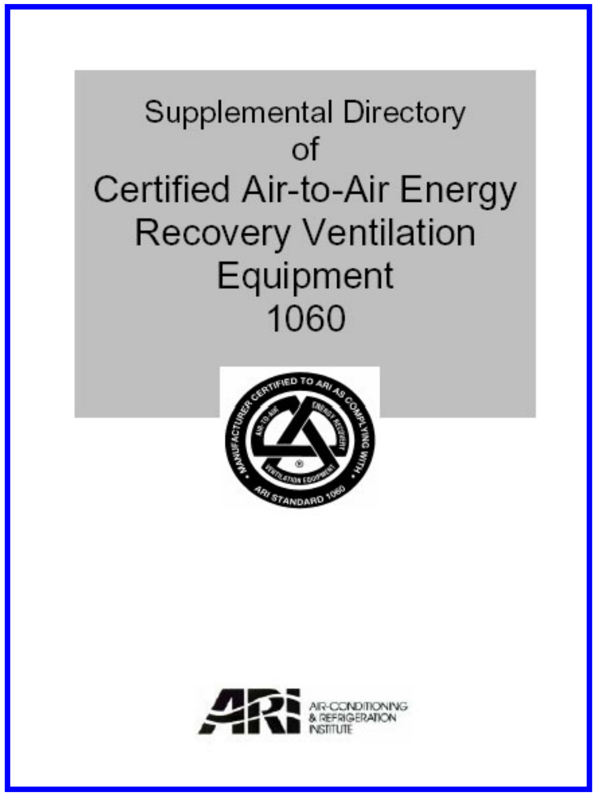
The chart below gives an example of how the entering air temperature is changed as the effectiveness changes at two (2) temperature ranges. At 20°F and 40% (quantity of) outside air, the entering air temperature is 68.4°F with 70% effectiveness, and 70.6°F at 80% effectiveness. This 10% change in the effectiveness only results in a 2.2°F change in the entering air temperature. As the outside air to return air temperature differential decreases <u>or</u> the percentage of outside air decreases, the difference in the entering air temperature at different effectiveness levels will also decrease.



There is another very important requirement when considering the effectiveness ratings provided by the different ERV manufacturers. The Air Conditioning and Refrigeration Institute (ARI) introduced certified ratings of ERV Components in Standard 1060 in 2001. This standard will be discussed at length in the information following, but *one of the prime changes that resulted from the new standard was a new rating system for effectiveness*. This new system results in lower effectiveness by removing any air leakage from the rating. Those manufacturers that do not incorporate an ARI certified component typically claim higher effectiveness than they would achieve for the same component at the standard. ***It is important to always select a Manufacturer that utilizes an ARI Certified Components, to insure the desired results are achieved. All RSI Energy Recovery Ventilators contain an ARI rated component.***

ARI Standard 1060 and Energy Recovery Ventilators

The Air Conditioning and Refrigeration Institute (ARI) introduced a certification program based on Standard 1060 in the year 2001. This standard was developed to provide certification for components that are utilized in Energy Recovery Ventilation equipment. These components include rotary (enthalpy) wheels, plate heat exchangers, and heat pipe heat exchangers.


Supplemental Directory
of
Certified Air-to-Air Energy Recovery Ventilation Equipment
1060

AIR-CONDITIONING & REFRIGERATION INSTITUTE

ARI certification provides the assurance that the ERV component will perform to the certified ratings. Ratings for both the Components and the Packaged ERVs can be viewed on the ARI website. The address is www.ari.org/directories/erv. The general directory is for Component manufacturers, and the supplemental directory is for Packaged ERVs that utilize the certified components.

Some manufacturers that are not certified are making claims that their equipment is tested "in accordance with ARI Standard 1060. One way to be truly sure is to see the ARI Standard 1060 seal on the component. Any Certified Packaged Equipment that has a certified Component will have the seal, and a clarifying statement.

Standard 1060 introduced several new terms to the ERV market. Two of these are **"Net Effectiveness"** and **"Exhaust Air Transfer Ratio (EATR)".** Net Effectiveness is the Application Effectiveness less the loss generated by leakage from the exhaust airstream into the intake air stream (EATR). Net effectiveness is the number that ARI certified manufacturers must show in all their technical data. Since ARI uses a tracer gas in the test, net effectiveness cannot be measured at the jobsite.

ARI Clarifying Statement:

Energy recovery COMPONENT certified to the ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program in accordance with ARI Standard 1060-2000. Actual performance in packaged equipment may vary.

Always look for the SEAL!

ERVs and Economizer Operation

Energy Recovery Ventilators are designed to temper the outside air temperature & humidity to be as close to the exhaust air temperature as possible. ***This is desirable in all conditions except during "economizer" conditions.*** When cooling is required and it is cool outside, an economizer provides outside air to a building through an air conditioning unit by means of a damper system, while de-energizing the air conditioners compressor. By doing this, the energy required to operate the compressor is saved. Example: If the outside temperature is 55^{o}, and the return temperature is 75^{o}, the rotating enthalpy wheel will warm the outside air before it enters the building. This is undesirable when cooling is required in the building.

In a response to this issue, ERV manufacturers have developed an "Economizer Option" control system. The typical system incorporates a method of "stopping" the rotation of the wheel during economizer conditions, thereby allowing the cool outside air to enter the building without being treated. Periodically the wheel is rotated for a specified time to clean the wheel during this cycle.

Warning! ***Unless the ERV is providing 100% of the air conditioning unit's airflow capacity, an economizer that closes a return damper should never be used on the air conditioning unit*** unless a bypass airflow system is used**.** When an economizer closes the return damper, the a/c unit blower will try to pull 100% of its design CFM through the ERV. Example: On a twenty (20) ton unit, with an ERV providing 40% outside air, the unit is getting 4,800 CFM from the space and 3,200 CFM from the ERV. If the return damper closes, all 8,000 CFM must come through the ERV. In reality, this is not possible due to the excessive static that would be generated. *The reality is that both the a/c unit blower and the ERV wheel could be damaged in such an application.*

The BEST way to get "True Economizer" operation is by utilizing the patented RSI *pivoting wheel* that moves the wheel out of the airstream during economizer operation, thus allowing 100% economizer operation. Other methods utilizing bypass dampers to bring outside air into a building without crossing the wheel may be available, but are generally much more expensive.

Energy Recovery Mode of Operation

Wheel Rotating Out of Airstreams

Enthalpy Wheel Rotating to Economizer Operation Position

"True" Economizer Mode of Operation

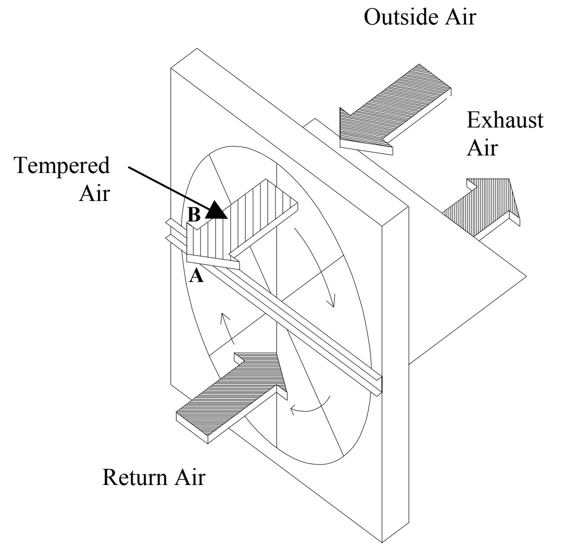
Enthalpy Wheel Out of Airstream

Bypass Damper

Energy Recovery Ventilators and "Purge"

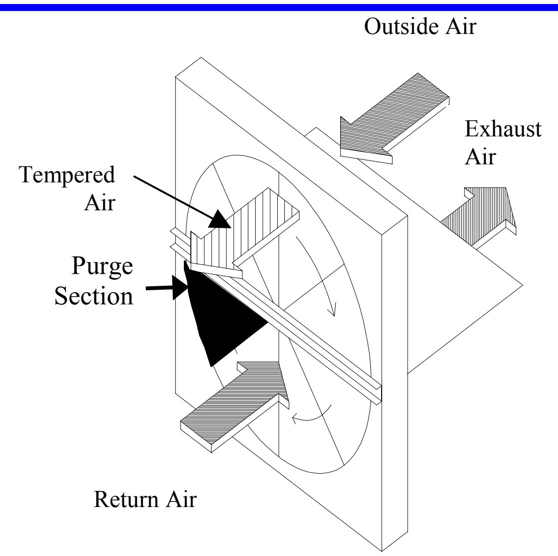
Purge removes exhaust air that would otherwise be carried to the outdoor air intake airstream by the rotating wheel.

Energy Recovery Ventilators that utilize a rotating wheel will always have a small amount of exhaust air transferred to the outdoor intake airstream as the wheel spins. ARI describes this as the Exhaust Air Transfer Ratio (EATR). ARI requires that the EATR be published in all certified ratings data. In the drawing, airflow at position "A" can be rotated to position "B" before the exhaust blower can remove the air. In typical applications this small amount of leakage is not an issue, because the major percentage of the return air from the space is being supplied back to the space. An example would be a building with supply air of 4,000 CFM, exhaust air of 1,000 CFM, and 3,000 CFM returned to the space. With a leakage of 5%, 1,050 CFM could be brought into the building through the ERV, with 1,000 CFM of exhaust. This would provide a desired positive building pressure, while overcoming the EATR.



Mechanical Purge systems are utilized in many applications where simply adjusting airflow to compensate for EATR would work just as well. A mechanical purge system blocks the portion of the exhaust airstream on the exhaust side of the wheel just before the wheel rotates into the outside air intake airstream. In this manner, the exhaust air can be exhausted before it enters the outdoor air intake airstream. The drawing to the right shows the position of the purge "section". Even with a purge section, there will be some leakage of the exhaust to the intake airstream. ***A mechanical purge system actually reduces the amount of energy recovery*** that the enthalpy wheel can achieve due to the reduced the amount of surface area of the wheel. Mechanical purge systems actually reduce the amount of saved energy ***and*** increase fan requirements.

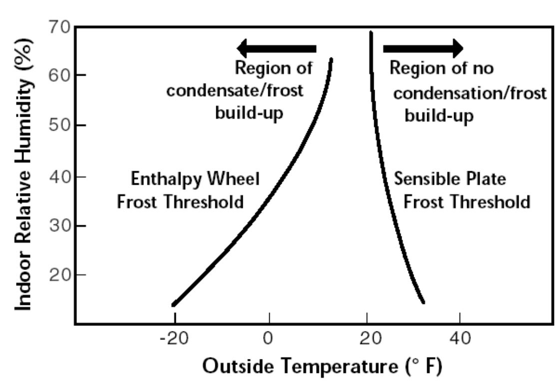
Never use a Rooftop Systems ERV in an application that has polluted exhaust. The RSI equipment is designed to be used in general building applications.



ERVs and Frost Control

Unlike a Heat Recovery Ventilator (HRV) with a sensible plate heat exchanger, an ERV with a rotating wheel does not accumulate condensation in the process of recovering energy. In extreme cold conditions frost can be generated on the wheel. The chart to the right shows the frost threshold of an ERV with an enthalpy wheel. As you can see, typically frost control systems are not required unless the operating temperatures are below 10^{o}F.

RSI has an option to remove frost on the wheel. This option uses the industry standard method of de-energizing the outside air intake blower momentarily (based on discharge air temperature) and allowing the warm exhaust air to remove any frost from the wheel.



ERVs – Cost and Payback Analysis

Energy Recovery Ventilators today are much more cost effective for the typical building (retail, school, office, etc.) than in the past. Even so, ERVs still have a high initial cost when only the ERV is being considered, and not the whole air conditioning system. On the next several pages, the "up front" cost will be analyzed in comparison to the overall cost of the system. The overall air conditioning system design is greatly impacted by the performance of the ERV.

ERV System Design Impact:

1. **Energy Savings Dollars during Cooling Operation.**
2. **Energy Savings Dollars during Heating Operation.**
3. **Energy Usage for ERV Blower Operation.**
4. **Reduction in A/C Tonnage Cost due to Pretreated Outside Air.**
5. **Reduction in A/C Operating Cost due to Tonnage Reduction.**
6. **Reduction in Electrical Demand Charges.**
7. **Improved Comfort Level of the Building.**

Government Involvement

The reality of today's world is that most applications in North America can easily justify the cost of Energy Recovery Ventilators. The energy crunch is getting worse, and Government policies are going to require some type of energy regulations and improved Indoor Air Quality. The Environmental Protection Agency (EPA) and the Occupational Safety and Health Association (OSHA) are becoming involved with IAQ.

In 1994, OSHA proposed (in the Federal Register) that it be placed in charge of IAQ for all commercial buildings**.** ***Their proposal included the following requirements for <u>all existing</u> and new buildings:***

1. A log and drawing of every air conditioning unit location on the building.
2. The amount of outside air entering through each unit.
3. Who commissioned each a/c unit.

The importance of this information is to understand that today there is pending legislation (House Bill #3532) that puts the EPA and OSHA in charge of IAQ in "***schools and other buildings***". It can be assumed if this passes, that OSHA will push for their previous requirements.

Performance Modeling Software

The impact of the ERV system resulting in air conditioning tonnage savings, and on the utility savings for the ventilation can be determined from the **RSI – Airxchange Performance Modeling Software.**

The software provides the following:

1. Energy Savings Dollars during Cooling Operation.
2. Energy Savings Dollars during Heating Operation.
3. Energy Usage for ERV Blower Operation.
4. Reduction in A/C Tonnage Cost due to Pretreated Outside Air.

The software does not provide the following:

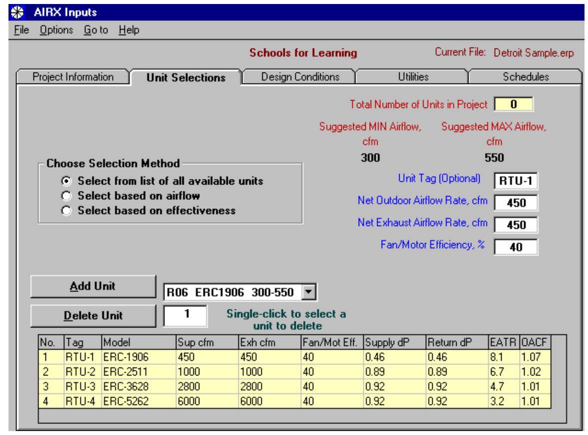
1. Reduction in A/C Operating Cost due to tonnage reduction.
2. Reduction in Electrical Demand Charges due to the reduced tonnage required for the building.

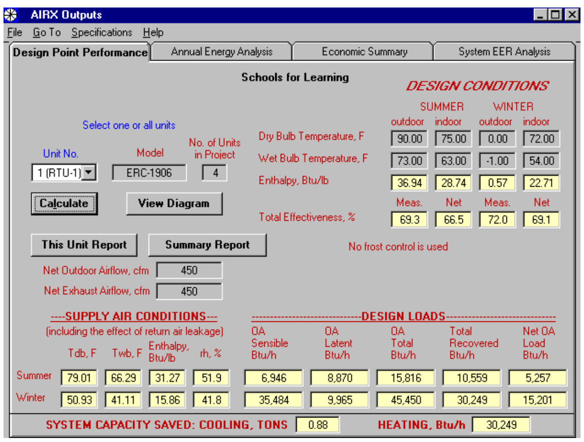
Performance Modeling Software – Continued

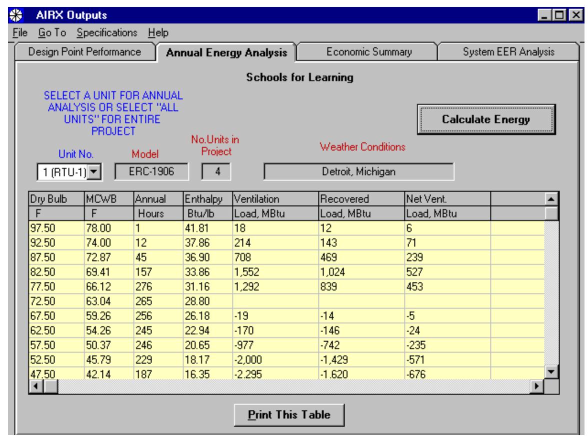
The performance modeling software is very easy to use and understand. It allows the user to input the Project Information, Unit Selections, Design Conditions based on location, appropriate Utility information, and building Schedules.

When this information is input, the program provides the following:

1. Leaving (shown as supply) air conditions.
2. **System size reduction for cooling and heating.**
3. Energy savings based on weather bin data.
4. **Ventilation cost savings using utility rates.**







Example Project:

This project is located in Detroit, MI. Four (4) ERVs were selected for this project and they totaled 10,250 CFM of outside air. The modeling software shows that the four ERVs provide a total reduction of 19.08 tons of air conditioning, and 656,719 Btu/h of heating. If a typical air conditioning system installs for $1,000 per ton, the result would be an ***"up front" equipment savings of $19,080.***

The economic impact ***on the ventilation cost*** of using the ERVs is a total ***savings of $3,426 per year*** at $.10/kwh. In this example, at a lower cost per kwh, the savings are greater, since the dollars spent on the ERV blowers is reduced.

Rooftop Systems, Inc. AIRX ERC ECONOMIC SUMMARY

Unit	Model	Supply cfm	Exhaust cfm	Coolg Saved MBtu	Cooling $ Saved	Heatg Saved MBtu	Heating $ Saved	Fan kWh Used	Fan $ Spent	Net Savings
1	R06 ERC190	450	450	2,487	92	24,008	154	579	45	201
2	R11 ERC251	1000	1000	5,875	218	56,522	362	2,433	190	391
3	R28 ERC362	2800	2800	14,534	540	140,912	903	6,935	541	902
4	R62 ERC526	6000	6000	30,967	1,151	300,531	1,926	14,682	1,146	1,932
	SUMMARY									
	All Units	10250	10250	53,863	2,002	521,973	3,346	24,629	1,922	3,426

Rooftop Systems, Inc. AIRX ERC SUMMARY DESIGN POINT DATA

DESIGN CONDITIONS	Dry Bulb, F	Wet Bulb, F	Enthalpy, Btu/lb
SUMMER, Outdoor	90.00	73.00	36.94
SUMMER, Indoor	75.00	63.00	28.74
WINTER, Outdoor	.00	-1.00	.57
WINTER, Indoor	72.00	54.00	22.71

Unit	Model (Eff.)	Supply cfm	Exhaust cfm	C/H	Supply DB F	Supply WB F	OA Load Btu/h	Recovered Load Btu/h	Net Load Btu/h	A/C Red. Tons	HTG Red. Btu/h
RTU-1	R06 ERC19	450	450	Clg	79.01	66.29	15,816	10,559	5,257	0.88	
	(69.26%)			Htg	50.93	41.11	45,450	30,249	15,201		30,249
RTU-2	R11 ERC25	1000	1000	Clg	78.49	65.93	35,190	24,922	10,268	2.08	
	(72.67%)			Htg	53.55	42.78	100,381	71,101	29,280		71,101
RTU-3	R28 ERC36	2800	2800	Clg	79.69	66.78	98,296	61,785	36,510	5.15	
	(64.51%)			Htg	47.35	38.70	284,523	177,293	107,230		177,293
RTU-4	R62 ERC52	6000	6000	Clg	79.80	66.86	210,615	131,674	78,941	10.97	
	(63.70%)			Htg	46.79	38.30	609,969	378,076	231,892		378,076
	All Units	10,250	10,250	Clg			359,917	228,940	130,976	19.08	
				Htg			1,040,322	656,719	383,602		656,719

Performance Modeling Software – Continued

The form below is the design information provided by the performance software for a 1,000 CFM Energy Recovery Ventilator in Kansas City, Missouri. The building is occupied five (5) days per week, twelve (12) hours per day. The information shows a reduction of 2.56 tons of cooling required, and a reduction of 71,635 btu/h of heating. ***The critical information for a building load design is the outside entering air conditions. In typical building load software applications, these "Outside Air" conditions are substituted with the "Supply Air" conditions generated by the performance software. In this example the 96°F dry bulb / 75°F wet bulb would be replaced with the 79.81 / 66.47 conditions.*** The "Supply" air conditions shown are the same as the Tempered Outside Air conditions used in previous examples. In this example, a 7 ½ rooftop unit could be used instead of a 10 ton unit.

Rooftop Systems, Inc. EXAMPLE DESIGN POINT ANALYSIS

DESIGN CONDITIONS	Dry Bulb, F	Wet Bulb, F	Enthalpy, Btu/lb
SUMMER, Outdoor	96.00	75.00	39.11
SUMMER, Indoor	75.00	63.00	28.95
WINTER, Outdoor	-1.00	-2.00	.30
WINTER, Indoor	72.00	54.00	22.86

Project Unit: RTU-2 **Model Number:** R11 600-1,000 CFM Range

SUPPLY AIR FLOW RATE, cfm	1,000	
EXHAUST AIR FLOW RATE, cfm	1,000	
Latent Effectiveness	67.54%	
Sensible Effectiveness	75.57%	
Measured Effectiveness (S/W)	73.50%	75.60%
Net Effectiveness (S/W)	71.60%	73.60%

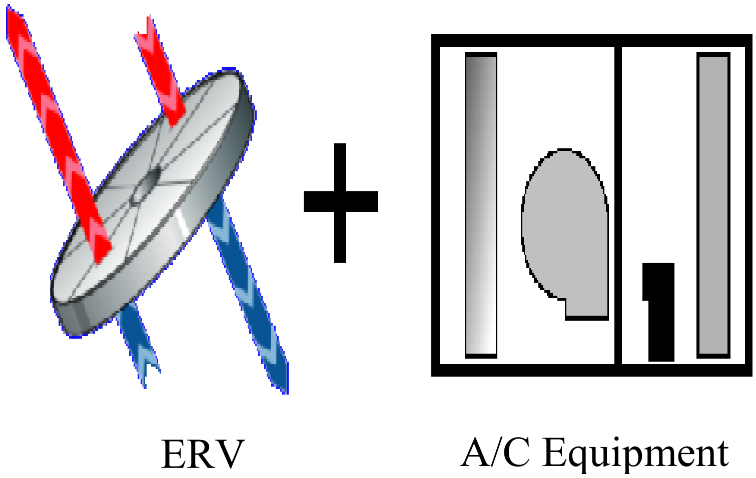
SUPPLY AIR CONDITIONS (Entering into A/C Unit)	**Summer**	**Winter**
Dry Bulb Temperature, F	***79.81***	***53.48***
Wet Bulb Temperature, F	***66.47***	***42.76***
Enthalpy, Btu/lb	31.65	16.74
Relative Humidity, %	50.50	40.30

DESIGN LOADS, Btu/h	**Summer**	**Winter**
Outside Air, Sensible	21,257	78,300
Outside Air, Latent	21,600	22,488
Outside Air, Total	42,859	100,788
Total Recovered	30,730	71,635
Net OA Load	12,129	29,153

INSTALLED HVAC REDUCTION		
COOLING, Tons	2.56	
HEATING, Btu/h		71,635

Performance Modeling Software – Continued

A System EER analysis can performed by using the software. By entering the capacity and EER of the a/c equipment into the SystemEER page of the software, the efficiency of the total system can be determined. The chart below is an example of a 7½ ton unit unitized with the ERV from the previous example. A SystemEER of 11.33 was generated by having a 9.0 EER unitary air conditioner connected to an ERV with 1,000 CFM of outside air.



Unit Model	ERV RER	Unitary Name	Unitary Capacity	Unitary EER	SystemEER
RTU-2	R11	7.5 Ton	90,000	9.0	11.33

EFAST

As stated previously in this document, the Environmental Protection Agency (EPA) is getting involved in indoor air quality.

EPA has developed the ***ERV Financial Assessment Software Tool (EFAST)*** for building designers to use. The program was specifically designed for schools, but works well for other project types. The program can be downloaded from the following:

www.epa.gov/iaq/schooldesign/saves.html

EFAST allows the designer a great deal of flexibility in modeling the building. The program has different roof types, exterior wall types, window configurations, and much more. ***It also allows the designer to see the payback based on whether the ERV is independent from the air conditioning system, or unitized (integrated) with the air conditioning system.***

ARI Certification Data

The data below provides ARI certified ratings for the various Rooftop Systems ERV product lines. The "*" is replaced by the appropriate letter designator for each type RSI model. An example would be R06 for a rooftop ERV. See the RSI engineering handbook for details of the different type models.

		RSI *06 Models		
Enthalpy Wheel ARI Airflow Data	Nominal Airflow CFM	500 @ .6∆		
	EATR - -0.50 H_2O	9.90%		
	EATR - 0.00 H_2O	0.20%		
	EATR - +0.50 H_2O	0.00%		
	OACF - -0.50 H_2O	1.02		
	OACF - 0.00 H_2O	1.33		
	OACF - +0.50 H_2O	1.59		
Thermal Ratings @ 0" Pressure Diff.		**Sensible**	**Latent**	**Total**
Total Effectiveness	100% Airflow Heating	68%	60%	65%
	75% Airflow Heating	73%	65%	70%
	100% Airflow Cooling	68%	60%	64%
	75% Airflow Cooling	73%	65%	69%
Net Effectiveness	100% Airflow Heating	68%	60%	65%
	75% Airflow Heating	73%	65%	70%
	100% Airflow Cooling	68%	60%	64%
	75% Airflow Cooling	73%	65%	69%

		RSI *11 Models			RSI *20 Models		
Enthalpy Wheel ARI Rating Data	Nominal Airflow CFM	900 @ 1.0∆			1600 @ .95∆		
	EATR - -1.00 H_2O	9.30%			7.80%		
	EATR - 0.00 H_2O	0.70%			0.40%		
	EATR - +1.00 H_2O	0.00%			0.00%		
	OACF - -1.00 H_2O	0.97			0.97		
	OACF - 0.00 H_2O	1.19			1.16		
	OACF - +1.00 H_2O	1.34			1.29		
Thermal Ratings @ 0" Pressure Diff.		**Sensible**	**Latent**	**Total**	**Sensible**	**Latent**	**Total**
Total Effective-ness	100% Airflow Heating	76%	68%	73%	68%	61%	65%
	75% Airflow Heating	81%	73%	78%	72%	67%	71%
	100% Airflow Cooling	76%	68%	72%	68%	61%	64%
	75% Airflow Cooling	81%	73%	76%	72%	67%	70%
Net Effective-ness	100% Airflow Heating	76%	68%	73%	68%	61%	65%
	75% Airflow Heating	81%	73%	78%	72%	67%	71%
	100% Airflow Cooling	76%	68%	72%	68%	61%	64%
	75% Airflow Cooling	81%	73%	76%	72%	67%	70%

		RSI *28 Models			RSI *36 Models		
Enthalpy Wheel ARI Rating Data	Nominal Airflow CFM	2600 @ .95∆			3100 @ .9∆		
	EATR - -1.00 H_2O	6.10%			4.90%		
	EATR - 0.00 H_2O	0.40%			1.30%		
	EATR - +1.00 H_2O	0.00%			0.30%		
	OACF - -1.00 H_2O	0.99			0.99		
	OACF - 0.00 H_2O	1.13			1.07		
	OACF - +1.00 H_2O	1.23			1.12		
Thermal Ratings @ 0" Pressure Diff.		**Sensible**	**Latent**	**Total**	**Sensible**	**Latent**	**Total**
Total Effective-ness	100% Airflow Heating	68%	60%	65%	68%	60%	65%
	75% Airflow Heating	74%	67%	71%	74%	67%	71%
	100% Airflow Cooling	68%	60%	63%	68%	60%	63%
	75% Airflow Cooling	74%	67%	70%	74%	67%	70%
Net Effective-ness	100% Airflow Heating	68%	60%	65%	68%	60%	65%
	75% Airflow Heating	74%	67%	71%	74%	67%	71%
	100% Airflow Cooling	68%	60%	63%	68%	60%	63%
	75% Airflow Cooling	74%	67%	70%	74%	67%	70%

ARI Certification Data – Continued

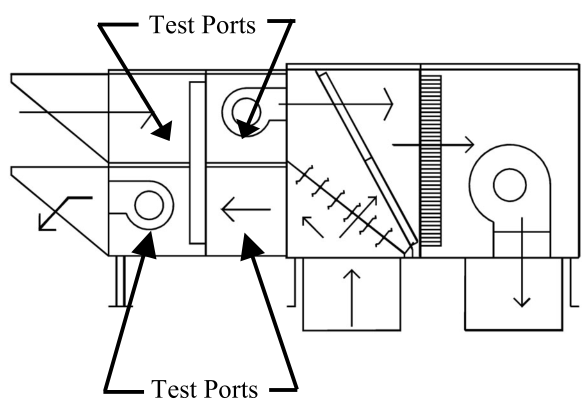
		RSI *46 Models			RSI *62 Models		
Enthalpy Wheel ARI Rating Data	Nominal Airflow CFM	3900 @ .95Δ			5500 @ .95Δ		
	EATR - -1.00 H_2O	4.40%			4.00%		
	EATR - 0.00 H_2O	1.10%			1.00%		
	EATR - +1.00 H_2O	0.20%			0.20%		
	OACF - -1.00 H_2O	0.99			0.99		
	OACF - 0.00 H_2O	1.06			1.06		
	OACF - +1.00 H_2O	1.11			1.10		
Thermal Ratings @ 0" Pressure Diff.		**Sensible**	**Latent**	**Total**	**Sensible**	**Latent**	**Total**
Total Effectiveness	100% Airflow Heating	68%	60%	65%	68%	60%	65%
	75% Airflow Heating	73%	67%	71%	73%	67%	71%
	100% Airflow Cooling	68%	60%	63%	68%	60%	63%
	75% Airflow Cooling	73%	67%	70%	73%	67%	70%
Net Effectiveness	100% Airflow Heating	68%	60%	65%	68%	60%	65%
	75% Airflow Heating	73%	67%	71%	73%	67%	71%
	100% Airflow Cooling	68%	60%	63%	68%	60%	63%
	75% Airflow Cooling	73%	67%	70%	73%	67%	70%

Factory Test Procedures for Energy Recovery Ventilators

RSI provides a factory run test on each of the Energy Recovery Ventilators that we manufacture. This test includes the following:

- Test each blower for correct turning direction.
- Verify static pressure across the wheel on both the intake and exhaust air streams.
- Verify all internal air seals are installed correctly.
- Verify CFM performance for intake and exhaust.
- Test the pivoting system on economizer units.
- Verify pulley alignment with a "laser" alignment system.
- Perform all Agency Approval tests.

Note: Test ports are provided for field balancing.



Unitized Energy Recovery Ventilators Care and Maintenance

The heart of the Unitary Energy Recovery Ventilator is the Energy Recovery Wheel (defined by ARI as a rotary heat exchanger). The wheel has a patented design of parallel layers of wrapped polymeric material that is impregnated with a silica gel (desiccant). This unique design makes it the only truly cleanable wheel on the market today. The small wheels (30 inch diameter and smaller) are slide out cassettes, and the larger wheels have pie segments that are removable for cleaning. Typically the wheel should be cleaned once a year with water and a detergent, or with alkaline based coil cleaners. Applications that produce tar, oil, grease, etc., will require more frequent cleanings.