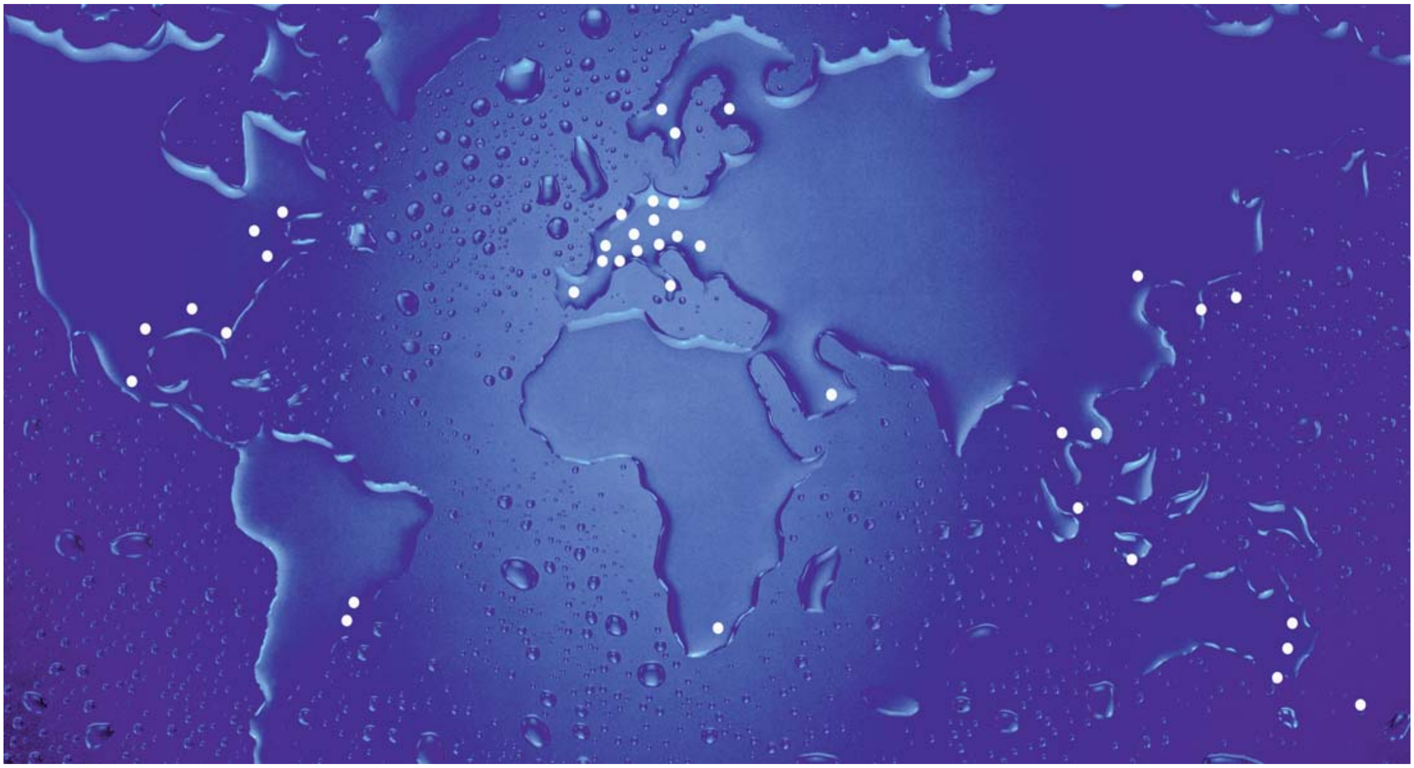
DEHUMIDIFICATION: Natatorium Application & Product Guide

Design, Construct, and Operate to Control Indoor Humidity

Munters

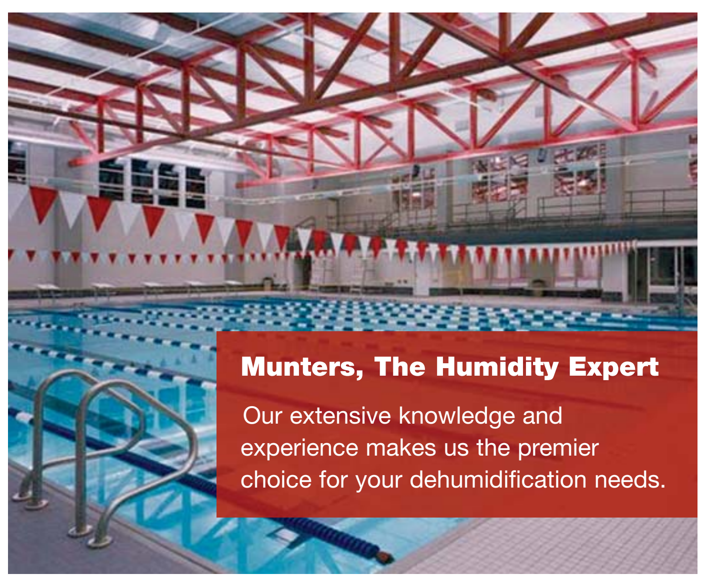
The Humidity Expert



Munters is the world leader in dehumidification

Munters is the largest manufacturer of dehumidifiers in the world. Since developing the first desiccant dehumidifier in the late 1930's, Munters has continued to innovate in the fields of dehumidification and energy recovery. Our long history and extensive expertise in dehumidification makes us the premier choice for your dehumidification needs.

Natatoriums have historically posed a difficult environment for the conventional HVAC system. The continuous moisture load swimming pools generate challenges the mechanical system and creates multiple opportunities for structural damage. The combination of humidity and chlorine not only attack the building, but also provide a breeding ground for mold and bacteria which can jeopardize occupant health and comfort. Munters offers a variety of systems in several different sizes, configurations, and thermodynamic process options to meet the customer's needs.

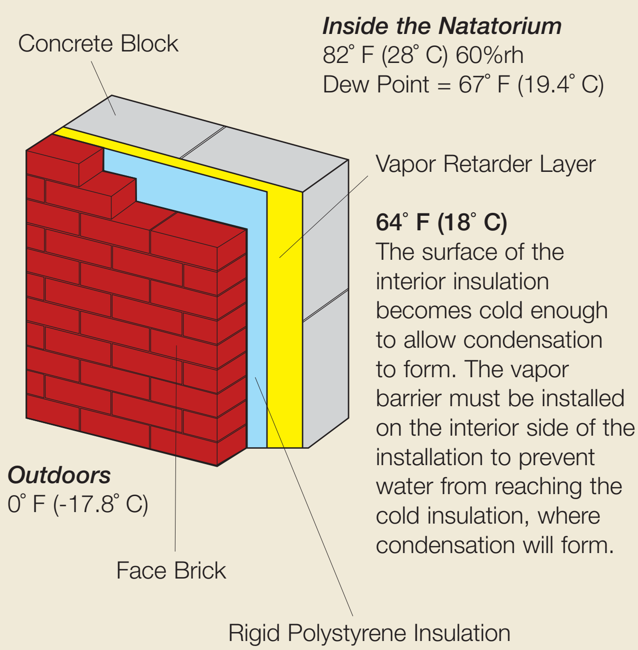


Protect the building and its occupants

An efficient HVAC system must function properly during all seasons and be capable of handling all possible indoor and outdoor air conditions—even those abnormal swings. The system should provide precise humidity control because the evaporating water from the pool is continuously released into the air. and must be constantly removed. Space air condition and water temperature must also be balanced for occupant comfort based on the type of pool . (see chart at right).

Building Design

It is important to start with the correct envelope construction to avoid significant problems during the life of the building. A proper vapor barrier is needed to keep moisture from being trapped in the buildings walls and roof assembly. Additionally care should be taken with regard to the window quantity, design and installation, as well as the wall construction detail and its insulation. Condensation on building elements during low outdoor air temperatures should be carefully guarded against. Please refer to the ASHRAE handbooks and The Humidity Control Design Guide published by ASHRAE for more information on this subject.



■ FROM ASHRAE

The recommended conditions for pools as indicated in the ASHRAE Applications Handbook and Humidity Control Design Guide:

Type of Pool	Air Temp °F	RH%	Water Temp °F
Recreational	75 to 85	50 to 60	75 to 85
Therapeutic	80 to 85	50 to 60	85 to 95
Competition	78 to 85	50 to 60	76 to 82
Diving	80 to 85	50 to 60	80 to 90
Whirlpool/Spa	80 to 85	50 to 60	97 to 104

Introduce Outside Air into the Building

Outside air must be brought into the space to dilute the chlorine that has evaporated from the pool and to provide fresh air for the occupants.

■ FROM ASHRAE

Standard 62.1 – 2004 calls for:
0.48 CFM PER SQUARE FOOT OF POOL AND DECK AREA &
7.5 CFM PER PERSON IN THE SPECTATOR AREA

In order to make room for this outside air, mechanical exhaust is required. This exhaust should exceed the outdoor air quantity to maintain negative air pressure in the pool area. Pay special attention that the airflow moves in the correct direction. This ensures that humidity and odors will not transfer into adjacent spaces, and also keeps high humidity out of the wall cavities to minimize the potential for condensation.

Prevent Condensation

High humidity and condensation on the building structure can cause significant damage. A detailed dew point analysis of the building is required to eliminate condensation both during initial design and through the end of construction. Thermal bridges in the walls and windows should be analyzed and reviewed carefully to avoid building damage.

Calculate the Loads

TOTAL HUMIDITY LOAD = OA HUMIDITY LOAD + INTERNAL HUMIDITY LOAD + POOL LOAD

Pool Evaporation Rate

FROM ASHRAE APPLICATIONS HANDBOOK

Evaporation Rate Equation:

POOL LOAD = 0.1 X POOL AREA X ΔVAPOR PRESSURE X USE FACTOR

Where:
Load = the evaporation rate of the pool (lbs/hr)
Pool Area = the surface area of the water (sq. ft.)
ΔVapor Pressure = the difference in vapor pressure of the air and water (in of Hg)
Use factor = the occupancy factor from ASHRAE.

Type of Pool	Use Factor
Residential	0.5
Fitness Club / Condo	0.65
Therapy / Elderly Swim	0.65
Hotel	0.8
Institutional / School	0.8
Public Pools	1.0
Spas and Whirlpools	1.0

Vapor Pressure (Inches of Mercury)

Fluid Type	Relative Humidity	Temperature °F													
		78	80	82	84	86	88	90	92	94	96	98	100	102	104
Water	100%	0.967	1.033	1.103	1.176	1.254	1.336	1.423	1.515	1.612	1.714	1.821	1.935	2.054	2.180
Air	50%	0.484	0.517	0.551	0.588	0.627	0.668	---	---	---	---	---	---	---	---
	60%	0.581	0.620	0.662	0.706	0.753	0.802	---	---	---	---	---	---	---	---

Outside Air Humidity Load

FROM ASHRAE APPLICATIONS HANDBOOK

OA Humidity Load Equation: use ASHRAE design dew point conditions:

OA HUMIDITY LOAD = 0.0057 X OA X ΔHUMIDITY RATIO

Where:
Load = the humidity load of the outside air (lbs/hr)
OACFM = Ventilation Air Quantity (cfm)
ΔHumidity Ratio = the difference in absolute humidity of the outside air and the space (grains/lb)

Properly calculating the internal and external loads of the facility is a critical step in designing a natatorium. The HVAC equipment is sized based on load calculations and the type of facility being constructed. An indoor swimming pool has a remarkable chance of experiencing moisture problems, but with accurate load calculations of the pool evaporation rate, peak outside air loads, and the internal load in the space you can successfully design a healthy and enjoyable natatorium.

Internal Humidity Load

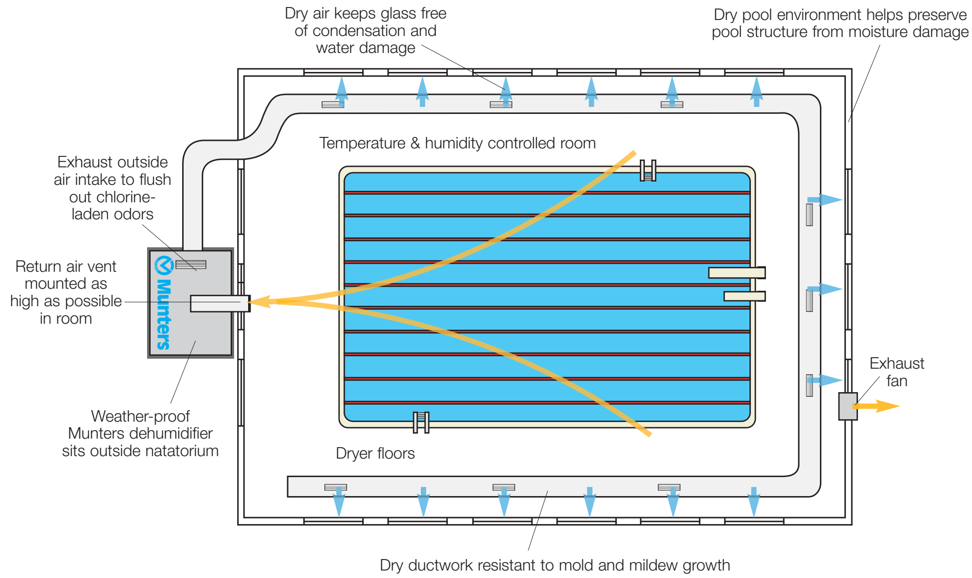
People are an internal load to the space and their activity should be considered in the calculation. Use the chart below to determine the activity load per hour and add to the pool evaporation load.

Activity per hour	btu/hr	lbs/hr
Seated at Rest	105	0.10
Seated Very Light Work	158	0.15
Seated, Light Work	210	0.20
Walking, Standing	252	0.24
Moderate Dancing	546	0.52
Walking Briskly w/Loads	630	0.60
Light Exercise	872	0.83
Medium Athletic Activity	966	0.92
Athletics	1092	1.04

Duct Design

The air distribution system should be designed in such a way as to minimize stagnation in the building envelope. While keeping velocity over the pool surface low, air movement is desirable to control chloramines.

Supply air should be washed over windows and other surfaces that may experience low temperatures in cold weather that might lead to condensation. Exhaust and return air inlets should be located high to capture hot and humid air. Whirlpools should have an exhaust air connection directly above.



Ductwork should be aluminum, painted galvanized, 300 series stainless steel or lightweight corrosion resistant fabric. Munters offers DryFlo Ducting. DryFlo ducting is cylindrical tubes constructed of a durable fabric that uniformly disperses air into the space. (*See Munters Distribution System illustration above*)

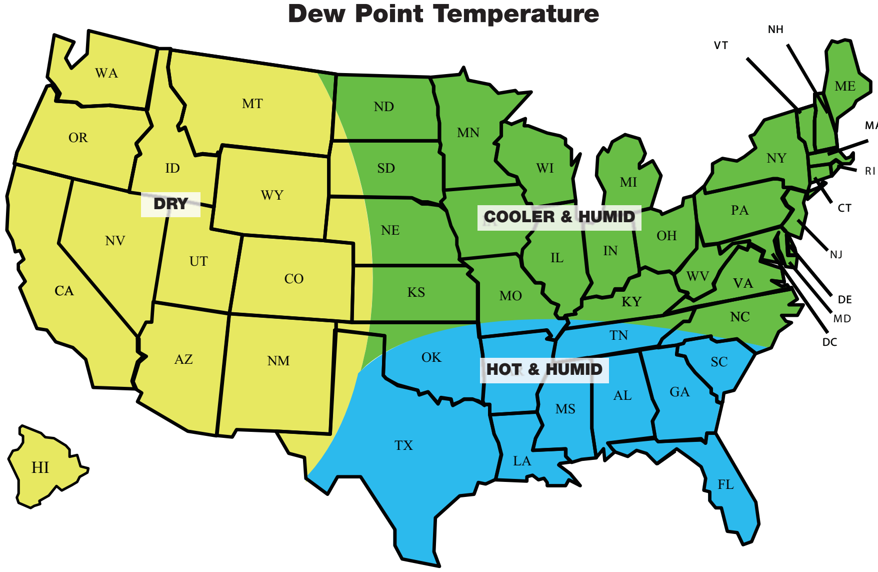
Choose pool technology best suited for that region

Weather is a critical component of the building load. When climate is hot and dry, it presents different challenges for a HVAC system than when it is hot and humid. Differing outdoor conditions require specific performances from dehumidification and air conditioning systems. The same type of system throughout the country will not efficiently meet the needs of different area and different climate requirements.

Energy recovery and mechanical dehumidifier requirements are significantly different based on outdoor conditions. In the west, the outdoor condition is generally much lower than the space condition. Outdoor air can naturally be used for indoor dehumidification, and if provided with an efficient energy recovery device, it can be done at significantly reduced operating costs.

In the east, outdoor air can be used part time for dehumidification and the mechanical dehumidification cycle is only needed for the higher ambient humidity. With colder temperatures in the north, energy recovery for winter operation is easily justified. Depending on the priorities of the user, a significantly different system may be appropriate to maximize energy efficiency.

Dew Point Temperature



Munters Offers Different Solutions

Four different types of systems are available to meet both the difficult requirements of the natatorium and the diverse climates these buildings may experience. These different solutions can be optimized to provide the best solution from a first cost, life cycle cost, and sustainability perspective. They allow for the optimization of energy savings and performance.

Selecting the Right System

1 *Where is the building located and what is the local climate?*

Hot and Humid: Southeast U.S.
Humid, but with cold winter climate: Northeast U.S.
Hot and Dry: Southwest U.S.
Dry, but with cold winter climate: Northwest U.S.

2 *What are the priorities of the system required?*

1. **Reliability**
2. **First Cost**
3. **Operating Cost**
4. **Increased Ventilation during most of the year**

3 *What is the system size requirement?*

Small - **< 150 lbs/hr**
Medium - **> 150 lbs/hr, < 300 lbs/hr**
Large - **> 300 lbs/hr**

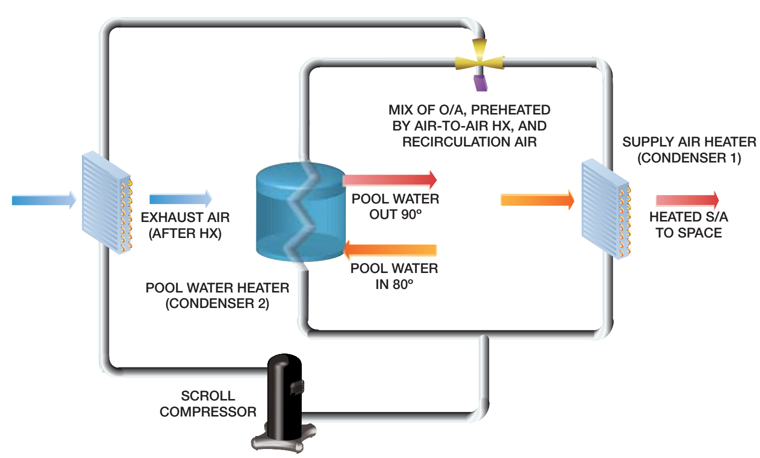
System Types and Features

	Wringer Pool	DryCool	Pool Fresh Air	Pool Desiccant
Climate	Southeast, Northeast, Southwest, Northwest	Southeast, Northeast	Southwest, Northwest	Southeast, Northeast
Priority	Reduced compressor runtime for enhanced reliability, Low operating cost, Increased ventilation	Low first cost	Eliminated compressor runtime for enhanced reliability, Low operating cost, Increased ventilation	Reduced compressor runtime for enhanced reliability
System Size	Small, Medium, Large	Small, Medium	Small, Medium, Large	Medium, Large

The system features listed do not outline the extent of the product line availability, rather they outline the features of the systems in competitive environments.See the specific system description on the following pages to see the available capacities of each product.

Heat Pump Option

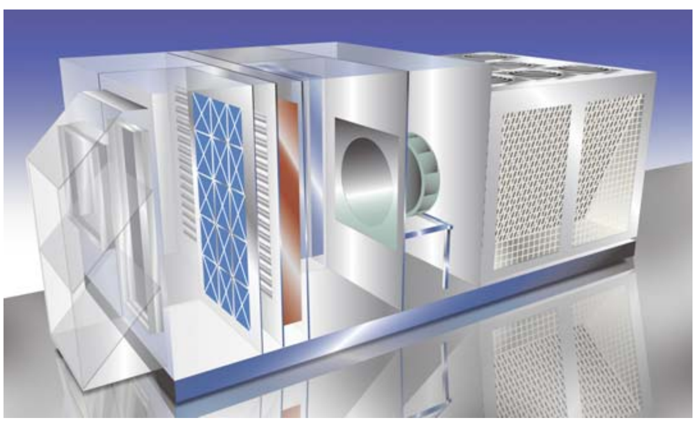
Wringer Pool and Pool Fresh Air systems are available with the heat pump option to heat the pool water. This options adds an evaporator coil to the exhaust air stream as it leaves the unit to recover the last amount of heat from the building exhaust. This allows the heat pump system to efficiently heat the pool water all year long. The dehumidification cycle is not required to operate and the system is sized based on the energy available in the exhaust air stream. The heat pump is also configurable to provide air heating in the winter whenever sufficient heat is available from the exhaust air stream, and providing very efficient heating of the outside air after it has been preheated by the sensible heat exchanger.



Wringer Pool

Products Description

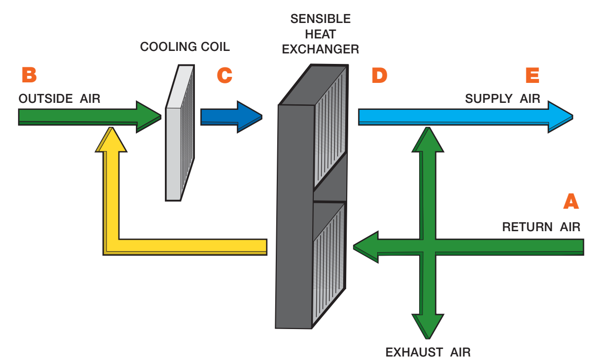
The Wringer Pool dehumidifier utilizes energy recovery to provide heat recovery in the winter and pre-cool/reheat during the summer. The combination of mechanical dehumidification and outside air dehumidification provides an extremely efficient and reliable dehumidification system. The energy derived from the cooling coils is used to reheat the supply air through a refrigerant reheat coil. During high outdoor humidity the cooling coil acts as the dehumidifier, using the heat exchanger to minimize energy. When the humidity outside is lower than the desired space condition, the unit brings in more outside air to meet the dehumidification load without the need for the cooling coil or compressor run hours, while the heat exchanger recovers the heat from the exhaust air stream to minimize the heating requirement. The unit modulates the outside air to the minimum position during very cold conditions to minimize energy requirements. In addition, a heat pump option can be added to the exhaust air stream to provide pool water and/or supply air heating to increase overall unit efficiency.



Wringer Capacity Chart

Unit	CFM	Pool Size (sq. ft.)	Dimensions (in.) L x W x H	Weight (lbs.)
WR 04	4,000	1,000 - 1,500	84 x 66 x 192	4,700
WR 06	6,000	1,500 - 2,250	84 x 66 x 192	7,400
WR 08	8,000	2,000 - 3,000	84 x 66 x 192	9,000
WR 12	12,000	3,000 - 4,500	100 x 74 x 216	12,700
WR 18	18,000	4,500 - 6,750	132 x 78 x 234	22,000
WR 24	24,000	6,000 - 9,000	144 x 98 x 252	27,000
WR 30	30,000	7,500 - 11,000	144 x 114 x 276	32,000
WR 40	40,000	10,000 - 15,000	144 x 146 x 312	39,000
WR 50	50,000	12,000 - 18,000	144 x 156 x 396	44,000

Wringer Airflow & Schematic



State		Summer			Winter		
Point		CFM	°F	Grains	CFM	°F	Grains
A	**Return**	10,000	84	104	10,000	84	77
B	**Post Cooling Coil**	9,000	93	65	2,000	-13	2
C	**Post Desiccant Wheel**	9,000	89	65	2,000	55	4
D	**Outside Air**	9,000	70	65	2,000	55	4
E	**Supply Air**	9,000	70	65	9,000	105	61

Product Features

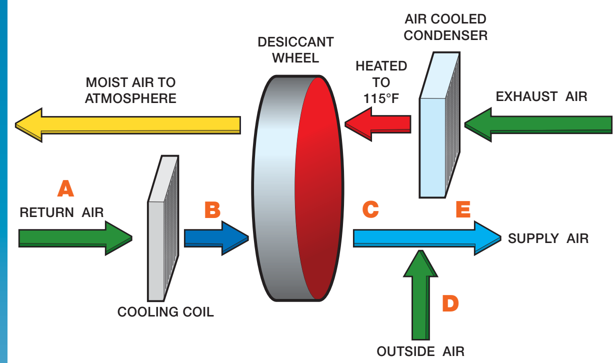
- 2” double wall casing
- Sensible counter-flow, cross-flow, and heat pipe heat exchangers with up to 88% efficiency
- Simple dehumidification and energy recovery modes for easy maintenance and control
- Outside air dehumidification mode for reduced compressor run hours
- Increased ventilation throughout many operating hours
- Built in building exhaust fan to maintain negative pressure
- Packaged DX, split system DX, water cooled DX & chilled water options
- DDC microprocessor controls option
- Option for 100% outside air during purge mode
- Stainless steel drain pans
- Heat pump air and water heating available as option
- ETL listed

DryCool Pool

Product Description

The DryCool pool dehumidifier provides energy efficient dehumidification in a small packaged product at low cost. Condenser heat is recovered from the direct expansion refrigeration system to provide the reactivation energy for the desiccant dehumidification process. The cooling energy of the refrigeration system is used to cool and dehumidify the air prior to entering the desiccant wheel. The hybrid refrigerant-desiccant system provides an efficient dehumidifier by eliminating the overcooling required with a refrigeration only based dehumidifier. The system uses the reactivation fan as the exhaust air fan to maintain negative pressure in the space while further enhancing efficiency and minimizing the unit footprint and cost.

DRYCOOL Airflow & Schematic



State		Summer			Winter		
Point		CFM	°F	Grains	CFM	°F	Grains
A	**Return**	6,000	82	100	6,000	82	100
B	**Post Cooling Coil**	6,000	51	56	6,000	82	100
C	**Post Desiccant Wheel**	6,000	69	34	6,000	82	100
D	**Outside Air**	4,000	95	120	4,000	20	10
E	**Supply Air**	10,000	79	68	10,000	90	64

Product Features

- Foam injected 2” double wall casing
- Desiccant enhanced process for lower connected tonnage and lower operating cost
- Packaged DX, split system DX, water cooled DX and chilled water options
- Coated cooling coils and other critical components
- DDC microprocessor controls
- Option for 100% outside air during purge mode
- Stainless steel drain pans
- ETL listed

DryCool Pool Capacity

Unit	Maximum CFM OA	Maximum CFM Return	Maximum CFM Total	Minimum Exhaust	Maximum Exhaust	Tons	Dehumid lbs/hr	Dimensions L x W x H	Weight Pounds
HCU-V 1005	1,000	1,200	2,200	250	1,200	5	40 lbs/hr	58 x 43 x 61	
HCUc-2410	1,350	2,400	3,750	500	1,500	10	70 lbs/hr	178 x 65 x 57	3,500
HCUc-3412	2,250	3,400	5,650	833	2,500	12	90 lbs/hr	178 x 65 x 57	3,500
HCUc-3415	2,700	3,400	6,100	1,000	3,000	15	105 lbs/hr	178 x 65 x 57	3,500
HCUc-4015	2,700	4,000	6,700	1,000	3,000	15	115 lbs/hr	193 x 65 x 72	4,250
HCUc-4020	2,700	4,000	7,600	1,333	4,000	20	145 lbs/hr	193 x 65 x 72	4,250
HCUc-6020	3,600	6,000	9,600	1,333	4,000	20	160 lbs/hr	226 x 86 x 70	5,250
HCUc-6030	5,400	6,000	11,400	2,000	6,000	30	225 lbs/hr	226 x 86 x 70	5,250
HCUc-8030	5,400	8,000	13,400	2,000	6,000	30	240 lbs/hr	249 x 96 x 86	7,850
HCUc-8040	7,200	8,000	15,200	2,667	8,000	40	315 lbs/hr	249 x 96 x 86	7.850

Capacity based on 82F 60% RH space condition

Pool Fresh Air

Products Description

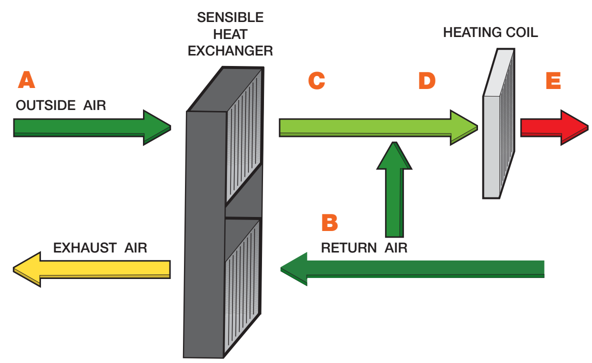
The Pool Fresh Air unit is an enhanced energy recovery system. The core of the unit is an efficient sensible energy recovery heat exchanger. The chart below shows that outdoor air can be used to provide dehumidification for natatorium environments effectively up to approximately 60ºF dew point. The outdoor air supply can be modulated to provide the correct dehumidification capacity and to not over-dehumidify when possible. In western or similar climates, the 60ºF dew point condition is rarely exceeded. This allows the system to maintain the desired space humidity most of the time with no need for mechanical dehumidification. On occasion when it is exceeded the resultant increase in space humidity is small. Temperature and humidity in the space will exceed the design condition for a short period of time, but the trade off is a simplified unit design with no refrigeration system. Cooling can be provided with indirect evaporative cooling, enhancing the system performance and efficiency. Direct evaporative humidification can be added to the supply air. This will minimize the evaporation rate of the pool and the chemical requirements for pool maintenance. Simple, low operating cost, low maintenance, and improved air quality through increased ventilation make the Pool Fresh Air unit an attractive option for natatoriums.

Outdoor Air Dehumidification

Outside Dew Point Temp. ºF	OA CFM	lbs of H_2O Removed	OA CFM	lbs of H_2O Removed	OA CFM	lbs of H_2O Removed
0	5,000	302	10,000	605	20,000	1,210
5	5,000	297	10,000	595	20,000	1,189
10	5,000	290	10,000	581	20,000	1,162
15	5,000	282	10,000	564	20,000	1,128
20	5,000	271	10,000	543	20,000	1,085
25	5,000	258	10,000	517	20,000	1,034
30	5,000	242	10,000	484	20,000	968
35	5,000	223	10,000	447	20,000	894
40	5,000	202	10,000	404	20,000	808
45	5,000	177	10,000	354	20,000	707
50	5,000	147	10,000	293	20,000	587
55	5,000	111	10,000	222	20,000	444
60	5,000	69	10,000	138	20,000	276
65	5,000	19	10,000	39	20,000	78

Note: Based on space condition of 82ºF, 60% RH.

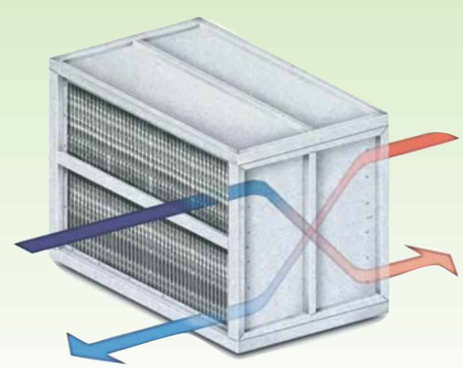
FRESH AIR Airflow & Schematic



State		Summer			Winter		
Point		CFM	ºF	Grains	CFM	ºF	Grains
A	**Return**	10,500	84	104	10,500	84	77
B	**Post Cooling Coil**	2,000	95	118	2,000	0	4
C	**Post Desiccant Wheel**	7,000	61	80	2,000	0	4
D	**Outside Air**	7,000	68	80	2,000	71	4
E	**Supply Air**	10,000	76	80	10,000	98	55

Product Features

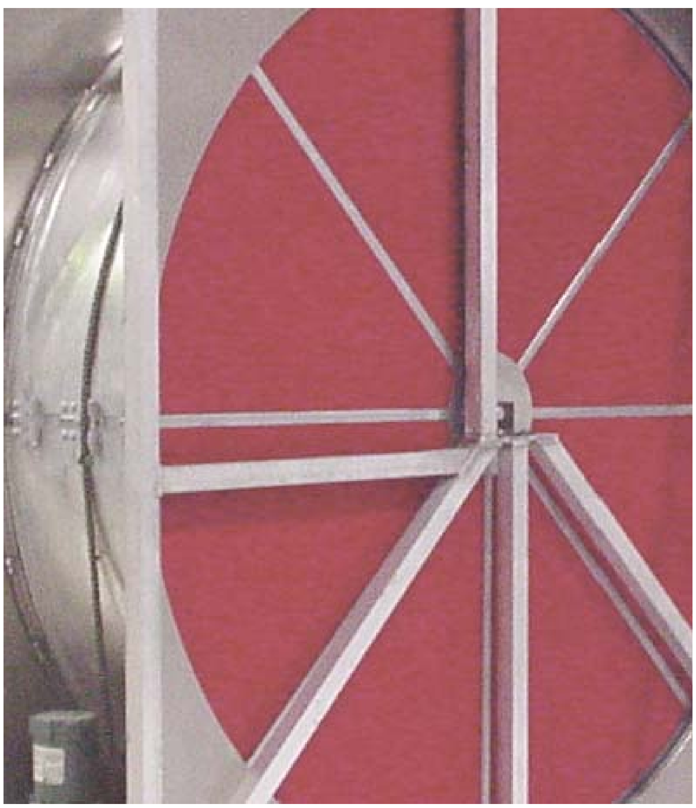
- 2” double wall casing
- Optional indirect evaporative cooling to provide cooling during high ambient temperatures
- Optional direct evaporative cooling to minimize pool evaporation during low dew point conditions
- Sensible counter-flow, cross-flow, and heat pipe heat exchangers with up to 88% efficiency
- Simple dehumidification and energy recovery modes for easy maintenance and control
- Outside air dehumidification mode eliminating compressors
- Increased ventilation throughout many operating hours
- DDC microprocessor controls option
- Option for 100% outside air during purge mode
- Heat pump air and water heating available as option
- ETL listed



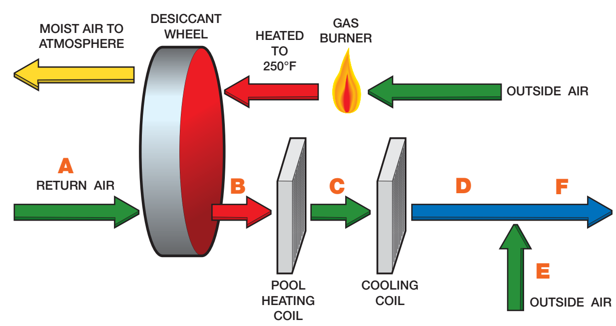
Pool Desiccant

Products Description

The Pool Desiccant unit utilizes a silica gel desiccant dehumidification wheel with gas fired reactivation to provide dehumidification without the need for compressorized refrigeration. Cooling coil operation is only required to provide temperature reduction in the space during high ambient temperatures. The wheel turns at a slow 0.1 rpm minimizing maintenance. The desiccant process heats and dehumidifies the supply air reducing the heating required in the heating mode. The effect of this process provides low relative humidity inside the unit and therefore reduced corrosion. Great flexibility and reliability are provided in a packaged large capacity unit.



DDS Airflow & Schematic



State		Summer			Winter		
Point		CFM	°F	Grains	CFM	°F	Grains
A	**Return**	10,000	80	100	10,000	82	100
B	**Post Desiccant Wheel**	10,000	119	54	10,000	82	100
C	**Post Heating Coil**	10,000	119	54	10,000	125	100
D	**Post Cooling Coil**	10,000	65	54	10,000	125	100
E	**Outside Air**	5,000	95	120	5,000	20	10
F	**Supply Air**	15,000	75	76	15,000	90	70

Product Features

- Foam injected 2" double wall casing
- Desiccant dehumidification process for lower connected tonnage and lower compressor run hours
- Low relative humidity during dehumidification process for reduced corrosion
- Packaged DX, split system DX, water cooled DX and chilled water options
- Coated cooling coils and other critical components
- DDC microprocessor controls option
- Option for 100% outside air during purge mode
- Stainless steel drain pans
- ETL listed

Pool Desiccant Capacity Chart

Unit	Maximum CFM			Minimum Exhaust	Maximum Exhaust	Tons	Dehumid lbs/hr	Dimensions L x W x H	Weight Pounds
	OA	Return	Total						
DDS 20	10,000	10,000	12,000	250	10,000	100	250 lbs/hr	219 x 80 x 70	6,500
DDS 30	30,000	30,000	30,000	500	15,000	200	350 lbs/hr	219 x 96 x 101	8,500
DDS 40	50,000	50,000	50,000	1,000	25,000	300	500 lbs/hr	280 x 134 x 101	10,500

Economic Evaluation and Life Cycle Cost

Munters has software tools to analyze the operating cost of each system. Unit selection and cost data are inputted with design parameters, local weather data, and energy costs. The output is annual energy cost, annual energy savings, and simple payback.

$5,000 vs. $16,000

Operating Cost of Munters Pool Fresh Air Product

Location	Chicago, IL.	**Change Over Dew Point**	58.3	**Cooling Equipment C.O.P**	3
Supply CFM	20,000	**Heat Recovery Effectiveness**	65.0	**Summer Building Load**	119 MBH
Required Supply Air Humidity Ratio	0.0121	**Cooling Fuel Cost**	$0.100/kwh=$9.77/Million BTU of Cooling Input	**Winter Building Load**	189 MBH
Summer Outside Air	5,000	**Cost of Heating Fuel**	$1.00/1,000,000 BTU	**Max Evaporation Rate**	198 #/Hr.
Return Air Temperature	82	**Efficiency of Fuel Conversion (Heating)**	80	**DX LAT**	50.2 ºF
Return Air Relative Humidity	60	**Outside Air CFM at Change Over**	12,000		

Dry Bulb	Temp. MCWB*	DP	Total Hours.* at Condition	Outside Air	Dehumid Coil Tons	Dehumid Coil Cost	Condenser Heat Available BTUH	Required Supply Air Temp.	No Heat Supply Air Temp.	Cost to Heat Supply Air	Condenser Air Reheat Credit	Condenser Water Heat Credit	Dollars Spent Total
120	75	63.3	0	5,000	27.64	$0	414,652	73.2	74.1	$0	$0	$0	**$0**
97	76	67.6	6	5,000	31.03	$22	465,418	74.3	74.1	$0	$0	$1.66	**$20.16**
92	74	66.4	58	5,000	28.99	$197	434,864	75.4	74.1	$2	$2	$16.06	**$181.01**
87	72	65.4	165	5,000	27.11	$524	406,969	76.5	74.1	$11	$11	$45	**$478.63**
82	70	64.5	324	5,000	25.38	$964	380,774	78.3	74.1	$38	$38	$89.70	**$874.24**
77	67	62.0	487	5,000	20.81	$1,188	312,183	79.8	74.1	$75	$75	$114.66	**$1,073.22**
72	64	59.6	681	5,000	16.54	$1,320	248,038	82.0	74.1	$147	$147	$64.29	**$1,255.49**
67	61	57.4	759	10,001	0.00	$0	0	82.6	79.4	$66	$0	$0	**$66.00**
62	57	53.7	700	7,525	0.00	$0	0	83.2	79.4	$72	$0	$0	**$72.06**
57	52	48.0	604	5,729	0.00	$0	0	83.7	79.5	$70	$0	$0	**$69.60**
52	47	42.3	581	4,766	0.00	$0	0	84.3	79.5	$76	$0	$0	**$76.04**
47	43	38.7	565	4,380	0.00	$0	0	84.9	79.3	$86	$0	$0	**$85.61**
42	38	32.8	572	3,934	0.00	$0	0	85.5	79.2	$97	$0	$0	**$96.78**
37	34	29.9	725	3,756	0.00	$0	0	86.1	79.0	$138	$0	$0	**$138.10**
32	30	27.0	869	3,612	0.00	$0	0	86.6	78.8	$184	$0	$0	**$183.99**
27	25	21.3	589	3,392	0.00	$0	0	87.2	78.7	$136	$0	$0	**$135.66**
22	21	18.9	371	3,322	0.00	$0	0	87.8	78.5	$94	$0	$0	**$93.54**
17	16	13.3	231	3,194	0.00	$0	0	88.4	78.4	$63	$0	$0	**$62.78**
12	11	7.6	164	3,098	0.00	$0	0	89.0	78.2	$48	$0	$0	**$47.88**
7	6	1.6	115	3,026	0.00	$0	0	89.5	78.0	$36	$0	$0	**$35.94**
2	1	-4.7	89	2,971	0.00	$0	0	90.1	77.8	$30	$0	$0	**$29.67**
-3	-3	-81.9	93	2,843	0.00	$0	0	90.7	77.8	$33	$0	$0	**$32.64**
													Annual Energy Expense $5,109.04

Operating Cost of Conventional Refrigeration-Based Pool Dehumidifier as Comparison

Location	Chicago, IL.	**Heat Recovery Effectiveness**	0	**Cooling Equipment C.O.P**	3
Supply CFM	20,000	**Cooling Fuel Cost**	$0.100/kwh=$9.77/Million BTU of Cooling Input	**Summer Building Load**	180 MBH
Required Supply Air Humidity Ratio	0.0121	**Cost of Heating Fuel**	$1.00/1,000,000 BTU	**Winter Building Load**	300 MBH
Min Outside Air	5,000	**Efficiency of Fuel Conversion (Heating)**	80	**Max Evaporation Rate**	198 #/Hr.
Return Air Temperature	82	**Return Air Relative Humidity**	60		

Dry Bulb	Temp. MCWB*	DP	Total Hours.* at Condition	Outside Air	Dehumid Coil LAT/Tons	Dehumid Coil Cost	Condenser Heat Available BTUH	Required Supply Air Temp.	No Heat Supply Air Temp.	Cost to Heat Supply Air	Condenser Air Reheat Credit	Condenser Water Heat Credit	Dollars Spent Total
120	75	63.3	0	5,000	62.1/40.5	$0	608,142	73.7	72.1	$0	$0	$0	**$0**
97	76	67.6	6	5,000	60.5/46.9	$33	703,896	74.8	69.6	$1	$1	$1.66	**$31.34**
92	74	66.4	58	5,000	60.9/45	$307	676,459	75.8	68.7	$11	$11	$16.06	**$290.50**
87	72	65.4	165	5,000	61.3/43.5	$842	652,889	76.9	67.8	$41	$41	$45.68	**$796.50**
82	70	64.5	324	5,000	61.7/42.1	$1,602	632,694	77.9	66.8	$98	$98	$89.70	**$1,511.98**
77	67	62.0	487	5,000	62.5/38.7	$2,211	580,941	79.0	66.2	$169	$169	$134.82	**$2,075.71**
72	64	59.6	681	5,000	63.3/35.7	$2,853	536,244	80.0	65.5	$268	$268	$135.71	**$2,665.17**
67	61	57.4	759	5,000	63.9/33.2	$2,955	498,342	81.1	64.7	$337	$337	$42.41	**$2,819.62**
62	57	53.7	700	5,000	64.8/29.2	$2,397	438,289	82.1	64.2	$341	$341	$0	**$2,354.74**
57	52	48.0	604	5,000	66/24.1	$1,711	362,567	83.2	63.8	$318	$374	$0	**$1,754.98**
52	47	42.3	581	5,000	82/0	$0	0	84.2	74.5	$153	$0	$0	**$153.47**
47	43	38.7	565	5,000	82/0	$0	0	85.3	73.3	$185	$0	$0	**$184.55**
42	38	32.8	572	5,000	82/0	$0	0	86.3	72.0	$223	$0	$0	**$222.57**
37	34	29.9	725	5,000	82/0	$0	0	87.4	70.8	$327	$0	$0	**$327.40**
32	30	27.0	869	5,000	82/0	$0	0	88.5	69.5	$447	$0	$0	**$446.72**
27	25	21.3	589	5,000	82/0	$0	0	89.5	68.3	$340	$0	$0	**$339.58**
22	21	18.9	371	5,000	82/0	$0	0	90.6	67.0	$237	$0	$0	**$237.08**
17	16	13.3	231	5,000	82/0	$0	0	91.6	65.8	$162	$0	$0	**$162.05**
12	11	7.6	164	5,000	82/0	$0	0	92.7	64.5	$125	$0	$0	**$125.29**
7	6	1.6	115	5,000	82/0	$0	0	93.7	63.3	$95	$0	$0	**$95.04**
2	1	-4.7	89	5,000	82/0	$0	0	94.8	62.0	$79	$0	$0	**$79.11**
-3	-3	-81.9	93	5,000	82/0	$0	0	95.8	60.8	$88	$0	$0	**$88.48**
													Annual Energy Expense $16,761.40

**Weather data used for Chicago, IL. Heat exchanger effectiveness is based on dry sensible heat transfer. Condensing within the heat exchanger will increase performance.*

Operating Cost of Wringer Pool Product

Location	Washington DC	**Change Over Dew Point**	58.3	**Cooling Equipment C.O.P**	3
Supply CFM	20,000	**Heat Recovery Effectiveness**	65.0	**Summer Building Load**	60 MBH
Required Supply Air Humidity Ratio	0.0121	**Cooling Fuel Cost**	$0.100/kwh=$9.77/Million BTU of Cooling Output	**Winter Building Load**	200 MBH
Summer Outside Air	5,000	**Cost of Heating Fuel**	$1.00/1,000,000 BTU	**Max Evaporation Rate**	198 #/Hr.
Return Air Temperature	82	**Efficiency of Fuel Conversion (Heating)**	80	**DX LAT**	58.3 ºF
Return Air Relative Humidity	60	**Outside Air CFM at Change Over**	12,000		

Dry Bulb	Temp. MCWB*	DP	Total Hours.* at Condition	Outside Air	Dehumid Coil Tons	Dehumid Coil Cost	Condenser Heat Available BTUH	Required Supply Air Temp.	No Heat Supply Air Temp. F°	Cost to Heat Supply Air	Condenser Air Reheat Credit	Condenser Water Heat Credit	Dollars Spent Total
120	77	67.1	0	5,000	43.66	$0	327,485	79.2	76.4	$0	$0	$0	**$0**
97	76	67.6	6	5,000	41.89	$29	327,485	79.2	76.4	$1	$1	$0	**$29.46**
92	74	66.4	72	5,000	38.40	$324	327,485	80.4	76.4	$8	$8	$0	**$324.01**
87	72	65.4	243	5,000	35.05	$998	327,485	80.9	76.4	$30	$30	$0	**$998.35**
82	70	64.5	428	5,000	31.86	$1,598	327,485	81.5	76.4	$59	$59	$0	**$1,598.11**
77	68	63.7	631	5,000	28.80	$2,130	327,485	82.1	76.4	$97	$97	$0	**$2,130.02**
72	66	63.0	925	5,000	25.88	$2,805	327,485	82.7	76.4	$157	$157	$0	**$2,805.21**
67	61	57.4	858	10,001	0.00	$0	0	83.2	79.9	$77	$0	$0	**$77.48**
62	56	51.8	755	6,779	0.00	$0	0	83.8	80.1	$76	$0	$0	**$75.73**
57	51	46.0	688	5,325	0.00	$0	0	84.4	80.1	$79	$0	$0	**$79.01**
52	47	40.0	671	4,508	0.00	$0	0	84.9	80.1	$88	$0	$0	**$87.98**
47	42	36.3	665	4,175	0.00	$0	0	85.5	80.0	$100	$0	$0	**$100.24**
42	37	30.3	734	3,781	0.00	$0	0	86.1	79.9	$123	$0	$0	**$123.42**
37	33	27.3	708	3,625	0.00	$0	0	86.7	79.7	$133	$0	$0	**$133.20**
32	29	24.1	621	3,492	0.00	$0	0	87.2	79.6	$129	$0	$0	**$129.15**
27	24	17.8	362	3,295	0.00	$0	0	87.8	79.5	$82	$0	$0	**$81.80**
22	19	11.0	212	3,152	0.00	$0	0	88.4	79.4	$52	$0	$0	**$51.82**
17	15	8.9	101	3,117	0.00	$0	0	88.9	79.2	$27	$0	$0	**$26.77**
12	10	2.0	51	3,030	0.00	$0	0	89.5	79.0	$14	$0	$0	**$14.49**
7	6	1.6	13	3,026	0.00	$0	0	90.1	78.8	$4	$0	$0	**$3.97**
2	1	-4.7	1	2,971	0.00	$0	0	90.6	78.7	$0	$0	$0	**$0.32**
-3	-4	-81.9	0	2,843	0.00	$0	0	91.2	78.6	$0	$0	$0	**$0**
													Annual Energy Expense $8,870.54

Operating Cost of Conventional Refrigeration-Based Pool Dehumidifier as Comparison

Location	Washington DC	**Heat Recovery Effectiveness**	0	**Cooling Equipment C.O.P**	3
Supply CFM	20,000	**Cooling Fuel Cost**	$0.100/kwh=$9.77/Million BTU of Cooling Input	**Summer Building Load**	180 MBH
Required Supply Air Humidity Ratio	0.0121	**Cost of Heating Fuel**	$1.00/1,000,000 BTU	**Winter Building Load**	300 MBH
Min Outside Air	5,000	**Efficiency of Fuel Conversion (Heating)**	80	**Max Evaporation Rate**	198 #/Hr.
Return Air Temperature	82	**Return Air Relative Humidity**	60		

Dry Bulb	Temp. MCWB*	DP	Total Hours.* at Condition	Outside Air	Dehumid Coil Tons	Dehumid Coil Cost	Condenser Heat Available BTUH	Required Supply Air Temp.	No Heat Supply Air Temp. F°	Cost to Heat Supply Air	Condenser Air Reheat Credit	Condenser Water Heat Credit	Dollars Spent Total
120	75	63.3	0	5,000	62.1/40.5	$0	608,142	73.7	72.1	$0	$0	$0	**$0**
97	76	67.6	6	5,000	60.5/46.9	$33	703,896	74.8	69.6	$1	$1	$1.66	**$31.34**
92	74	66.4	72	5,000	60.9/45	$381	676,459	75.8	67.8	$14	$14	$19.93	**$360.62**
87	72	65.4	243	5,000	61.3/43.5	$1,240	652,889	76.9	66.8	$60	$60	$67.25	**$1,172.33**
82	70	64.5	428	5,000	61.7/42.1	$2,116	632,694	77.9	65.8	$129	$129	$118.49	**$1,997.31**
77	68	63.7	631	5,000	62/41	$3,034	615,350	79.0	64.7	$226	$226	$174.69	**$2,859.12**
72	66	63.0	925	5,000	62.2/40.1	$4,347	601,517	80.0	64.7	$385	$385	$256.08	**$4,091.29**
67	61	57.4	858	5,000	63.9/33.2	$3,341	498,342	81.1	64.5	$381	$381	$153.41	**$3,187.39**
62	56	51.8	755	5,000	65.3/27.4	$2,426	411,333	82.1	64.1	$361	$361	$26.75	**$2,399.73**
57	51	46.0	688	5,000	66.4/22.5	$1,822	338,867	83.2	63.8	$357	$291	$0	**$1,887.00**
52	46	40.0	671	5,000	82/0	$0	0	84.2	74.5	$177	$0	$0	**$177.25**
47	42	36.3	665	5,000	82/0	$0	0	85.3	73.3	$217	$0	$0	**$217.21**
42	37	30.3	734	5,000	82/0	$0	0	86.3	72.0	$289	$0	$0	**$285.60**
37	33	27.3	708	5,000	82/0	$0	0	87.4	70.8	$320	$0	$0	**$319.72**
32	29	24.1	621	5,000	82/0	$0	0	88.5	69.5	$319	$0	$0	**$319.23**
27	24	17.8	362	5,000	82/0	$0	0	89.5	68.3	$209	$0	$0	**$208.71**
22	19	11.0	212	5,000	82/0	$0	0	90.6	67.0	$135	$0	$0	**$135.47**
17	15	8.9	101	5,000	82/0	$0	0	91.6	65.8	$71	$0	$0	**$70.85**
12	10	2.0	51	5,000	82/0	$0	0	92.7	64.5	$39	$0	$0	**$38.96**
7	6	1.6	13	5,000	82/0	$0	0	93.7	63.3	$11	$0	$0	**$10.74**
2	1	-4.7	1	5,000	82/0	$0	0	94.8	62.0	$1	$0	$0	**$0.89**
-3	-4	-81.9	0	5,000	82/0	$0	0	95.8	60.8	$0	$0	$0	**$0**
													Annual Energy Expense $19,770.76

Weather data used for Washington, DC.
Heat exchanger effectiveness is based on dry sensible heat transfer. Condensing within the heat exchanger will increase performance.

$8,000 vs. $19,000

This two-page comparison allows the designer and end user to make intelligent decisions regarding system configuration and payback criteria. Together, Munters can assist in selecting the correct systems and options to meet the customers needs and desires.

Munters Flexibility

Natatoriums vary in size, shape, and location. Some are low, small rooms, others are atriums of hotels with vast deck areas and high ceilings. Some are totally interior with no transmission load, while others are completly enclosed in glass with large transmission loads. Munters provides a standard or customized product for precise application for any amount and proportion of sensible and latent capacity to meet the load. Munters provides systems with increased outside air throughout the year to improve indoor air quality, while reducing the air to minimum required airflows during extreme temperatures to minimize operating cost.

Munters

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