enviroPLATE™

October 4, 2012
IGSHPA Conference – Indianapolis, IN

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enviroPlate™ surface water heat exchanger

- Alternative to HDPE loops in surface water applications
  - Reduced labor and time to install
  - Flanged header connections
  - Low thermal resistance
- 304 stainless steel, marine-tolerant ALX6N stainless steel, or titanium for aggressive conditions
- Standard plate size, 4’ x 15’ (nominal 120 ft²), 16 gauge construction
- Detailed submittal drawing
- Example – racked plate system

enviroPlate™ advantages

- Optimized dimple and baffle arrangement due to the flexibility of CNC laser welding
- CNC laser welding provides constant uniformity during manufacturing, ensuring consistent performance, volume, & pressure drop
- Higher pillow height offers increased additional surface area, and greater overall plate rigidity
- Laser welded plates are inflated to within 11/16” of the edge of the plate, increasing the internal wetted area of the plates and external heat transfer area
- The external heat transfer area is about 130 ft^2 due to the higher pillow height for a 4’ x 15’ plate (120 ft^2 nominal) with a fluid capacity of 10+ gallons

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- Standard plate size – 4’ x 15’
- Number of plates determined by heat pump schedule, HE and HR, flow rate, fluid type and host water temperatures
- Custom plate sizes and shapes available to meet specific conditions or specialized requirements

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Flanged Header Line Connections

Header line connections are Flanged x HDPE fusion to eliminate leak potential of threaded connections

Racked assemblies arrive ‘shrink wrapped’

Racked assemblies complete with skids

Racked assemblies and single plates come standard with integrated lift points

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Palletized or Racked Assemblies

Palletized assemblies arrive ready to install

Surface water systems using metallic plate heat exchangers

- Typically cooling dominant systems are very forgiving, even in warm water host conditions
- Heating dominant loads, with a plate installation in cold water environments, require more detailed attention to sizing to avoid icing and potential system failure

- "Rule of Thumb" HDPE pond loops, typically sized at 300' to 500' per nominal HP ton, historically have been reasonably trouble free, but are more labor intensive with commensurately higher cost, as system size increases.
- A typical 4' x 15' plate has a nominal exposed area of 120 ft². The equivalent ¾" DR11 HDPE exposed area requires a pipe length of 436.5 feet. For 1" DR11 HDPE, a pipe length of 348.5 feet is required to have the same exposed surface area of 120 ft².

enviroPlate™ testing involved the following:

- Cold water conditions, extended heat extraction (HE), variety of flow rates, varying rates of HE
- Summer water conditions, extended heat rejection (HR), variety of flow rates, varying rates of HR
- Use of premium 2-stage compressor heat pump for building data points at varying load conditions, both heating and cooling
- Ability to control test components individually for data acquisition matrix
- Flow testing with known flow rate to determine actual pressure drop map

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Testing

enviroPlate™ sizing inputs

- Customer may order number and configuration of plates preferred, or MG can assist with recommendations

Required for making sizing recommendations:

- Heat pump schedule
- Heat rejection (cooling load + compressor energy)
- Heat extraction (excludes compressor energy)
- Heating and cooling loads, for reality check
- Flow rate
- Summer water temperature
- Winter water temperature
- Customer response form

- Load Calculations – Residential
  - Usually a load that is driven by climate
  - Peak heat loss and heat gain are typically sufficient; load durations for “dry” ground loop calculations are determined by seasonal durations
  - In most cases only peak loads are necessary to determine HP schedule for enviroPlate™ system
- Load Calculations – Commercial
  - Typically defined as internally driven
    - For example, most commercial buildings and schools are cooling dominated, even in winter
  - Requires a monthly energy load calculation for “dry” loops
  - May only require peak loads to determine HP schedule for enviroPlate™ system

Commercial annual load profile example

	TOTAL COOLING	PEAK COOLING	TOTAL HEATING	PEAK HEATING	Monthly Load Factor	
	mbtu	mbtuh	mbtu	mbtuh	Cooling	Heating
January	91620	975.7	60001	876.5	0.13	0.09
February	81846	1005.9	60016	901.6	0.12	0.10
March	133518	1528.4	25908	629.0	0.12	0.06
April	160963	1906.2	7293	253.5	0.12	0.04
May	377044	2735.0	29	0.7	0.19	0.06
June	295396	3171.9	0	0.0	0.13	0.00
July	333676	3322.8	0	0.0	0.13	0.00
August	284150	3136.2	4	0.2	0.12	0.03
September	353318	2818.3	30	0.9	0.17	0.05
October	191111	2029.9	6502	278.4	0.13	0.03
November	141033	1709.1	16273	525.1	0.11	0.04
December	97041	1001.8	36753	721.1	0.13	0.07

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HP Performance Inputs

Example performance sheet cut, nominal 5.0 ton GSHP

1825 CFM Nominal (Rated) Airflow Cooling, 2050 CFM Nominal (Rated) Airflow Heating

Performance capacities shown in thousands of Btuh

EWT °F	GPM	WPD		Cooling - EAT 80/67°F							Heating - EAT 70°F						
		PSI	FT	Airflow CFM	TC	SC	kW	HR	EER	HWC	Airflow CFM	HC	kW	HE	LAT	COP	HWC
20	15.0	5.0	11.6	Operation not recommended							1750	41.0	3.87	28.3	91.7	3.10	4.0
	15.0	5.0	11.6								2050	41.8	3.71	29.2	88.9	3.30	3.5
30	7.5	0.6	1.5	1580	65.8	41.6	2.78	75.1	23.7	-	1750	44.6	3.96	31.5	93.6	3.29	4.1
	7.5	0.6	1.5	1825	67.3	45.6	2.90	77.2	23.2	-	2050	45.4	3.8	32.6	90.5	3.50	3.6
	11.3	2.3	5.3	1580	66.7	42.1	2.65	75.7	25.2	-	1750	46.4	4.01	33.1	94.6	3.39	4.1
	11.3	2.3	5.3	1825	68.3	46.2	2.77	77.8	24.7	-	2050	47.3	3.85	34.3	91.4	3.60	3.5
	15.0	4.8	11	1580	68.1	42.9	2.60	76.8	26.2	-	1750	47.4	4.04	34.0	95.1	3.44	4.0
	15.0	4.8	11	1825	69.7	47.1	2.71	78.9	25.7	-	2050	48.3	3.88	35.2	91.8	3.65	3.5
90	7.5	0.2	0.4	1825	57.5	43.9	4.99	74.6	11.5	6.6	2050	84.7	4.88	68.1	108.3	5.09	5.6
	11.3	1.9	4.3	1580	58.7	41.0	4.46	73.9	13.2	5.5	1750	87.8	5.24	70.0	116.5	4.91	6.4
	11.3	1.9	4.3	1825	60.0	44.9	4.65	75.9	12.9	5.6	2050	89.5	5.02	72.4	110.4	5.22	5.5
	15.0	3.5	8.0	1580	59.9	41.4	4.31	74.6	13.9	4.6	1750	90.5	5.32	72.3	117.9	4.98	6.3
	15.0	3.5	8.0	1825	61.3	45.4	4.49	76.6	13.6	4.6	2050	92.2	5.10	74.8	111.7	5.30	5.4
100	7.5	0.1	0.3	1580	52.4	38.6	5.32	70.7	9.8	8.0	Operation not recommended						
	7.5	0.1	0.3	1825	53.6	42.3	5.55	72.6	9.7	8.2							
	11.3	1.8	4.2	1580	54.9	39.6	4.96	71.9	11.1	6.8							
	11.3	1.8	4.2	1825	56.2	43.4	5.18	73.9	10.9	6.9							
	15.0	3.3	7.6	1580	56.1	40.1	4.79	72.5	11.7	5.6							
	15.0	3.3	7.6	1825	57.5	43.9	5.00	74.6	11.5	5.7							
110	7.5	0.1	0.2	1580	48.6	37.1	5.95	69.0	8.2	9.7							
	7.5	0.1	0.2	1825	49.7	40.7	6.21	71.0	8.0	9.9							
	11.3	1.8	4.0	1580	51.0	38.1	5.54	70.0	9.2	8.2							
	11.3	1.8	4.0	1825	52.2	41.7	5.78	72.0	9.0	8.4							
	15.0	3.1	7.2	1580	52.2	38.6	5.34	70.6	9.8	6.7							
	15.0	3.1	7.2	1825	53.5	42.3	5.58	72.5	9.6	6.9							
120	7.5	0.1	0.1	1580	44.9	35.7	6.67	67.9	6.7	11.5							
	7.5	0.1	0.1	1825	46.0	39.2	6.97	69.8	6.6	11.7							
	11.3	1.7	3.9	1580	47.1	36.6	6.21	68.5	7.6	9.8							
	11.3	1.7	3.9	1825	48.3	40.1	6.48	70.5	7.4	9.9							
	15.0	2.9	6.8	1580	48.3	37.0	5.99	69.0	8.1	8.0							
	15.0	2.9	6.8	1825	49.5	40.6	6.25	70.9	7.9	8.1							

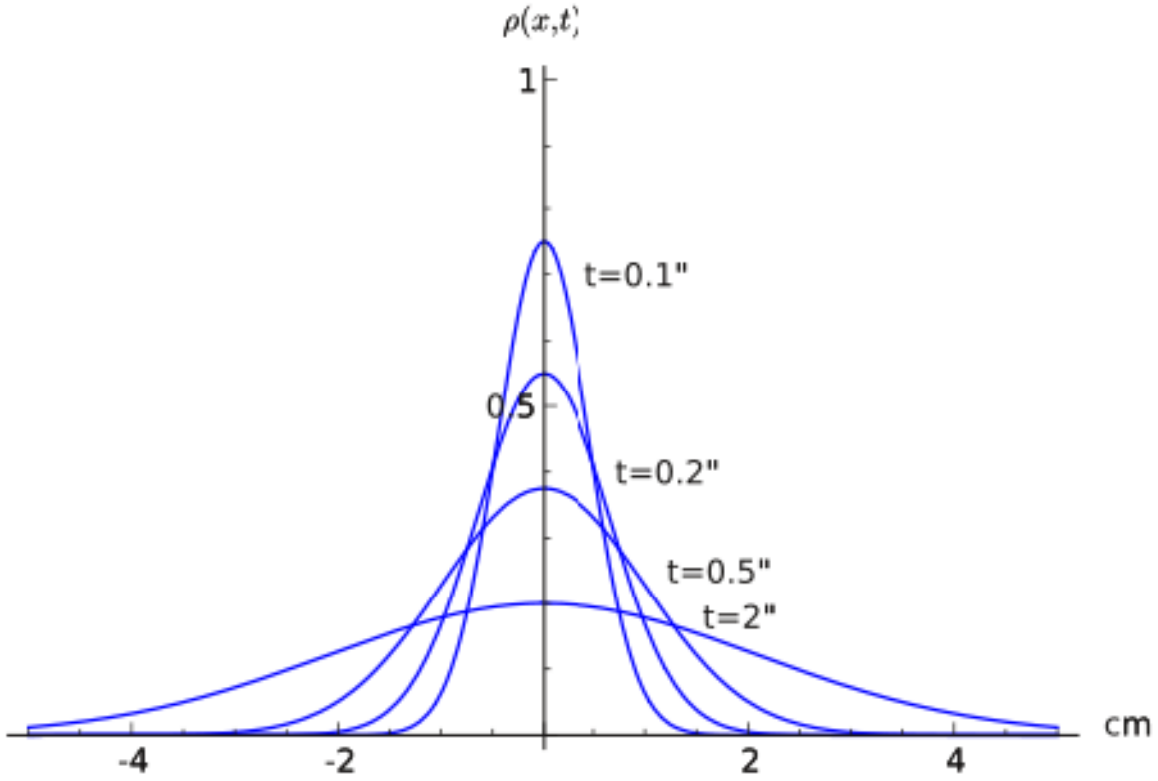
Design Considerations – Typical "Dry" Ground Loop

- "Dry" closed loop ground heat exchangers require that the ground loop have sufficient capacity to maintain a specific range of EWT to the equipment to operate indefinitely – they cannot be treated as an unlimited pipeline of energy
- Closed "dry" loop design require calculations involving loads, equipment performance and knowledge of the host geology
- Most closed loop systems are designed to feed GSHP equipment with an EWT range from 30°F to 90°F, although most equipment will tolerate extreme EWT ranges of 20°F to 120°F if sufficient fluid flow is maintained
- **One size does not fit all – *avoid rule of thumb estimating!***

- "Wet" closed loop heat exchangers are somewhat more forgiving for cooling loads, but much more critical for heating dominant loads
- Closed "wet" loop design require calculations involving loads, equipment performance and knowledge of the host water conditions
- Most "wet" closed loop systems are designed to feed GSHP equipment with an EWT range from the lowest winter pond water temperature in heating conditions, to the highest summer pond water temperature or slightly higher. This is usually well within the operating range of most extended range GSHP equipment.
- **One size does not fit all – *avoid rule of thumb estimating!***

- Typically a heating dominant application, with a cold water body, will require more plate capacity than for a comparable cooling dominated load for the same nominal tonnage of HP equipment
- Colder water has reduced brownian* motion. The water in effect insulates itself causing a dampened heat exchange process. Our calculation sheet adjusts for water's reduced brownian motion and insulatory affect around the plates. This is for use in situations were the pond/lake is approaching freezing conditions.

* *From Wikipedia:* **Brownian motion** (named after the botanist Robert Brown) or **pedesis** (from Greek: πήδησις "leaping") is the presumably random drifting of particles suspended in a fluid (a liquid or a gas) or the mathematical model used to describe such random movements, which is often called a particle theory.



Conceptual diagram of brownian distribution, describing why thermal resistance is higher closer to the plate surface. With heating dominant loads in cold water situation this becomes more critical, requiring increased plate area to reduce thermal resistance for sufficient heat extraction.

enviroPlate™ sizing example (Avon, CO)

- Peak cooling load of 72,000 btuh
- Peak heating load of 124,000 btuh
- Summer pond temperature of 70°F
- Winter pond temperature of 35°F (below ice)
- Three ClimateMaster TT049 heat pumps
- Example 1 – results
- Example 2 - results

enviroPlate™ sizing example (Avon, CO)

- Peak flow of 36.0 gpm
- Four plates recommended
- 25% propylene glycol by volume
- Pressure drop at design conditions, 30°F, 9.0 gpm per plate @ 3.7 psi (8.5 ft/hd)
- Pressure drop calculation sheet
- Additional pressure drop for header line length, header pipe size, internal HP pressure drop to be included for final circulation pump selection

enviroPlate™ sizing software

- Evaluation of plate test data to integrate with information from literature
- Determine calculations and output for commercial use of eP product
- Construct software to be compatible for variety of applications, from mild cooling to harsh, long-term heating situations
- Ability to test system design by changing key input variables
- Detailed review of inputs and internal calculations for quality control

enviroPlate™ sizing example (Avon, CO)

- Four plates, piped in parallel
- Minimum purge rate for air removal, 4’ x 15’ plate, 25 gpm @ 5 psi (11.5 ft/hd), pure water, per plate – 100 gpm @ 5 psi (11.5 ft/hd) total
- Purge prior to adding antifreeze
- Fluid flow to lower water port from heat pump(s), purging and final operation
- Installation considerations

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Example Installations

Installations range from Aspen, Colorado….

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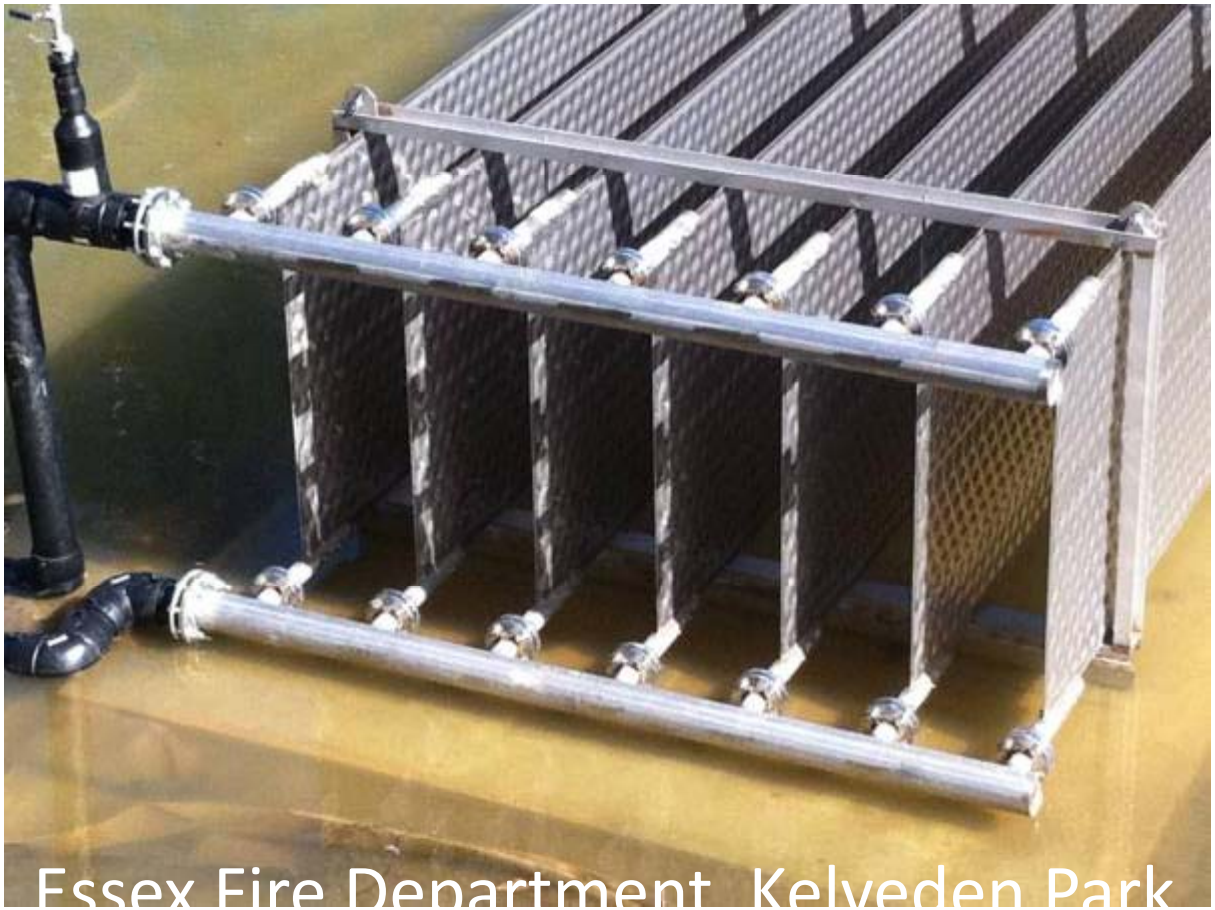
Example Installations



….. to the United Kingdom

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Example Installations

Paepcke Events Center, Aspen, CO

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Example Installations

Lot 309, Big Sky, MT
Yellowstone Club

Lot 309, Big Sky, MT – LEED Platinum Yellowstone Club

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QUESTIONS ?

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