Monday, July 31, 2023

Waterside Economizers Part 11: Summary of Design Thoughts

Monday Morning Minutes | by Norm Hall, July 31, 2023

We can conclude the series on waterside economizers with a summary of suggestions for the engineer to consider. ASHRAE 90.1 Energy Standards require this energy-saving design in northern states when the outdoor temperature is below 45°F wet bulb/50°F dry bulb. The engineering team may wish to use this summary and define a company solution to this energy-saving code requirement.

Start with the Code Requirements

The State Energy Codes vary. Some adopt the ASHRAE 90.1 Standard updates quickly while others wait and update less frequently. The State code may follow the ASHRAE wording remarkably close.

Make the Best Engineered Determination of the Winter Chilled Water BTUH Load

- One owner's building use may not be the same as another. Use the best information available to determine the load requirement when the outdoor conditions drop to a point where the waterside economizer or free cooling heat exchanger is required.

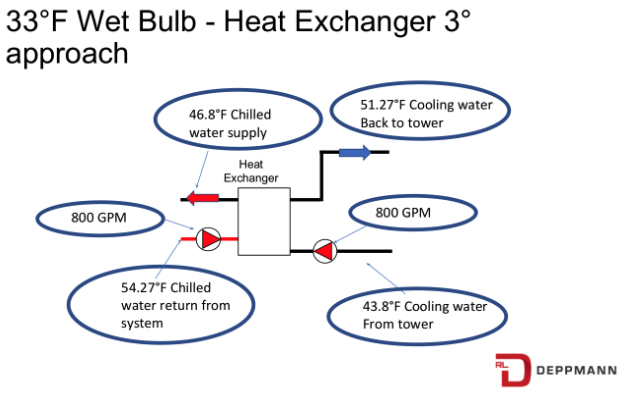
- Too high an estimate will increase both the capital cost and operation cost for the project. Too low an estimate will reduce the capital cost but drastically affect the operational costs by turning on mechanical chillers to supplement the heat exchanger.

Make Sure to Consider the Winter Load When Selection the Type, Number, and Sizes of the Cooling Towers

Photo Credit: Brian Hobbs

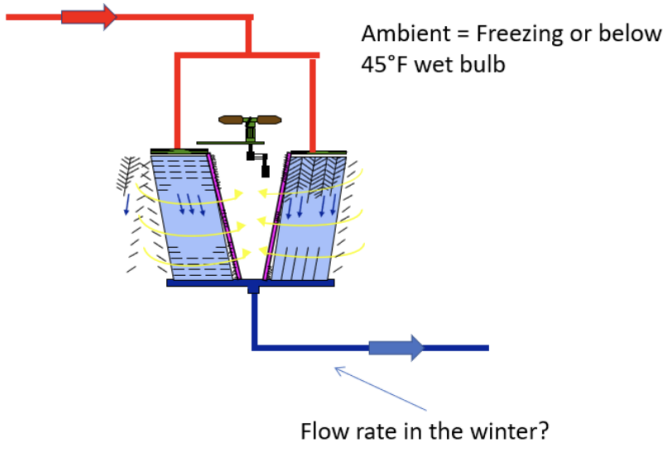
- There may be options in the design of the cooling tower, the safe minimum water supply temperature from the tower, flow rates, and the owner maintenance and control. It is best to understand the options before completing the cooling tower system selection.
- Verify the Tower Approach and Range during the winter operation. Read Water Side Economizers Part 3: Cooling Tower Temperatures to learn more.

Select a Minimum Supply Temperature from the Tower



The minimum temperature from the cooling tower will change with the weather. Once the temperature gets closer to freezing, there may be more owner attention or cycling. The minimum temperature you design may be higher than the absolute minimum of the tower. Read Waterside Economizers Part 7: Tower Side Temperatures to learn more.

Determine the Winter Operation Flow Rate and Consider Keeping It Constant

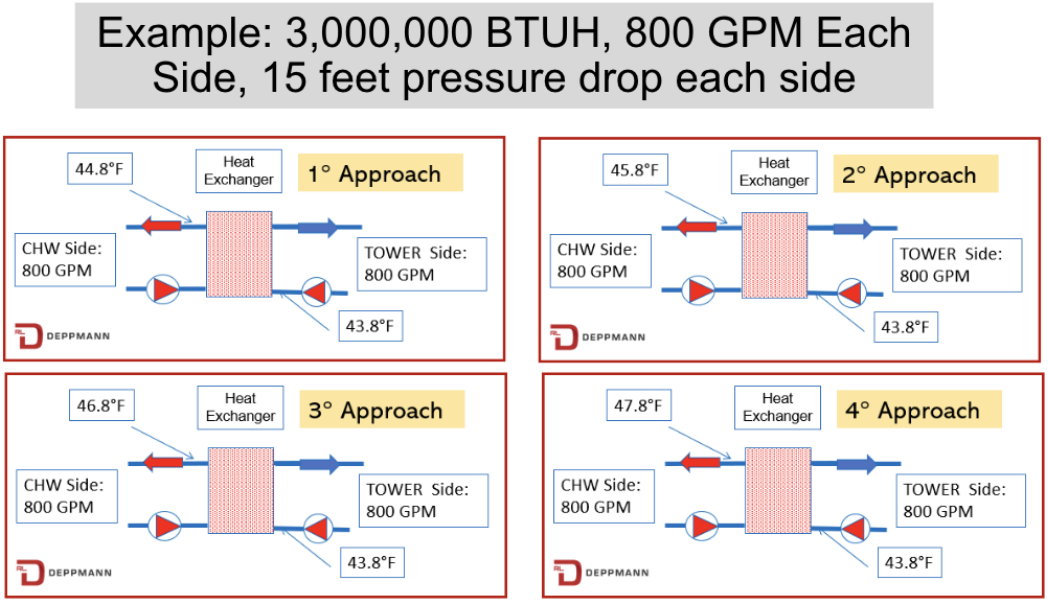


- The engineer determined the BTUH winter load when the water side economizer is operational. That load, coupled with the tower range and approach limitations will

determine the water supply flow and temperatures from the tower to the heat exchanger.

- Lean toward keeping the flow rate to the heat exchanger constant. Towers may have different minimum flow rates in different winter conditions. Evaluate the gain for changing it vs. the added controls and the effect on the heat exchanger. Read Waterside Economizers Part 6: Tower Side Flow to learn more.

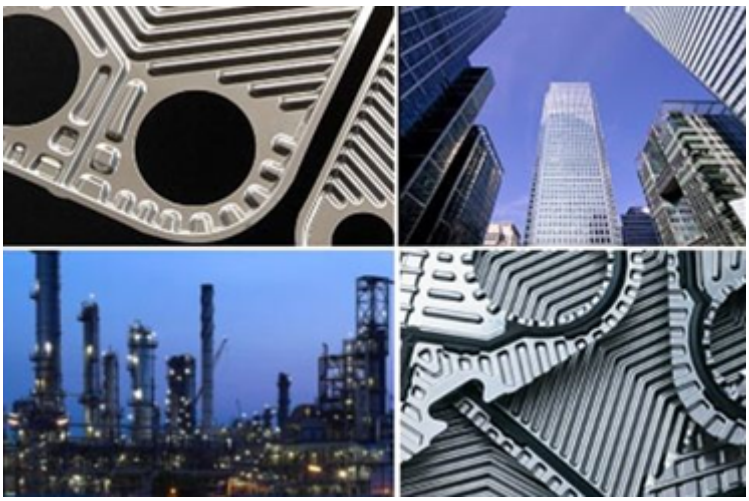
Determine the Chilled Water Supply Temperature from the Heat Exchanger



- The water supply temperature from the heat exchanger to the chilled water system cannot be lower than the supplied tower water temperature. The closer the chilled water supply from the heat exchanger is to the tower supply temperature, the higher the first cost. This is the time to evaluate warmer CHW supply temperatures.

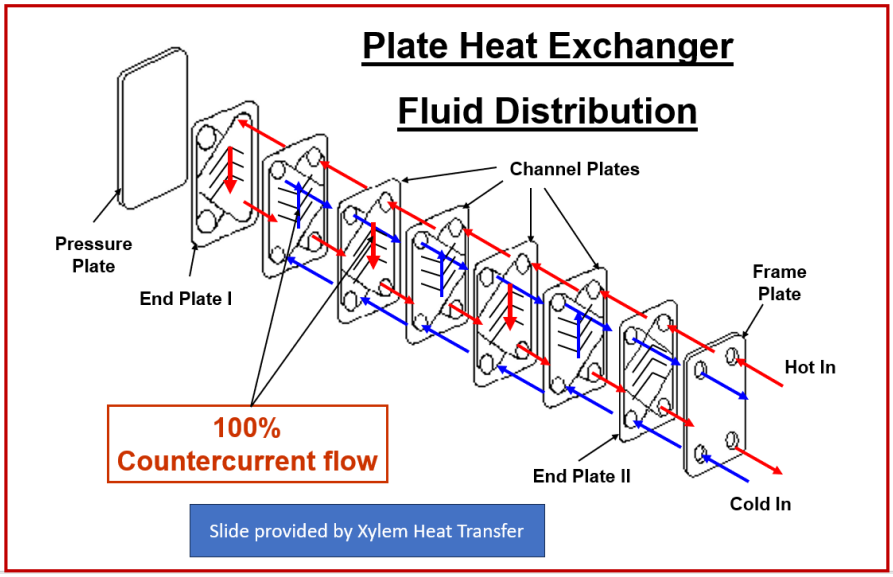
- We suggest never using less than a 2-degree heat exchanger approach. You may want to standardize on a 3-degree approach to allow some comfort in the selection and the initial cost. Read Water Side Economizers Part 8: The Heat Exchanger Approach to learn more.

Determine the Heat Exchanger Location and Pressure Drop



- We suggest locating the heat exchanger on the chilled water return to the chiller system. We also suggest a separate pump for the chilled water to the heat exchanger. This reduces the possible fouling, allows for more BTUH when the outdoor temperature is 45 degrees, and reduces the control expense. Read Waterside Economizers Part 5: Heat Exchanger Location Options to learn more.
- There may be some advantage in selecting the heat exchanger chilled water pump and then determining the pressure drop required by the heat exchanger. Getting both from one representative (like Deppmann) will have advantages.

Select the Heat Exchanger and the Trim for Solids and Fouling Management



The owner will appreciate the design that protects the waterside economizer heat exchanger from dirt and fouling. Read Waterside Economizers: Heat Exchanger Fouling & Maintenance to learn more.

In Michigan and Northern Ohio, Start with a Contract with R.L. Deppmann Company

I should have started with this one, but you already knew this one! Click here to contact us and get started.

We look forward to questions and an opportunity to be part of the discussion with your team.

PART 1: Free Cooling Heat Exchangers

PART 2: State Energy Codes

PART 3: Cooling Tower Temperatures

PART 4: Chilled Water Temperatures

In a plate heat exchanger, the plates are very thin, and the passageways are small. The small passageways allow higher velocities. The higher velocities provide a better “U” value and more BTUH per square foot of heat transfer surface. This is a good thing.

Fouling is a term used for the coating of the heat transfer surfaces. The thin plate offers little resistance to heat transfer. If we add a coat of fouling product, it adds resistance and reduces the heat transfer or output of the exchanger. What can this coating be? Think of the salt or calcium deposits from harder waters; think dirt or sand; think biologicals such as

algae. For all of these we might think of a cooling tower. That is the prime source of fouling in a water economizer.

You might ask, “Norm, if I keep the velocity high, will that help.” The answer is yes. The velocity helps scour the plates. Our challenge here is the intermittent operation of the heat exchanger. On and off in the spring and fall based on the weather. The water sits for extended periods. They will foul. The time until the plates foul enough to warrant action is the variable. It will depend on the water quality from the tower or chilled water system.

Another concern is particulate. To understand the issue, we look at the plate channel area.

Plate Heat Exchanger Passageways and Particulate

Plate heat exchangers have small passages. How small is small? The Xylem Bell & Gossett GPX® series of gasketed plate heat exchangers is a commonly specified series for water side economizers. They meet the AHRI requirements resident in most State codes. So, what is the passageway size in this top brand of waterside economizer?

B&G recommends the maximum particulate size in this series. The maximum size varies by model, but the range is 0.043 inches (1.2 mm) to 0.075 inches (1.9 mm).

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Just to visualize, that is the thickness of a credit card to the thickness of two credit cards. Not excessively big.

Now think of the spring and fall in Michigan and Ohio. Cottonwood seed pods are 0.1 inches (2.5 mm). The list is large including the ever-flying Locust and maple seeds. If they blow in the wind and the cooling tower is open enough, the heat exchanger will see them.

All of these are large enough to plug a heat exchanger. OK, I have your attention. What do we do about it?

Ways to Reduce the Operational Expense of Water Side Economizer Heat Exchangers

Here are a few examples of ways to reduce the fouling and plugging of heat exchangers. There may be at least two that are new to you.

1. Eliminate most of the problems at the cooling tower. This could be a sweeper system, Tower/Condenser Water Systems – Side Stream Separator Systems. It

could also be the type of tower. A tower with less drift and side opening. Cooling Tower Design to Save the Planet: Drift Eliminators.

2. Add a 20-mesh internal port heat exchanger strainer. Gasketed Plate and Frame Accessories for Heat Exchangers. This strainer can be serviced without disturbing the piping. A simple differential pressure sensor across the constant flow heat exchanger tower connections can alarm when it is time for service.
3. Add a sediment separator followed by a strainer on the pumped inlet to the heat exchanger. If the flow rate is constant, these are a terrific way to catch the things that sink and the things that float. Sediment Separators in Variable Flow Cooling Tower Water Systems.
4. Select a Xylem Free Flow series of heat exchanger from B&G. The Free-Flow can pass fibrous particles up to 2 mm in diameter and 5 mm long.

- This style of heat exchanger will manage larger particles. Depending on the model the maximum recommended particle size jumps to 0.106 inches (2.7 mm) up to 0.226 inches (5.8 mm).
- There is a first cost price for this technology. The cost can jump by 60 to 80% and the lead time will be much longer. That said, if the owner saves a single plate pack replacement, it will pay for itself repeatedly.

Fouling and plugging of water side economizers are a real concern. The engineer has tools to use to fight the battle and save the owner operating expenses.

PART 1: Free Cooling Heat Exchangers

PART 2: State Energy Codes

PART 3: Cooling Tower Temperatures

PART 4: Chilled Water Temperatures

PART 5: Heat Exchanger Location

PART 6: Tower Side Flow Rate

PART 7: Tower Side Temperatures

PART 8: The Heat Exchanger Approach

PART 9: Heat Exchanger Pressure Drop