Chiller condenser protection and savings with AHRI performance certification

Industrial chillers are widely used in many industries such as HVAC, general manufacturing, food processing, pharmaceutical and industrial applications such as packaging material manufacturing and plastics.

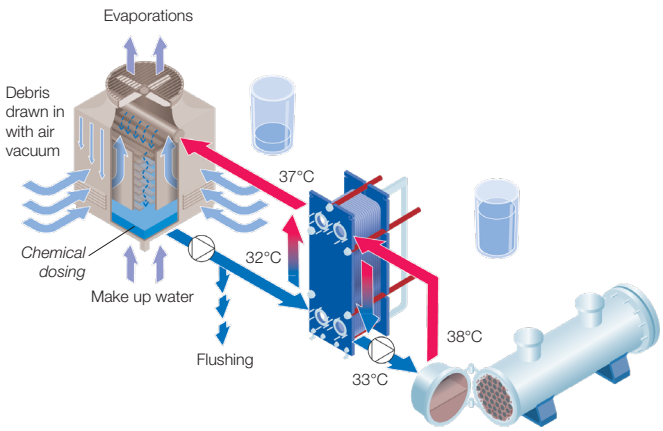
The condenser of a chiller can be either water cooled or air cooled. In the case of water cooled, often the cooling source is an open cooling tower. A sustainability concern is the increasing electricity consumption of the refrigerant compressor, due to higher condensing pressures caused by fouling and inefficiencies of the condenser.

Three problems are associated with an open cooling tower water (CTW) and chiller condenser:

1. Calcium carbonate ($CaCO_3$) coating of the inside of the condenser tubes, leading to reduced heat transfer efficiency, higher condensing temperature and pressure.
2. Debris blocking the tubes, reducing CTW flow to the condenser and loss in efficiency.
3. Chloride ion corrosion of the tubes, forced to be manually blanked which will reduce heat transfer area and efficiency.

Each of the above three effects lead to higher electricity costs. This is due to the higher lift in the compressor caused from higher condensing temperatures and higher condensing pressures. These detrimental effects accumulate over the years and cannot be reversed with manual or chemical cleaning.

As little as a 1 mm coating of $CaCO_3$ inside the tubes, can lead to an average 5-7°C higher condensing temperature, which means 7-10% higher chiller running costs in electricity bills, all year round and every year (1.5% for every °C).



An Alfa Laval gasketed plate heat exchanger (GPHE), installed between the condenser and the cooling tower, will protect the condenser from the detrimental effects associated with open cooling towers. The chiller condenser's tubes will be life long free of debris, $CaCO_3$ coating, corrosion and will life long run as new.

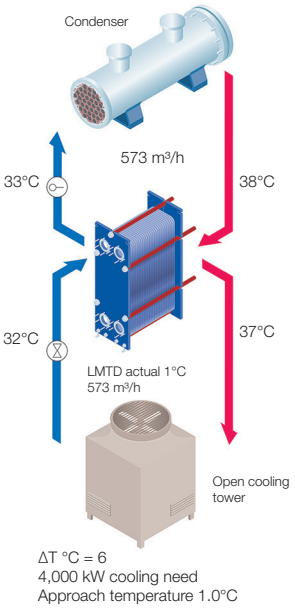
Selection of chiller condenser protection gasketed plate heat exchanger

Selection and specification of the GPHE is critical with some manufacturers using software with tolerances of 0.5°C, resulting in lower capital cost (CAPEX) but higher operating costs (OPEX) from under surfaced GPHE. Growing trends in the competitive GPHE market can see offers of as low as half the required and specified performance, with half the price of a performance certified GPHE.

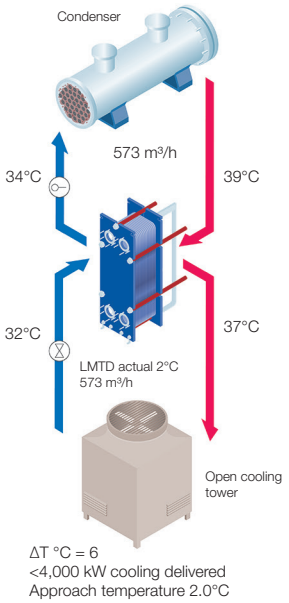
Hence AHRI performance certification is becoming a necessity in today's GPHE market.

The available cooling tower water temperature delivered to the condenser from an under surfaced GPHE, can be 1°C higher than design, all year long. This will cause saturation temperature (Tsat), to be 1°C higher and hence the saturation pressure (Psat) will be higher, according to the enthalpy graph of the refrigerant gas.

AHRI performance certified GPHE operation *exactly* to design



30% under surfaced GPHE operation gives higher condensing temperature



Performance of an under-surfaced GPHE will cause higher plant OPEX due to higher condensing temperatures at the chiller condenser.

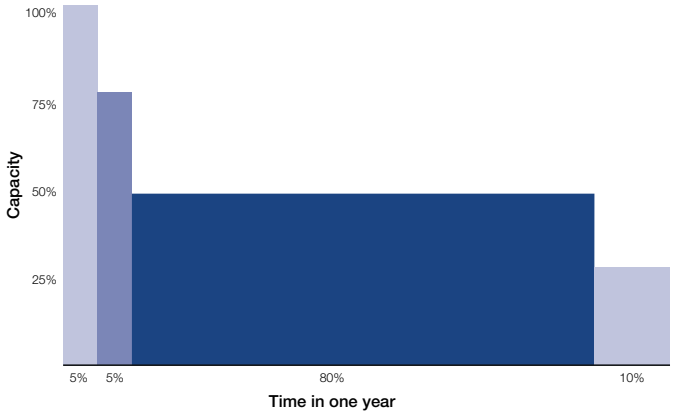
T_{con} ↑ P_{sat} ↑

Energy Hunter – HVAC

Payback period for sustainability

Chillers are one of the highest consumers of electricity in utilities part of a plant with huge compressors, running constantly to compress the refrigerant gasses as a part of the refrigeration cycle. To save our natural resources and help sustainability, there are new legislations in many countries to monitor the condenser efficiency. Regulations require condensers to be opened, inspected and cleaned annually to ensure efficient operation and reduce national electricity costs.

A peak cooling capacity of 4 MW obtained from a chiller, equates to a compressor power consumption of 800 kW based on a COP of 5 as an example.



Assuming an annual average of 25% of peak load due to seasonal conditions, 200 kW of electricity in one year means 200 kW x 8,760 hrs/year x 0.10 euro/kW hr is 175,200 euro per year in chiller electricity bills.

Due to an under surfaced GPHE a 1°C higher condensing temperature from 32.8°C to 33.9°C results in 7.34 bar to 7.60 bar higher condensing pressure (3.6%) for R134a refrigerant.

Pressure bar(g)	Dew °C
6.83	30.6
6.95	31.1
7.08	31.7
7.21	32.2
7.34	**32.8**
7.47	33.3
7.60	**33.9**
7.73	34.4

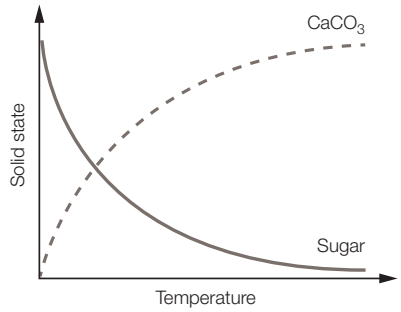
An average of 3.6% savings* with an AHRI performance certified GPHE installed, is equal to 175,200 euro x 3.6 = 6,318 euro per year in electricity costs. Each year every year!

Performance certified GPHEs pay back the initial investment difference, in under one year.

* Power consumption is assumed to be proportional to the pressure increase.

Less formation of scale with GPHE installed

The condenser is often the hottest point of the cooling tower loop. With condensing temperatures of 40-80°C, it is here most of the scale forms and adheres to hot condenser surfaces. With a GPHE installed to protect the condenser, the formation of scale is very much less as the wall temperatures will be 30-40°C. Scale $CaCO_3$ behaves opposite to that of sugar. The higher the surface temperature the more the formation of scale on hot surfaces.



▼ PRACTICAL TIPS

1. Specify what you want and get what you specify with AHRI performance certified gasketed plate heat exchangers using the description below when purchasing gasketed plate heat exchangers for condenser protection.

"The plate heat exchangers shall be AHRI certified in accordance with the AHRI Liquid to Liquid Heat Exchangers Certification Program".

The gasketed plate heat exchanger specs as selected, shall be verified and registered by AHRI before purchase"

AHRI CERTIFIED® www.ahridirectory.org Liquid to Liquid Heat Exchangers AHRI Standard 400

2. A commonly used **thermistor** temperature measurement device will read as accurate to 1% of the compete scale. If scale is 50°C the accuracy is 1% hence, plus or minus 0.5°C. Inaccuracy in measuring performance in the plant, using delta T between inlet and outlet 0.5°C + 0.5°C = 1°C.

Can you ever be sure of actual performance with seasonal load and cooling capacities?

Can we afford to waste our natural resources with under-surfaced non-performance certified gasketed plate heat exchangers as chiller condenser protection units?

Rule of thumb:
1 ton of refrigeration = 3.5 kW of cooling. I.e. 1,000 tons = 3,516 kW