# AHRI performance certified gasketed plate heat exchangers for sustainable high-rise buildings

High-rise buildings carry high levels of static pressure due to their height. A building with 300 meters height means static pressure at the ground level of at least 30 bar. This demands unnecessary high investment costs to HVAC critical equipment such as chillers, boilers, and their associated automation equipment if located at the basement, as they need to withstand this high pressure.

Gasketed plate heat exchangers (GPHE) are standard industry practice for breaking this static pressure, located in plant rooms at regular intervals along with the height of the structure. Taller height means a greater number of zones as pressure breakers and security for associated equipment such as chillers.

Many designers specify an approach between the inlets and outlets at 2.0°C or 1.5°C or even 1.0°C depending on the water temperatures required at the fan coils and the total system design. With equal flow rates and equal delta T for each side, this approach temperature equates to the LMTD for the selection of the GPHE.

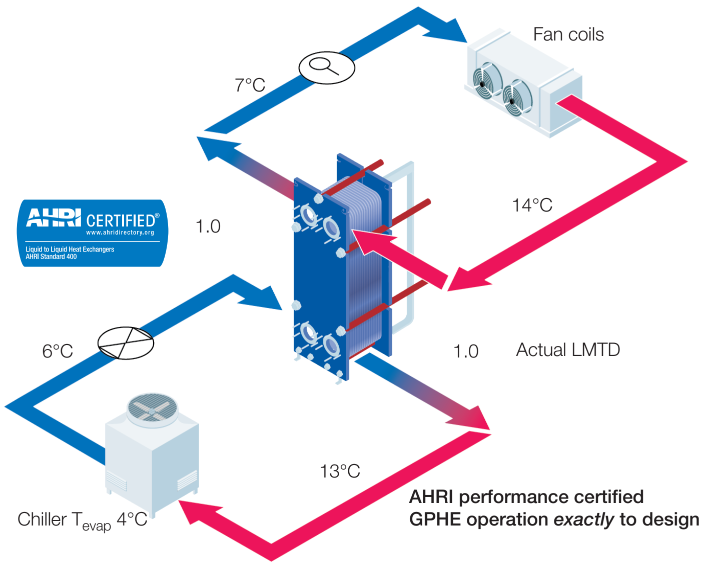
Buildings are getting taller and taller with the tallest (2019) being Burj Khalifa in Dubai at almost 1 km into the sky installed with Alfa Laval GPHEs. With energy savings in mind and total cost of ownership, for taller buildings, the trend is down to as low as 0.6°C approach temperature.

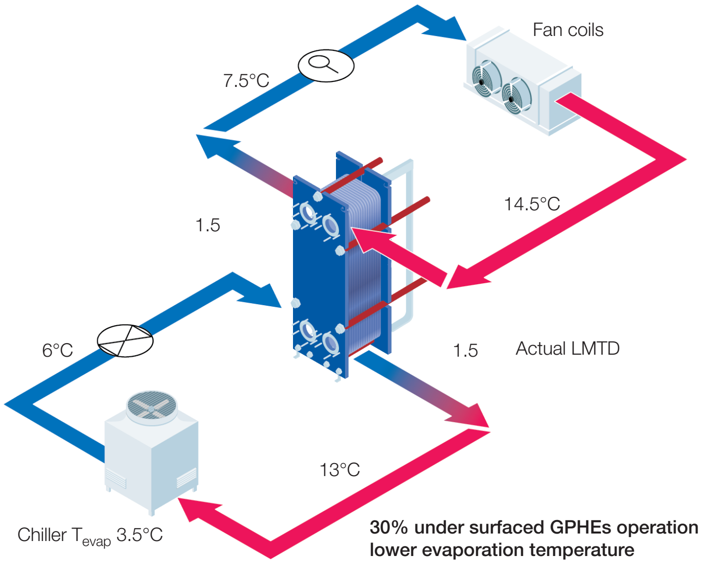
## Why AHRI performance certified gasketed plate heat exchangers should be specified

Fan coils located at cooling points require chilled water for cooling and hot water for heating. In case of a GPHE for cooling working as a pressure breaker, the temperature program can be 14°C → 7°C on the fan coil side cooled by chilled water at 6°C →13°C. This means an approach temperature of 1°C.

A non-AHRI performance certified GPHE operating as a pressure breaker if selected with tolerances can deliver only an approach temperature of 1.5°C, providing 7.5°C water to the fan coils, returning at 14.5°C.

To meet the set 7°C, the chiller will have to operate at a lower temperature regime and hence a lower evaporation temperature resulting in a higher compressor lift.




0.5°C lower chiller evaporation temperature means lower saturation temperature of the gas, lower evaporation pressure and hence a higher compressor lift.

A 1°C lower evaporation temperature results in 3.5% higher chiller energy consumption.

$T_{con}$ ↓  $P_{sat}$ ↓

# Energy Hunter – HVAC

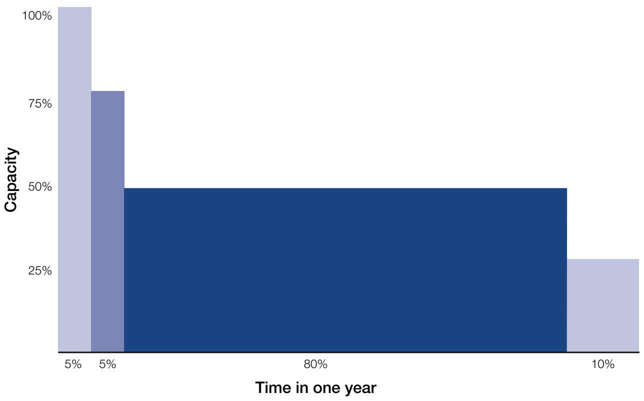
## Calculation of savings with AHRI performance certified gasketed plate heat exchanger in a 4,000 kW cooling capacity

Typical operation of HVAC systems are constant temperature and variable flow rate to minimize on overall pumping costs.

With an underperforming GPHE, the set 7°C going to the fan coils is not met, actuating the flow control valve to allow more chilled water flow. In turn, the return to the chiller is not 13°C as system design and reduces to 12°C. Hence the plate heat exchanger operates with 1.5°C LMTD instead of the designed 1°C, and the chiller evaporation temperature $T_{evap}$ reduces from design 4.0°C to 3.5°C.

Generally accepted chiller compressor energy consumption is 3.5% more power is used for every 1°C lower $T_{evap}$.

For a cooling capacity of 4,000 kW, the chiller power consumption will be 1,259 kW with a COP of 3.2 and with a lower evaporation temperature 0.5°C, the extra compressor power consumed will be 63 kW.




Cost of energy kWh 0.10 euro

| Capacity | Flow rate | Duration in one year | | Chiller compressor extra energy | | Additional annual cost |
|---|---|---|---|---|---|---|
| 4,000 kW | 491 m³/hr | 10% | 876 hrs | 63 kW | 55,188 kW | 5,519 EUR |
| 3,000 kW | 369 m³/hr | 20% | 1,752 hrs | 47 kW | 82,782 kW | 8,278 EUR |
| 2,000 kW | 246 m³/hr | 60% | 5,256 hrs | 32 kW | 165,564 kW | 16,556 EUR |
| 1,000 kW | 123 m³/hr | 10% | 876 hrs | 16 kW | 13,797 kW | 1,380 EUR |
| | | **100%** | **8,760 hrs** | **36 kW** | **317,331 kW** | **31,733 EUR** |

Annual average

HVAC cooling applications, the operation of the system is not always at peak design capacity, and flow conditions, hence the extra energy consumption of pump and chiller will vary throughout the year. The table above shows the annual seasonal effect on capacity demand, resulting in extra yearly power consumption of 31,733 euro/year for a 4,000 kW cooling capacity, with an underperformance GPHE installed.

Ultimately it is our **social responsibility to specify AHRI performance certification** to ensure the correct operation of chillers at design parameters to save on chiller compressor electricity consumption!

## Market trends and why vastly differing solutions are offered

Many engineers believe that it is the kW capacity that determines the size of a GPHE, but it is the approach temperature and the allowed maximum pressure drop that plays the highest role in the selection of a unit. Yes, a 500 kW unit can be double the size of a 1,000 kW unit, depending on the value of LMTD.

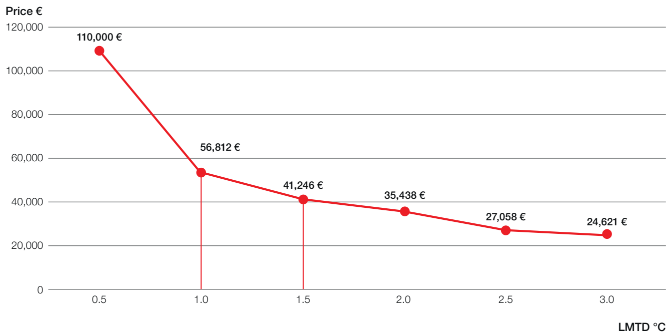
When it comes to measuring the actual temperature and pressure drop of either side, the accuracy at best is 0.5°C and 10 kPa with thermocouples, digital equipment and at full flow. With higher demands from GPHEs and expected 1°C LMTD (approach temperature), the effect of 0.3°C tolerance equates to 30% underperforming GPHEs.

### Heat transfer equation

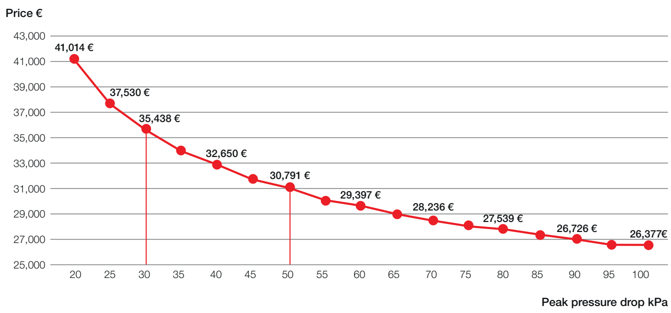
$$Q = k \cdot A \cdot LMTD$$

| | | | |
|---|---|---|---|
| LMTD Tolerance: | 0.3°C | 0.3°C | 0.3°C |
| Specified LMTD: | 2.0°C | 1.0°C | 0.6°C |
| Less area and underperformance | 15% | 30% | 50% |

### What if the selection was made with 1.5°C LMTD instead of the specified 1.0°C?




### What if the selection was made with 50 kPa pressure drop instead of the specified 30 kPa?



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