10 Big Mistakes with Plate Heat Exchangers

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Abstract
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10 Big Mistakes to avoid in Plate Heat Exchanger calculation and material selection

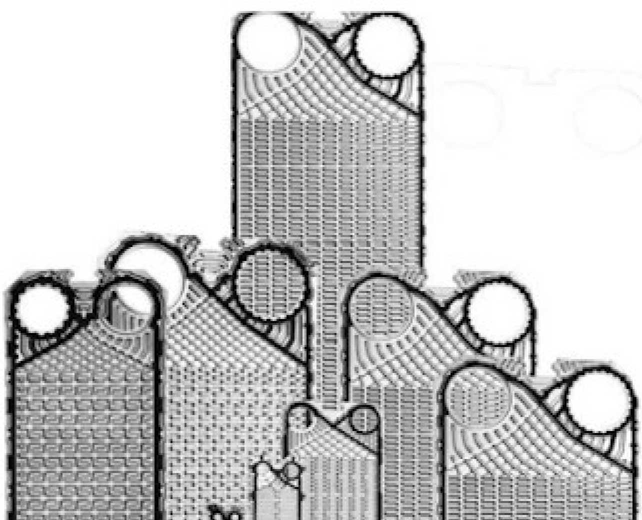
In the recent years use of Plate Heat Exchangers increased more than other type Plate & Frame Heat Exchangers Market ,therefore it's time to focus on mistakes to avoid in calculation and material selection.

#1 Selection of connection size: typical nozzle velocity with water is 5.5 m/s. Major part of PHE design software switches to larger size if it is higher. Standard velocity in piping is 2-2.5 m/s so that size of connections is normally smaller and conic reductions are often required. Don't select automatically PHE with connections same size of piping: double check velocity in nozzles!

#2 Fouling Factor has been topic of discussion since years. PHE FF must be 1/10 of Shell&Tube HEX FF as finally API 662 recommended. There is confusion among process engineers on FF to be used in PHE and often EPC Contractors data sheets are mentioning FF for S&T HE's. Investigations demonstrated that these values are not giving good results in PHE since they often results in oversized units with premature fouling due to reduced velocity and turbolence.

#3 Plate pack size must be considered from maintenance standpoint. Many times to reduce impact cost of large frames, selection is a PHE with plates pack of 400 plates... easy to sell not to open and close!

#4 Diameter of channel plate required is often underestimated. Of course pressing depth of 2.2 mm is more efficient than a 4.4 mm, but if application is Oil & Gas in a refinery in the Middle East long life of PHE is a priority.



#5 Pressure drop is a driving force in PHE's creating turbolence to get high U value. In calculation DP can dramatically change Heat Transfer Area required.

Furthermore Process Engineers specified sometimes DP for S&T HE's while typical DP in PHE is 0.7 bar.
Before deliver calculation double check if DP could be increased!

$$Nu = C\,\mathrm{Re}^{x}\,\mathrm{Pr}^{y}\left(\frac{\mu_{bulk}}{\mu_{wall}}\right)^{z} \Rightarrow \alpha = C\,\mathrm{Re}^{x}\,\mathrm{Pr}^{y}\left(\frac{\mu_{bulk}}{\mu_{wall}}\right)^{z}\frac{k}{d_h}$$

$$\Delta p = \frac{1}{2}\rho u^{2}\frac{4L}{d_h} f\left(\frac{\mu_{wall}}{\mu_{bulk}}\right)^{b}, where \{f = f($$

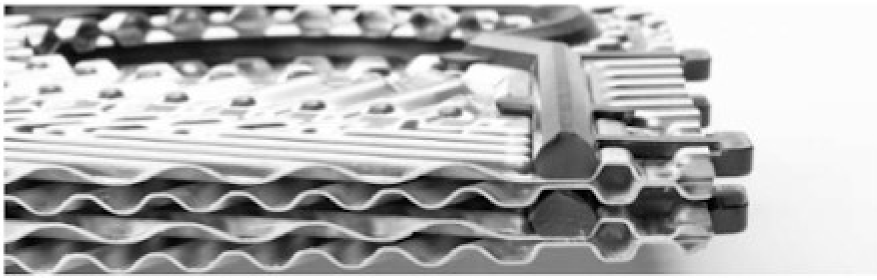
#6 Plate material selection is related to fluids involved. Stainless steel is common material with water, but often Chloride level ppm is underestimated

Chloride level (ppm, mg/L)	Suitable grades
<200	1.4301 (304), 1.4307 (304L), 1.4404 (316L)
200 – 1000	1.4404 (316L), 1.4462 (2205)
1000 – 3600	1.4462 (2205), 6% Mo Super austenitic, Super duplex
>3600 and sea water	6% Mo Super austenitic, Superduplex

316L is not required in PHE because there are no weldings, but 316 instead of 304 can be useful in many applications. Brackish water can require 254 SMO while sea water requires Titanium!

#7 Gasket material is a weak point of PHE expecially in case of multipurpose use (like in Pharmaceutical). Try to find a gasket material suitable for different fluids is not so easy...

Wide range of materials is available Viton® Extreme, Aflas® TFE/P, Viton® FKM, EPDM P.C., Buna-n, Silicone, NBR etc. but if you are in trouble don't hesitate to select a semiwelded SPHE or fully welded WPHE!



#8 Heat Recovery is one of the main reason to select a PHE rather than other type of Heat Exchangers: countercurrent flow, LMTD=1 possible etc.
The LMTD is defined by the logarithmic mean as follows:

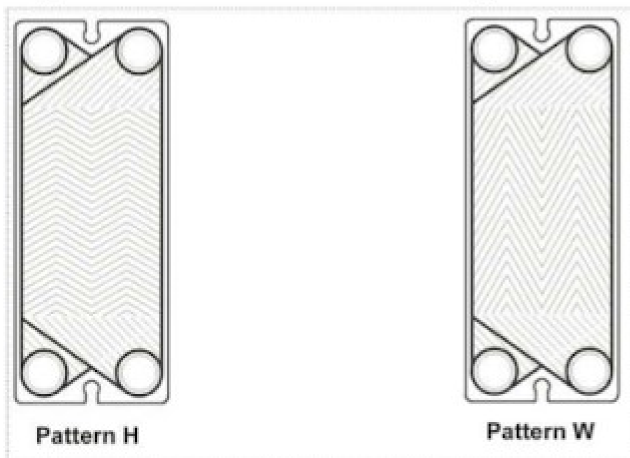
$$LMTD = \frac{\Delta T_A - \Delta T_B}{\ln\left(\frac{\Delta T_A}{\Delta T_B}\right)} = \frac{\Delta T_A - \Delta T_B}{\ln \Delta T_A - \ln \Delta T_B}$$

where ΔT is the temperature difference between the two streams at end A, and ΔTis the temperature difference between the two streams at end B. With this definition, the LMTD can be used to find the exchanged heat in heat exchanger:

$$Q = U \times Ar \times LMTD$$

where Q is the exchanged heat duty (in watts), Uis the heat transfer coefficient (in watts per kelvinper square meter) and Ar is the exchange area.
If duty is not District Cooling, industrial applications cost/benefit better ratio in PHE is usually when LMTD is equal to 5.
Therefore if Process Engineer is asking for LMTD 3 show always LMTD 5 option: CapEx will result more convenient!

High & Low Theta Heat Exchanger Plates



#9 Plate Pack mixing: with different chevron angle required thermal length can be achieved (NTU) with consequent minor Heat Transfer Area.

This is good for calculation...what about maintenance ? How plate assembly will be correct in field if mixing is 72/28? Double check increase of HTA in case of 100% plate H theta or L theta and 50/50 (M channel). Maintenance Manager will be happy and will spread idea that your PHE's are easy to assembly....

#10 Pressure Vessel Code in Oil & Gas application typical requirement is ASME VIII Div.1 with U stamp and nozzle load calculation according to API 662 table 2 severe conditions. In PHE design this include extra costs for material (SA-516 Gr.70 for frame, SA-193 Gr.B7 for bolts, SA-194 Gr. 2H for nuts etc.) even if you mentioned according to ASME VIII Div. without U stamp.
Verify on data sheets required code, otherwise you will in trouble!

Taking into consideration these 10 Big Mistakes to avoid you will be ready to design every kind of Plate Heat Exchangers....good calculations!