What is the most important factor that you are looking for when selecting a Heat Exchanger?

- Size?
- Weight?
- Length?
- Hold-up volume?
- Cost?

All of them !!!
Tranter International
Middle East & Africa Region

Ashwin Bawankule
Assistant Manager Sales – Middle East & Africa
Agenda

- Basics of Heat Transfer
- Performance of Heat Exchanger
- Typical Discussions / Concerns
- Code Compliance
- New GT Plate Series
Law of Heat Transfer

Heat flows from **HOT** => **COOL** medium

Energy rejected from HOT side = Energy absorbed by COLD side

(.......minus losses to the surroundings)
Heat Load and Heat Balance

The heat balance of a heat exchanger is:

\[ Q_H = m_H \times C_{p_H} \times \Delta T_H \] for hot side

\[ Q_C = m_C \times C_{p_C} \times \Delta T_C \] for cold side

\[ Q_H = Q_C \]
Heat Load

\[ Q = U \times A \times \text{LMTD} \]

- \( Q \) - Heat Load
- \( U \) - Heat Transfer Co-efficient
- \( A \) - Area
- \( \text{LMTD} \) - Log Mean Temperature Difference
Heat Transfer Co-efficient

$h_h$ & $h_c$ - Heat Transfer Film Coefficients for hot side & cold side

t - Thickness of plate

$k$ - Thermal conductivity of plate

$R_f$ - Fouling resistance

\[
U = \frac{1}{\frac{1}{h_h} + \frac{1}{h_c} + \frac{t}{k} + R_f}
\]
Logarithmic Mean Temperature Difference

\[
\text{LMTD} = \frac{\Delta_A - \Delta_B}{\ln \left( \frac{\Delta_A}{\Delta_B} \right)} \quad [\degree C]
\]
Effect of LMTD

High Θ
Tall plate or multi-pass.
“Difficult” job, requires more area for fixed heat load and flow rates.

Low Θ
Short plate and single pass.
“Easy” job, requires less area for fixed heat load and flow rates.
Thermal Length & Plate Length
Relation Between Heat Transfer And Pressure Drop

\[ U \sim (\Delta p)^{1/3} \]

Pressure drop, \( \Delta p \) = “price” you must pay for the heat transfer

High pressure drop \( \Rightarrow \) high velocity \( \Rightarrow \) high U-value \( \Rightarrow \) smaller unit

........BUT higher pumping cost (for very high \( \Delta p \) )
Relation Between Heat Transfer And Pressure Drop

\[ U \sim (\Delta p)^{1/3} \]

Required heat transfer area vs. pressure drop
GPHE Product Range

35 Different sizes of heat exchanger plates

Smallest Model GC-12
HTA = 0.03 m²

Largest range of plates available in the market

Largest Model GL-430
HTA = 4.63 m²
Performance of Heat Exchanger
**Performance of Heat Exchanger**

Heat Exchanger Performance =

Thermal Performance (Thermodynamic)

(Pressure drop, heat Transfer) +

Mechanical Performance

(Design Pressure and Temperature, Particular Codes, Special requirements etc..)
## Case Study for Pressure Drop

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Cold in</th>
<th>Cold out</th>
<th>Cold flow</th>
<th>Hot In</th>
<th>Hot out</th>
<th>Hot flow</th>
<th>PD Cold</th>
<th>PD Hot</th>
<th>LMTD</th>
<th>Heat duty</th>
<th>Model</th>
<th>Price</th>
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<tr>
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<td>0°C</td>
<td>0°C</td>
<td>Lps</td>
<td>0°C</td>
<td>0°C</td>
<td>Lps</td>
<td>kpa</td>
<td>Kpa</td>
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<td>13.33</td>
<td>40</td>
<td>14.44</td>
<td>5.55</td>
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</table>
\[ U \sim (\Delta p)^{1/3} \]

\[ Q = U \ast A \ast LMTD \]
## Case Study for LMTD

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</table>
Q = U * A** LMTD
Parameters affecting cost of heat exchanger

- **Design Pressures and Temperatures:**
  - Higher the pressure & temperatures, higher the cost
  - May require thicker materials, thicker frames, larger bolts

- **Manufacturing to particular codes**
  - Special material may be needed, adds costs
  - May increase lead time

- **Special Requirements**
  - Painting, Coating
  - SS Bolts, Complete SS Carrying and Guide bar
Typical Discussions / Concerns
Typical Discussions / Concerns

- Fouling factor
- Flow direction
- Gaskets fixing means
- Weight of heat exchanger
- Codes / standards
**Fouling Factor**

Fouling Margin

The purchaser shall specify a percentage of fouling margin, $F$, calculated by

$$F = \left( \frac{U_{\text{clean}}}{U_{\text{service}}} - 1 \right) \times 100$$

Where $U$ is the heat transfer co-efficient (overall thermal transmittance)
Fouling Factor – A Self Fulfilling Prophecy

Comparison of fouling resistance in PHE to tube-side fouling resistance (Müller-Steinhagen, 2006).
**Fouling Factor**

By adding a fouling factor in PHE’s, overall heat transfer co-efficients could be lowered significantly as increasing the heat transfer area required.

Increased area is generally achieved by adding plates to the heat exchanger.

Additional plates will reduce the flow rate per channel, increasing the fouling possibility.

One possibility is to increase the length of the plate. This will maintain the velocity and eliminate the over performance issues of added plates. However, this will increase the pressure the pressure drop but will not eliminate the issue of potential fouling.

**Bottom line:** advise not to add fouling factor. If you have to it should be kept to a minimum and achieved by increasing plate length.
Flow Direction

- Co-Current Flow
- Counter-Current Flow
- Parallel Flow
- Diagonal Flow
Flow Direction

Different Flow Direction

Counter-Current Flow

Same Flow Direction

Co-Current Flow
Flow Direction

Diagonal Flow

Parallel Flow
Flow Direction

Counter Current Diagonal Flow

Counter Current Parallel Flow

Co-current Diagonal Flow

Co-current Parallel Flow
Parallel versus Diagonal Flow

- Simple piping for individual unit
- Simpler layout for hygienic service
- Standardization
Parallel versus Diagonal Flow

- Better distribution
- Better heat transfer
- Simple pipeline
- Identical plates
- NO crossover of pipes

It is only inside the heat exchanger that flow travels **diagonally**
Parallel versus Diagonal Flow

• Pipe connected to headers in case of diagonal / parallel flow.
• Overall pipeline layout in plant room will be same.
• Pipeline DO NOT CROSS.
• Overall simplicity or complexity is same in case of diagonal / parallel flow
Parallel versus Diagonal Flow

Parallel Flow

Diagonal Flow
Glued versus Clip-on gaskets

- **Clip-on gasket**
  - Easy to fix on the plate
  - Extra glue not required
  - Some fear of “reaction” with glue....!

- **Glued gasket**
  - Easy to assemble the heat exchanger
  - Easy to disassemble the heat exchanger
Glue / clip / button on the gasket plays NO role in performance of the heat exchanger.
Gasket Fixing Means

- Purpose of gaskets in PHE is to ensure that the gasket fixed onto the plate will remain in its place ONLY until the unit is assembled/tightened.

- Glue / clips play NO role in an assembled unit during normal operation.

- Glue / clips DOES NOT take part in thermal performance of PHE.
Gasket Fixing Means

- Clips / glue are useful ONLY at the time of unit assembly / maintenance.
- In assembled heat exchanger clips / glue is of no use.
Typical Clip-on Gasket
Recently Executed Projects

with Clip-on, Glued, Diagonal and Parallel Gaskets

- Doha Oasis Mixed Used Development
- Lusail Rail Transit Depot
- Abdul Wahab Gholam Hotel And Residential Apartment Tower
- Qatar Foundation / Education City Stadium
- Qatar Academy Expansion – Middle School
- ISF Camp
Weight of Heat Exchanger
Weight of Heat Exchanger

Weight of Heat Transfer plates
  +
Weight of Gaskets
  +

Weight of Frame
  
  Weight of Fixed Cover
    +
  Weight of Removable Cover
    +
  Weight of Support Column
    +
  Weight of Guide Bars
    +
  Weight of Tightening Bolts
Weight of heat exchanger (1700 kg) = Frame (1250 kg) + HT plates & gaskets (450 kg)
Code Compliance
Code Compliance

- **ASME / PED**
  - Objective to ensure strong mechanical design
- **ASME involves AI**
- **PED self governed**
- **Customization possible in ASME**
- **Only Pre-approved designs in PED**

- **Exclusions**
  - **HEAT TRANSFER**
  - Pressure drop
  - Fouling
  - Ease of Maintenance / Service
Code Compliance

- ASME / PED
  - Same heat transfer
  - Same heat transfer plates
  - Same gaskets
  - Pre-approved MOC for frames only
  - Pre-approved design / thickness for frame only
  - Pre-approved ITP / QAP
Code and Standards

- TEMA
  - Tubular Exchanger Manufacturer’s Association
- API 662
  - General refinery services
- EN 1148
  - Water to water heat exchangers for district heating
- PTC 12.5
  - Power test code
ARI 400 versus AHRI Certified

- ARI 400
  - Standard on performance rating & tests
- AHRI Liquid / Liquid Heat Exchangers Certification Program
  - Performance certified by AHRI

Is not same as

“in accordance with AHRI standard 400”
AHRI Certified

- Units certified by AHRI displayed in the directory (AHRI homepage)
- Certified models must have a unique denomination
- AHRI has got a version of all manufacturers selection software's
  - Customers can contact AHRI and verify specifications
  - The software is used to generate all duties for tests
  - Tests verify that the software within tolerances
- Changes in selection software and rerates published in directory
- AHRI certification limited to only thermal performance
- Has no connection to pressure vessel regulation
AHRI Certified PHEs

Lusail Rail Transit Depot Project

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity of each unit, KW</th>
<th>Qty</th>
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</thead>
<tbody>
<tr>
<td>GC-044</td>
<td>298</td>
<td>2</td>
</tr>
<tr>
<td>GC-044</td>
<td>453</td>
<td>2</td>
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<tr>
<td>GC-044</td>
<td>417</td>
<td>3</td>
</tr>
<tr>
<td>GC-044</td>
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<td>2</td>
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<tr>
<td>GX-091</td>
<td>1,853</td>
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</tr>
<tr>
<td>GX-091</td>
<td>2,417</td>
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</table>
New GT Plate Series
New GT Series

Tranter, has introduced the new GT series of plate & frame heat exchangers

- Available globally
- Offering a significant boost in heat exchanger Performance and unit integrity
- Includes models GT-155, GT-160 and GT-165
## New GT Series

<table>
<thead>
<tr>
<th>Feature</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>HydroFit™</td>
<td>Variable draw depth to help distribute flow from port to heat transfer area</td>
</tr>
<tr>
<td>OmniFlex™</td>
<td>Flatter plates. No dead areas on plate. Results in better heat transfer</td>
</tr>
<tr>
<td>Halo™</td>
<td>Plate alignment feature common to ThermoFit™ plate range</td>
</tr>
</tbody>
</table>

[Image of GT Series plate layout]
**HydroFit™**

Variable draw depth to help distribute flow from port to heat transfer area, HydroFit™ flow distribution allows for:

- better flow across plates
- more efficiency
- reduced fouling

![Diagram of Heat Exchanger](Image)
OmniFlex™

Unique heat transfer area pattern provides:

- Better plate flatness because plates are more evenly strained during pressing
- Even fluid flow (no dead areas) caused by the “V” in the chevron
- Improved mechanical contacts
Halo Plate Alignment system accurately captures the plates and gaskets it comes in contact with

- Plate-to-Plate nesting
- Optimal Plate Alignment
- Exceptional Strength
Overview of GT-155/160/165 Plates

Available Industrial Codes

- AHRI Standard 400 certified
- ASME Section VIII Division 1 with U-1 Stamp certification
- Canadian CRN
- EC Pressure Equipment Directive CE Mark
- China ML

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Diameter</td>
<td>mm</td>
<td>150</td>
</tr>
<tr>
<td>Draw Depth</td>
<td>mm</td>
<td>2.3</td>
</tr>
<tr>
<td>Width</td>
<td>mm</td>
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</tr>
<tr>
<td>Length</td>
<td>mm</td>
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<tr>
<td></td>
<td>mm</td>
<td>1853</td>
</tr>
<tr>
<td></td>
<td>mm</td>
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<tr>
<td>Thickness</td>
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<td></td>
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<td></td>
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<tr>
<td></td>
<td>mm</td>
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THANK YOU

QUESTIONS ....