Heat Pump - Industrial Applications

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Agenda

- Introduction to EM3
- What is a Heat Pump
- Different Applications for Heat Pumps
- Types of Heat Pumps
  - Grade of heat
  - Scale
  - Refrigerants
  - Maintenance
- Economics
- Financial Support
  - EEOS
  - SSRH - Support Scheme for Renewable Heat (RoI)
  - RHI - Renewable Heat Incentive (UK)
Who are we?

- Ireland’s largest Industrial Energy Services company
- 40 Full time employees
- Rapid Growth since 2014
- Provide energy management services to companies with €540 Million energy spend globally
- Very Strong Process and Utilities expertise
- Science based engineering and energy opportunity analysis – Data Scientists supporting Engineering team
- Opening Chicago office in 2020
Heat Pump Projects of Interest

- **Munster Dairy Plant** - 1,400 kW Heat Pump - Commissioned Q4 2019
  - Concept Design, Detailed Design, Construction, Commissioning & Verification

- **Scotland - RHI Project** - Heat Pump, CHP, Heat Recovery & RHI
  - Concept Design, Detailed Design, Construction, Commissioning & Verification

- **Munster - New Cheese Plant** - Design 2020
  - Concept Design of utilities including Heat Pumps, CHP and Chillers

- **The Netherlands - Nutrition Facility** - Heat Pump System Design
  - Design of Heat Pump to recover heat from process cooling circuit and deliver low grade hot water for process heating

- **North West Ireland** - Heat Pump System Design
  - Design, construction and commissioning of Heat Pump system to recover heat from cooling tower circuit and deliver low grade hot water for process heating

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What is a Heat Pump?

At its simplest, a heat pump is a refrigeration system operating at elevated pressures in order to make the heat that is normally dumped from the condenser, usable for beneficial heating.
Heat Pump Applications

- Obviously the use of Heat Pumps is extensive - everything from condensing clothes dryers to home and office heating
- The big industrial applications for heat pumps though can be any form of low grade heating

- Wash Water - Power washing of food processing areas
- CIP water Pre heating - most CIP systems use cold water
- Dehumidification - using heat pump output in reheat coils
- Dryer pre-heating
- Process cooling/heating
- LPHW Systems for space heating/HVAC
Wash Water Systems

- Wash Water - Power washing of food processing areas
- Up to 100 m³/day used in some facilities
- Water typically heated from cold
- Heat Recovery can get part of the way
- Heat Pumps can provide a very cheap source of heat
LPHW Systems

- If LPHW Systems are sized for <65°C
- Heat Pumps can be a very efficient form of heat generation
- Conventional LPHW system design
- Sources of heat need to be there when the heating is required
  - Cooling Tower Heat
  - Combined Cooling & Heating - Chilled water
  - Other low-grade waste heat source
Recip Industrial

- Same concept as the ammonia packaged chillers
- Medium Cost option
- Process genesis
- Maintenance is high

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Cost</th>
<th>Grade of Heat</th>
<th>COP</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH3 (0 GWP)</td>
<td>Low</td>
<td>&lt;65°C</td>
<td>Medium</td>
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</table>

W = Heat pump unit water/water.
All data and nominal capacities kW at 1800 rpm.
All HeatPACs: 60 Hz or VSD operation possible.
Economics

Exercise 1 - with current steam and Elec costs - when is it economical to use Heat Pumps

Thermal Cost per kWh Calculator

<table>
<thead>
<tr>
<th>EFFICIENCY OF SYSTEMS</th>
<th>Ice Water COP</th>
<th>Thermal/Electrical Ratio CHP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam LPHW MHW</td>
<td>4</td>
<td>1.1</td>
</tr>
<tr>
<td>90% 95% 90% 42%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std HP</td>
<td></td>
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Thermal Generating Equipment

<table>
<thead>
<tr>
<th>Thermal Generating Equipment</th>
<th>Cost per kWh Thermal Energy</th>
<th>Investment Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regeneration Displacing Steam and Ice Water</td>
<td>€ 0.049</td>
<td>€</td>
</tr>
<tr>
<td>Regeneration Displacing LPHW and Ice Water</td>
<td>€ 0.048</td>
<td>€</td>
</tr>
<tr>
<td>Heat Recovery Displacing Steam</td>
<td>€ 0.028</td>
<td>€</td>
</tr>
<tr>
<td>Heat Recovery Displacing LPHW</td>
<td>€ 0.025</td>
<td>€</td>
</tr>
<tr>
<td>Heat Pump with beneficial Cooling</td>
<td>€ 0.007</td>
<td>€</td>
</tr>
<tr>
<td>CHP</td>
<td>€ 0.023</td>
<td>€</td>
</tr>
<tr>
<td>LPHW</td>
<td>€ 0.026</td>
<td>€</td>
</tr>
<tr>
<td>MHW</td>
<td>€ 0.028</td>
<td>€</td>
</tr>
<tr>
<td>Steam</td>
<td>€ 0.028</td>
<td>€</td>
</tr>
<tr>
<td>Standard Heat Pump</td>
<td>€ 0.017</td>
<td>€</td>
</tr>
</tbody>
</table>

Investment Cost per kWh Output Capacity

| € 25,000 | Units | 1 |

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**Economics**

**Single Screw:**
- Heating Capacity: 1,376 kW
- Heating COP: 3.9
- Cooling COP: 2.9
- Combined COP: 6.8
- Electricity Consumed: 2,084,000 kWh
- Heat Generated: 8,078,000 kWh
- Electrical Balanced Cost: €52,000 (electricity consumed - CHW equivalent)
- Gas Cost Savings: €315,000

**Twin Screw:**
- Heating Capacity: 1,441 kW
- Heating COP: 3.6
- Cooling COP: 2.5
- Combined COP: 6.1
- Electricity Consumed: 2,367,000 kWh
- Heat Generated: 8,494,000 kWh
- Electrical Balanced Cost: €81,000 (electricity consumed - CHW equivalent)
- Gas Cost Savings: €331,000

**Recip Industrial:**
- Heating Capacity: 1,400 kW
- Heating COP: 3.4
- Cooling COP: 2.5
- Combined COP: 5.9
- Electricity Consumed: 2,417,000 kWh
- Heat Generated: 8,276,000 kWh
- Electrical Balanced Cost: €86,000 (electricity consumed - CHW equivalent)
- Gas Cost Savings: €323,000

**CO2 Heat Pump:**
- Heating Capacity: 1,460 kW
- Heating COP: 3.9
- Cooling COP: 2.9
- Combined COP: 6.8
- Electricity Consumed: 2,070,000 kWh
- Heat Generated: 8,070,000 kWh
- Can only heat cold water - no LPHW
- Electrical Balanced Cost: €50,500 (electricity consumed - CHW equivalent)
- Gas Cost Savings: €314,000
HEAT PUMP PROJECT

UPGRADE
Installation of 1,400kW Heat Pump for Generation of LPHW & CHW. This provides 1,400kW of LPHW & CHW and reduces the load on less efficient steam boilers. Heat Recovery Project with 3.3-year payback.

PROJECT
Commissioned in 2019

PROCESS
Evaporation, Drying and Packaging process

PLANT

3.3 Years Payback  IRR: >30%

ENERGY SAVINGS – 15.8 million kWh

FINANCIAL SAVINGS - €372,000

CO₂ – 2,850 tonnes
**UPGRADE**

**PROJECT**
Commissioned in 2017

**PROCESS**
Blending, drying and packaging processes

**PLANT**
Food Ingredient Factory

**INSTALLED**
- 1 x 1,050 kW Heat Pump
- 200m³ Hot Soft water Buffer Tank
- 1,200 KW CHP Unit
- 1,000 kWh LPHW Boiler

**GAS USAGE**
\( \text{p.a (BOD)} \)

- 3.3 Years Payback
- IRR: >42%
- FINANCIAL SAVINGS - £1 million p.a.
- \( \text{CO}_2 – 4,850 \) tonnes

**HEAT RECOVERY PROJECT** (RHI SCHEME)

**FINANCIAL SAVINGS**
£1 million p.a.

**CO\(_2\)**
4,850 tonnes

**3.3 Years Payback**
IRR: >42%

**INNOVATIVE ENERGY SOLUTIONS**
Financial Support

- EEOS - Energy Efficiency
- SSRH - Support Scheme for Renewable Heat (RoI)
- RHI - Renewable Heat Incentive (UK)
Questions?