UTILIZATION OF THERMAL ENERGY TO INCREASE SYSTEM EFFICIENCY

FLORØ 18-19 SEPTEMBER 2019
MMC FIRST PROCESS IS A NORWEGIAN COMPANY.

We are totally transforming the seafood industry by offering complete and sustainable system solutions for the handling, processing and cooling of fish to the seafood industry onshore and offshore - worldwide.
Our vision is to transform the world’s seafood industry so it can manage nature’s marine resources in a more sustainable and environment-friendly manner, and thereby create added value for businesses and society at large.
THE COMPANY

The most complete supplier of total system solutions for handling of seafood to the fishery and aquaculture industries at sea and on shore

Unmatched competence and range of technology within fish handling, processing and refrigeration

Based in Norway with 160 employes in Fosnavåg, Ålesund and Haugesund

3 in 1 => Power in One – a Complete Gamechanger

New building in Aalesund ready 26th of September 2019
2200m2 workshop. 2100m2 office and administration
View from my office
AQUACULTURE

ON BOARD
FISH HANDLING AND PROCESSING

ONSHORE
FISH HANDLING AND PROCESSING

SYSTEM SOLUTIONS BY INDUSTRY
TECHNOLOGY
COMPLETE SYSTEM SOLUTIONS

- Logistics & Handling
- Processing
- Refrigeration
- Energy Optimization
- Water Treatment
- Automation & Control
ENERGY ONBOARD A SHIP
HYDROGEN FUEL CELL

- Efficency:
  - Electricity 50-60%
  - Waste energy 40-50% @ temperature 70-80 gr.C

- How can we utilize this waste energy on ships???
THERMAL ENERGY SYSTEM

- VCR Heat Pump
- Freezing
- Cooling
  - HVAC
  - LT Cooling
  - Energy storage
  - Dump cooling
- Fuel Cell
- LT Cooling system
- Direct heating
  - General heating
  - HVAC
  - Energy storage
  - Dump heating
HOW MUCH WASTE ENERGY CAN BE RECOVERED??

- Depends on:
  - Operational profile, type of ship, sailing route, speed etc.
  - Ambient temperature in air and sea during a year
  - Energy generator and configuration
  - Energy consumers and configuration
  - Energy storage facilities
  - Crew awareness on energy use
## Energy Savings – Operational Profile

### Total Savings kWh, Color Hybrid, 2x Sandefjord-Strømstad

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Total</th>
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<tr>
<td>Energy from Climeon</td>
<td>10 529</td>
<td>10 427</td>
<td>25 641</td>
<td>40 205</td>
<td>55 641</td>
<td>62 070</td>
<td>68 635</td>
<td>64 919</td>
<td>52 569</td>
<td>39 203</td>
<td>25 341</td>
<td>12 455</td>
<td>467 633</td>
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<tr>
<td>Reduced Energy by for Adsorption Cooling</td>
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<td>Energy from Diesel engines</td>
<td>1 590 662</td>
<td>1 435 810</td>
<td>1 575 550</td>
<td>1 509 335</td>
<td>1 545 550</td>
<td>1 487 470</td>
<td>1 532 556</td>
<td>1 536 273</td>
<td>1 496 971</td>
<td>1 524 199</td>
<td>1 588 737</td>
<td>18 385 103</td>
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<td>Energy in propulsion loss</td>
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<td>46 176</td>
<td>51 124</td>
<td>49 475</td>
<td>51 124</td>
<td>49 475</td>
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<td>51 124</td>
<td>49 475</td>
<td>51 124</td>
<td>601 940</td>
<td>-</td>
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<tr>
<td>Propulsion Energy kWh</td>
<td>1 900 197</td>
<td>1 716 307</td>
<td>1 900 197</td>
<td>1 838 900</td>
<td>1 900 197</td>
<td>1 838 900</td>
<td>1 900 197</td>
<td>1 838 900</td>
<td>1 900 197</td>
<td>1 838 900</td>
<td>1 900 197</td>
<td>22 373 283</td>
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</table>

### Heating effect shore power

- Utilized Energy from HT system for HVAC heating: 837 543, 749 656, 712 896, 542 656, 398 583, 265 486, 193 996, 226 379, 356 145, 546 426, 663 841, 817 297, 6 310 904
- Utilized Energy from LT system for HVAC pre-heating: 161 859, 146 212, 132 145, 92 630, 59 255, 31 790, 16 404, 22 980, 50 953, 92 376, 121 488, 138 574, 1 688 666
- LT cooling energy balance (Waste energy to sea): 104 967, 94 625, 101 364, 95 812, 96 879, 93 648, 95 168, 95 745, 94 102, 99 169, 98 515, 104 582, 1 174 610

### Total savings

- 1 011 932, 906 295, 870 681, 875 496, 511 475, 359 346, 270 036, 314 278, 459 667, 678 005, 830 070, 988 126, 7 667 024

### Additional savings Absorption chiller

- 62 070, 68 635, 64 919, 52 569, 248 192

### Other Parameters

- Sea Water Temperature: °C
- Outside Air temperature: °C
- Ambient Design temperature: °C
- Inside air temperature: °C
- GT Air temperature: °C
- RH load for heating: °C
- Max load LT pre-heating HVAC: 994 kW
- Max load HT heating HVAC: 650 kW
- Misc heating fixed: kW
- Misc heating temp dependent: kW
- Specific heat capacity water/glycol 30%: 3994 J/kgK
- Max. Temperature in Accu. Tank: °C
- Min. Temperature in Accu. Tank: °C
- System Volume: 350 m³
- Propulsion loss: 3 %
THERMAL ENERGY STORAGE - OPERATIONAL PROFILE

Temperature in accu.tank

- January
- February
- March
- April
- May
- June
- July
- August
- September
- October
- November
- December
<table>
<thead>
<tr>
<th>Waste Energy Management System</th>
<th>Color Hybrid</th>
<th>2x Sandefjord - Strømstad</th>
<th>2x Strømstad - Sandefjord</th>
<th>Night time</th>
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<tr>
<td>Capacity</td>
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<td>16</td>
<td>16</td>
<td>6</td>
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<tr>
<td>Measuring In</td>
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<td>16</td>
<td>16</td>
<td>6</td>
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<tr>
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<td>61</td>
<td>61</td>
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<tr>
<td>Transit speed</td>
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<tr>
<td>Slow down</td>
<td>710</td>
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<tr>
<td>Port Unloading</td>
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<tr>
<td>Transit Out</td>
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<td>Port Unloading</td>
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<tr>
<td>Port in</td>
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<td>Night time</td>
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<tr>
<td>Additional heating effect (kW) to/from system volume (approx. 350m³)</td>
<td>kWh</td>
<td>-32</td>
<td>-31</td>
<td>-30</td>
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<td>---</td>
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<tr>
<td>Energy to/from system volume kWh</td>
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<td>-32</td>
<td>-31</td>
<td>-30</td>
</tr>
<tr>
<td>Corrected Energy to/from system volume kWh</td>
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<td>-52</td>
<td>-52</td>
<td>-52</td>
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<tr>
<td>Energy level in system volume, (350m³, 90 35 deg C)</td>
<td>kWh</td>
<td>70.1</td>
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<td>LT cooling effect balance</td>
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<td>Actual temperature in system volume (accu. tank)</td>
<td>kWh</td>
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<tr>
<td>Corrected temperature in system volume (accu. tank)</td>
<td>kWh</td>
<td>76.7</td>
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</tbody>
</table>

**Further Information**

- **LT Cooling effect balance**
- **Utilized Effect from LT system for HVAC pre-heating**
- **Corrected Energy to/from system volume**

**Energy Savings – Operational Profile August**

- **Energy to/from system volume kWh**
- **Corrected Energy to/from system volume kWh**

**Technical Details**

- **Energy level in system volume, (350m³, 90 35 deg C)**
- **Corrected energy level in system volume**
- **LT cooling effect balance**
- **Actual temperature in system volume (accu. tank)**
- **Corrected temperature in system volume (accu. tank)**

**Miscellaneous**

- **LT cooling effect balance**
- **Utilized Effect from LT system for HVAC pre-heating**
- **Corrected Energy to/from system volume**

**Additional Information**

- **Sea Water Temperature**
- **Outside Air temperature**
- **Ambient Design temperature**
- **Inside air temperature**
- **LT Air temperature**
- **% load for heating**
- **Max load LT pre-heating HVAC**
- **Max load HT heating HVAC**
- **Misc heating fixed**
- **Misc heating temp dependend**
- **Specific heat capacity water/glass 39%**
- **Max. Temperature in Accu. Tank**
- **Min. Temperature in Accu. Tank**
- **System Volume**
- **Propulsion loss**

**Units**

- **kWh**
- **°C**
- **m³**

**Values**

- **10.4**
- **16.5**
- **20**
- **1.5**
- **9**
- **1.5**
- **76**
- **150**
- **3936**
- **90**
- **350**
- **3%**
I BELIEVE IN HYDROGEN AS AN ENERGY CARRIER

Thank you for your attention!
A COMPLETE GAME CHANGER