Aspects of energy efficient use of port installations

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Agenda

- The chair for materials handling, material flow, logistics
- Why to aim an energy efficient use of equipment
- Selected examples of technical equipment for energy-efficient handling
- Comparison of handling appliances used in transhipment with the regard to productivity and energy use
fml – Chair for materials handling, material flow, logistics

42 members of staff
- 18 established post
- 24 third-party funds employees

Responsibilities
- Research
- Teaching
- Industrial projects
Research profile

Areas of Work:
- Automation & Identification
- Calculation & Design
- Digital Tools & Simulation
- Methods & Concepts

Research focuses:
- Changeable material flow systems
- "Internet of things"
- RFID in logistics
- Virtual and Augmented Reality
- Logistics planning
- Automotive logistics
- Construction logistics
- Conveyors in Intralogistics
- Storage & order picking systems
- Crane engineering & Design of load-supporting structures
- FEM-Analysis & Multi-body simulation
- Bulk material conveyance
Research profile

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Research focuses:

Bulk material conveyance

![Image of a bulk material conveyance system]
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Increasing of energy costs

History of energy costs in Europe
Index Jan 2002 = 100%

References: OPEC, Eurostat

Electricity & Natural gas

Crude oil

Electricity
Natural gas
Crude oil

0% 100% 200%
300%
400%
500%

0% 100% 200%
300%
400%
500%

Greenhouse gas CO$_2$

If we don’t reduce the CO$_2$-output by 50% until 2050, parts of earth will possibly be uninhabitable.

Since begin of industrialisation the CO$_2$ in our atmosphere increased by 30%, half of it since 1970!

The increase of the CO$_2$-concentration is linked to the expected climate change.

The most important way to protect our climate is an efficient use of energy! Thus climate protection is also self-interest.

If everyone reduces his climate contamination by 10%, this will relate to the total amount of Spain and Finland together.

Most of our energy sources consist of carbon.

In the Kyoto Protocol the industrial countries committed bindingly to reduce greenhouse gases in the EU by 8% between 2008 and 2012 under the 1990 level.

References: Max-Planck-Gesellschaft, BayLfU
Power consumption at the bulk cargo- and container handling

**Container handling:**
**German Seaport, 5.3 Mio TEU annual handling volume**
- Diesel e.g. for the use of industrial trucks
- Consumption about 3.4 l/TEU (about 0.36 l/t)
- Electricity, e.g. gantry crane, lightning
- Consumption about 16.7 kWh/TEU (about 1.76 kWh/t)

**Bulk cargo handling:**
**German Seaport, 2.4 Mio t annual tonnage**
- Diesel e.g. for the use of industrial trucks and wheel loader
- Consumption about 0.22 l/t
- Electricity, whole port facility
- Consumption about 2.7 kWh/t

References: ZDS
Energy users in harbours

- Ship discharge
- Conveying upon silo
- Quay conveying
- Other consumption
- Silo conveying technique
Power consumption of a storekeeper for agribulk commodities

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship discharge</td>
<td>41.1 %</td>
</tr>
<tr>
<td>Quay conveying</td>
<td>7.0 %</td>
</tr>
<tr>
<td>Vertical conveyor upon silo</td>
<td>11.7 %</td>
</tr>
<tr>
<td>Silo conveying technique</td>
<td>11.5 %</td>
</tr>
<tr>
<td>Other consumption</td>
<td>28.7 %</td>
</tr>
</tbody>
</table>

As percentage of the total energy consumption
Energy use in the industry

Example Germany:

Electric motors as main energy source is used in electric motors by over 60%.

References: Umweltbundesamt
Prospects of energy efficient use of equipment

About 25% of the current consumption of electric motors can be saved by economic profitable actions (RoI < 2 or 3 years)!

→ Altogether about 10% of the total current consumption of Germany and so operating costs can be saved!

In decisions for electric motors the Life Circle Costs must be noted!

→ Less than 3% of the TCO are acquisition costs, more than 95% are energy costs!

→ Investments in energy efficient motors are amortized in few years.

References: Umweltbundesamt, BayLfU
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Energy efficient electric motors

- New winding technology and alloys for stator sheets
- Improvement of electric motor efficiency from 75% (normal) to 85% (excellent)
- Gearing optimal staged depending on use
- Efficiency optimization over the whole drive chain
- „Soft-Drivemanagement“ and „Power-Save-Strategy“

- Reduce of operating costs by 40%
- Power consumption at electric motors are 98% of the total operating costs

References: Getriebebau Nord, F+H
Energy saving by rotation speed controlled power unit by FC

- Conventional three-phase current drive

  ➔ Connection power ➔ Effective power

  ➔ Idle power

- Frequency converter operated electric drive

  ➔ Power consumption depending on demand

References: F + H
Examples

30% energy saving by change-over to frequency converter

40% energy saving by change-over to frequency converter

References: Thyssen, RWE
New diesel engines

- Multiple injection
- Engine characteristic map controlled
- Modern control electronic
- Aerator engine demand-driven

→ Optimisation of fuel consumption

→ Reduction of exhaust emission by 50%

→ Noise reduction

References: F + H
Improved hydraulic power units

- Reduced leakage current with volumetric efficiency of 95%
- Mechanical efficiency of 85%
- Adjusted globe valves and manometric switches design
- Broad optimum of efficiency over rotation speed
- Downsizing electric motor and pump
- Reducing of cooling

→ Hybrid hydraulic power units combine rotation speed variable, controlled electric motors with hydraulic pumps

→ Saving of energy in operation

References: KEM
Efficiency in energy and data transfer

- Secured energy supply and data transfer
- „Monitored“ energy chains
- Reduced electrical and mechanical resistors

→ Reliability increased
→ Saving of energy

References: F + H
Hybrid technology for forklifts to reduce consumption and CO₂ emission

- Hybrid forklift
- Energy recovery at breaking and load lowering
- Energy storage with better efficiency and power density
- Example: RX70Hybrid / Still 2.5 l Diesel/h (2.5 t, 60 cycles/h as per VDI 2198 new)

1990 – 2008:

→ Reduce of energy consumption of electrical forklifts by 20%
→ Reduce of energy consumption of diesel forklifts by 30%

References: Still
5 Driving programs for optimal initial setting
- Speed control for long distances
- Characteristic curves optimisation of drive
- Intelligent activating of electric components
- Super-Caps as storage for electrical power out of mechanical power

References: Still
Dockside cranes with reduced energy consumption

- Anti-swinging-system
- Intelligent drive control „Eco-Drive“

→ Reducing of diesel consumption up to 30%

- Optimised hydraulic control
- Demand-driven drive control

→ Less energy consumption

References: F + H, Sennebogen
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Only motional and climbing resistances to overcome

Permanent start-up and breaking procedures of discontinuous conveyors are omitted

For bulk cargo handling the continuous conveyors are energetically unbeatable!
### Comparison of continuous ship unloader

<table>
<thead>
<tr>
<th></th>
<th>Chain Type</th>
<th>Screw Type</th>
<th>Pneumatic</th>
<th>Belt Type</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power consumption for conveying [kWh/t]</strong></td>
<td>0.25</td>
<td>0.7–0.8</td>
<td>&gt; 1</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Total Power consumption [kWh/t]</strong></td>
<td>0.4</td>
<td>0.9–1.0</td>
<td>&gt; 1</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Availability of unloader</strong></td>
<td>Very high</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Average Capacity</strong></td>
<td>Up to 85%</td>
<td>75%</td>
<td>55–65%</td>
<td>60–70%</td>
</tr>
<tr>
<td><strong>Material Breakage</strong></td>
<td>Very low</td>
<td>High</td>
<td>Very high</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Dust emission</strong></td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td><strong>Noise emission</strong></td>
<td>Very low</td>
<td>Low</td>
<td>Very high</td>
<td>Low</td>
</tr>
</tbody>
</table>
## Comparison of energy costs

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<tr>
<td><strong>Average efficiency</strong></td>
<td>80 %</td>
<td>75 %</td>
<td>60 %</td>
<td>65 %</td>
</tr>
<tr>
<td><strong>Annual Unloading days</strong></td>
<td>95 d</td>
<td>101 d</td>
<td>126 d</td>
<td>117 d</td>
</tr>
<tr>
<td><strong>Total annual personnel costs</strong></td>
<td>23.438 €</td>
<td>25.000 €</td>
<td>31.250 €</td>
<td>28.846 €</td>
</tr>
<tr>
<td><strong>Power consumption per ton</strong></td>
<td>0.40 kWh/t</td>
<td>0.95 kWh/t</td>
<td>1.00 kWh/t</td>
<td>0.40 kWh/t</td>
</tr>
<tr>
<td><strong>Total annual energy costs</strong></td>
<td>36.000 €</td>
<td>85.500 €</td>
<td>90.000 €</td>
<td>36.000 €</td>
</tr>
<tr>
<td><strong>Total annual Tie-Up costs</strong></td>
<td>3.740.530 €</td>
<td>3.989.899 €</td>
<td>4.987.374 €</td>
<td>4.603.730 €</td>
</tr>
<tr>
<td><strong>Total annual operating costs</strong></td>
<td>3.799.968 €</td>
<td>4.100.399 €</td>
<td>5.108.624 €</td>
<td>4.668.576 €</td>
</tr>
<tr>
<td><strong>Unloading costs per ton</strong></td>
<td>4.22 €/t</td>
<td>4.56 €/t</td>
<td>5.68 €/t</td>
<td>5.19 €/t</td>
</tr>
</tbody>
</table>
Energy savings in the industry are available up to 30% today

- **Efficient devices and efficient installation**
  - Saving potential: 10% to 15%

- **Optimized usage of installation and devices**
  - Saving potential: 5% to 15%

- **Controlling, monitoring and audit**
  - Saving potential: 2% to 8%
Let’s do it!
Save the world and make money!

Thank you for your attention!