Welcome

Choo, WoonFu
Woonfu.choo@siemens.com

Industry Sector
Industry Automation Division
Vertical Glass & Solar

Waste Heat Recovery (WHR) for the glass industry

- Why WHR
- How does it work
- Where is it in operation
- Siemens concept for WHR within plant wide integrated automation solution

Waste Heat Recovery is one of many solutions to save energy in the glass industry

- Why WHR
- How does it work
- Where is it in operation
- Siemens concept for WHR within plant wide integrated automation solution

Energy consumption in the glass industry

Approximately 512 TWh/a of energy are consumed in the glass industry worldwide.
- 128 TWh/a for electrical Energy
- 384 TWh/a for fossil Energy

Environmental concerns
Approximately 203 to 1000 kg of CO2 / 1000 kg of glass produced.

Total energy consumption in the glass industry
(In comparison with other countries)

<table>
<thead>
<tr>
<th>Rank Country</th>
<th>WHa</th>
<th>Date of Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 China</td>
<td>6,898,000,000</td>
<td>2011</td>
</tr>
<tr>
<td>2 United States</td>
<td>5,771,000,000</td>
<td>2009 md.</td>
</tr>
<tr>
<td>3 Japan</td>
<td>2,007,000,000</td>
<td>2009 md.</td>
</tr>
<tr>
<td>4 Russia</td>
<td>897,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>5 India</td>
<td>800,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>6 Canada</td>
<td>560,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>7 Germany</td>
<td>560,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>8 France</td>
<td>400,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>9 Australia</td>
<td>800,000,000</td>
<td>2011 md.</td>
</tr>
<tr>
<td>10 Brazil</td>
<td>116,000,000</td>
<td>2006 md.</td>
</tr>
<tr>
<td>11 Indonesia</td>
<td>126,000,000</td>
<td>2008 md.</td>
</tr>
<tr>
<td>12 Vietnam</td>
<td>11,500,000</td>
<td>2011 md.</td>
</tr>
<tr>
<td>13 Malaysia</td>
<td>9,000,000</td>
<td>2009 md.</td>
</tr>
<tr>
<td>14 Philippines</td>
<td>56,000,000</td>
<td>2015 md.</td>
</tr>
<tr>
<td>15 Thailand</td>
<td>20,000,000</td>
<td>2012 md.</td>
</tr>
</tbody>
</table>

With the assumption of 5% saving

5% of 128 TWh/a Electrical Energy
→ 6 TWh/a Energy saving

It could sustain approximately a city with 5 million inhabitants for their electricity consumption.

<table>
<thead>
<tr>
<th>P &amp; O</th>
<th>Population (Inhabitants)</th>
<th>Electricity use per capita (World Ave)</th>
<th>Consumption TWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOME</td>
<td>7.2M</td>
<td>613 KWh</td>
<td>4.887</td>
</tr>
<tr>
<td>APN</td>
<td>818 KWh</td>
<td>615 KWh</td>
<td>4.880</td>
</tr>
</tbody>
</table>

Source: Website of Central Intelligence Agency
Waste Heat Recovery

- Why WHR
- How does it work
- Where is it in operation
- Siemens concept for WHR within a plant-wide integrated automation solution

Waste heat recovery plant

Modular Equipment – Waste Heat Recovery Boiler

Modular Equipment - Condensation

Water-cooled vacuum condensation with cooling tower

Modular Equipment – Steam turbine with generator
Example for a conventional float glass furnace:
- Waste heat flow: 80,000 Nm³/h
- Temperature: 450°C
- Electrical power output: 2 MW

Example for two hollow glass furnaces (combination of the 2 waste gas flows on 1 boiler, see next slide / 2 lines concept, alternative 2):
- Waste heat flow: 48,000 Nm³/h + 60,000 Nm³/h
- Temperature: 400°C
- Electrical power output: 2 MW

Waste Heat Recovery System with various options

Waste Heat Recovery System in operation with Siemens products
- Germany
  - Float Glass: Euroglas in Osterweddingen, 3 MW electrical power
  - Float Glass: F-Glass in Osterweddingen, 2.5 MW electrical power
- Belarus
  - Float Glass: Gomel, 3 MW electrical power

WHR as integrated part of a glass plant
- Batch
- Warm area
- Cold End
- Utilities
- Further processing
- WHR
- Why WHR
- How does it work
- Where is it in operation
- Siemens concept for WHR within plant wide integrated automation solution
Automation architecture & Energy distribution

Low voltage distribution and Motor Control Center with SIVACON 8P* Automation System

SIMATIC PCS 7 – AS (redundant)

Distributed I/O ET 200M

Variable speed drive system SINAMICS

Measurement: pressure, temperature, flow, ...

Cooling tower

Water pump, Condensate pump
electro-pneumatic position controllers

Valve control 1LA*

Turbine and generator automation system

Steam turbine

Generator 3000 kW

Energy distribution and synchronization MV/LV

WHR application full integrated in Simatic PCS 7!

Efficient Engineering

Our engineering services typically include:
Feasibility studies and concept development
Development of mass and heat balances
Basic & detailed engineering
Equipment specifications
Suppliers – Qualifications
Supervising on behalf of our customers incl. Construction Management and Commissioning
Training

Our expertise offer customers with high quality engineering and performance in implementation of projects.

Advantages in Waste Heat Recovery

Cost Savings
- Heating in winter and cooling in summer
- Increase of productivity
- Reduction of energy consumption costs
- Fast amortization within a few years (4 to 6 years based on electricity tariff)
- No additional personal required in control room

Safety of Investment
- Less dependency on external sources of energy
- Less dependency on constant rising energy costs
- Installation without influence on the production process
- Installation during line operation possible (if bypass is available)
- Use of standard components
- SIEMENS with strong experience in power plants

Sustainability
- Improvement of environmental protection

Reference: Waste heat recovery plant with 2.5 MW electrical power output: f-Glass, Germany (Float glas 700 t/day)

60 % of electricity produced by furnace waste heat flow !

Highly advanced energy recovery and reliable control technology

One of the project partners was Siemens. The company is system automation technology for the plants and the turbines for energy recovery. CEO (Wolfgang Rabiger) is one of the first glass plants in the world recovery is an essential part of the process waste heat (modern heat recovery plant). The system is the most important component is a system between industrial process and turbine. This rotordynamics, which is also to improve the economy, and the control of the energy recovery system. The energy recovery system will supply steam energy. By controlling different parameters, the energy recovery system can be started or stopped at any point. By optimizing the usage of the electricity required for the float glass plant customer, we are able to cope with a power outage. For example:

* CEO Dr. Ing. Wolfgang Rabiger in Glassfocus 2010

Thank you for your attention!