Adaptation to Climate Change in Industry: Pilot Projects for Water Savings through Eco-efficiency Approach

Prof. Dr. Göksel N. Demirer
Department of Environmental Engineering
Middle East Technical University
Ankara, Turkey

International Sustainable Water and Wastewater Management Symposium
26-28 October 2010, Konya, Turkey
United Nations (UN) Joint Programme

“MDG-F – 1680: ENHANCING THE CAPACITY OF TURKEY TO ADAPT TO CLIMATE CHANGE”

Total Budget: 7.000.000 $  
Project Duration: 3 years (2008-2011)  
Beneficiary: Ministry of Environment and Forestry

Executing UN Agencies:

1. United Nations Development Programme (UNDP)
2. United Nations Environment Programme (UNEP)
3. United Nations Industrial Development Organization (UNIDO)
4. Food and Agriculture Organization of the United Nations (FAO)
UNIDO Eco-efficiency Programme

Project Team

Executing Agencies:
Technology Development Foundation of Turkey (TTGV)
United Nations Industrial Development Organization (UNIDO)

Project Coordinator:
Şenol Ataman (UNIDO)

Project Consultant:
Prof. Dr. Göksel N. Demirer (METU)
UNIDO Eco-efficiency Programme

Aim of the Project

To foster the implementation of Eco-efficient (Cleaner) Production and Environmental Sound Technologies for the management of climate change risks at industrial sector.

Pilot scale: **Water Saving**

Priority Sectors:  - Food/Drink,
                  - Chemical,
                  - Textile/Tannery,
                  - Metal/Machinery

Project Activities: Awareness raising, Capacity building, Trainings, Pilot projects, Guiding Documents, Booklets
Pilot Projects in the Selected Companies

**Aim:**
- Realize full-scale demonstration projects in the priority sectors so as to accumulate know-how and experience for national information and dissemination activities.
- Raise awareness and develop capacity on Eco-efficiency (Cleaner Production) concept.

**Approach:**
- Questionnaires, Company visits, Meetings
- Select companies from priority sectors (6 Company)
- General Selection Criteria
  - Priority sector, Willingness of the company, Eco-efficiency application potential etc.
Pilot Project Implementations

Companies

Implemented Projects
- Company #1 (Adana): Food
- Company #2 (Kayseri): Drink
- Company #3 (Niğde): Metal

Contracted Project
- Company #4 (Adana): Chemical

Project Preparation
- Company #5 (Ankara): Metal
- Company #6 (Bursa): Textile
Company #1 – Food (Adana)

Company Information

Industrial Sector:
Marinated, smoked and frozen seafood

Annual Water Consumption:
90,000 m³
Company #1 – Food (Adana)

Project Summary

**Application:**
Recycle/reuse of water used for anchovy thawing and gutting (filleting) processes.

**Implemented System:**
Filtration + Sedimentation + Ozonation
Reuse of treated process water

**Project Budget:** 26.900 $ † UNIDO Financing
19.800 $ † Company Financing

**Expected Water Saving:** % 35–40 (30.000–35.000 m³/ year)
Before the Implementations

Anchovy Thawing

- Prior to gutting (filleting), frozen anchovies were thawed by using **continuous supply of ground water**.
- Annual water consumption: **17,500 m³**

Anchovy Gutting (Filleting)

- Thawed anchovies were filleted manually by the help of **fresh ground water supply**.
- Annual water consumption: **24,500 m³**
### Environmental Performance Indicators (EPI) and Benchmarking

<table>
<thead>
<tr>
<th></th>
<th>Current Water Consumption (m³/tons Anchovy)</th>
<th>Reference Value (^{1,2})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchovy Thawing</td>
<td>25</td>
<td>1-12</td>
</tr>
<tr>
<td>Anchovy Gutting (Filleting)</td>
<td>35</td>
<td>1-11</td>
</tr>
</tbody>
</table>

[1] Cleaner Production Assessment in Fish Processing (2000) COWI Consulting Engineers and Planners AS for UNEP and Danish Environmental Protection Agency

## Implemented System

<table>
<thead>
<tr>
<th>System</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Screening</td>
<td>A.1. Wastewater pump and various fittings (Valves, etc.)</td>
</tr>
<tr>
<td></td>
<td>A.2. Stainless steel water collection channels</td>
</tr>
<tr>
<td></td>
<td>A.3. Stainless steel drum filter</td>
</tr>
<tr>
<td>B. Sedimentation/Floatation</td>
<td>B.1. 25 m³ sedimentation tank</td>
</tr>
<tr>
<td></td>
<td>B.2. Oil and grease separator</td>
</tr>
<tr>
<td>C. Ozonation</td>
<td>C.1. 15 m³ water tank</td>
</tr>
<tr>
<td></td>
<td>C.2. Ozone generator</td>
</tr>
<tr>
<td></td>
<td>C.3. Stainless steel hydrophore</td>
</tr>
<tr>
<td>D. Monitoring and Control</td>
<td>D.1. Electric. Equip. (Control Panel, Cable etc.)</td>
</tr>
<tr>
<td></td>
<td>D.2. PLC hardware and programming</td>
</tr>
</tbody>
</table>
## Company #1 – Food (Adana)

### Current Water Consumption vs. Expected Savings

<table>
<thead>
<tr>
<th>Process</th>
<th>Current Water Consumption</th>
<th>Expected Water Consumption</th>
<th>Expected Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m³ / tons anchovy</td>
<td>m³ (annual)</td>
<td>m³ / tons anchovy</td>
</tr>
<tr>
<td>Anchovy Gutting (Filleting)</td>
<td>35</td>
<td>24,500</td>
<td>4 – 8</td>
</tr>
<tr>
<td>Anchovy Thawing</td>
<td>25</td>
<td>17,500</td>
<td>3 – 6</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>42,000</td>
<td>7 – 14</td>
</tr>
<tr>
<td>Total in the Company</td>
<td>-</td>
<td>90,000</td>
<td>-</td>
</tr>
</tbody>
</table>
Company #2 – Drink (Kayseri)

Company Information

Industrial Sector:
Fruit juice and milk production

Annual Water Consumption:
750,000 – 850,000 m³
Company #2 – Drink (Kayseri)

Project Summary

Application:
Cooling water recovery in fruit processing and fruit juice production lines.

Implemented System:
Two separate cooling tower systems were implemented to recycle/reuse cooling water used separately in the fruit processing and juice production lines.

Project Budget: 28.600 $ † UNIDO Financing
28.300 $ † Company Financing

Expected Water Saving: % 40–45 (350.000–400.000 m$^3$)
Company #2 – Drink (Kayseri)

Before the Implementations

**Fruit Processing**
- Fruit Processing Line is used during summer and fall seasons, approximately 6 months a year, when fruits are received and processed before being sent to the fruit juice production line.
- Ground water was used in *once-through cooling* system.
- Annual Cooling Water Consumption: 300,000 – 350,000 m$^3$

**Fruit Juice Production**
- Concentrated fruit prepared in the fruit processing line is mixed with water and other ingredients to form fruit juice.
- Ground water was used in *once-through cooling* system.
- Annual Cooling Water Consumption: 140,000 – 180,000 m$^3$
## Environmental Performance Indicators (EPI) and Benchmarking

<table>
<thead>
<tr>
<th>Reference Values</th>
<th>Water Cons. (m³ / m³ drink)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Binnie, 1987b (cited in Gumbo et. al., 2003)</td>
<td>2.3</td>
</tr>
<tr>
<td>Gumbo et. al., 2003</td>
<td>3.5</td>
</tr>
<tr>
<td>Hsine et. al., 2005</td>
<td>2.5 – 3.5</td>
</tr>
<tr>
<td>Environment Report, 2006</td>
<td>1.5</td>
</tr>
<tr>
<td>IFC, 2007</td>
<td>6.5</td>
</tr>
<tr>
<td>ETBPP, 2009</td>
<td>2.3 – 6.1</td>
</tr>
<tr>
<td><strong>The Company</strong></td>
<td><strong>23 – 27</strong></td>
</tr>
</tbody>
</table>
# Company #2 – Drink (Kayseri)

## Environmental Performance Indicators (EPI)

<table>
<thead>
<tr>
<th>Process</th>
<th>The Company (%)</th>
<th>Sector Average 1, 2, 3 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the product</td>
<td>6 – 7</td>
<td>23 – 60</td>
</tr>
<tr>
<td>Washing / Cleaning</td>
<td>No data available</td>
<td>7 – 55</td>
</tr>
<tr>
<td>Utility Operations (Boiler water, pasteurization etc.)</td>
<td>No data available</td>
<td>11 – 17</td>
</tr>
<tr>
<td>Cooling</td>
<td>57 – 65</td>
<td>1 – 5</td>
</tr>
<tr>
<td>Others</td>
<td>No data available</td>
<td>1 – 5</td>
</tr>
</tbody>
</table>

## Implemented System

<table>
<thead>
<tr>
<th>System</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Cooling Tower</td>
<td>A.1. Tower</td>
</tr>
<tr>
<td>B. Pumping System</td>
<td>B.1. Stainless steel water pump (to the tower)</td>
</tr>
<tr>
<td></td>
<td>B.2. Stainless steel water pump (from the tower)</td>
</tr>
<tr>
<td>C. Water Transmission Line</td>
<td>C.1. Stainless steel pipes and various fittings (Valves etc.)</td>
</tr>
<tr>
<td>D. Monitoring and Control</td>
<td>D.1. Inverter</td>
</tr>
<tr>
<td></td>
<td>D.2. Control panel</td>
</tr>
</tbody>
</table>
## Company #2 – Drink (Kayseri)

### Current Water Consumption vs. Expected Saving

<table>
<thead>
<tr>
<th>Process</th>
<th>Current Water Consumption (m³ / year)</th>
<th>Expected Water Consumption (m³ / year)</th>
<th>Expected saving (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling Water</td>
<td>455,000 – 519,000</td>
<td>90,000 – 105,000</td>
<td>80</td>
</tr>
<tr>
<td>Total Consumption of the Company</td>
<td>750,000 – 850,000</td>
<td>345,000 – 390,000</td>
<td>41 - 47</td>
</tr>
</tbody>
</table>
Company #3 – Metal (Niğde)

Company Information

Industrial Sector:
Spare parts for automotive industry

Annual Water Consumption:
70,000 m³ (process)
80,000 m³ (irrigation)
Company #3 – Metal (Niğde)

**Project Summary**

**Application**
Water saving measures in the heat treatment and surface finishing lines.

**Implemented System:**
(i) Recycle/reuse of cooling water used in the heat treatment process and
(ii) Minimize evaporation losses, improving rinsing and good housekeeping/management practices in the surface finishing process.

**Project Budget:** 29.011 $ † UNIDO Financing
5.222 $ ‡ Company Financing

**Expected Water Saving:** %15–20 (15,000 m³ process water)
Company #3 – Metal (Niğde)

Current Situation

Heat Treatment Line

- Fresh groundwater is used in production processes in the company. In the heat treatment line, cooling is performed by means of continuous supply of groundwater. No recycle or reuse practices are applied to the cooling water.
- Annual Water Consumption: 13,000 m³

Surface Finishing

- Surface finishing of metal parts are accomplished in a series of batch tanks (reactors) by dibbing parts into to the tanks consecutively.
- Annual Water Consumption: 4,000 m³
Company #3 – Metal (Niğde)

**Proposed System**

**Heat Treatment Line**

- In the proposed system, cooling water will be recirculated to the main water storage tank of the factory, which provides process water.
- As a result of this application about 90–95 % of the cooling water of heat treatment process will be recovered and used for other process as water curtain painting, vulcanization, cooling, metal forming etc. which do not require any specified water characteristics.
Company #3 – Metal (Niğde)

Proposed System

Surface Finishing Line

- Increase/optimize the rinsing period of the metal parts.
- Increase drag out time after dibbing.
- Increase the retention time of the parts in the tanks.
- To mimic countercurrent rinsing by dividing rinsing tanks into two.
- To implement drain boards in order to avoid water and chemical losses during transfer of the parts from one tank to another.
- To optimize drum filter operation period for effective drainage of the water from the surface of the metal parts back to the tanks.
Project Monitoring / Reporting

- Implemented projects shall be monitored up to 1 year according to the contract made between TTGV and the associated company.
- Based on the monitoring results current water consumption shall be compared with the consumption after implementation.
- Outcomes of the pilot projects shall be clarified by means of detailed analyses.
- Other benefits (energy saving, occupational health and safety etc.) shall be identified and reported.
- Reports and guiding documents shall be prepared for dissemination activities.
Thank you

Prof. Dr. Göksel N. Demirer
Department of Environmental Engineer
Middle East Technical University
Tel: 312 210 58 67
e.mail: goksel@metu.edu.tr