Improving Water Management at a Refinery Complex in Romania

Project Title: Study on Technical Alternatives for Qualitatively and Quantitatively Improving Water Management System
Leader: Rompetrol Refinery Complex Petromidia (Navodari, Romania)
Partner: Montgomery Watson Harza (Chicago, USA)
Location: Navodari, Constanta County, Romania
Project Duration: April 2001- January 2002
EcoLinks Project Investment: Total Project Investment: US$ 72,078; EcoLinks Grant Support: US$ 49,352; Project Team Cost Share Contribution: US$ 22,726.

Best Practice: Transferable Solution

This project is a Best Practice because it generated and tested a methodology for developing a detailed water management implementation plan to improve energy efficiency and reduce raw water consumption and wastewater discharge using a participatory framework. The methods and participatory process, defined and applied in this project, provide a model for other similar companies seeking to improve water management for environmental benefits and economic savings. Furthermore, the general types of water management issues identified through this project provide a basis for researching and resolving water management problems at other large industrial complexes.

Project Summary

The Petromidia Refinery Complex is located on the coast of the Black Sea in Romania. The Complex was built in 1975 on a strip of land between Lake Tasaul and the Black Sea and totals 450 hectares. The Complex includes a petroleum refinery and a petrochemical plant designed to process 4.8 million tons of crude oil per year. The refinery process at the Complex includes crude distillation, hydrotreating,

catalytic reforming, aromatic recovery and separation, catalytic cracking, delayed coking, gas desulfurization, and sulfur recovery. The Refinery produces leaded and unleaded gasoline, diesel fuel, jet fuel, fuel oil, coke, various aromatics, propane, butane, and sulfur. The petrochemical operations include pyrolysis and polymerization processes producing polypropylene (PP), low and high density polyethylene (LDPE and HDPE), and dimethylterephthalate (DMT).

Due to the importance of water in refinery and petrochemical operations, an updated water management plan could considerably increase the environmental performance and economic efficiency of the Complex making it more market competitive. Water supply, wastewater collection, wastewater treatment, wastewater discharge limits need to be evaluated. As the plant currently operates at a lower capacity than designed (3 to 3.5 million tones per year),there are many opportunities for energy and water saving, but also a number of constraints linked to the existing equipment and its flexibility to operate efficiently at lower output rates.
Process water for the refinery and petrochemical plant, for example, is pumped from the Danube-Black Sea Cana (Carasu) approximately 20 km away. Due to the oversized process water supply pumps, the process water is pumped from the Danube-Black Sea Channel at a rate of approximately 1,700 m^3/hr exceeding requirements by up to 800 m^3/hr.

Firewater is pumped from Lake Tasaul and used without treatment. Although intended primarily for fire protection, this water is used in certain process applications as well. Firewater alternatives such as using wastewater for fire protection could be more efficient and have fewer environmental impacts. Potable water is currently provided by RAJA Constanta, although Petromidia is considering alternatives because of concerns about water quality.

The project team considered all these aspects and proposed solutions to a large number of process operations, including: water supply, waste water collection, wastewater treatment, cooling towers, boilers, petrochemical process water, refinery process water and ground and storm water.

With the support of an EcoLinks Challenge Grant, Rompetrol Refinery Complex Petromidia and Montgomery Watson Harza, a US consulting firm, collaborated to assess and improve water management at the Complex. With implementation of the water management plan developed through this project, the following benefits are generated:

1) Environmental compliance costs are reduced;
2) Energy consumption and equipment efficiency are optimized; and
3) Wastewater discharges are reduced.

Energy efficiency is improved significantly with realization of the Implementation Plan produced by this project. Approximately 1.8 million kWh per month are saved. A total annual savings of $1.9 million can be generated with implementation of the alternatives developed through this project.

Project Activities

This project involved four main steps: information gathering, identification and evaluation of alternatives; staff awareness and training; and development of an implementation plan. These activities are described below in more detail.

1. Gathered information on current water management at the Complex.

Action: Gathered information on water use and wastewater production and treatment at the Petromidia Complex. Water management issues and opportunities were outlined. Available data on the quantities and characteristics of water and wastewater were identified, and a program of data gathering was established to fill data gaps.

Information on flow rates was gathered at various plant locations where water is used and wastewater is generated. Water sampling was conducting to determine the characteristics of water supplies and wastewater discharges, and to evaluate the effectiveness of each of the treatment processes within the wastewater treatment plant. An analysis of raw water, cooling water, boiler water, refinery and petrochemical process water was conducted. Storm water and groundwater collection systems, flow rates, and samples were analyzed.

Product(s): 1) Data on water management; 2) Water balance diagram; 3) Flow diagram of wastewater treatment plant, tabulation of dimensions and capacities of various treatment processes; 4) Technical Memorandum submitted to Petromidia summarizing the information gathered on water issues.

2. Developed and analyzed alternatives for improving water management.

Action: Based on the information gathered, alternatives for improvements were identified within four distinct focus areas: 1) improvement of equipment design and function; 2) rehabilitation of equipment; 3) water balance assessment; and 4) process modifications. The requirements for implementing the various alternatives for improving water management were considered. For each alternative, Petromidia started from the current state of the art; identified needed modifications; and evaluated the feasibility of implementation including the reliability, flexibility to adapt to future conditions, ease of operation, monitoring requirements, residues, chemical requirements, energy requirements, and costs. Each alternative was carefully reviewed and the most favorable alternatives were selected and incorporated into an Implementation Plan.

A Technical Memorandum was produced and included the following considerations:

- Installation of smaller pumps in separators, groundwater and storm water pumping stations, to improve cost efficiency
- Installation of 24 flow meters (16 in the water treatment plant and 8 in the waste water treatment plant), to measure the raw water intake and the waste water discharge
- Installation of interface oil /water level indicators in the three grease separators where the oil layer at the surface is thick, in order to improve the separation of grease from the water-grease mixture and reduce the pollution of

wastewater with petroleum waste; installation of simple water level indicators in the rest of the eleven separators

- Repair of the oil skimmers in separators, in order to reduce the petroleum in the waste water treatment plant
- Replacement of large raw water pumps (4,500 m^3/h) with smaller ones (600 – 1,400 m^3/h), better suited to the current plant operation's level
- Equipment rehabilitation—cooling tower repairs: replacement of screens with rollers to improve heat transfer; replacement of water pipes to reduce water leakage; use of smaller pumps to save energy and money ; repair the concrete structure to improve the cooling
- Replacement of the existing cooling towers with smaller units, to save energy and improve cooling indicators
- Improvement, repair and separation of the process water sewers from the networks conveying conventionally pure water
- Rehabilitation of the storm and groundwater sewers and investigation of the process discharges into those sewers
- Alternative use of marox caustic waste to neutralize petrochemical process acid waste
- Reuse of marox caustic waste for sulfides and mercaptans
- Boiler blowdown used for process purposes
- Sour water stripper discharge in the atmospheric and vacuum distillation unit's de-salter
- Modification and repair of waste water treatment plant
- Wastewater used as fire water

Product(s): 1) Technical memorandum comprising identified alternatives.

3. Conducted an awareness and training module.

Action: During this module, the Petromidia staff was presented with an update of the project. Lectures on the project were given, and project activities were discussed. The alternatives were reviewed. Staff participants provided comments and suggestions for improving the alternatives where possible.

Product(s): 1) Training module 2) Course manual including lectures.

4. Developed an Implementation Plan.

Action: An Implementation Plan was drafted summarizing the core elements of the alternatives that were determined to be most relevant. Steps for implementing the alternatives were outlined.
Product(s): Implementation Plan.

Table 1. Implementation Plan (selection)

Alternatives	Saved Energy KWh/month	Investment US $	Savings	Simple payback years
Install smaller pumps in separators, storm water and ground water pump stations	32,800	56,000	16,900 US $/year	2.53
Install flow meters	NA	270,000	75,000 US $/year	3.6
Install level indicators in grease separators	NA	205,000	Waste water quality improvement	Not available yet
Repair oil skimmers in separators	NA	1,800	Reduced petroleum discharge into WWTP	Not available yet
Install smaller raw water pumps	230,580	141,000 to 181, 000	14,490 to 16,537 US $/month	9.75 to 11 months
Rehabilitation of cooling towers	NA	3,865,904	Not available yet	Not available yet
Replace existing cooling towers with smaller units	Not assessed yet	4,850,000	1,200,000 US $/year	4
Re-use of Marox caustic waste for sulfides and mercaptans	More power need for pumps (increased from 22 to 55 kW /motor)	2, 750	857.6 US $/month	3.21 month
Boiler blowdown used for process purposes	1,552,778	Not assessed yet	28,060 US $/month	Not assessed yet
Waste water used as fire water	64,800 kWh/month	22,180	13,450 US $/month	1.65 months

Project Benefits

This project produced an Implementation Plan including specific alternatives and steps for improving water management at Petromidia. The staff is better prepared to participate in and improve water management. Less energy and raw water will be consumed, and less wastewater will be produced. Notable economic savings can be generated from improved energy efficiency.

Capacity Building Benefits

As part of this project, the Petromidia staff attended a training course on water management issues. The staff participated in identifying solutions to water

management issues that were incorporated into the Implementation Plan for improving water management. The Petromidia staff furthermore gained a better understanding of water usage and wastewater generation within the Complex as a result of the research conducted as part of this project.

Environmental Benefits

Upon completion of the Implementation Plan developed through this project, environmental performance will be enhanced. Less energy and water is consumed, and wastewater discharge is reduced. Wastewater treatment facilities are more effective and efficient.
Several notable energy savings are generated as a result of the Implementation Plan. Approximately 1.8million kilowatthours per month are saved by installing smaller pumps in groundwater and storm water pumping stations, using smaller raw water pumps, installing a new pipe network between boilers and different processing sites, using demineralized water to protect the installations, and by using wastewater as firewater.

Wastewater discharge was reduced through implementation of three alternatives outlined in the Implementation Plan. Wastewater discharge was decreased from 1000-1100 m^3/h to 600-750 m^3/h. Water resources are, therefore, used more efficiently and pollution associated with wastewater discharge is reduced.

Economic Benefits

Several economic benefits were generated from this project. In addition to a reduction in environmental compliance costs, savings are generated from reduced energy and raw water consumption and reduced wastewater discharge.

Energy costs are reduced by optimizing energy consumption and equipment efficiency. For example, with installation of smaller raw water pumps, notable economic savings are generated. The energy and economic savings amount to 230,580 kWh per month and approximately $15,500 per month respectively. New smaller raw water pumps can be purchased and installed for an approximate investment of $161,000 with a return on investment time of 11 months.

The Implementation Plan involves three key alternatives regarding wastewater discharge. With implementation of these three alternatives the reduction in wastewater discharge produces a savings of $21,500 per month or $258,000 per year.

With full actualization of the Implementation Plan (items outlined in Technical Memorandum), an approximate investment of $10.5 million (payback periods vary, but do not exceed four years) generates a savings of:

- $1.2 million per year;
- $57,700 per month; and
- $75,000 one-time savings.

Lessons Learned

The following lessons were learned during this project:

- The active involvement of the staff in designing the water management system was an especially critical aspect in making this project a success. For example, the project required extensive knowledge about refinery and chemical plant operations that could only be obtained from staff members due to their work experience at Petromidia.

- The Project Leaders site specific knowledge in conjunction with the Project Partner's experience working on similar projects in other regions provided a rich basis from which to make more sound decisions.

- On-site visits with all project partners facilitated clearer communication and decision making amongst the team members.

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