Water reuse in the power and steel production sector

Gujarat, India

water scarcity impact

Reduced withdrawal	●
Reduced consumption	●
Improved water quality	
Increased productivity	●
Net basin benefit	●

volumetric impact
1 479 000 m^3/yr

capital cost
$380 000

estimated unit cost of water
<5 ¢/m^3

Water Stress
Gujarat India

Arid & low water use
Low (<10%)
Low to med (10-20%)
Med to high (20-40%)
High (40-80%)
Extremely high (>80%)
No data available

Water Stress Map:
Gassert, F., M. Landis, M. Luck, P. Reig, and T. Shiao. 2013. "Aqueduct Global Maps 2.0."

Confidence level
Low Medium High

Water Scarcity Impact Key
Main Minor

Credits
We wish to acknowledge the input of Desai Ashit of Essar Power Plant and Bharatendu Dave of Essar Steel Plant in the preparation of this case study.

Project Overview

The Essar steel and power plants are located in Gujarat, India. The power plant is a multi-fuel combined-cycle plant using 3 900 000m^3 of water per annum and generating 515MW of power. The Essar steel facility is located adjacent to the power plant and with a steel-making capacity of ten million tonnes per year is the fourth largest steel factory in the world. Both plants abstract water from the river Tapti and wastewater effluent is discharged into the sea.

In order to reduce the combined water footprint of the sites the power plant cooling system has been improved to reduce the freshwater demand. Blow down water that was previously discharged to the ocean is now transferred to the steel plant. In addition, wastewater from the steel plant is being treated for reuse in the power plant and for localised irrigation of landscaping. These interventions have reduced the demand on freshwater in the power plant by 835 000m^3/yr and in the steel factory by 644 000m^3/yr.

Key Elements

- Changes in the material specification of the powerplant condenser in order to increase the acceptable chloride concentration in the cooling towers.
- Transfer of cooling system blowdown water from the power plant to the steel plant for use as make up water.
- Recovery of backwash and clarifier sludge water in the water treatment works.
- Installation of a natural swale system for filtration of surface runoff and subsequent use for irrigation.
- The project cost of $380 000 was funded by Essar Gujarat.

Key Outcomes

- 86% of power plant waste water reused which would have otherwise been discharged to the ocean.
- 45% of recycled wastewater used in the steel plant.
- Total fresh water savings of nearly 1479 000m^3/yr
    - 381 000m^3/yr fresh water savings from increasing the chloride concentration of water used in the cooling towers.
    - 644 000m^3/yr fresh water saving from reuse of Essar power plant blow down water in Essar steel plant process .
    - Fresh water savings of 105 000m^3/yr by use of water extracted from clarifier sludge.
    - 349 000m^3/year fresh water saving from reuse of recovered backwash water.
- Payback periods:
    - Reducing blow down water in cooling tower: 1.1 years.
    - Reuse of power plant blow down water in steel plant: 4.8 months.
    - Recovering backwash water: 4.6 months.
    - Recovering water from sludge: 2.2 years.

Gujarat, India

Intervention Features

¬ Wastewater reuse in power generation ¬ Wastewater reuse in steel production
¬ Condenser process retrofit ¬ Reuse of cooling blowdown water

Project Levers

(1) Increased acceptable chloride concentration in the cooling towers:

Cooling towers require periodic blowdown water in order to reduce the concentration of chlorides in the cooling system. Retrofitting CU-Ni tubes in places of stainless tubes in the condenser increased the permissible concentration factor. This resulted in savings in water use and chemical dosing. The cost of this implementation was $147 513 and resulted in an annual saving of 381 000m^3 with a 1.1-year payback period.

(2) Use of recycled cooling system blowdown water as make-up water for Essar steel:

The steel facility has three prominent iron making technologies at a single location. These include a Blast Furnace, Midrex (DRI) and Corex. The Midrex (DRI) is the world'd largest Direct Reduced Iron (DRI) plant with a capacity of 6.8 million tonnes per anum. The Midrex process requires a water system for cleaning the top gas leaving the furnace, during this process an increase in pH occurs due to dissolved carbon dioxide which in turn causes dissolved contaminants to precipitate.

Alkaline blowdown water from the power plant, which was previously disposed of at sea, is ideal for counteracting the high pH cooling water. A pipeline was laid between the power and steel plants enabling the water to be used as make up water in the furnace cleaning system. The water is also used for fire fighting systems, dust control, horticulture and for irrigation of the plantation in the township. The investment was $92 336 and the quantity of fresh water saved in the steel plant as a result of reuse of blowdown water is 644 000m^3/year with a payback period of 4.8 months.

(3) Recovery of process water from the water treatment works:

Backwash wastewater from the pressure sand filters and softeners are collected in a recovery pit. This water substitutes for 2% to 3% of the plant's total raw water intake. The investment associated with the recovery was $63 156 resulting in fresh water saving of 349 000m^3/year at a pay back of 4.58 months. A thickener was installed and used to extract water from the clarifier sludge. The water is reused while the left over sludge is used as fertiliser for plants. This implementation cost $77 659 and gives annual fresh water savings of 105 000m^3. It has a payback period of 2.2 years.

Outcomes and Challenges

The project also resulted in:

- Chemical dosing requirements being reduced.
- Reduced freshwater abstraction from the river.
- Reduced water treatment chemical cost.
- Provision of sludge for horticulture.

Above: Reuse of blowdown water for horticultures; Water collected in swale for reuse (© Bharatendu, D)

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