

## A Case Study

# West Bay Complex – Doha Recycling Plant

## Introduction

As part of the development of West Bay complex in Doha, Qatar, a five star hotel was built which was to be managed by the Four Seasons. During initial phases of the project, it was envisaged that a seawater Reverse Osmosis system would be installed to cater for the clean water requirements for cooling water make up and irrigation.

Metito was requested to evaluate the process and recommend the most economical solution. It was determined that in view of the capacity of the plant the cost of seawater intake system was not justified. Subsequently, it was suggested to check the possibility of using the available Treated Sewage Effluent (TSE). Though the quality of TSE was good enough for open irrigation, it did not meet the project guidelines for on-premises irrigation. In addition to irrigation, the demand for cooling tower make up water was also needed to be sufficed.

Metito engineers accepted this challenge as a plant for recycling of sewage for industrial use would be the first of its kind in the State of Qatar.

The challenge was not limited to the process design only, but due to space limitations the entire plant was required to be installed in an enclosed space in the basement of the hotel building. After a careful review of Metito design, execution plan and commercial aspects, the client entrusted the job to Metito.

Living up to its name, Metito completed the work within the contractual time utilising optimised scheduling.

During pre-commissioning tests, inferior influent water quality was observed in terms of suspended solids. Minor design changes with respect to the media type in the multimedia filters were performed.

Since its commissioning in 2004, the plant has been working to the complete satisfaction of the client.



## Scope of Work

The scope includes design, engineering, supply, delivery, erection & commissioning of the Waste Water Recycling Plant on turnkey basis.

## Plant General Information

The Waste Water Recycling facility includes:

- Plant feed pumps
- Media filters
- Activated carbon filters
- UV Sterilizer
- Chemical dosing systems for pre-treatment and post-treatment
- Polishing Reverse osmosis unit
- pH correction system
- Post-chlorination system
- Flushing/Cleaning system

## Plant Technical Characteristics

The source of feed water for the plant is treated sewage effluent (TSE) from Ashghal Drainage Affairs. Tapping into the main TSE line with the necessary pipework, valves and flow meter, the influent TSE water is stored in an underground water storage tank.

From here the influent is pumped to the plant by means of feed pumps.

## Plant Data Summary

The plant is designed in two sections:

### 1. Polishing RO Unit for Cooling Tower Make Up

No. of plants offered	One
No. of streams in plant	One
Plant feed flow	51.0 m <sup>3</sup> /h
RO Feed flow	48.1 m <sup>3</sup> /h
RO Product capacity	31.25 m <sup>3</sup> /h
Recovery	65 %
Product capacity of plant	750 m <sup>3</sup> /day

### 2. Irrigation Water Filtration Unit

No. of plants offered	One
No. of streams in plant	Two
Plant feed flow	51.0 m <sup>3</sup> /h
Plant product capacity	765 m <sup>3</sup> /day

## Influent Analysis

Total dissolved solids	1792 - 3472 ppm
Feed water temperature	22 - 35 Deg.C
Total suspended solids	1.2 - 18.8 ppm
COD	6-37 ppm
BOD	0.5- 4 ppm
Total coliform	Max. 2419 CFU/100 ml
Fecal coliform	Max. 242 CFU/100 ml
E-coli	Max.238 CFU/100 ml



## Treated Water Analysis

### 1. Polishing RO Plant for Cooling Tower Make Up Application

The permeate water analysis at the outlet of the polishing RO plant is as follows:

Total dissolved solids	≤ 500
pH	6.5-8.0
Chlorides	< 750
Sulphates	< 20.0 mg/l
Sodium bi Carbonate	< 200.0 mg/l
Suspended Solids	Nil mg/l

### 2. Irrigation Water Filtration Unit

Total suspended solids	< 5.00 ppm
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## Process Description

### Intake & Filtration

This section of the plant is common for cooling tower make up unit and Irrigation water filtration system.

### Feed Water Supply

The source of feed water for the plant is treated sewage from Ashghal's TSE line. TSE water is received and stored in the underground water storage tank.

Plant feed pumps are installed in the dry pit beside the storage tank. These pumps supply the feed water to the treatment plants and are operated on duty/standby basis.

### Coagulant Dosing

To improve the accumulation properties, a coagulant, ferric chloride, is dosed at the discharge of the feed pumps. Dosing of FeCl<sub>3</sub> reduces the pH of raw water and oxidises matter thus ensuring effective removal in the media filtration system.

### Pre-chlorination

Hypochlorite is dosed in the discharge line of the filter feed pumps to prevent bacterial growth in the pipeline between filter feed pumps and the UV unit. The chemical is dosed only twice a week for 30 minutes at a time.

### Filtration

The plant is provided with a two stage filtration system. First stage is Dual Media filters followed by a second stage Activated Carbon filters. The dual media filters remove suspended matter while activated carbon filters remove residual organics and chlorine.

A total of 3 dual media filters and 3 activated carbon filters are installed in the plant. Both types are operated on 2 duty + 1

common standby basis. One filter of each type is dedicated for the RO unit and another for the irrigation unit. The standby is used as common for both.

The feed water pumps transfer raw water to the dual media filters. The coagulated feed water passes through the filters for the removal of particulate organic and suspended matter. The filtration process is controlled automatically for operation and backwashing. When the timer reaches the preset time for backwashing, or the differential pressure across the filters reaches the pre-set value, the backwash sequence begins. The exhausted filter is isolated and standby filter goes into service.

Two backwash pumps (1 working + 1 standby) are provided for filter backwashing. The backwash pumps take suction from the backwash water tank. A common backwash system is used for the dual media and activated carbon filters.

After carbon filtration, the water intended for irrigation travels to the filtered water storage tank while the cooling tower make up stream is sent for further treatment through the reverse osmosis plant.

### **Polishing Reverse Osmosis Plant ( cooling tower make up unit )**

After the filtration stage, feed water to the RO unit undergoes chemical conditioning:

#### **Acid Dosing**

Acid dosing is provided to adjust the feed pH to control the brine LSI. It also reduces the scaling potential.

#### **Antiscalant Dosing**

In addition to acid, antiscalant is added to prevent scaling on membrane surfaces. The use of antiscalant ensures longer membrane life , reduced cleaning frequency and reduced acid consumption

#### **SBS Dosing**

To prevent any residual chlorine entering the RO membranes, de-chlorination is affected by dosing sodium meta-bisulphite downstream of the media filters through a dedicated injection system.

#### **Micron Filtration**

After media filtration and chemical conditioning, water passes through cartridge filters where suspended solids above 5-micron size are removed thus giving added protection for the high pressure pumps and the R.O. membranes downstream. At this stage, water meets the guidelines of feed to the R.O. permeators.

In the event of an "off specification feed water ", the units are designed to automatically shut down and the off-specification feed water is dumped to waste until stable operation of the pre-treatment plant produces feed water of acceptable quality.

### **Disinfection**

An Ultraviolet (UV) disinfection unit is provided on the feed water line to the RO plant after cartridge filtration. The UV disinfection system is used for normal operation of the plant. Ultraviolet technology provides a proven, accepted and environmentally friendly method of disinfecting wastewater. When exposed to UV-C light, microorganisms are inactivated within seconds through a physical reaction with the organism's DNA. Thus biological fouling on the membranes is prevented.

### **Reverse Osmosis**

After cartridge filtration and UV disinfection, water is boosted to the required pressure by a high pressure pump, and is divided inside the R.O. permeators into permeate and reject streams by pressure. 65% of the feed water and a small quantity of total dissolved solids are transported across the special fouling resistant membranes to the permeate stream. The remaining water flows out through the brine out fall line.

The permeate is monitored in terms of conductivity and quality. Should the product fail to meet the preset parameters, it is dumped to drain by means of actuated valves to avoid mixing with good quality water. It can also be recycled if desired.

The permeate then flows to the storage tank.

### **Post Treatment**

In order to achieve a neutral pH and desired LSI, lime is added in the permeate water before entering the storage tank.

The RO permeate water is stored in a blending/break tank which feeds the blending pumps and permeate transfer pumps. Disinfection by sodium hypochlorite dosing is carried out on the permeate transfer pumps discharge line.

### **Flushing**

System auto flushing is automatically initiated upon system shutdown, and this flushes out the salts from the membranes.



## Cleaning

During normal operation and with proper pre-treatment, deposits of mineral scale, biological matter, silt and insoluble organic constituents build up on the membrane surface at a very slow rate. Frequent chemical cleaning is not required for properly operated RO systems, however, it was anticipated that cleaning will be carried out every four months; this varies according to the feed water characteristics.

The cleaning system design offered minimises the use of operating chemicals and maximises the membrane efficiency in the long run

## Brine Disposal & Reuse

The reject exiting from the RO plant travels to a reject water pumping station, and is then used in the marina area for flushing of boats before it discharges into the sea.

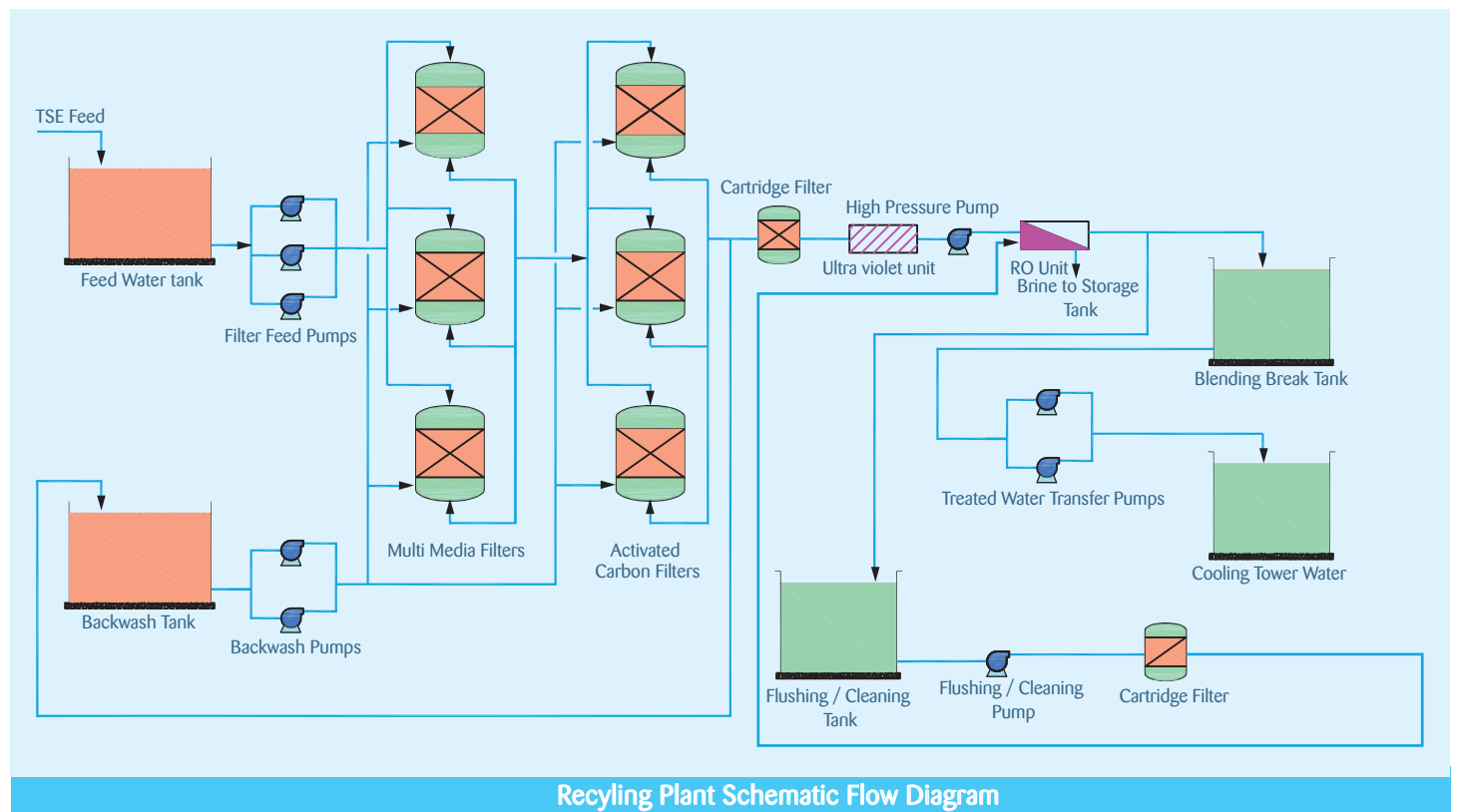
## Electrical & Control Equipment

The plant is fully automatic and controlled by Programmable Logic Controller (PLC). The main control panel of the plant

(MCP) is a free standing enclosure protected to IP 55. It is a combined panel that houses the PLC and motor controls. It also houses the incoming supply breaker together with branch circuit breakers for individual motor starters mounted on the common back plate.

A Man Machine Interface (MMI) is provided through an Allen Bradley Panel View – Plus 700 type touch screen panel. It is mounted on the door of MCP and is a touch screen panel by which the operator can have access to all control and monitoring components /instruments of the plant, such as monitoring instruments for reject flow, product flow, pH, conductivity and ORP. It also receives and displays all alarms signals.

The plant provided by Metito contributed to preserving the environment by using recycled water for cooling purposes, for irrigation and for marina use prior to discharging a minor portion of the feed water to sea. It helped the hotel complex maintain a “green” concept in addition to reducing its water bill. In the end, it was a win-win project for the hotel and the environment.



Recycling Plant Schematic Flow Diagram