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RECLAMATION AND REUSE OF MUNICIPAL EFFLUENTS FOR VARIOUS PURPOSES

Reclamation and reuse of secondary effluent in the automotive industry

In the extremely water-stressed and highly industrialized mega-city of Chennai/India, secondary effluent is reclaimed and reused for various industrial purposes. In March 2016, a contract was awarded to VA TECH WABAG for a 45,000 m^3/d water reclamation plant at Koyambedu (Figure 1), which will provide high-grade water (UF and RO are the core process steps) inter alia to large automotive production facilities south-west of Chennai (at Irungattukottai, Sriperumbudur and Oragadam) via a 60 km-long pipeline (Figure 2).

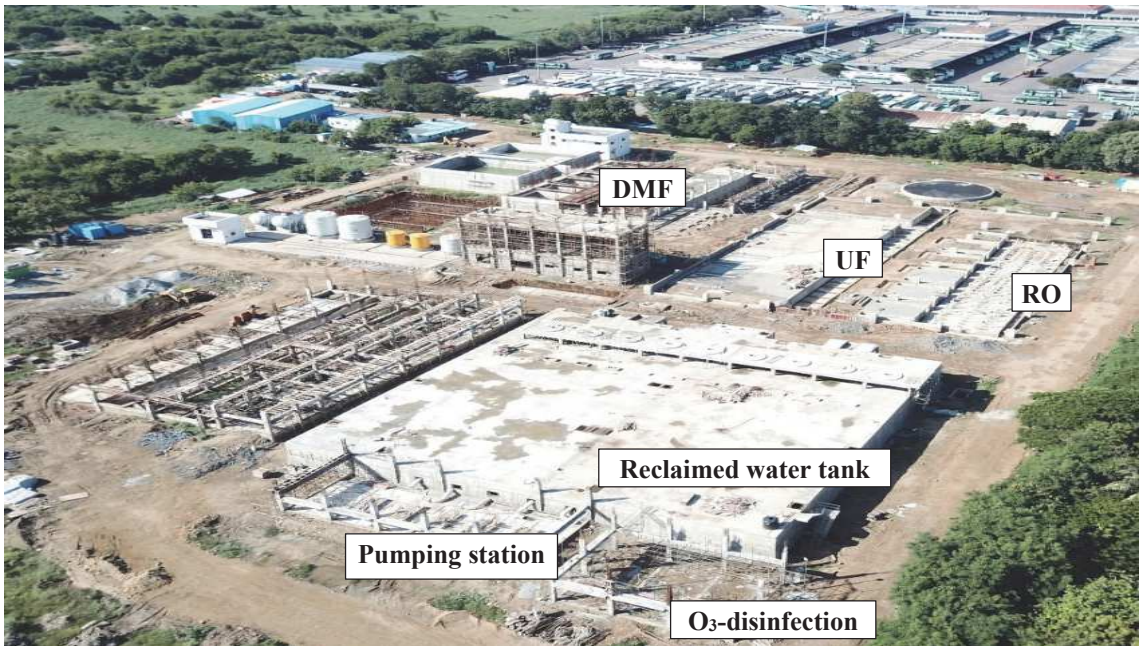

Figure 1 – Chennai/Koyambedu Water Reclamation Plant (photo taken in January 2019)

This contract also includes 15 years of operation and maintenance which guarantees a safe and reliable supply (of high quality water). In order to increase redundancy, robustness and resilience, in this project an advanced multi barrier system is employed.

Figure 2 – Reclaimed water pipeline (photo taken in August 2019)

The process (Figure 3) comprises pre-treatment with chlorine dioxide dosing (pre-disinfection and pre-oxidation in the equalization tank) and dual media rapid gravity filtration, polishing by basket strainers (50 µm), ultrafiltration (Inge Dizzer XL 0.9 MB 70 WT), cartridge filtration (5 µm), reverse osmosis (Dow BW30XFR-40034i) and ozone (O_3) disinfection of the RO permeate at site (dosing of O_3 into the treated water pipeline) and at the Irungattukottai and Sriperumbudur intermediate storage tanks. The major design parameters/standards are the TDS and silica concentrations which are 1,500 mg/l and 40 mg/l respectively in the source water (secondary effluent from the Koyambedu Sewage Treatment Plant), and 70 mg/l and 5 mg/l respectively in the RO permeate (reclaimed product water).

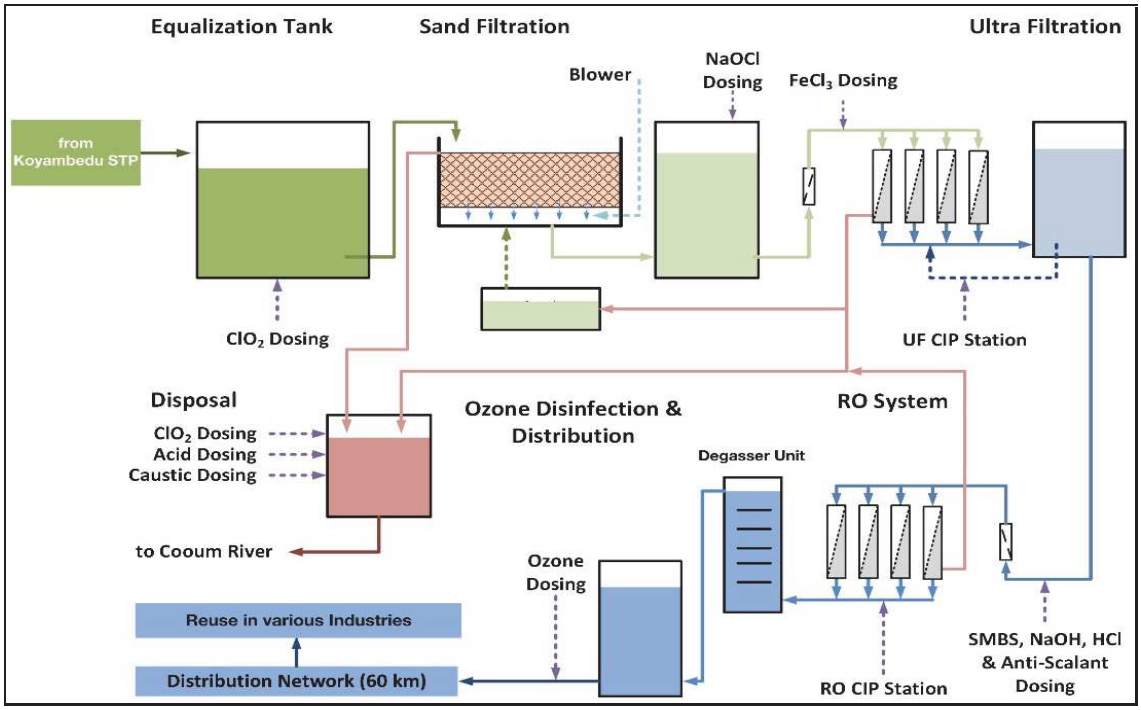

Figure 3 – Koyambedu Water Reclamation Plant – simplified process flow diagram

After start-up of the Koyambedu WRP (in December 2019), the total reclaimed water supply in Chennai will amount to approximately 125,000 m^3/d. This represents approximately 15 % of the total quantity of sewage generated. As compared to urban reuse (<1 %) this is a relatively high percentage although by and large there is still sizeable potential for reuse (urban, industrial and possibly indirect potable reuse [IPR]) in this water-stressed conurbation. In this connection, it can be stated that the reuse of secondary effluent represents both a drought-proof and fresh/drinking water preserving supply at relatively low cost. Seawater desalination is more expensive. In Chennai, the specific cost of desalinated water (produced by a 100,000 m^3/d SWRO) is approx. 0.7 EURO/m^3 (OPEX + CAPEX). The cost of a comparable water reclamation plant producing the same quantity (100,000 m^3/d) and quality (300 mg/l TDS.) is estimated to be roughly less than half (approx. 0.3 EURO/m^3) of the afore-mentioned value for sea-water desalination. However, as water stress is very high, both options have to be employed in order to provide a secured water supply.

Reclamation and reuse of municipal secondary effluent as cooling tower make-up

An example of cooling water reclaimed from municipal secondary effluent is shown in Figure 4. This represents the process flow diagram of the Baotou water reclamation and cooling make-up reuse application (Lahnsteiner et al 2019). Baotou is the largest industrial city in the autonomous province of Inner Mongolia. Annual precipitation in Baotou amounts to approximately 300 mm and therefore, due to high levels of industrialization and a low level of natural water resource renewal, water reuse is a major priority in the city. In order to comply with national water conservation policy, as well as to save costs for freshwater from the municipal network, the Baotou Donghua Power Plant is re-using reclaimed municipal secondary effluent as make-up water for its cooling water circuit.

The water reclamation plant consists of coagulation, flocculation, lamella sedimentation and biological aerated filters (BAF, bio-filtration) and is located on the site of the Baotou Donghedong UWTP. The raw water consists of secondary effluent from the Baotou Donghedong (Donghe East) and the Baotou Donghexi (Donghe West) municipal used water treatment facilities. The reclaimed water has to meet the quality requirements for the reuse of secondary effluents as make-up water for cooling water circuits laid down by the "Code for the design of wastewater reclamation and reuse GB/T50335-2016" (major parameters: pH 6.5–8.5, turbidity ≤ 5 NTU, BOD_5 ≤ 10 mg/l, COD ≤ ≤ 60 mg/l, Fe^{2+} ≤ 0.3 mg/l, Mn^{2+} ≤ 0.1 mg/l, Cl^- ≤ 250 mg/l, SiO_2 ≤ 50 mg/l, total hardness ≤ 450 mg/l $CaCO_3$, NH_4-N ≤ 10 mg/l, total phosphorous ≤ 1 mg/l, TDS ≤ 1,000 mg/l, residual chlorine ≥ 0.5, fecal coliforms ≤ 2,000).

The secondary effluent is pre-treated by coagulation with aluminum chloride and static in-line mixers, flocculation, polymer dosing, and lamella sedimentation. The main process step is bio-filtration (BAF, BIOPUR-NK), which employs granular carrier material (expanded clay), up-flow operation and excess head backwashing, in order to minimize filter media losses. The main advantages of bio-filtration consist of reduced space requirements and high process stability. The main reason for choosing compact BAF technology as a tertiary treatment step was the rather limited land available at the Donghedong UWTP. The major purpose of the BAF process step is nitrification.

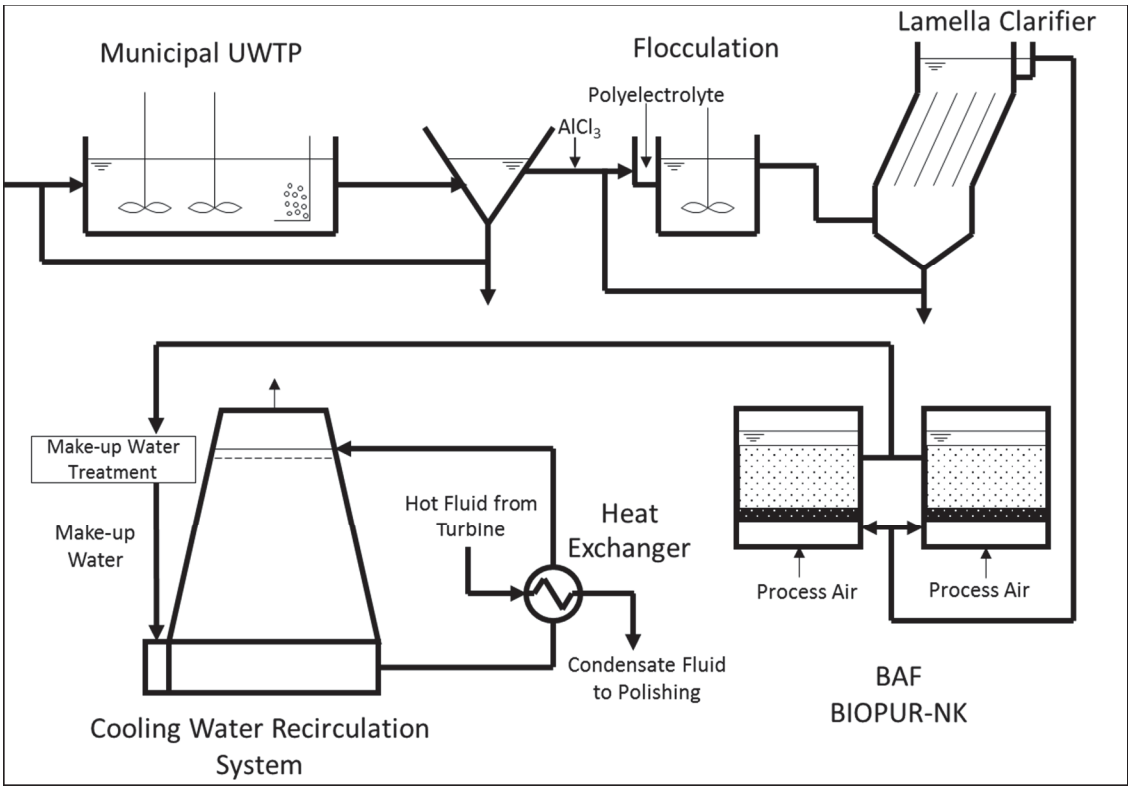

Figure 4 – Baotou water reclamation and reuse scheme

In general, it can be stated that the reuse of secondary effluent as cooling make-up water is a very beneficial application, as large quantities of relatively low-quality water are required for cooling purposes. Moreover, this practice is sustainable, as substantial amounts of fresh water (from the public network) can be saved [1].

Reference

1. Lahnsteiner, J. Introduction to Industrial Water Reuse and Recycling / J. Lahnsteiner, P. Andrade, R. Mittal // Handbook of Water and Used Water Purification / ed. by J. Lahnsteiner. – Springer Nature, 2019.