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Exploitation results of seven RO plants for recovery and reuse of treated effluents in textile industries

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Abstract

The paper comprises a case study on the implementation of the advance treatment process (ATP) in seven small-scale textile industries. The ATPs installed and commissioned are in compliance with the Statutory Board directions for recovery and reuse of treated effluent leading to zero effluent discharge. The textile effluents are treated in effluent treatment plants comprising a physicochemical option followed by biological activated sludge process, pressure sand filtration and activated carbon adsorption. The tertiary treated effluents (25–65 m^3/d) are high in total dissolved solids, chlorides and hardness, and partly reused for washing screens, cloth and ash quenching. The tertiary treated effluent contained suspended solids and total dissolved solids in the range, 4–30 mg/L and 1980–2682 mg/L, respectively, with COD concentrations in the range, 125–410 mg/L and did not meet the stipulated standards for discharge into inland surface waters. A part of the tertiary treated effluent (4.0–9.5 m^3/d) is routed to ATP for recovery of boiler feed quality water. The ATP comprises a multi-grade filter, ultrafiltration (UF) unit and a reverse osmosis (RO) unit. The multi-grade filter ensured complete removal of suspended solids with a marginal decrease in COD. The fouling index (b) for the feed to the ultrafiltration was estimated to be varying in the range 0.6–2.1× 10^{-3} s^{-1}.The UF operated at 200–300 kcals with 88–95% permeate recovery. This unit achieved 80–90% removal of BOD and COD and 65–90% removal of phosphates. The RO unit at a pressure range of 1270–1670 kPascals produced 68–84% permeate. The permeate characteristics conforms the boiler water quality as prescribed by the Indian Standards Institution for low-pressure drum type boilers. The pH of the recovered water was adjusted with alkali to pH 10–11 and mechanically deaerated for use in boilers. Recycle/reuse of tertiary treated effluents for various purposes and reuse of the recovered water from advance treatment process as boiler water make-up has resulted in a reduction in water requirements by 30–35% in each industry.

Keywords: Textile wastewater; Ultrafiltration; Reverse osmosis; Recycle/reuse; Boiler water

1. Introduction

Waste management with recourse to effluent recycle/reuse is necessary to meet the ever-increasing water demand leading to water conservation. The reuse of water in production often requires a higher standard of treatment than is required in order to satisfy discharge norms [1]. The application of membrane separation pro-

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cesses provide industries with a technology to achieve water quality limits and produce reusable water [2,3] and has proved to be an effective process in concentrating the bulk of pollutant into small liquid volume for further disposal [4]. Ultrafiltration allows for water clarification and disinfection, without by-products, in a single step and with constant permeates quality [5]. Reverse osmosis (RO) is another membrane process with a history in industrial applications in the removal of salts from solutions, furnishing almost deionised water [6].

The textile processing industry consumes large volumes of water and chemicals for wet processing of textiles [7]. The discharge of the textile wastewaters into the environment without proper treatment causes serious and long-lasting consequences to humans, plant, and animal life [8]. Conventional processes such as coagulation, flocculation, biological and carbon adsorption used currently for treatment of wastewater can be employed for textile wastewater [9–15]. However, due to dwindling supply and increasing demand of water in the textile industries, their future in India depends on effluent treatment processes for recovery of reusable water.

Numerous studies have been conducted to assess the reuse of permeate obtained after RO treatment of textile effluents and dyebath [16–19]. The Fenton process in conjunction with coagulation and ion exchange treatment of secondary treated textile wastewater produces recovered water of reusable quality [20]. The composite permeate was used for dyeing of cotton and polyester fabric and in the textile processing itself. In our earlier studies, effective operation and maintenance led to discernable improvement in the effluent treatment of a small-scale textile industry. The application of membrane processes led to zero effluent discharge [21]. The objective of the present study was post implementation assessment of the advanced treatment process (ATP) in seven small-scale textile industries, with recourse to recovery of boiler make-up water from treated textile effluents for recycle and reuse.

In steam generation systems, ensuring the quality of the boiler feed water is essential for successful unit operation. This reduces the use of boiler chemicals because of less frequent blow down requirements. Several studies have been conducted to recover boiler feed water from wastewaters. Boiler feed water of high purity was recovered from secondary treated sewage, by treating in full scale plant comprising of prescreening, microfiltration and RO [22,23]. Membrane technology has also been extended to agricultural and food processing industrial wastewater treatment for providing process quality water to sugar refinery and boiler feed water [24, 25]. RO application for plating wastewater with recourse to reuse as boiler feed water is also reported [26]. The advanced treatment system comprised of RO plant preceded by pretreatment and ion exchange demineralizer for reclaiming water by 90 per cent of inflowing wastewater. A biologically treated refinery wastewater was treated by RO and electrodialysis reversal membrane processes for reclaiming water for cooling tower make-up and boiler feed water [27]. The reuse of refinery and petrochemical effluent as boiler feed water and/or cooling water after treatment comprising dead end ultra filtration and RO is also reported [28].

2. Material and methods

2.1. Industry and existing effluent treatment plant details

The industries studied are situated as a cluster of small-scale textile units located in the southern part of India. The industries are engaged in dyeing and printing processing of manmade polyester fabric and the rated capacity of each industry is given in Table 1. The raw water source is ground water, and the textile processing and dyeing operations use this source. The poly-