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PERFORMANCE EVALUATION OF EFFLUENT TREATMENT PLANT OF PHARMACEUTICAL INDUSTRY

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ABSTRACT

There is an increasing trend to require more efficient use of water resources, both in urban and rural areas. The aim of the present research work was to determine the behavior of various parameters of the pharmaceutical wastewater. The company produces bulk drugs, antibiotics, pain killers, food additives, personal care products and others. It is important for the industry to develop its own wastewater treatment system before discharging the effluent in order to meet the Gujarat Pollution control Board (GPCB) standards. Reduction of pollutants in the wastewater down to permissible concentrations is necessary for the protection of ground water and the environment. In order to design an appropriate treatment system the characteristic of the wastewater generated need to be found out with reference to the following parameters; temperature, pH, total dissolved solids (TDS), Chemical oxygen demand (COD) and ammonical nitrogen. An intensive analytical programme was followed for 4 months for monitoring pharmaceutical wastewater. Samples are collected from three points; Wet well, primary clarifier (PC) and Secondary clarifier (SC) and effluent out let to evaluate the performance of Effluent Treatment Plant. The pH, TDS, COD and NH_3-N removal efficiency of Effluent Treatment Plant were found 11.71%, 92.15%, 99.47% and 90.11% respectively.

INTRODUCTION

Pharmaceutical companies perform business activities in research, development and the marketing of drugs that aim to improve the wellbeing of the patients. In a traditional sense, drugs are chemical based, meaning that one chemical is usually focused to treat a specific symptom or disease (Pattikawa, 2007). Wastewater pollution is the main issue of this sector. In pharmaceutical industries wastewater is mainly generated through the washing activities of the equipment. The presence of Pharmaceuticals and personal care products (PPCPs) was first identified in surface and wastewaters in the United States and Europe in

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1960s (Zollinger *et al.*, 1965). Public awareness were raised after a study showed that organic wastewater contaminants, including PPCPs, were present in 80 % of 139 U.S. streams (Kolpin *et al.*, 2002). Although the concentration levels of PPCPs found in the environment are at trace concentrations, their chemical persistence, microbial resistance and synergistic effects are still unknown (Ankley *et al.*, 2007), which is a cause for concern, Moreover, low concentrations can elicit adverse effects on aquatic life (Miege *et al.*, 2009). A limited number of studies also found pharmaceuticals in drinking water (Webb *et al.*, 2003). Furthermore, pharmaceutical industry wastewaters may contain organic solvents, catalysts, additions, reactants, intermediates, raw materials and APIs (Sreekanth et.al, 2009) which makes them difficult to treat. The presence of toxic or recalcitrant substances in such wastewater results in lower Chemical oxygen demand (COD) removal efficiencies (Chelliapan *et al.*, 2006). It has been estimated that up to half of the pharmaceutical wastewater produced worldwide is released without any treatment (Enick *et al.*, 2007). Level of wastewater pollution varies from industry to industry depending on the type of process and the size of the industry (Gracia *et al.*, 1995). Hence Effluent Treatment Plants or ETPs are used by leading companies in the pharmaceutical and chemical industry to purify water and remove any toxic and non-effluent-treatment-plant toxic materials or chemicals from it. The ETP plants are used widely in pharmaceutical industry to remove the effluents from the bulk drugs. During the manufacturing process of drugs, varied effluents and contaminants are produced. The effluent treatment plants are used in the removal of high amount of organics, debris, dirt, grit, pollution, toxic, nontoxic materials, polymers etc. from drugs and other medicated stuff. The ETP plants use evaporation and drying methods, and other auxiliary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment. The effluent water treatment plants are installed to reduce the possibility of pollution; biodegradable organics if left unsolved, the levels of contamination in the process of purification could damage bacterial treatment beds and lead to pollution of controlled waters (Kavitha *et al.*, 2012).

The aim of the present research work was to determine the behavior of various parameters of the pharmaceutical wastewater. Characterization of wastewater was evaluated in terms of pH, total dissolved solids (TDS), Chemical oxygen demand (COD) and NH_3-N for the influent and effluent from the selected plants. The performance of the effluent treatment plant was also evaluated and the quality of the reclaimed wastewater was compared with Gujarat Pollution control Board (GPCB) standards to determine its suitability for reuse.

MATERIALS AND METHODOLOGY

The source for the collection of wastewater samples throughout the present studies was the Pharmaceutical industry. The study was conducted in a Pharmaceutical industry located in Ankleshwer, Gujarat. The methodology involved the collection of samples at the different units of the treatment plant. The flow diagram of effluent treatment was given in Figure 1. The effluent treatment plant consist of Wet well, Equalization tank, Neutralization tank, Primary clarifier, Lagoon, Aeration tank- 1, Secondary clarifier – 1, Aeration tank- 2, Secondary clarifier – 2 and Filtration tank at the end and treated effluent is discharged in to drainage. Present research study was conducted for a period of 4 months, the wastewater samples were collected using sterile one liter plastic containers. Samples were collected in pre-sterilized bottles from Wet well, primary clarifier, secondary clarifier-2 and effluent outlet for physicochemical analysis (pH, TDS, COD and NH_3-N). All samples were transported to the laboratory and analyzed within 30 min. All parameters were analyzed in accordance with standard methods of GPCB.

RESULTS AND DISCUSSION

Data taken during 4 months of this study are presented and discussed. The samples were analyzed for the following parameters:

pH: pH of the individual sample was measured immediately after its collection by a pH meter. The pH of the effluent varied from 7.35 to 8.37 measuring maximum of 8.37 and minimum of 7.35. Similarly the pH value found by Vuppala *et al.*, (2012); Gangagni Rao *et al.*, (2005) and Chaudhary *et al.*, (2013) were 6.2-8.2, 7.5–7.6, 6.2 -8.2 respectively. However the pH found out by Nandy *et al.*, (2001) was 4.2-4.5 which is too less compared to the values of above carried out studies.

Total dissolved solids (TDS): The total solid concentration in waste effluent represents the colloidal form and dissolved species. The probable reason for the

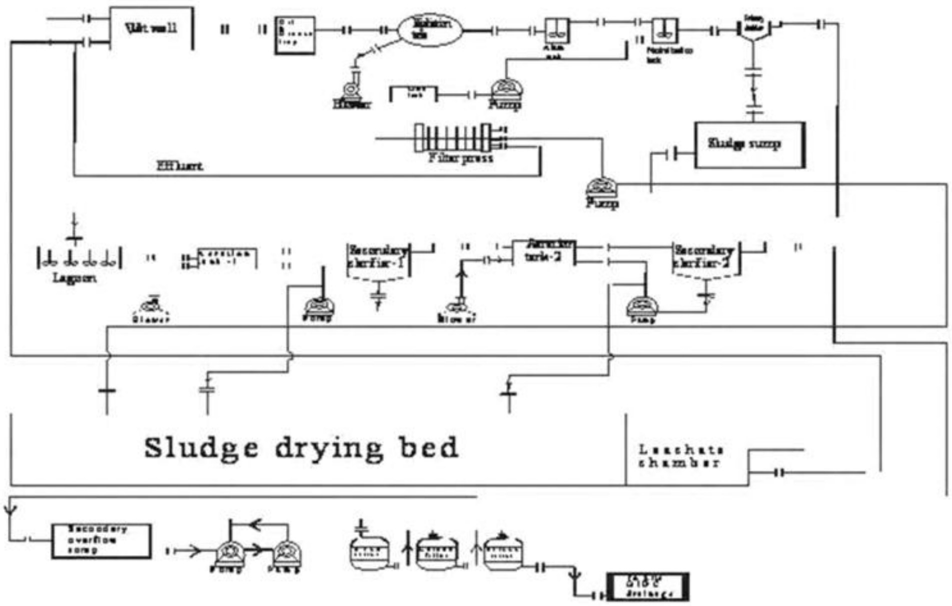

Fig. 1 Flow diagram of Effluent treatment plant

Table 1. Effluent characteristics of Pharmaceutical industry and % reduction achieved from effluent treatment plant

Tank	pH	COD	TDS	NH_3-N
wet well	8.37	9551.11	6979.50	208.17
Primary Clarifier	7.97	8353.79	6962.26	189.13
Secondary Clarifier - 2	7.94	1567.00	6895.77	138.04
ETP outlet	7.39	50.98	547.76	20.58
% Reduction	11.71	99.47	92.15	90.11

fluctuation of value of total solid and subsequent the value of dissolved solids due to content collision of these colloidal particles. The rate of collision of aggregated process is also influenced by pH of these effluents. The TDS of the effluent varied from 7000 mg/L to 542 mg/L. Similarly the TDS found out by Tapas Nandy *et al*., (2001); Vuppala *et al*., (2012) and Chaudhary *et al*., (2013) were 135-1250, 1615 mg/L, which is reduced to 974 mg/L and 1132.2 mg/L, which is reduced to 972 mg/L respectively. However the TDS found out by Rao *et al*., (2005) was 20000 that is high compared to other research carried out.

Chemical Oxygen Demand (COD): COD determination samples were preserved using H_2SO_4 and processed for COD determination after the entire sampling operation was complete. The COD of the effluent varied from 9598 mg/L to 99.46 mg/L. Similarly the COD found out by Vuppala *et al.,* (2012); Sanjay Chaudhary *et al.,* (2013) were 1304.38 mg/L, which is reduced to 43.49 mg/L after secondary clarifier and; 624 mg/L , which is reduced to 284.8 mg/L after secondary clarifier respectively. However the COD found out by Nandy *et al*., (2001) and Rao *et al*., (2005) were 5000-80000 and 25000 respectively that is high compared to the values of this study.

Ammonical Nitrogen (NH_3-H): The Ammonical nitrogen was ranging from 209.6 mg/L to 51.46 mg/L.

Average data for effluent characteristics is given in Table 1. Below with % reduction achieved.

From the above results it can be concluded that the parameters: pH, TDS, COD and NH3-N so obtained

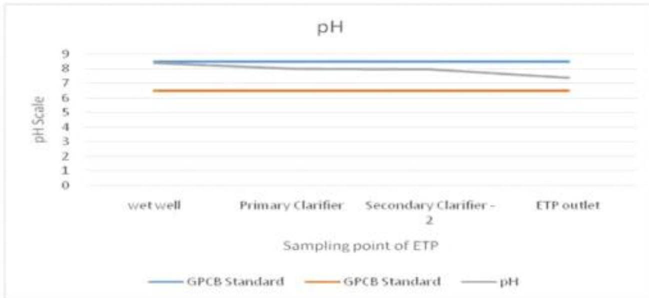

Fig. 2 pH value for effluent

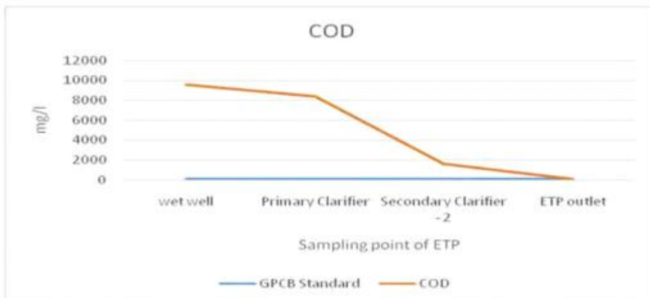

Fig. 3 COD value for effluent

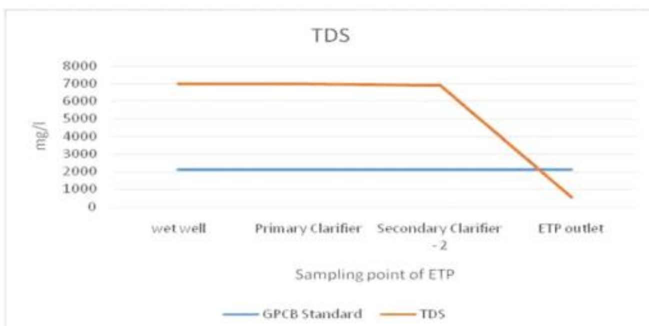

Fig. 4 TDS value for effluent

were within the limited of the Gujarat Pollution Control Board and thus were fit for discharge in water bodies. The reduction achieved at the installed project site were observed to be 11.71%, 99.47%, 92.15% and 90.11% for pH, COD, TDS and NH3-N respectively. This showed that the installed effluent treatment plant worked efficiently.

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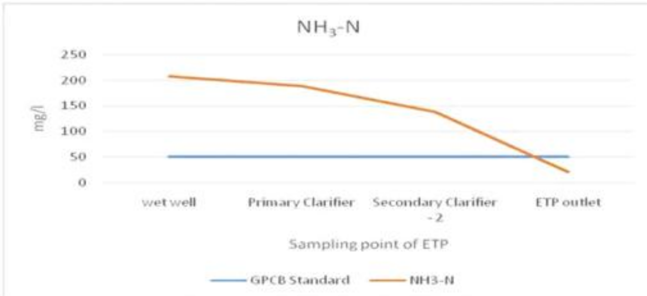

Fig. 5 NH3-N value for effluent

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