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Review on physico-chemical analysis of various pharmaceutical industrial effluents & its impact on the environment

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Abstract

Present paper deals with the review analysis of various physico-chemical parameters like temperature, pH, turbidity, TDS, DO, total hardness, chlorides, alkalinity, phosphates, sulphates, BOD,COD, heavy metals etc. in the effluents of pharmaceutical industries in India. During the review analysis of various pharmaceutical effluents, it has been studied that the values of DS and SS were higher than permissible limits in the pharmaceutical effluents of various industries. Different metals were found within the permissible limit in ground water sample except for the heavy metals like Cr, Pb, Cd and Ni which were found to be above the permissible limit recommended by WHO standards. The value of BOD and COD was many fold higher as compared to the permissible limits. Increased level of water pollution due to discharge of pharmaceutical effluents highlights the need for continuous assessment/characterization of pharmaceutical industrial wastewater. There is a great need that each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise 'Polluter pays' principle should be implemented.

Keywords: Pharmaceutical effluents, Water pollution, BOD, COD, Heavy metals

Introduction

Environmental pollution is one of the major challenges of today's civilization (Kaushiket al. 2012; Spinaet al. 2012). To resolve this problem of environmental degradation, a renewed dedication to a proven strategy is needed. Cleaner Production is a preventive environmental management strategy, which promotes eliminating waste before it is created to systematically reduce overall pollution generation, and improve efficiencies of resources use (Hashmi, 2005).

Pharmaceutical effluents are the wastes generated by pharmaceutical industry during the process of manufacturing of drugs. Though the wastewater discharged is small in volume, yet it is highly polluted because of presence of substantial amounts of organic pollutants (Overcash, 1986). Level of wastewater pollution varies from industry to industry depending on the type of process and the size of the industry (Garciaet al., 1995).

Antibiotics, lipid regulators, anti-inflammatories, antiepileptics, tranquilizers, and cosmetic ingredients containing oil and grease are the representative pharmaceutical and personal care products found in receiving waters (Lateef, A. 2004) .Toxic

materials including many organic materials, metals (such as zinc, silver, cadmium, thallium, etc.) acids, alkalis, non-metallic elements (such as arsenic or selenium) are generally resistant to biological processes unless very dilute. Metals can often be precipitated out by changing the pH or by treatment with other chemicals. Many, however, are resistant to treatment or mitigation and may require concentration followed by land filling or recycling (EEA, 2001). An important pollution index of industrial wastewaters is the chemical oxygen demand (COD) and biological oxygen demand (BOD), while the nutrient status of wastewater is measured in terms of nitrogen and phosphorus. In addition, other important quality parameters include pH, temperature and total suspended solids (Ezenobi & Okpokwasili, 2004).

Wastewater from any industry is often rich in color, containing residues of reactive dyes, organic chemicals and bleaching agents. The untreated effluent containing such substances appears cloudy due to large amounts of suspended matter and has extremes of pH (Priya et al., 2005). As per the report (Allahet al., 2006), the raw effluent mainly consist of various detergents at high concentrations, which forms froths on water bodies. The industrial effluents are a complex mixture of many polluting substances such as organochlorine-based pesticides, heavy metals, pigments and dyes. These effluents contain highly toxic dyes, bleaching agents, salts, acids, and alkalis (El-Nashar, 1998). Heavy metals like Cd, Cu, Zn, Cr, and Fe are present in the dye effluents (Gulf Breeze et al., 1995). Environmental pollution caused by such industrial effluents results in adverse effects on the general health of the workers, as well as the residents who live near the chemical synthesis industries (Asamudoet al., 2005) and farmers/field workers (Cappuccinoand Sherman, 1992). Various industrial processes primarily generate raw or untreated effluents (Mirbagheri et al., 2006). These effluents are high in chemicals and organic substances. Raw effluent passes through various treatment stages resulting in low concentrations of chemicals in the treated effluent for which treatment plants are normally used (Vijayarengan and Lakshmanacharya, 1993). "Heavy metals" are chemical elements with a specific gravity at least 5 times that of water. When water is contaminated with these heavy metals, it becomes toxic and dangerous for our biological system. There are 35 metals of concern because of occupational or residential exposure; 23 of these are the heavy elements or "heavy metals": Sb, As, Bi, Cd, Ce, Cr, cobalt, Cu, Ga, Au, Fe, Pb, Mn, Hg, Ni, Pt, Ag, Te, Tl, Sn, U, V, and Zn (Glanzeet al.,1996). Small amounts of these elements are actually necessary for good health but large amounts of any of them may cause acute or chronic toxicity. Long-term exposure of heavy metals resulted in slowly progressing physical, muscular, and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy and multiple sclerosis. Repeated long-term contact with some metals (or their compounds) may cause cancer (Bishnoi & Arora, 2007). Dehradun has seen rapid industrial development since it became the capital of Uttarakhand. The effluents from pharmaceutical industries from Selaqui region of Dehradun are usually discharged into the surrounding environment without proper treatment and ground water quality is affected (Bishnoi & Arora, 2007). Characterisation and treatment of wastewater discharged from a pharmaceutical R&D unit showed wide variation in waste characteristics due to the varied manufacturing operation/reactions employed. The combined waste exerted high BOD/COD value of 1385 mg/L and 5716 mg/L, respectively. The physico chemical followed by biological treatment caused

partial reduction of BOD/COD. However, the reverse osmosis system removed the pollutants to a considerable extent and brought down total dissolved solids, BOD and COD (Gandhiranjan et al., 2008). The study of treated effluent of IPCA Laboratories, Pologround, Indore revealed that the concentration of TS was quite higher than permissible limits (i.e. 500mg/l). The values of DS and SS were higher than permissible limits. Concentrations of chloride varied but were much higher than the permissible limit (i.e. 250mg/l). BOD and COD values were many folds higher as compared to the permissible limits (Dubey and Dixit, 2012).Analysis of physico-chemical parameters of untreated industrial effluents collected from pharmaceutical industries at Bangalore regions revealed that the treated effluent showed less inorganic compounds. The pharmaceutical effluents could be easily treated and after treatment majority of the inorganic compounds were removed (Rohit and Ponmurugan, 2013). Samples of industrial effluents were tested for the physicochemical parameters like color, pH, TDS, SS, chloride, sulphate, COD, oil and grease etc. The results of few samples were in the permissible limits and few samples were having higher value than the normal limit indicating that further treatment was required before the release of water into the main water resources (Surti, 2016).Physico-chemical analysis of effluents from pharmaceutical industry of Karnataka for temperature, pH, TSS, TDS, BOD, COD, oil & grease, chlorides & sulphates showed variations (Kavitha et al., 2013). The data revealed that the effluent treatment plant could withstand the shock loads without affecting the efficiency of the plant.

Concentrations of some heavy metals in the effluents of pharmaceutical Industries operating in the industrial area (Selaqui region) of Dehradun were determined using atomic absorption spectrophotometer. Iron was detected as the heavy metal with highest concentration of 10.80 mg/L. The maximum concentration for Pb was found to be 0.26 mg/L while 0.55 mg/l for Cd. Zinc was obtained in the range of 1 to 1.3 mg/L, Copper was found in the range of 0.08 to 0.38 mg/L and Nickel 0.03 to 0.12 mg/l. Chromium, lead, cadmium and nickel were found to be above the permissible limit recommended by WHO standards. (Ramola & Singh, 2013).

BOD values of effluent samples collected from pharmaceutical, dyes, engineering and paint industries were 1047.3, 776.2, 604.8 and 535.8 mg/L respectively which lie above the maximum permitted BOD content of < 100 to 300 mg/L. The COD values in the different industrial effluent samples were also very much higher than maximum permissible limit of 4.0 mg/L according to USPH Standard. The overall results highlighted towards the discharge of highly polluted waste water effluent from industries of Taloja Industrial area of Mumbai. So these industrial effluents were polluting Kasardi River thereby affecting the growth of vegetation and aquatic life (Lokhandeet al., 2011).

Physico-chemical analysis of waste water effluents discharged from pharmaceutical based industries located along the Dombivali industrial belt of Mumbai, India from June, 2012 to May, 2013 showed that the concentration level of majority of toxic heavy metals like Cu, Cr, Pb, Fe and Zn was maximum of 14.06, 0.57, 0.42, 18.93 and 3.31 ppm respectively in the month of February, while Ni concentration was maximum of 0.43 ppm in the month of June. Minimum of 3.00 ppm of DO was found in the month of February. Level of many toxic heavy metals except Zn and various physico-chemical parameters were above the tolerable limit set for inland surface water (Singare and Dhabarde, 2014).

Results and discussion

Review analysis has shown that pharmaceutical effluents have altered the physico-chemical factors of aquatic bodies to a large extent and have affected the aquatic diversity, man-kind & altered agricultural soil properties thus reducing the agricultural productivity. The occurrence and fate of pharmaceuticals in the environment, and in aquatic media in particular, have received considerable attention by the scientific community during the last two decades. All over the world, the countries are struggling to arrive at an effective regulatory regime to control the illegal discharge of industrial effluents into their ecosystems. Therefore, there is a need to treat the pharmaceutical effluents efficiently before discharging it into any adjacent water body/field to minimize the environment degradation.

Conclusion

It has been concluded that the pharmaceutical effluents have been contaminating the surface water as well ground water resources causing adverse affects on human health & environment. As India progresses towards strict regulation of industrial effluents to control water pollution, greater efforts are required to reduce the risk to public health as colourless and odourless toxic pollutants are released into the ecosystems. Hence there is a need that each industry should treat their effluents, in accordance with the legal requirements, before discharging these into the streams otherwise 'Polluter pays' principle should be implemented.

It is the call of time & nature to move towards ecosystem specific discharge standards to maintain the health and productivity of natural resources on which the majority of Indians are dependent.

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