A Review on Wastewater Treatment with Special Emphasis on Chemical Treatment Methods

Sonali R. Dhokpande, Sunil J. Kulkarni, Dr. Jayant P. Kaware

Abstract— **The environmental protection and related research is gaining more and more importance because of rapid industrial growth and diminishing water resources. The efficient treatment of industrial wastewater is very important part of environmental research. The industrial wastewater treatment includes physical, chemical and biological methods. The common treatments adopted includes settling, activated sludge process, aeration, anaerobic biological treatments, adsorption, and membrane separation techniques. The chemical treatment methods have their own advantages like economy (depending on chemical dose required), easy and simple method of treatment, energy saving. The current review aims at summarizing the research carried out for application of the chemical treatment methods for wastewater. In addition, few new wastewater treatments are also discussed.**

Index Terms— **organic matter, heavy metal, removal efficiency.**

I. INTRODUCTION

Treatment of industrial wastewater by using efficient method is very important aspect of modern day research. The industrial growth is the key to the financial and social stability and growth of the country. The manufacturing sector which is the most important part of the growth story faces severe problem of meeting the disposal standards. The scarcity of water in many parts of the world and also India adds to the seriousness of the wastewater disposal problem. The industries like mining, tanning, chemical, pharmaceutical, paint, dye, surfactant, electroplating, food, sugar, distillery etc. discharges the wastewater containing various organic and inorganic pollutants [1, 2, and 3]. Various methods like physical, biological, chemical and membrane treatments can be used for the removal of various treatment techniques [4, 5]. Adsorption by using low cost adsorbent was effective for domestic and distillery effluent [6, 7]. Adsorbents like flyash, rice husk carbon and groundnut shell carbon were used successfully for the removal of pollutants [8, 9]. Various biological treatments were also reported for the treatment for wastewater [10]. The treatment of wastewater by using various chemical agents is carried out by various investigators [11]. These methods need the addition of chemicals which work as coagulating agents, flocculating agents and solvent [12, 13, 14, 15]. Electrochemical removal was also found to be efficient method. The present review is aimed at presenting summery of chemical treatment methods used for wastewater treatment
with respect to methodology and effectiveness.

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II. RESEARCH ON CHEMICAL TREATMENT TECHNIQUES

Dwairi and Gougazeh developed Southern Jordanian natural zeolitic tuffs outcropped in Uniza volcano and tested for their heavy metals' removal capacity [16]. They carried out an investigation on removal of manganese and cadmium. They performed batch and column studies for removal of these pollutants. They achieved about 100 percent removal of these metals. They observed that the zealots have higher preferences for cadmium. Increase in shaking time increased removal.Electrochemical reduction/oxidation in treatment of heavy metal wastewater was studied by Chen et.al.[17].The most important factor was that this process was easy to control to treat metal wastewater and organic compounds were removed simultaneously. According to them, advantages of the electrochemical methods included lower operating costs and less usage of extra chemical r eagents and simultaneous achievements of fairly pure metals and removal of organic pollutants. Cascade Line Reactor was used by Pavlovic for selective removal of heavy metals from metal-bearing wastewater [18]. They carried out experiments using synthetic metal-bearing effluent with chemical composition similar to the effluent. Sodium hydroxide was used as precipitation agent. The result indicated that efficiency of copper, iron and manganese removal was very satisfactory (higher than 90%).According to their investigation, for copper, minimum achieved concentration was 0.62 mg/dm^3.A review on phytoremediation of lead from wastewater using aquatic plants was carried out by Singh et.al.[19]. They discussed chemical precipitation and other conventional methods in addition to phytoremediation. According to them foliage plants and trees may be the best means of improving water quality. In case of chemical methods, the advantage was cost effectiveness and simplicity. The production of large amount of sludge is a problem in this case. According to Amer, the chemical treatment methods are very important in metal finishing industries [20]. These methods are tedious due to several liquid chemicals to complete the metal removal step. This type of treatment may produce hazardous waste which

must be treated further. Turkar et.al. discussed various methods involved in waste water treatment to control water pollution [21].In their review they discussed the treatment methods such as activated carbon adsorption, chemical oxidation, biological treatment, etc. Improved ferrite process was used for completely treating heavy metal laboratory waste liquid by Lou et.al. [22]. They adopted ten common heavy metals and various anions to synthesize the simulated laboratory waste liquid. According to them, use of the extended reaction ferrite process (ERFP) rather than conventional ferrite process (FP) is better alternate as conventional ferrite process (FP) could not be used to treat the simulated waste liquid completely.

Bhat et.al. carried out investigation on use of oxalic acid for removal of heavy metal ions from waste water[23]. They investigated the potential of the oxalic acid to remove the heavy metal ions from the waste water and the effect of pH and temperature on the removal efficiency. According to the investigation, it was found that with increase in pH the removal efficiency of the oxalic acid remained almost constant. The maximum removal was obtained at pH 6.5. They concluded that oxalic acid was a promising complexing agent for the removal of heavy metals. Performance of electrocoagulation with aluminum electrodes for simultaneous removal of nickel, copper, zinc and chromium from synthetic aqueous aliquot solutions and actual electroplating wastewater was studied by Dermentzis et.al.[24].They studied effect of pH, current density,initial metal ion concentration,COD and contact time. A glass cell of 400 ml with 250 ml aliquot solutions was used for experimentation. Nickel, copper and zinc were removed in 20, 40 and 50 minutes respectively. Nickel, copper, zinc, chromium, COD concentrations reduced under admissible limits in 60 minutes. Chaturvedi carried out a review on electrocoagulation(EC) [25]. EC requires simple equipment and is easy to operate. Low initial investment with low operating cost, less maintenance, no problem of neutralizing excess chemicals and no possibility of secondary pollution caused by chemical substances,, formation of settleable sludge, faster filtration of waste generated and less total dissolved solids (TDS) content are few important advantages of EC. According to him it is very important to define adequate scale-up parameters.

Natural coagulants were used by Kazi and Virupakshi for the treatment of tannery wastewater [26]. Natural coagulants like Moringa oleifera, and Cactus were used for treatment by them. Conventional jar test apparatus was used for investigation. Their study indicated that optimum dosage for Cicer arietinum, Moringa oleifera, and Cactus were 0.1, 0.3 and 0.2gm/500ml respectively. Corresponding pH values were 5.5, 4.5 and 5.5. The maximum COD reduction of 90 percent was observed for Cicer arietinum. Heavy metals precipitation methods and various chromium reduction methods were tested for wastewater samples by Chang et.al. [27]. They used three methods using sodium metabisulfite, ferrous sulfate, dimethyl dithiocarbamate, ferrous sulfate, and alum. They observed that first three methods were efficient in chrome removal. An investigation was carried out on Treatment of semiconductor wastewater in sludge production and removal of heavy metals by Fatehah et.al. [28]. Their research was aimed determining the coagulation efficiencies on total solids (TS) removal from semiconductor wastewater by applying various locally available starches as natural coagulants. Alum [$Al_2(SO_4)_3 \cdot 18H_2O$] and polyaluminium chloride (PAC) were used as conventional commercial coagulants to compare the coagulation efficiency with the natural coagulants. They observed that natural coagulants employed in the study have similar coagulation characteristics with the commercial coagulants. In their investigation the highest TS removal were estimated by potato flour (90%).In their work, Awaleh highlighted the various industrial wastewater treatment technologies currently available [29].These technologies included physico-chemical and biological processes as well as constructed wetland and conventional or advanced oxidation processes. According to them combined anaerobic and aerobic treatment processes were effective in the removal of soluble biodegradable organic pollutants. Use of membrane in final stage is also increasing. They also discussed chemical methods like ozonation, chlorination, hydrogen peroxide treatment. According to them cost of oxidizer is a limiting factor in such treatments as it has to be produced on site. Phytoextraction was discussed for heavy metal removal from municipal sewage sludge by Pogrzeba et.al [30]. The main objective of their study was to assess the effectiveness of the phytoextraction process in removing heavy metals from sludge. It was concluded by them that the mesh method of harvesting should be effective in Cd removal from sludge when chelating agents were used. Nosier carried out experiments for removal of cadmium from industrial wastewater by cementation [31]. They carried out removal of $Cd^{++}$from waste solutions by cementation on zinc in a batch stirred tank reactor lined with a cylindrical zinc sheet. They studied the effect of various parameters like impeller rotation speed, initial Cd^{++}concentration, temperature, and time of cementation on the removal. With increasing degree of agitation, temperature and initial Cd^{++}concentration, the removal of cadmium increased. Also it was found that the removal was diffusion controlled.

An investigation on extraction of certain heavy metals from sewage sludge using different types of acids was carried out by Gaber et.al.[32]. They used nitric, hydrochloric, citric and oxalic acids for the removal of heavy metals like chromium, copper, nickel, lead and zinc from contaminated sewage sludge at different pH and reaction time. Maximum extraction efficiency was obtained for pH value of 2 for inorganic acids. They concluded that citric acid was a promising extractant for the removal of heavy metals from sewage sludge. Mustapha carried out investigation on optimal dosing of chemicals from leather industry wastewater[33]. They used ferric chloride ($FeCl_3$) dosage for the coagulation and a standard polyelectrolyte solution of 1 ml. They fed the coagulant with 0.5 ml increaments. For polyelecrolyte, the sample was fed with optimum amount of coagulant and 0.5,1,1.5,2,2.5 and 3 ml of polyelecrolyte was taken in 6 beakers. It was observed during their investigation that pH value of 10 was the best optimum value for metals removal in the leather waste water. 98% and 86% removal for Cu_2^+ and Ag^+ was achieved. Kosinska and Miskiewicz studied precipitation of heavy metals from industrial wastewater[34]. They used desulfovibrio desulfuricans in their treatment. They obtained Cr_{total}, SO_4 and COD removal efficiencies of 87.6%, 88.9% and 78.7%, respectively. The measures like replacing the swine manure with a more efficient source of simple organic compounds, optimizing the operating parameters of the

bioreactor, substituting the continuous mode of operation for the batch mode can help in improving the removal of heavy metals from industrial wastewater. Seehamoke and Sungsitthisawad used alum sludge from a surface water supply treatment plant for removing heavy metals from chemical oxygen demand test wastewater[35].The reagents added for COD test contain heavy metal. So it is necessary to remove heavy metals from this effluent. The optimum pH for removal was 4 and alum dose was 160g/l. At these conditions, it was possible to 99.9% of the silver, 99.8% of chromium and 99.9% of iron.

CONCLUSION

The treatment of industrial wastewater by using efficient and low cost technology is very important aspect of modern day research. Phytoremediation, biosorption and other physico-chemical treatments are investigated for removal of various pollutants. The chemical treatments have the advantage of energy saving. They are comparatively easy and simple. This type of treatment method uses various chemical agents as coagulants, flocculants and solvents. The treatment techniques like ozonation, chlorination, hydrogen peroxide treatment have their advantages and uniqueness under certain conditions of effluent quality and composition. It can be concluded that, among various new and old conventional treatment techniques, chemical treatment methods are very efficient and important in the industrial wastewater treatments. Use of natural coagulants and various modifications for cost effectiveness can make the chemical and electrochemical treatments more effective.

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