Introduction

1.0 INTRODUCTION

Environment is defined as the totality of circumstances surrounding an organism or group of combination of external physical conditions that affect and influence the growth, development and survival (Farlex, 2005).

Environment can also be defined as "the sum of all social, biological and physical or chemical factors which compose the surroundings of man". So man is both a creator and moulders of his environment (Kudesia, 2000).

Pollution describes the introduction of foreign substances into the biosphere (Oze *et al.,* 2006). Environmental pollution is becoming a global problem in which water pollution is an important issue as water is used directly for various purposes (Lokhande and Vaidya, 2004). Environmental deterioration by man is attributable to three major causative factors: Over-population, Urbanization and Industrialization (Kanan, 1991).

Rapid growth of industries and urbanization with new technical advancements have contaminated the existing water resources by discharging wastewater containing organics, colours, heavy metals from electroplating industry, mining operations and the refining of metals (Kumar, 2004). Industrial pollution is mainly caused by the discharge of industrial effluents into the water body (Rana, 2005).

Industrialization has brought along with it the hazards of environmental pollution as it has the material comforts. The industrial pollutions have spoiled the three wealths of life: water, air and soil. The industrial effluents have caused havoc for all (Kudesia, 2000).

A wide variety of substances, both inorganic and organic forms, are present in the effluents of breweries, tanneries, dying, textiles, pulp and paper mills, steel industries, electroplating, mining operations and paint industries etc. Many of these substances present in the effluent are not easily degradable in nature and thus cause pollution problems. Sodium, copper, chromium, cadmium, mercury, lead, arsenic, nickel, etc. are the common heavy metals present in industrial discharges (Omkar, 2003).

According to World Health Organization (WHO), the metals of most immediate concern are aluminium, chromium, magnesium, manganese, iron, cobalt, copper, nickel, zinc, cadmium, mercury and lead (Ulmanu *et al.,* 2003) which are discharged into water bodies that can be toxic to aquatic life and may cause natural waters unsuitable as potable water sources (Gupta and Singh, 2004).

Industrial and municipal waste water frequently contain metal ions. These metal ions when present in sufficient quantity can be harmful to aquatic life and human health (Kortenkamp *et al.,* 1996). Heavy metals are widespread pollutants of great environmental concern as they are non-degradable and thus persistent (Gupta *et al.,* 2000). Hence safe and effective disposal of waste water containing heavy metals is always a challenging task for industrialists and environmentalists due to the fact that cost effective treatment alternatives are not available (Rao *et al.,* 2003).

The treatment process of industrial waste water like reduction, chemical precipitation, ion exchange, reverse osmosis, ion floatation, evaporation, adsorption, settling and clarification are some of the methods to remove heavy metals (Gupta *et al.,* 1999; Shyamala and Lalitha, 2004; Volesky, 1990).

Heavy metals occur as natural constituents of the earth crust and are persistent environmental contaminants since they cannot be degraded or destroyed. To a small extent, they enter the body system through food, air and water and bio-accumulate over a period of time (Lenntech, 2004; UNEP /GPA, 2004).

Heavy metals are continuously released into the aquatic environment from natural processes like volcanic activity and weathering of rocks. Industrial processes have greatly enhanced the mobilization of heavy metals. They are highly toxic as ions or in compound forms; they are soluble in water and may be readily absorbed into living organisms (Lapedes, 1974). After absorption these metals can bind to viral cellular components such as structural proteins, enzymes and nucleic acids and interfere with their functioning.

Heavy metals are major pollutants in marine, ground, industrial and even treated waste waters (Valdman *et al.,* 2001). The important toxic metals such as Cd, Zn, Ni, Cr and Pb find their way to the water bodies through waste waters (Ajmal *et al.,* 1998). The release of large quantities of heavy metals into the natural environment has resulted in a number of environmental problems (Kaewsarn and Yu, 2001; Yan and Viraraghavan, 2001; Bansal, 1996) and due to their non-biodegradability and persistence, can accumulate in the environment elements such as food chain and thus may pose a significant danger to human health (Bakkaloglu *et al.,* 1998; Yetis *et al.,* 1998).

Concern over their problem has led to the development of alternative technologies for effective removal of these pollutants from aqueous effluents. Various techniques have been employed for the treatment of heavy metals, such as chemical precipitation, adsorption, electrolysis, ion exchange and reverse osmosis (Brown *et al.,* 2000; Kandah, 2001).

Nickel is one of the heavy metals which persists in the environment. Major anthropogenic sources of Ni(II) metal ions are metal extraction, metal fabrication, paints and pigments as well as manufacturing of batteries (Garg *et al.,* 2007). In humans, nickel can cause serious problems such as dermatitis, allergic sensitization and lung and nervous system damages and is also a known carcinogen (Malkoc, 2006).

Chromium does not occur in significant amounts naturally but it is formed as a by product of many industrial activities (Cohen *et al.,* 1993). The extensive use of chromium in industries has resulted in higher chromium concentrations in aquatic systems. Generally chromium exhibits two valence states, i.e., Cr(III) and Cr(VI). Trivalent chromium is essential to animals and human beings (Baral *et al.,* 2008). Where as, hexavalent chromium is highly toxic in nature to animals and human beings when present at millimolar concentrations (Wang and Li, 2004).

The main techniques, which have been utilized to reduce the heavy metal ion content of effluents, include lime precipitation, ion exchange (Dean *et al.,* 1972), membrane processing and electrolytic methods (Braukmann, 1990).

These methods have been found to be limited, since they often involve high capital and operational costs. In recent years, much interest has been exhibited in the use of adsorption technique for the removal of toxic metals and organic materials from waste water. Adsorption has long been recognized as one of the efficient processes for the treatment of waste water (Jamode *et al.,* 2003).

Activated carbon has been frequently used as an adsorbent. Despite its extensive use in the water and waste water treatment industries, activated carbon remains an expensive material. This had led to the production of low cost alternatives to commercially available activated carbon. Therefore, there is an urgent need that all possible sources of inexpensive adsorbents should be explored (Khan *et al.,* 2004). Many adsorbent materials have been evaluated for low cost operation and high efficiency (Katyal *et al.,* 2003).

Agricultural and animal wastes like bagasse, peanut hull, jack fruit peel, soybean hull, rise husk, groundnut shell, papaya wood, cassava waste, banana pith, orange waste, hen egg shell membrane, wool, silk, onion skin, animal horns and human hair have been used to remove heavy metal ions from waste waters. These adsorbents have been developed as alternatives to activated carbon due to the cost of regenerating the latter. Activated carbon is characterized by a large sorption capacity because of its large surface area. Examples include the removal of Cu^{2+} and Cd^{2+} ions from aqueous solution by seafood processing waste sludge (Lee and Davis, 2001), the removal of Hg^{2+}, Pb^{2+},Cd^{2+} and Cu^{2+} ions from industrial waste water on the activated agricultural waste of coir pith (Kadirvelu *et al.,* 2001a).

Human hair waste is highly effective for the removal of phenol from aqueous solutions. When compared to other materials, hair is easier, safer to collect and less expensive. The human hair waste has been converted into a cheap potential adsorbent (Banat and Al-Ashesh, 2001; Bass *et al.,* 2001).

The objectives of the present study were:

1. To study the efficiency of removal of heavy metals, nickel(II) and chromium(VI) present in the synthetic solutions using powdered human hair.
2. To identify the optimal experimental conditions for the removal of nickel(II) and chromium(VI) by the selected adsorbent powdered human hair.
3. To perform adsorption kinetic studies following Langmuir and Freundlich isotherms in order to assess the suitability of human hair for metal adsorption.

The experiments were conducted on a laboratory scale batch process. The investigations were focused with reference to sorption of nickel(II) and chromium(VI) and to provide an in-depth understanding of nickel(II) and chromium(VI) metal ions sorption mechanisms and mobility of these metal ions onto selected sorbent under varying experimental conditions namely different pH, temperature, adsorbent dosage, initial concentration and contact time of metal ions and adsorption of one metal ion in presence of the other.