CHAPTER - I

INTRODUCTION

1.1 General

Earth is the only planet in the solar family known to have life owing to the presence of atmosphere, hydrosphere and lithosphere. It was estimated that about trillions of organisms (living things) are growing on the earth (both plants and animals). These living things are found in water, land and also in the air.

All the materials cycling like carbon, nitrogen, water etc. makes the sustenance of life on the earth. During this material cycling, energy is transferred from one species to another and it makes the organisms to grow. These living things excrete their waste into their surrounding area and make the surrounding filled with wastes. The nature created many mechanisms to ensure proper material cycling by the way of eating and being eaten.

The appearance of human species on the earth surface is the beginning of the material cycling imbalance. Owing to the superior characteristics the human being started to have control over all other species on the earth. During the course of civilization growth, man invented many technologies for their life enhancement. Especially after the second world war, the human population is growing exponentially and this tremendous increase of population destroys all the available natural resources.

The world population drastically increased from 2.5 billion to 6.5 billion during the period between 1950 and 2005 (Christian, 2010). The economical gap between the high income class people and low income class

people have got widened. This sort of economical bias makes the poor people to go for deforestation to ensure their survival. Along with deforestation, the economically backward people destroyed the grassland, soil as well as wild life.

It was estimated by the biologists that the human activities are the prime factor for exponential extinction of life on the earth (Sulaiman et al., 2015). The human foot print destroys various part of the world, wetlands, coral reefs, forests and grass lands (Wanjui, 2013).

“Any change in the physical, chemical and biological properties of water is called as pollution”. This alteration is caused by the discharge of dyes, heavy metals, pesticides, fertilizers, detergents and other chemical products. The environment is degraded by the human community and the human community is affected by the environmental degradation (Yola et al., 2014a).

Among the resources which are depleted by growing human population is the depletion of fresh water resources. Over consumption of fresh water for industrial, agricultural and domestic purpose are the main cause of fresh water resources depletion on the other side, discharge of unwanted and waste by-products on the water bodies creates water pollution. These over utilization and discharge of pollutants deplete the availability of fresh water.

The obvious signs of water pollution are the bad taste of drinking water, foul odour from water bodies, and uncontrolled growth of aquatic weeds in the water bodies etc. This type of water pollution retards the growth of valuable aquatic animals and plants. The death of these plants and animals

will induce the bacterial decomposition and this decomposition produces lot of unwanted and undesirable by products (Li et al., 2009). Also, the discharge of coloured dyes and pigments retards the photosynthesis by preventing the penetration of light into the water (Atar and Olgum, 2009). The by-products generated during the breakdown of the pollutants produce some harmful products which are highly harmful and carcinogenic (Suteu and Zaharia, 2009).

Many industries like textile, dyeing, paper and plastic industries use large varieties of complex organic dyes in-order to colour their products. To satisfy the needs of these industries, there are more than 1,00,000 dyes available commercially and their annual production is around 7×10^5 tons per year (Meyer, 1981; Zollinger, 1987). As result of this huge production and application, considerable amount of dye bearing wastewater are generated. The presence of even a trace quantity of dye is not desirable in fresh water (Robinson et al., 2001; Banat et al., 1996). According to ecological and toxicological association of dye stuffs manufacturing industry (ESTD), out of 4000 dyes tested, nearly 90% of the dyes had LD_{50} values are greater than 2×10^3 mg /kg (Shore, 1996).

Though the industrial development and the growth in agriculture to creates pollution, but their development is unavoidable in-order to satisfy the needs of growing population. In this context, it is essential to develop same technologies that can effectively treat and recycle the generated wastewater. There are many physical, chemical and biological methods have been developed and tested for the treatment of wastewater (Yola et al., 2014b; Atar and Olgun, 2007). The scope of these technologies is limited owing to their

high cost, complicated technology and very narrow range of applicability to the pollutants (Ravikumar et al., 1998).

Especially during the past 20 years, there are several technologies have been developed and employed for the effective removal of pollutants present in the wastewater (Ghoreishi and Haghighi, 2003). Among the reported methods, adsorption using activated materials attracts the researchers considerably (Jain et al., 2003). The wide applicability of adsorption is due to its low cost, wide selectivity and simple technology (Ho and Mckay, 2003). A perfectly designed adsorption system can produce good quality water as the adsorption can be operated in batch and column mode.

Adsorption using high surface activated materials is one of the most effective methods for the removal of wide range of organic and inorganic pollutants. Activated carbon with high surface area is one of the most preferred adsorbents over other adsorbents due to its inertness, easy availability etc. The high operating cost and difficulties in regeneration of activated carbon leads to many researchers to search for more economic adsorbents. Use of biomass consisting mainly of agricultural and forestry waste, can be regarded as a renewable energy source with great potential to supply the global material demands as they have high cellulose content, which will give good quality activated carbon. Moreover, the use of biomass contributes for the reduction of the greenhouse effect and also solves the problem of solid waste disposal. A good quality low cost adsorbent should be economically cheap, easily available and disposable without regeneration.

Exploration of materials in the nano scale has great advantages due to high surface area, uniform properties, excellent process ability etc. Carbon in nano scale has some exciting morphologies like nanotubes, nano spheres such as fullerenes, single layered nano sheets and so on. The nano carbon variants like hollow carbon nano spheres and carbon nano-tubes have been successfully used as composites for hydrogen storage (Ampoumogli et al., 2012), PEM fuel cell cathode (Marie et al., 2009), oral drug delivery (Wang et al., 2014; Saha et al., 2014), super capacitors (Fan et al., 2015) are also used for the remediation of water contaminated with oil (Murugesan et al., 2017). Hollow carbons, bamboo shaped tubes and smooth tubes were successfully synthesized from benzene, ethylene and acetylene using mixture of metal salt catalysts (Fe, Ni and Co) at high temperature by Kovalevski and Safronov (1998).During high temperature pyrolysis, the decomposition of precursor oil into a carbon nucleus with solid/liquid & liquid/gas interfaces ends with the radial and concentric texture growth of fluid cokes leads to the formation of nano carbon balls (Inagaki, 1996).

1. 2 Batch mode adsorption

For an effective design of an adsorption system for industrial applications, the knowledge about equilibrium and kinetics are essential (Stenzel, 1993, Hsuen, 2000). The batch mode adsorption has many advantages such as1) It is less expensive and less time consuming 2) The interpretation of results are very simple 3) Many process variables can be analysed. Based on the above facts it is essential to design an adsorption system in batch mode operation.

1.3 Column mode adsorption

Continuous operation at industrial level for the treatment of large quantity of wastewater requires the adsorption system in continuous flow operations. Continuous column mode operation can be designed easily using the results obtained in the laboratory scale. Adsorption and regeneration are very easy in column mode operation when compared with that of batch mode (Valdman et al., 2001).

The great advantage of both batch and column mode adsorption system is that the pollutant present in the large volume of wastewater can be concentrated onto a small volume of solid mass (adsorbent) and can be disposed easily (Robinson et al., 2002; Padmesh et al., 2006; Chu, 2004).

1.4 Scope of the present investigation

Most of the developing countries like India are facing the problem of pollutants released onto the environment without proper treatment. There is an increasing awareness among the people about the minimization of pollutants discharged onto the environment by the industries. The strict regulatory requirements set by the government also force the industries to go for an effective pollution control methodologies. The existing methods and materials are costly, it is difficult for the small scale industries to adopt those technologies.

Synthesis of a novel and low cost adsorbent from biologically renewable material can be beneficial for industries especially small scale industries. In-order to make the material most efficient, it is essential to improve the surface area either by reducing the size of the particle or by

activation. Synthesis of a nano sized adsorbent can improve the surface area drastically. The problem associated with the nano adsorbent is that their recovery after usage. This can be solved by doping the nano adsorbent with magnetically active materials. An adsorbent with all the above qualities will serve a better choice for the adsorbent removal effectively and economically.

Chapter 1 of the thesis deals with the present scenario of the pollution and its impact on human health, treatment technologies and based on these facts, the scope of the thesis is designed. Chapter 2 deals with the review of literature about the current advancements in pollution treatment technologies with their merits and demerits. Based on the review of literature, the objective of the work is designed. Chapter 3 deals with the materials and methodologies employed for the present study. All the results obtained and their detailed discussions are presented in chapter 4. Based on the results and discussion the conclusions drawn are presented in chapter 5.