Chapter 1:

1. INTRODUCTION

1.1 Solid waste disposal problem.

The incremental trend of human settlement in and around the metropolitan cities, urban centers and peri-urban interface, yields an uphill task of management of municipal solid waste (MSW) owing to both quantity and quality in addition to land acquisition conflict that being poised in recent times. As a result of various commodity used by inhabitants of the city in effect of consumer market, the nature of disposal problem is invocating in ascending trend. 366 numbers of Indian cities representing 70% of Indian urban population generate one-tenth of millions of solid waste per day indicating a per capita waste generation of 500 gm/day. In 2001 the above cities produced $3.16 \times 10^6$ tons of waste and currently generate 46 million tons, which shows a formidable increase in a tune of 50% increase in one decade. More than 90% of the MSW generated in India is disposed in unscientific way that results in environmental pollution (Kumar et al. 2009). The land filling has been to the main method of the waste management. The same disposal-tripping site are on use years long together by overlaying waste material even their useful life span is over. Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid known as leachate even at the closer stage. Leachate extracts a series of contaminants and attributes to a complex interplay between the hydrological and biogeochemical reactions. The emission of leachate imparts various environmental problems for which the issue is a serious threat to society as it has potential for causing ground water pollution along with partial contribution for adverse effect on soil fertility (Aziz et al., 2004). Leachate contains large amount of organic matter of which humic substances are the major group along
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with ammonia nitrogen, toxic metals, chlorinated organic, phenolic compounds even pesticidal residues etc. More than 90 organic and metal organic compounds and 50 inorganic elements have been traced by number of investigations conducted at different times in different parts of the world (Cecilia et al., 2008). The age of landfill, also influence the characteristics of leachate pollutant concentrations. A few no. of studies have been conducted by some earlier researchers to explore the characteristics of leachate from various landfill sites of Indian metropolis and other important cities. The data of such investigations show a significant pollution load is being imparted by such leachate.

1.2 Environmental effect of leachate generation

Older, poorly designed or poorly managed landfills can create a number of adverse environmental impacts such as wind-blown litter, attraction of vermin, and generation of liquid known as leachate is defined as any contaminated liquid effluent percolating through deposited waste and emitted within a landfill or dump site through external sources, of which its route of exposure and toxicity often remains unknown (Park et al., 2002; Al-Sabahi et al., 2009; Al-Yaqout et al., 2005; Mor et al., 2006). More precisely, it is a soluble organic and mineral compound formed when water infiltrates into the refuse layers, extracts a series of contaminants and instigates a complex interplay between the hydrological and biogeochemical reactions. Various environmental problems associated with landfill system of MSW disposal, leachate is gaining a serious threat to society as it has potential for causing ground water pollution along with partial contribution for negative effect on soil fertility (Aziz et al., 2004; Baun and Christense 2004; Fatta et al., 1999). Under normal conditions, leachate migrates down through the pores within the waste mass, and in modern containment landfills, it drains away in the engineered drainage layer, collected at the lowest point
in a sump or storage reservoir. Leachate contains large amount of organic matter of which humic substances are the major group along with ammonia nitrogen, toxic metals, chlorinated organics, phenolic compounds even pesticidal residues etc. More than 90 organic and metal organic compounds and 50 inorganic elements are traced through various studies conducted in different parts of the world (Cecilia et al., 2008).

1.3 Vulnerability of leachate and LPI

The presence of this large number of hazardous compounds in landfill leachate should have a significant impact on future landfill risk assessment and the development of leachate treatment methods. In the context, an indexing parameter has been introduced by Kumar and Alappat (2003-a) known as leachate pollution index (LPI) and sub-leachate pollution index there on to examine the strength of leachate quality as well as to be used as a decision making numerical tools.

1.4 Treatment aspect

The treatment method is selected based on identified pollutants and its concentration. An integration of treatment methods composed of physico-chemical and biological method are preferred as end of pipe technology (Foo 2008; Abbas et al., 2009; Keenan et al., 1983; Kılıç et al., 2007). A few detail works have been done on leachate treatment particularly by the biological methods (anaerobic and aerobic). The major thrust has been given for removal of organic materials including nutrients (COD, N, P). Some studies have been conducted by few researchers for removal of heavy metals (Foo 2008). Biological process is conventionally preferred to physico-chemical one but only such scheme is not fulfilling the satisfactory output effluent quality due to presence of many dissolved toxic constituents in leachate. Adsorptive process is a common conventional and economical process for treatment of dissolved toxic and
organic matters. Activated carbon is widely used materials for adsorption system (Abdul et al., 2007; Aktas and Cecen (2001)). However, various other low cost carbonaceous materials derived from wood, bagasse, rice husk etc. have been explored as adsorbent (Aghav et al., 2009). In Indian context, data are not abundance for predicting any kind of pollution index in reality i.e. with respect to Indian condition on leachate quality. Adsorption process was not employed much in Indian context to explore the abating potential of leachate pollutants particularly for Xenobiotic and hydrocarbon inclusive phenolic compound in landfill leachate. However, the suitability of technologies to Indian conditions has not been sufficiently studied especially with respect to low cost and sustainable management of entire MSW stream particularly preventing and reducing the effect of leachate pollution including high phenol and organic treatment. Though modern landfill sites are facilitated with impermeable liner materials to prevent leachate pollution, still some existing dumpsites releases the leachate containing high amount of organics, metals, toxic organics including phenolic compounds. With reference to the limitations of earlier work, Present research work was undertaken with a aim to explored the pollution potential of leachate as release out from Dhapa landfill site with a primary emphasis as organic content (COD) and phenolic constituents. Experimental study have been conducted by chemical treatment using different chemical coagulants followed by incorporation of adsorption process using some low cost materials such as wood charcoal and rice husk charcoal and the adsorption results are compared with granular activated carbon in the present study. The adsorption experiments have been carried out by batch kinetic study and detailed column break through study.
1.5 Organization of thesis

Chapter 1 consists of introduction of the municipal solid waste landfill site, leachate generation and different compositions of it along with introduction of the work. Limitations of the earlier work are discussed in this chapter. Comprehensive review of literature pertaining to phenol removal by adsorption method, batch study including kinetic models, different isotherms and fixed bed study is presented in Chapter 2. In chapter 3 objective of thesis and scope of the work is mentioned. Details of experimental procedures involved including collection of sample and the analysis of data is presented in Chapter 4 as Materials and methods. The experimental results, data analysis of results related to leachate pollution Index (LPI) and sub leachate pollution index (Sub-LPI), analysis of batch study and fixed bed study is discussed in Chapter 5 as results and discussion. Concluding remarks on the present investigation are described point wise in Chapter 6. Future scope of the work is highlighted in Chapter 7. Lastly the references as cited in the thesis are all listed at the end of the thesis. Abstract and front pages of the published papers pertaining to the research work also enclosed as APPENDICES.