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Modeling and Simulation of Road Traffic Noise Using Artificial Neural Network and Regression

M. HONARMAND AND S. M. MOUSAVI*

The effect of traffic composition on the noise pollution has been investigated in a large city, where the population is over 2 millions. Noise measurements and vehicle counts were performed at three points of the city for a period of 12 hours. Two models of artificial neural network and regression were applied to predict in-city road traffic noise pollution. The MATLAB and DATAFIT softwares were used for simulation. The predicted results of noise level were compared with the measured noise levels in three stations. The values of normalized bias, standard squared error, mean-squared error, root-mean-squared error, and squared correlation coefficient calculated for each model showed that the results of two models are suitable, and the predictions of artificial neural network are closer to experimental data.

Key words: *Artificial neural network, road traffic noise, regression, modeling, simulation*

1. Introduction

The disturbance produced in our environment by various kinds of undesirable loud sounds is called noise pollution. Noise is one of the most pervasive pollutants. Like other pollutants, noise is a product of industrialization and modern civilization. It is an inescapable part of everyday life. It has become a growing concern throughout the world as it affects not only daily activities of people but also their productivity, health, and emotion. Noise pollution is one of the biggest problems in developing countries like India and Iran who try to catch the modernity on the wrong side as they do not adopt the right technology and legal measures to control it.

Noise pollution is an increasing problem throughout the world. Traffic noise is considered as one of the major contributors to noise pollution. Particularly, road traffic noise is considered to be one of the most widespread and growing environmental problem in urban areas. The report of a study conducted by the Organization of Economic Cooperation and Development in 1991 states that people consider noise to be the main local environmental problem, sometimes even more than air pollution or quality of drinking water.

Traffic noise, itself, is categorized in 4 major groups: vehicular, airport, railway, and seaport noise. Sources of vehicular traffic noise include all the vehicles in roads and streets of a city: cars, vans, trucks, buses, motorcycles, and etc. This type of noise pollution is considered as one of the most invasive types of noise pollution and often the most intrusive of all and has become an issue of immediate concern for authorities in cities. Vehicle noise is primarily generated by vehicle engines, exhaust systems, and aerodynamic friction. Tire–pavement interaction[1], speed bumps[2], traffic lights[3], stop signs, acceleration and deceleration, and road surface gradient are the factors affecting moving vehicle noise propagation level. Hence, traffic noise may well be affected by traffic volume, composition, speed, road surface, and its gradient. As a result, road traffic noise is among the extensively most studied fields of noise pollution and therefore, several studies have been made on different aspects of traffic noise[4-10].

Some researches have been conducted to determine and predict noise propagation level in different countries all around the world. These have led to development of various models for recent purpose. Sheadel has classified noise models into four categories, namely: regulatory, trade, commercial, and design[11]. Steele has reviewed some of the most popular developed models, such as Federal Highway Administration Traffic Noise Model (FHWA TNM) with STAMINA 2.0/ OPTIMA for United States, Calculation of Road Traffic Noise (CoRTN) for United Kingdom, Richtlinien zum Lärmschutz an Straßen (RLS) 90 standard for Germany, and etc[12].

Most models assume that emitted noise expands spherically and attenuates logarithmically with increasing distance from the source. However, this assumption is only valid for closed and void systems. Some of these models assume point source[13]. While this assumption is a simple assumption, noise sources, with good approximation, behave as area sources[14]. For closely spaced sources, i.e. major roadways, they have a linear behavior[15]. A dynamic optimization has been suggested for the prediction of periodic non-stationary road traffic noise[16]. The researchers have

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Investigation of Volatile Mono-Aromatic Hydrocarbons and 1, 3-Butadiene in an Urban Metropolis, India

R. K. SINGH[1*], D. S. RAMTEKE[1], H. D. JUNEJA[2], G. H. PANDYA[1] AND M. N. WAHALE[2]

In urban areas, benzene, toluene, ethyl benzene and xylenes (BTEX) constitute up to 60% of nonmethane VOCs. The present work was conducted to determine the ambient volatile 1, 3-butadiene and mono-aromatic hydrocarbons in an urban metropolis of Nagpur, India. Continuous sampling was carried out at high density traffic junctions, major petrol filling stations along with some residential areas during March to May, 2011. The samples were collected in 10 litre tedlar bags during the peak hours and analyzed within 24 hours by VOC analyzer based on Gas Chromatography-Photo Ionization Detection technique. Appreciably high concentrations of Total BBTEX were observed at petrol filling stations (237.1µg/m^3) and traffic junctions (134.3µg/m^3). The levels of BBTEX observed around a major traffic junction were significant to commuter exposure. In view of the health impacts to commuter, nearby residents and occupational exposure, preventive measures like use of CNG, installation of vapor recovery system at petrol filling stations and use of mask by the workers were needed. The correlation analysis and concentration ratio study indicates the impacts of petrol pumps and vehicular traffic on the urban air quality at the residential sites. The levels of benzene were well within the National Ambient Air Quality Standards at all the residential locations.

Key words : *BBTEX, traffic junctions, petrol filling stations, residential areas, commuter exposure, concentration ratios*

1. Introduction

The concentration of air pollution in urban areas is rapidly growing, which has become increasing complex due to growing industrialization, fossil fuel consumption, and ever-growing transportation networks.[1] Volatile organic compounds (VOCs) are important air pollutants in the urban atmosphere.[2-3] VOCs in ambient air originate from various biogenic and anthropogenic sources[4] and play an important role in the physicochemical process of the troposphere as they largely contribute to the formation of ozone and other photochemical oxidants.[5-6] Several VOCs are also precursors of ground-level ozone formation[7], and they are mainly emitted in areas of intense transport and industrial activity.[8] Many VOCs have been identified as toxic, carcinogenic or mutagenic at concentrations levels found in urban environment.[9]

1, 3-butadiene and mono-aromatic hydrocarbons like benzene, toluene, ethyl-benzene and xylene (BBTEX) are considered as volatile organic compounds (VOCs). These compounds are listed as Hazardous Air Pollutants (HAPs) in the US Clean Air Act Amendments (CAAA) of 1990.[10] The specific interest in 1, 3-butadiene is because, it is classified as "known or suspected carcinogens" along with benzene by Agency for Toxic Substances Disease Registry and United State Environmental Protection Agency (USEPA) and it has a unit risk factor some 30 times that of benzene.[11] The major environmental source of 1, 3-butadiene is the incomplete combustion of fuels from mobile sources (e.g. automobile exhaust). Other sources of 1, 3-butadiene include vehicle tire wear, petroleum refining, styrene-butadiene copolymer production and biomass burning, including residential wood combustion, agricultural burning, and managed forest fires.

Benzene, toluene, ethyl benzene, and xylene (BTEX) form an important group of aromatic VOCs because of their role in the troposphere chemistry and the risk posed to human health.[12] Among these VOCs, benzene has been a high priority urban air pollutant for assessment.[13-15] Benzene present in the urban and industrial atmosphere is essentially as a result of human activities, arising mainly from motor vehicle exhausts and other combustion processes utilizing fossil fuels, petrol storage and distribution, solvent usage and other industrial processes.[5-6] Toluene was the most abundant volatile compound found near the petroleum filling terminal. Ethyl benzene smells like gasoline and is present in air because of evaporative emission of gasoline. m- and p-xylene occurs

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Investigation of Volatile Mono-Aromatic Hydrocarbons and 1, 3-Butadiene in an Urban Metropolis, India

R. K. SINGH[1+], D. S. RAMTEKE[1], H. D. JUNEJA[2], G. H. PANDYA[1] AND M. N. WAHALE[2]

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1. Introduction

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Ambient Air Quality Assessment with Particular Reference to Particulates in Jharia Coalfield, Eastern India

GURDEEP SINGH[1], DEBANANDA ROY[2+] AND SWETA SINHA[3]

Jharia Coalfield is the critically polluted area with the intense mining and associated industrial activities. There has been widespread concern of particulate pollution with the alarming levels of Suspended Particulate Matter (SPM) and Respirable Particulate Matter (PM_{10} & $PM_{2.5}$). Coke oven plants, coal washing, thermal power stations and associated activities coupled with the transportation activities, give rise to critical air pollution levels in the region. This study envisages the assessment of air pollution of the region with particular reference to SPM, PM_{10} and $PM_{2.5}$. Eighteen monitoring stations were selected considering various sources of pollution such as mining, industrial, commercial and residential areas apart from siting criteria as per IS: 5182 Part XIV. Air quality monitoring was carried out following standard methodologies and protocols as per Central Pollution Control Board (CPCB)/ National Ambient Air Quality Standard (NAAQS) norms using Respirable Dust Samplers (RDS) and Fine Particulate Samplers ($PM_{2.5}$ Samplers). This study reveals considerable load of particulates (SPM, PM_{10}, $PM_{2.5}$) which exceed not only the NAAQS but also the coal mining areas standards of Jharia coalfield, thus falling under the category of critically polluted area. Air Quality Indexing has also been developed which provides a clear map of the deterioration of air quality and also presenting comparative ranking of all the monitoring locations with respect to air quality status in the study area.

Key words: *Air pollution, SPM, PM_{10}, $PM_{2.5}$, coal mining, air quality monitoring, CPCB, NAAQS, Air Quality Index*

Introduction

Jharia coalfield which has been intensely exploited for over the last 100 years is the main source of metallurgical coal in India. Coal reserves in Jharia Coalfield are estimated at 14212.42 Mt. in 0-600 metre depth (GSI, 2012) with production of 39.65Mt. coal in the year 2010-2012[1]. This coalfield is subjected to intensive mining activities and accounts for 30% of the total Indian coal production[2]. This huge amount of coal production, processing, transportation and other associated activities emit pollution in various forms. Over the past few years, with the introduction of mechanized mining techniques and heavy earth moving machines (HEMM), this problem has been further aggravated.

Jharia Coalfield is one of the most important coalfields in India, located in Dhanbad district, between latitude 23° 39' to 23° 48' N and longitude 86° 11' to 86° 27' E, about 260 km north-west of Kolkata, in the heart of Damodar Valley, mainly along the north of the river. The field is roughly elliptical, or sickle shaped, its longer axis running northwest to southwest, covering the area of over 460 sq km and extending for a maximum of about 38 km east-west and 19 km north-south. This is the most exploited coalfield because of available metallurgical grade coal reserves.

Study area, a part of Jharia Coalfield is depicted in **Fig. 1**. It is surrounded with different polluting sources like opencast coal mines, coal washeries, coke oven plants and thermal power stations, commercial and also residential areas. Eighteen (18) ambient air quality monitoring stations were selected for this study as per the siting criteria (IS: 5182 Part XIV) with special consideration of meteorological data and sources of pollution, apart from security, accessibility and availability of electricity. One reference ambient air quality monitoring station also established at ISM, Dhanbad which is relatively cleaner area providing background particulate levels in the study area.

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Heavy Metals in Soils and Vegetables Irrigated with Urban Grey Waste Water in Fagge, Kano, Nigeria

CHIROMA T. M.[1+], EBEWELE R .O.[2] AND HYMORE F. K.[2]

There is currently an increased consumption of vegetables within the local urban community. However, contamination of these vegetables with heavy metals poses a potential health hazard. Consequently, the potential contamination problem due to the effect of levels of some heavy metals (Fe, Mg, Zn, Mn, Cu and Cr) in soils and vegetables irrigated with drainage urban grey waste water were investigated. The maximum levels of Fe, Zn, Mn, Cu and Cr in the urban grey waste waters were respectively 2.8, 2.1, 19.5, 2.3 and 143.1 times, higher than the maximum recommended concentrations of these metals: 5.0 µg/mL, 2.0 µg/mL, 0.2 µg/mL, 0.2 µg/mL and 0.1 µg/mL, respectively, for irrigation waters. The soils were found to be contaminated with these metals to levels that range between 24 to 84 percent contaminations. Although the heavy metals concentration ranking in vegetable parts vary with plant specie, the concentrations of Fe, Zn, Mn, Cu and Cr in most parts of the vegetables were above their critical concentrations of 750 – 1000 µg/g, 100 – 400 µg/g, 300 – 500 µg/g, 20 – 100 µg/g and 5 – 30 µg/g, respectively, in plants. This suggests potential toxicity of these parts of vegetables. It was however found that over 40 percent of the concentrations of Fe, Mg, Zn and Cu in Onions, Fe in Okro, Cr in Bushgreen, Cu in Roselle and Zn, Cu in Carrot leaves can be easily removed by washing the leaves with water. However, only Cu concentration in Onions and Bushgreen leaves met the acceptable permissible level in plants after washing.

Key words: *Vegetables, soils, heavy metals, sewage water, critical concentrations*

1. Introduction

At a time when environmental quality and food production are of major concern to man, a better understanding of the behavior of heavy metal in soil – plant systems seems to be particularly significant. The sources of heavy metals in plants are their growth media (e.g. soil, air and nutrient solution) from which heavy metals are taken up by roots or foliage. Although heavy metals are essential to plant nutrition (micro – nutrients), plants growing in a polluted environment can accumulate heavy metal at high concentrations causing serious risk to human health when plant - based foodstuffs are consumed[1-3]. Urban effluents always contain heavy metals, and long–term irrigation with untreated urban effluents has been shown to increase the amount and bioavailability of heavy metals in the soil[4]. The irrigation of rice in Paddy field with cadmium contaminated water has claimed many lives along the estuary of River Jintu from increase uptake of cadmium in locally consumed rice grown in the field[5-6].

The ancient city of Kano, located in the northern part of Nigeria experiences an average annual rainfall of 70 mm for a period of five months. The long dry season period are used by the populace to cultivate vegetables, fruits and food crops to meet the increasing demands of the fast growing population. The irrigation waters used in the study area (Fagge) is untreated drainage urban grey waste water. It was also observed that untreated urban urban grey waste water contains heavy metals[4]. Therefore, the major objective of this study was to determine the extent of contamination by the heavy metals (Fe, Mg, Zn, Mn, Cu and Cr) not only of the irrigation water and soils but also, and particularly, the vegetables. This will help establish the safety or otherwise of crops irrigated with untreated drainage urban grey waste water and hence their potential toxic levels.

2. Materials and methods

2.1 Study area

The study area is the Fagge irrigation site along a major drainage in Kano municipality. The soil texture is slight to moderately light texture, sandy loam that is alkaline (pH 7.6 – 9.5). Soil samples were obtained from each farm by randomly taking soils from three spots within the farm, and were mixed according to their depth to give a representative samples. Plants were also randomly sampled within the farm to get a representative sample. Samples of water used for irrigating each farm were taken for analysis of heavy metal content. In each of these samples, the concentrations of the heavy metals (Fe, Mg, Zn, Mn, Cu and Cr) were determined by atomic

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Effect of Vermicompost Alone and Its Combination with Recommended Dose of Fertilizers on Available Nitrogen, Phosphorus, Potassium in Rice Field

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Rice variety KMP101 was treated with both organic and inorganic manure. The field and experimental studies were conducted, before applying organic and inorganic manures.The values obtained for available nitrogen, phosphorous and potassium were 360 kg/ha, 12 kg/ha and 166 kg/ha respectively. After treatment and harvest there was a gradual increase in available nitrogen, phosphorus and potassium ranging between 335-415, 14 -23 and 173- 235 kg/ha respectively among the treatments. Applying 15 t of vermicompost / ha and 10 t of vermicompost /ha and recommended dose of fertilizer showed a greater availability of nitrogen and phosphorus. It is revealed that after addition of organics into the soil year-wise, the soil became more stable. Also, the biological activity increased in the soil and was influenced to maintain the available nitrogen in the soil. Therefore, it is evident that vermicompost significantly increases the availability of available nutrients.

Key words: *KMP101, organic and inorganic manure, micro and macro nutrients*

Introduction

Plant growth and crop yield are conditioned by both external and internal factors such as light, temperature, water, nutrient supply, management and the incidence of pests and diseases. Soil type, texture and nutrient content support plant growth and yield. In a sandy soil, most nutrients are present in solution, or as salts. Furthermore, certain cations, such as potassium and ammonium, may migrate from the particle surface into the clay lattice and become fixed, or become relatively unavailable for plant use[6]. It is clear, that the restrictions imposed by soil on the movement and availability of nutrients, and on their uptake by plants will vary greatly[1].

Nitrogen may also be fixed temporarily in the form of microbial organic constituents, some of which may condense with modified lignin to form relatively stable organic compounds[8]. Available nitrogen released gradually into the soil is an essential element which is required in large quantity for better growth of two and produce sustained yield due to release of nitrogen through decomposition in its function CN ratio of the added materials. The availability of phosphorus compounds also varies greatly with the nature of the soil and its pH[7]. Organic acid produced during the decomposition of FYM and green manure are known to have beneficial effects in increasing the availability of phosphorus to crops. Also some metabolic produced during decomposition are known to form complexes with cations such as Fe and Al, thus, preventing them from reaction with P. the effective absorbing roots only occupy a small percentage of the total soil volume at any given time, so that the supply of nutrients in the immediate vicinity of the absorbing roots is rapidly exhausted. The speed with which these nutrients are replaced can, therefore, influence the rate of nutrient uptake and subsequent plant growth.

Among the sources of available organic manures, vermicompost is a potential source due to the presence of readily available plant nutrients, e.g. nitrates, exchangeable P, K, Ca and Mg, growth enhancing substances, and a number of beneficial micro-organisms. Since a number of micro-organisms are in close association with earthworms and vermicompost, enriching vermicompost with rock phosphate may enhance multiplication of beneficial microbes present and are expected to react with rock phosphate and convert the insoluble phosphate to plant available forms. Such vermicompost will have an added advantage in crop production. Nutrients in vermicompost are present in readily available forms for plant uptake.

Materials and methods

The experiment with Rice (*Oryza sativa)* variety KMP 101 was conducted during the study. The experiment was laid out in Randomized Complete Block Design (RCBD) in kharif and summer seasons with three replications. Prior to the laying out of experimental plot, composite soil samples were drawn to analyse the physical, chemical and biological characteristics.

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Determination of Cadmium, Lead and Zinc in Vegetables in Jaipur (India)

ASHOK KUMAR* AND P. S.VERMA**+

An atomic absorption spectroscopic method was used for the determination of Lead, Cadmium and Zinc in vegetables grown in and around Jaipur food stuffs irrigated with industrial waste water. Vegetable samples were collected after maturity, and analyzed, such as spinach (*Spinacia oleracea*), ladyfinger (*Abelmoschus esulentus*), pepper mint (*Menthe pipereta*), brinjal (*Solanum melongena*), coriander (*Coriandrum sativum*), cauliflower (*Brassica oleracea*), onion (*Allium* cepa), radish (*Raphanus sativus*), pointedgourd (*Trichosanthes dioica*), bottlegourd (*Lagenaria siceraria*), chilies (*Capsicum annum*), ribbedgourd (*Luffa acutangula*) and pumpkin (*Curcurbites pepo*). The concentration of Lead ranged between1.40-71.06 ppm, Cadmium 0.61-34.48 ppm and Zinc 0.39-187.26 ppm in vegetable samples. The results reveal that urban consumers are at greater risk of purchasing fresh vegetables with high levels of heavy metal, beyond the permissible limits, as defined by the Indian Prevention of Food Adulteration Act, 1954 and WHO.

Key words: *Atomic absorption spectroscopy, vegetable, Jaipur*

troduction

The presence of heavy metals in human body always aws scientific concern as these are considered responsible r affecting health, especially in recent time where the release toxic wastes in the environment has increased. The creasing trends in food contamination in urban areas are rgely attributed to the polluted environment in urban riculture, contaminated food transport and supply chains; or market sanitary conditions and the use of contaminated waste water for irrigation purposes.

Although heavy metals are present in food in very inute quantities, the human existence is due to their role in dy metabolism. It has been established that whatever is ken as food might cause metabolic disturbance if it exceeds e permissible limits of heavy metals. Thus, both deficiency d excess of essential micro-nutrients (e.g., iron, zinc, romium, etc.) may produce undesirable effects [1,3,4]. Effects toxic metals (cadmium, chromium, lead, nickel, etc.) on human alth and their interactions with essential heavy metals (trace ements) may produce serious consequences [4].The jectives of this paper are to measure the levels of heavy etal contamination in vegetables around Jaipur and assess w the heavy metal contamination might have impacted food fety standards.

Materials and methods

Study location and samples

Jaipur (longitude: 95° 24E; latitude: 27° 18 N), a city located at the central part of Rajasthan, is undergoing rapid urbanization and industrialization. The waste water generated from diverse industries is subjected to cause a great concern. The climate of city is dry and healthy and is subjected to extremeness of cold and heat at various places. Normal annual rainfall in this city is 55.64 cm. Number of large, medium and small industrial units that are running in the city is about 19,592. The area under study was heavily industrialized area and with flanking spots. Almost in all parts of Jaipur city and adjacent areas, a large number of industries, have come up in last two decades. Amanishah nalla, Sanganer industrial area, Malviya nagar industrial area, Baisgodam industrial area etc., play a major role in polluting different water resources. The farmers growing vegetables and other crops use water from these industrial sites. This direct use of waste water by the farmers necessitates evaluation of the quality of water to determine the effect on the fertility of the soil and quality of vegetable grown on it, but some other studies show that the metals like Cd and Zn enter in the food chain through their application in soil and this ultimately causes health concern significantly[6].

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Evaluation of Water Quality of River Narmada and Its Correlation with Occurrence of Enteropathogens

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Water quality of river Narmada was investigated employing the chemometric techniques and statistical analysis with a view to extract information about the variables responsible for spatial and temporal variation in physicochemical parameters. Analysis of Pearson's correlation revealed significant correlation among the physicochemical parameters while weak correlation with occurrence of enteropathogens. The multivariate statistics and principal component analysis applied to datasets indicated three to four components influencing the water to the extent of 78.172% (2003), 82.726% (2004), 83.819% (2005), 86.294% (2006), 85.952% (2007) and 76.620 % (2008) of total variance. The water samples collected on seasonal basis during 2003-2008 revealed the presence of multidrug resistance enteric pathogens viz. *Aeromonas, Enterobacter, Klebsiella, Salmonella, Serratia, Shigella* and *Vibrio* throughout the study period. Thus seasonal effects, agricultural wastes, domestic and industrial waste water discharges and their organic load caused main variation in water quality of river Narmada. These results will assist in the water management of river water for varied future demands including human consumption, irrigation, industrial and river conservation.

Key words: *Physicochemical, principal component analysis, enteric pathogens, antibiotic resistance, river Narmada*

ıtroduction

India supports more than 16% of the world population ith only 4% of the world's fresh water resources[1]. There are irteen major river basins (area more than 20,000 square lometres) in India, which occupy 82.4% of total drainage asins, contribute 85% of total surface flow and house 80% of e country's population[2]. The microbial population in a body natural water, to a large extent is determined by the physical d chemical condition, which prevails in that habitat. Increase faecal pollution in water resource is a problem in developing well as developed countries[3]. This problem is further ggravated where there is lack of sanitation systems, thus osing an increased risk for the outbreak of waterborne seases[4]. Rapid industrialization and consequent urbanization as led to several problems of water quality management ecause of ecological imbalance caused by the sewage sposal. Many compounds can impose effects at low oncentrations within chemical mixtures occurring in the vironment. This poses unique monitoring and measurement allenges as well as ways of understanding risks[5]. The scharge of domestic sewage and industrial effluents is the main source of river water pollution that propagates the pathogens especially the enteropathogenic microbial populations[6] (Sharma *et al.*, 2012). Isolation of pathogenic bacteria from water sources connotes a serious public health risk for consumers. This problem is further compounded by the increasing incidence of enteric pathogens with antibiotic resistance in fresh water system[7,8,9,10,11,12,13] (McArthur and Tuckfield, 2000; Engberg *et al.*, 2001; Ash *et al.*, 2002; Sharma *et al.*, 2005; 2008a; 2009a; 2009b). Antibiotics, on the contrary to the other chemical compounds, exercise a direct action on bacteria and can act as persistent pollutants by its continuous emission to different aquatic compartments[14,15] (Alonso *et al.*, 2001; Hirsch *et al.*, 1999). Such system shows a positive correlation between the presence of pollutants and spatial distribution of antibiotic resistance among the microbial populations[8,16] (Engberg *et al.*, 2001; Abu and Egenonu, 2008). The emergence and persistence of multidrug resistant pathogens in the aquatic gene pool of river Narmada possess a catastrophic situation for all forms of life and humans in special.

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Drinking Water Quality Assessment Studies for an Urbanized Part of the Nagpur District, Central India

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The water quality of Hingna area of Nagpur district, Central India was assessed for its suitability as drinking water. 22 water samples, representing both the surface and groundwater sources, were collected and analysed for different inorganic constituents by using the standard procedures. The result depicted abundance of major ions; $Ca^{2+} > Mg^{2+} > Na^{+} > K^{+} = HCO_3^{-} > Cl^{-} > SO_4^{2-} > NO_3^{-}$. The concentrations of different elements in water were compared with the drinking water standards defined by World Health Organization (WHO). The hydro-chemical results reveal that most of the samples were within the desirable limits of the drinking water quality. However, few samples of the area, showed higher values of total dissolved solids (TDS), total hardness (TH), and magnesium (Mg) indicating their 'hard water type' nature and found to be unfit for the drinking purpose. Such poor water quality of these samples is found due to the combined effect of urbanization and industrial activities. The potential health risks associated with various water parameters have also been documented in this paper.

Key words : *Water quality, hydrochemistry, WHO, urbanization, Nagpur, Central India*

Introduction

India is an agriculture dominating and thickly populated developing country. Therefore, in order to keep pace with the development and cater the increased food demand of a large population, the industrial development and increased agricultural activities have become indispensable in the country. Such developmental activities, however, are associated with an enhanced use of natural resources like land, water and the environment. Continued development and amplified use of these resources combined with its reuse affects their quality, if not protected (Singh and Singh, 2008)[34]. Hence, the environmental issues and their management strategies need to be given greater proper attention in this region (Ramesh and Elango, 2011)[31].

The quality of water is of vital concern to mankind as it has a direct link with the human health and to surrounding environment, and therefore knowledge about it is as essential as its quantity for the effective water resource management (Tiwari et al., 2011)[39]. In the recent years, the quality of surface and groundwater sources in India has become questionable for various designated uses in the modern society (Datta and Tyagi, 1996; Kapley et al., 1998; Pawar et al., 1998; Subba Rao et al. 2005; Jalali, 2005; Subrahmani et al. 2005; Umar and Ahmed, 2007; Dar et al., 2010; Prasanna et al., 2010; Ravi Kumar et al., 2010; Udayalaxmi et al., 2010; Ramesh and Elango, 2011; Deshpande and Aher, 2012)[9,20,27,35,18,36,42,8,26,32,41,31,11]. Hence, the study on water quality and its pollution impacts assume greater importance under the concept of sustainable development. In view of this, an attempt has been made to assess the quality and pollution status of water resources utilized in and around Hingna industrial area, which also represents a rapidly expanding urban part of the Nagpur district of Central India.

The study area

Nagpur, the third largest city of Maharashtra state, is one of the fastest growing industrialized cities in Central India (Marghade et al., 2011)[23]. This region is situated practically at geographical centre of India and lies in between latitude 21°06-21°12'N and longitudes 79°0-79°10'E. The area has witnessed rapid urbanization in addition to establishment of lots of industries in the fringe areas in the recent past. As a result, the demand of water has increased manifold in the region. The increased water demand has resulted into the development of severe pressure on the groundwater sources, in paucity of sufficient surface water sources. At present, the enhanced water demand of the population as well as industries is catered through the shallow water sources mostly in the

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An Approach to Demand Pattern Estimation: Monte Carlo Simulation and Fractal Analysis

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Day to day activities of urban population in normal routine conditions are largely affected by the operation of the urban water supply system. In addition, the working hours, pattern of shift duties and living standards in a society decide the quantum of water use at different times in a day. This demand pattern is an important parameter for water supply agencies in order to ensure safe and reliable water supply. In the present study, short term (hourly and daily) water demand is estimated for drinking as well as various other household activities. BIS standard of 135 lpcd and socioeconomic survey data are considered as the basis to derive a time series distribution of water consumption for different activities. Monte Carlo simulation (MCS) is performed to generate the random distribution of consumption pattern. The hourly water consumption for various activities shows persistent behavior with Hurst coefficient in the range of 0.592 to 0.837 and the peak flow factor of the estimated demand pattern is 5. This pattern is useful as a basis for design of service reservoir as well as pump scheduling. It is also an important parameter in the model study in performance assessment of water distribution system (WDS).

Key words: *Water distribution system, demand pattern, hourly water consumption, fractal model, R/S analysis, persistent behavior*

Introduction

Ensuring continuous and safe water supply to the consumer in a cost effective manner is possible by regular operation and maintenance (O&M) of the water distribution system (WDS) and knowing the hourly demands. Urban water demands are typically governed by societal working pattern and utilities in the area. Climatic factors to some extent also govern the demand as well as define the policies and strategies of water supply in the urban sectors[1,2]. In general, it is expected that during active household working time i.e. from morning, six to ten hrs and evening, from eighteen to twenty hrs, the consumption of water is at the peak.

Demand patterns, seasonal, daily or hourly are also required for water distribution modeling study[3]. Base demand and the demand multipliers are the important inputs in models to estimate actual water consumption[3]. Metering the consumption is a primary way of collecting water demand data in developing countries. However, life cycle cost of metering is high due to frequently damaging the meters in intermittent supplies with fluctuating pressure and sudden changes. Therefore, lack of sufficient amount of data is the main constraint to implement modeling techniques such as regression models[4], time series analysis[5] and artificial neural networks (ANN)[6,7] for performance assessment of the distribution network.

Various methods usually adopted to anticipate the short-term urban water consumption pattern include the mechanism research techniques[8-11] and socioeconomic surveys[2]. Flow trace analysis is another approach to obtain precise information about the water use patterns that reveals where, when, and how much water is used by a variety of devices including toilets, showers, baths, faucets, clothe washers, dishwashers, hand-held and automatic irrigation systems, evaporative coolers, home water treatment systems, leaks, and many more. Developed countries use software package to analyze flow trace data collected from customer water meters to provide accurate hourly water use profiles[12]. The short term (daily and hourly) water demand not only determines the operational characteristics of the system such as pumps on/off, and reservoir and treatment plant input/ output schedule[13,14], but also influences in selection of pumps and design of elevated service reservoirs (ESR) and ground service reservoirs (GSR)[15]. However, this pattern is definitely affected by the socioeconomic factors related to standards of living as well as the daily routine of local people. Again, during

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Comparative Studies on Performance Characteristics of CI Engine Fuelled with Neem Methyl Ester and Mahua Methyl Ester and Its Respective Blends with Diesel Fuel

S.S.RAGIT[1+], S.K.MOHAPATRA[2] AND K.KUNDU[3]

In the present investigation, neem and mahua methyl ester were prepared by transesterification using potassium hydroxide as a catalyst and tested in 4-stroke single cylinder water cooled diesel engine. Tests were carried out at constant speed of 1500 rev/min at different brake mean effective pressures. A series of tests were conducted which worked at different brake mean effective pressures, 0kPa, 1kPa, 2kPa, 3kPa, 4kPa, 5kPa, 6kPa and 6.5kPa.The performance and exhaust emission characteristics of the diesel engine were analyzed and compared with diesel fuel. Results showed that BTE of NME was comparable with diesel and it was noted that the BTE of N0100 is 63.11% higher than that of diesel at part load whereas it reduces 11.2% with diesel fuel at full load. In case of full load, NME showed decreasing trend with diesel fuel. BTE of diesel was 15.37 % and 36.89% at part load and full load respectively. The observation indicated that BTE for MME 100 was slightly higher than diesel at part loads. The specific fuel consumption (SFC) was more for almost all blends at all loads, compared to diesel. At part load, the EGT of MME and its blends were showing similar trend to diesel fuel and at full load, the exhaust gas temperature of MME and blends were higher than diesel. Based on this study, NME could be a substitute for diesel fuel in diesel engine.

Key words : *Filtered neem oil, mahua oil, transesterification, NME, MME, engine performance*

Introduction

Biodiesel is fatty acid of ethyl ester or methyl ester ıade from virgin or used vegetable oils and animal fats. The ıain common sources for biodiesel in India can be non edible ils obtained from plant species such as *Jatropha curcas* Ratanjoyt), *Pongamia Pinnata* (Karanja), *Calophyllum nophyllum* (Nagchampa), *Hevca brasiliensis* (Rubber) etc. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, Biodiesel operates in compression ignition engine, which essentially require very little or no engine modification because biodiesel has properties similar to petroleum diesel fuels. The use of biodiesel in conventional diesel engines results substantial reduction of un-burnt hydrocarbons, carbon monoxide and particulate matters. Biodiesel is considered clean fuel since it has almost no sulfur, no aromatics and has about 10% built in oxygen, which helps it to burn fully. Both edible oils such as soybean, Rapeseeds, Canola, Sunflower, Cottonseeds etc. and non-edible oils like Jatropha, Karanja, Neem, Mahua etc. have been tried to supplement diesel fuel in various countries. In U.S., biodiesel programme is based on their surplus edible oils like soybean and in Europe from Rapeseeds and sunflower oils. Under Indian conditions an emphasis is being laid by the government to explore the possibility of using non edible oils as biodiesel. Due to gradual depletion of world petroleum reserves and the impact of environmental pollution of increasing exhaust emissions, there is an urgent need for suitable alternative fuels for the use in diesel engines. In view of this, vegetable oil is a promising alternative because it has several advantages. The problem of high viscosity of vegetable oils has been approached in several ways such as preheating the oils blending or dilution with other fuels, transesterification and thermal cracking / pyrolysis[1].Vegetable oils possess almost the same heat values as that of diesel fuel. But a major disadvantage of vegetable oils is their inherent high viscosity. Modern diesel engines have fuel-injection systems that are sensitive to viscosity changes. High viscosity may lead to poor atomization of the fuel, to incomplete combustion, to coking of the fuel injectors, to ring carbonization, and to accumulation of fuel in the lubricating fuels. A way to avoid these problems is to reduce the viscosity

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Chemical Treatment as a Pre- requisite for Effective Disposal of Tri Nitro Toluene (TNT)

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Present methods for the disposal of old and rejected ammunition carry high risk and are not environment-friendly. Various processes such as wet air oxidation, molten salt oxidation, hydro thermal oxidation, incineration, electrochemical reduction, biodegradation and other methods have limited use for decontamination and are not suitable for disposal of large quantities of explosives. Thus there is dire need to develop alternate method for safe disposal of rejected explosives which will be eco-friendly. In this paper we have attempted to combine two methods i.e. chemical treatment followed by biological / microbiological treatment. For this purpose we have selected Tri Nitro Toluene (TNT) as a model compound, which is used extensively in many types of ammunition. As reported previously from our laboratory[15] the presence of nitro group from TNT was toxic to bacterial growth. By chemical treatment, nitro groups from TNT were converted into amine and mixed in soil for biodegradation. Our results suggest that after converting 'nitro groups' to 'amine groups' were much preferred by bacteria and faster mineralization is observed. Thus combined treatment to TNT as discussed in this study, showed much less phyto-toxicity and may have great potential to scale up the process for large quantities of explosive such as TNT.

Key words: *TNT, explosives, amines, seed germination, biodegradation*

1. Introduction

Safe disposal and treatment of waste, particularly hazardous waste is a current issue at Global level. After lapse of shelf life, explosive materials have to be disposed. They possess one or more nitro groups useful for destruction in warfare. After rejection due to toxicity, reactivity, flammability and corrosivity properties they come under category of hazardous waste. Adverse effects of open burning and open detonation of such explosives and related effects of the ash and residues on fauna, flora, air, ground water and soil contamination are reported in literature [1-3]

Many physical, chemical and biological methods have been tried in past for disposal of the explosives. Wet air oxidation, hydrothermal technology, molten salt oxidation, supercritical water oxidation, were the physical methods to mineralize organic compounds to carbon dioxide and water by oxygen or H_2O_2 or metal carbonate salts both at higher pressure and temperature [1-4]. In chemical methods, hydrogen peroxide treatment[5], oxidation with $KMnO_4$, photo degradation with TiO_2 as catalyst [6], electrochemical reduction [7], alkaline hydrolysis [8] processes were tried by many researchers. Microorganisms degrade organic compounds as well as pollutants for their need of food. Attempts for enzymatic, anaerobic and aerobic approaches were tried for TNT degradation [9-13], but at higher TNT concentrations they were found to be toxic and recalcitrant to the microorganisms[14, 15]. All the above methods were showed to be effective for decontamination of soil, water for small amounts of TNT, but these methods could not be used for safe disposal of explosives on large scale.

The objective of present study was to convert the nitro groups of explosives into amino groups by chemical treatment and study their effects on biodegradation and plants. We have selected Tri Nitro Toluene (TNT) as a model compound, due to its extensive use in many types of ammunition. We are confident that present technology can be upgraded for mass disposal of TNT and other explosive.

2. Materials and methods

2.1. Chemicals and microorganisms

TNT was obtained from High Energy Materials Research Laboratory, Pune. HCl, NaOH, KOH, $NaHCO_3$, $NaNO_2$, 2-Naphthol were of A.R. grade. Iron powder 80 to 100 mesh size electronic grade was used. Freshly distilled solvents Di-Chloro Methane, n-Hexane, Ethanol, Methanol, Ethyl acetate were used. The microorganisms were obtained from our own laboratory.

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Solubilization and Elimination of Coliforms from Sewage Sludge by Sonication

SNEHAL PATHKI, M. SURESH KUMAR* AND A.N. VAIDYA

Disposal of sewage secondary excess sludge is a great problem globally, and stabilization of this excess sludge by anaerobic digestion is hampered due to its constituents resistant to biodegradation. Sludge pre-treatment enhances the performance of anaerobic digestion.In this study, sewage sludge was collected from a full-scale sewage treatment plant and characterized. Ultrasonic method was used for the excess sludge disintegration of microbial flocks and cells, so as to breakdown the intracellular or extracellular polymeric materials to enhance the anaerobic digestion. The studies related to the effect of sonication on release of nutrients, increase in soluble COD and reduction in pathogenic coliforms as well as heterotrophic microorganisms and the optimization of sonication time were carried out. The results showed that the twenty minutes sonication (25 kHz) increased the soluble COD content, nutrient release and complete disappearance of fecal as well as total coliforms in the treated sludge. The results are presented and discussed in this paper.

Key words: *Sewage sludge, sonication, sludge treatment, pre-treatment of sludge, digestion of sludge, sludge stabilization*

roduction

The safe treatment and disposal of the sewage sludge a major concern for municipal sewage treatment facilities, roughout the world due to its environmental impacts. sposal alternatives that have been tried include sludge gestion, incineration and land application[1]. Sewage sludge s been utilized in agricultural applications for several years it represents an alternative source of nutrients for plant owth and is an efficient soil conditioner[2]. However, it poses ealth risk due to possible pathogens contamination and its ntact with edible parts of the plants. Hence, it is very much quired to reduce the pathogens and increase the stabilization solubilization of sewage sludge to minimize the digestion ne. Recently, interest for the anaerobic digestion of sludge as increased significantly to recover the energy during the udge degradation. But approximately 70% of the excess udge is bacteria, and hydrolysis of bacteria limits the whole naerobic digestion process due to its constituents resistant biodegradation[3-4]. Sludge pretreatment enhances the erformance of anaerobic digestion by accelerating the ydrolysis step by breaking up the bacterial cell membrane nd producing bioavailable substrate for anaerobic digestion[5-6]. n this context, researchers have been working on appropriate ludge pre-treatment methods to break the flocs and rupture ne microbial cells to increase the anaerobic sludge digestion fficiency [7,4].

Ultrasonic disintegration has been actually applied or the disruption of microbial cells in order to extract ntracellular material[8]. Subsequently, several authors have eported the successful application of ultra-sonication as pre-reatment process for sludge stabilization[9, 10]. Ultrasound disintegration of sludge is economic physical process for sludge disintegration. It neither generates secondary toxic compounds nor contributes additional chemical compounds. Sonication of sludge causes different degree of cell lysis and release of organic and nutrient species[11, 12]. The present study deals with the coliforms removal from sewage sludge and disintegration/lysis of the sludge floc/cells to facilitate the sewage sludge anaerobic treatment and safe disposal by land application.

Material and methods

Materials

Three sets of sludge samples were collected from the sewage treatment plant at Nagpur, India, in three seasons. This sewage treatment plant at Nagpur is designed for treating 100 MLD sewage, and it includes screening, primary clarification and secondary treatment by activated sludge. The activated sludge was collected from the sludge thickener. Primary and secondary sludges were thickened in the sludge thickeners from 4% to 7% solids concentration, normally the detention time maintained was 24 hours, and then this thickened sludge is sent to mesophilic anaerobic digesters.

Methods

Analytical procedures

Chemical oxygen demand (COD), nitrogen, total phosphorous (TP), total suspended solids (TSS), and volatile solid (VSS) were measured according to APHA standard methods [13]. Filtered sewage (through a 0.45 μ membrane) was used to quantify the COD, nitrogen and TP, and sludge samples were employed to analyze TCOD, TSS, and VSS. Supernatant

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Performance of Free Water Surface Constructed Wetland Using Typhalatifolia and Canna Lilies for the Treatment of Domestic Wastewater

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Discharge of untreated wastewater or partially treated wastewater into surface water bodies or on to land is a major cause of surface and ground water pollution thereby posing health hazards. Conventional wastewater treatment is generally not preferred for small communities due to higher capital and maintenance costs and lack of skilled supervision required for operation and maintenance. A constructed wetland treatment appears to be an appropriate alternative that can be employed both in developed and developing countries. A constructed wetland system is simple to construct and operate with low cost, and hence worth considering for the treatment of municipal wastewaters, especially from small communities. In this context, the site for carrying out the studies related to wastewater treatment was chosen at Kavikulguru Institute of Technology and Science (KITS), Ramtek, Dist. Nagpur. A Free Water Surface Constructed Wetland (FWSCW) of size 22.00m×6.50m×0.60m was constructed at KITS, Ramtek. The performance of FWS CW system was studied for domestic wastewater treatment with theoretical hydraulic retention times of 10 days, 7 days and 5 days. Important parameters, such as BOD_5, COD, TSS, NH_4-N, PO_4-P, DO, pH and faecal coliforms in both raw and treated wastewaters were monitored during a macrophytes life cycle. Based on the studies, it is concluded that minimum 5 days HRT is necessary for the treatment of wastewater in FWSCW using Typhalatifolia or Canna Lilies. Typhalatifolia is better in removal of pollutants from the wastewater in comparison to Canna Lilies and hence, is recommended for use in constructed wetland. The nutrient uptake capacity of Typhalatifolia is also quite encouraging and hence has great potential for application in treating wastewater from fertilizer industry. During the application of kinetic model, the observed and predicted values in respect of BOD, TSS and NH_4-N in case of Typhalatifolia and BOD, COD and TSS in case of Canna Lilies were found in good agreement corroborating the best fit mathematical model presented. The batch type constructed wetland system is an appropriate system for low and intermittent flow conditions.

Key words : *Constructed wetland, emergent macrophytes, submerged macrophytes, kinetic model, uptake rate constant, correlation coefficient*

roduction

Discharge of untreated sewage is the single most ortant cause for pollution of surface and ground water because e is a large gap between generation and treatment of domestic tewater in India. Technologies to treat and manage water end on the characteristics of the wastewater. Conventional age treatment comprising of primary and secondary are often hly technical and expensive to install and operate. The service of these conventional systems is about 20-25 years. Further, centralized system involves collection of wastewater from g distances making it more costly[3].

The Central Pollution Control Board (CPCB), Ministry of Environment and Forests, Govt. of India (2005) carried out a study on performance evaluation of the sewage treatment plants (STPs) in India. The study reveals that operation and maintenance of existing plants and sewage pumping stations is highly neglected, as nearly 39% plants are not conforming to the general standards prescribed under the Environmental (Protection) Rules for discharge into streams. STPs are usually operated and maintained by persons that do not have adequate knowledge of running the STPs and know only operation of pumps and motors. The

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Utilization of Waste Materials for the Treatment of Waste Water Contaminated with Sulphamethoxazole

LISHA KURUP

The activities were carried out to develop potential adsorbents from waste material and employ them for the removal of hazardous antibacterial, Sulphamethoxazole from the wastewater by adsorption technique. The selection of this method was done because of its economic viability. The method has the potency of eradicating the perilous chemicals which make their appearance in water and directly or indirectly into the whole biological system, through the ejection of effluents by the industries in flowing water. The adsorption technique was used to impound the precarious antibiotics from wastewater using Deoiled Soya an agricultural waste and Water Hyacinth a prolific colonizer. The adsorption capacity of these adsorbents was further enhanced by treating them with sodium hydroxide solution and it was seen that the adsorption capacity increases by 10% to 25 %. Hence a comparative account of the adsorption studies of all the four adsorbents i.e. Deoiled Soya, Alkali treated Deoiled Soya, Water Hyacinth and Alkali treated Water Hyacinth has been discussed in this paper. Different isotherms like Freundlich, Langmuir and Dubinin Radushkevich were also deduced from the adsorption data. Isotherm studies were in turn used in estimating the thermodynamic parameters. Deoiled Soya (DOS) showed sorption capacity of 0.0007 mol g^{-1} while Alkali treated Deoiled Soya (ADOS) exhibited 0.0011 mol g^{-1} of sorption capacity which reveals that the adsorption is higher in case of alkali treated adsorbent. The mean sorption energy (E) was obtained between 9 to 12 kJ/mol which shows that the reaction proceeds by ion exchange reaction. Various kinetic studies like order of reaction, mass transfer studies, mechanism of diffusion were also performed for the ongoing processes. The mass transfer coefficient obtained for alkali treated moieties was higher than the parent moieties. The breakthrough curves plotted from the column studies show percentage saturation of 90% to 98%. Moreover the adsorbed antibacterial were desorbed and regenerated in its original form. Thus, the method was able to remove the drugs from water but simultaneously could regenerate these expensive drugs.

Key words: *Adsorption, sulphamethoxazole, mass transfer, thermodynamics, adsorption isotherm*

. Introduction

Sulphamethoxazole is a sulphonamide bacteriostatic ntibacterial. It has been used since the 1960s in the treatment f various general infections in humans and other species. It orks against *Streptococcus, Staphylococcus ureus, Escherichia coli, Haemophilus influenzae,* nd oral anaerobes. It is used mainly for acute urinary tract nfections. It has also been used against gonorrhoea, neningitis and serious respiratory tract infections *Pneumocystis carinii*) and prophylactically against usceptible meningococci. With pyrimethamine, it is used in ne treatment of chloroquine-resistant *Plasmodium falciparum* nalaria[1]. Besides its usage in wide variety of infections we annot let down its ill effects. Sulphamethoxazole is prevalent n causing idiosyncratic toxic effects including hepatotoxicity nd systemic hypersensitivity reactions, skin rashes, osinophilia, nausea, vomiting, anorexia, and diarrhoea[2-3]. The ondition becomes more treacherous when these medicines pread out in our ecosystem. These drugs find their way into the aquatic system primarily through disposal from, hospitals, households and from pharmaceutical industries. Their discharge into water bodies adversely affects aquatic organisms[4]. These chemicals contain Nitrogen containing heteroaromatic moieties which may not undergo complete degradation and possess toxic and carcinogenic potential[5]. So far, an important negative impact is that continual sub-lethal levels of antibiotic residues in aquatic environments have led to the emergence of antibiotic- resistant strains of bacteria[6-7].

Different conventional techniques are available for the removal of drugs from water like reverse osmosis[8], ozonation and H_2O_2/UV[9-10], membrane filtration[11], adsorption[12] etc. Among these currently, adsorption technique is at the forefront for waste water treatment as it is much versatile and economical. Due to the high degree of purification achieved, this process is mainly used at the end of treatment sequence. The present work deals with the aim of exploring the adsorption capacity of waste materials so that the wastes

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Quantitative and Qualitative Characterization of Solid Waste Generated in Chitrakoot (India) and Its Management A Comparative Study of Karwi and Chitrakoot Nagar Panchayat

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Chitrakoot is a religious place in India and on a major festival day over 1,00,000-12, 00,000 people visit this place. Therefore, a study on solid waste generation was carried out. During the study, the MSW composition in Karwi was found as polythene (6.73%), plastic (5.14%), rubber (3.17%), metals (4.43%), glass (4.98%), wood (3.75%), cotton & cloths (6.37%), paper & cardboards (9.53%), vegetable wastes (13.52%), soil & constructional wastes (30.71%), garden waste (6.03%), rags (2.90%) and meat waste (2.72%) and in Chitrakoot the MSW composition was found as polythene (10.12%), plastic (4.78%), rubber (3.70%), metals (2.84%), glass (4.08%), wood (5.55%), cotton & cloths (4.29%), paper & cardboards (7.77%), vegetable wastes (11.66%), soil & constructional wastes (29.87%), garden waste (9.73%), rags (2.29%) and ash (3.32%). The waste management options provided by municipality are very poor and ineffective. No landfills, incineration and composting functions are performed. Chitrakoot municipality primarily has no function to reduce the size of waste including separation and recovery of valuable material. Community participation in solid waste management may be a better option.

Key words : *Solid waste management, quantitative and qualitative characterization, Karwi, Chitrakoot*

Introduction

Waste is an unwanted material intentionally thrown away for disposal[12]. Waste products arise from our ways of life and they are generated at every stage of process of production and development. Solid waste is used to describe non-liquid waste material arising from domestic, trade, commercial and public services. There are eight major classifications of solid waste generators: residential, industrial, commercial, institutional, construction and demolition, municipal services, process, and agricultural[24].

It comprises countless different materials: dust, food waste, packaging in the form of paper, metal, plastic or glass, discarded clothing, garden waste, pathological waste, hazardous waste and radioactive waste[24]. Domestic waste consists of the organic (combustible) and inorganic (non combustible) household waste[22]. It has three characteristics: weight, density and constituents of waste generated which vary from country to country according to the level of industrial development[23].

Municipal solid waste includes wastes generated from residential, commercial, industrial, institutional, construction cum demolition, processes, and municipal services. Commercial stores, hotels, restaurants, markets generate paper, cardboard, plastic, wood, food waste, glass, metals, special waste, etc.[22]. MSW also contains recyclable wastes (paper, plastic, glass, metals, etc.), toxic substances (paints, pesticides, used batteries, medicines), compostable organic matter (fruit and vegetable peels, food waste) and soiled wastes (blood stained cotton, sanitary napkins, disposable syringes)[5,15,8]. The quantity of MSW generated depends on a number of factors such as food habits, standard of living, degree of commercial activities and seasons. The knowledge of the sources and types of waste in an area is required in order to design and operate appropriate solid waste management systems[22]. The rate of waste generation is an index of socio-economic development and economic prosperity of the region. Waste quantities as well as composition are in extricably linked to the vibrancy of economic activity and resource consumption pattern of the society which generates the waste.

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Municipal Solid Waste Management in Kadapa Town A Case Study

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Solid waste management (SWM) is a worldwide phenomenon. It is a big challenge all over the world for human beings. The problem of municipal solid waste management (MSWM) is also prevailing in the environment of Kadapa town in India. Therefore, the present study was undertaken to find out the problems and prospects of municipal solid waste in Kadapa town. A detailed investigation was made regarding the methods of practices associated with sources, quantity generated, collection, transportation, storage, treatment and disposal of municipal solid waste in the study area. The data related to SWM in the study area was obtained through questionnaire, individual field visits, interaction with people and authentic record of municipal corporation. Status of the MSW in Kadapa town was studied. The results indicated that the major constituents of municipal solid waste were organic in nature and approximately one fourth of municipal solid waste was recyclable. Detailed data on solid waste management practices, including collection, recovery and disposal method, has been presented in this paper.

Key words : *Solid waste, generated, recyclable, organic*

ntroduction

There has been a significant increase in municipal olid waste (MSW) generation in India in the last few decades. his is largely because of rapid population growth and conomic development in the country. Solid waste anagement has become a major environmental issue in India[1]. olid waste is a growing environmental problem, municipal olid waste includes degradable, disposable napkins and udge sanitary resources. MSW management is complex issue ue to changing life style of people and rapid urbanization. olid waste is a general term used for highly heterogeneous - products of manufacturing and discarded goods which ave negligible economic value to the owner. In India, MSW produced at an average rate of 300 – 600 gm/capita/day. ccording to 1991 census 217 million people live in 4000 urban glomerations[2]. With the increasing economic activities and chnological development to fulfill the need and greed to or and rich, respectively, production of MSW is increasing uch faster than the previous decades in a similar stage of conomic development[3]. In India, it is observed that 90% of e MSW is disposed of on land without taking any specific ecaution. The deposited waste is rarely covered compacted d the depth of the filling is normal. Industrialization, banization and consequent increase in population have led the imbalance in the use of natural resources, and thus using damage to the ecosystem. Perhaps, it has been rightly id that people cause pollution because increase in population would lead to resource crunch that would in turn lead to many problems, like water pollution improper land use in adequate sanitary facilities and waste management particularly in the urban centers. India being a populated country, problem of solid waste disposal is becoming severe day by day. The quantity of garbage generated in urban areas depends on various factors. It is based on the standard of living occupation of the people and their dietary and climatic habits. Wastes, such as hazardous, and non hazardous, are being dumped randomly which lead to potential risk to health and environment[4]. More than 80% of the MSW collected from urban areas in the world is estimated to be deposited in the landfills or in open dumps. The present study discusses the status of the MSW of Kadapa town (A.P), and presents the detailed data on solid waste management practices, such as collection, recovery and disposal method.

Materials and methods

Quantification and characterization of municipal solid waste

The study was carried out on a sample of 30 randomly selected residences, 10 each from different income groups, such as High Income Group (HIG), Middle Income Group (MIG), Low Income Group (LIG). The location map of the study area is shown in **Fig. 1**. The income groups were classified based on Government norms. To know the generation of solid waste in residential areas of Kadapa, the refuse accumulated for 24 hrs was collected on the consecutive days and weighed.

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Secondary Zinc Waste Sludge: Resource Material with Potential Application

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The waste sludge generated during secondary zinc extraction process of an industry was studied for the recovery of electrolytic grade zinc and copper. The physical, chemical and mineralogical properties of the secondary zinc waste were studied in detail. Toxicity Characteristic Leaching Procedure (TCLP) test was carried out for the sample and concentrations of heavy metals present in the waste were estimated. The engineering properties of the samples prepared through high temperature fired route provided important information on the characteristics and composition of the waste. Different binders like fly ash and yellow clay were used in different formulations using Indian Standard sand to prepare the samples and to study the Solidification-Stabilisation (S/S) mechanism of the encapsulated waste mass. The leachability studies and engineering properties of the samples were evaluated to study the abatement of hazardous potential of waste and to explore better utilisation options for the secondary zinc waste sludge.

Key words : *Hazardous waste, secondary zinc waste sludge, leachate, TCLP, fly ash, solidification-stabilisation, compressive strength, UTM*

duction

Industrialisation is the consequence of man's ability he production of waste is the collective result of human vities and industrial processes. Industrialisation and nisation are essential for the growth and economy of the ety and country. Wastes can be defined as those tances which are of no use any longer, and are either arded or intended to be discarded of. Wastes can either azardous or non-hazardous in nature. Depending on their sical state, wastes can be categorised as solid, liquid or ous waste. Depending on the chemical state, wastes can lassified as hazardous or non-hazardous waste. Hazardous tes are harmful and toxic to human health and environment. per Manahan[1], a waste can be said as hazardous if it exhibits er of the characteristics of ignitability, corrosivity, reactivity oxicity. Industrial waste consists of the waste material erated during the processing, treatment and manufacturing lifferent industrial products. Often, the industrial wastes hazardous in nature and may cause threat to human health to the environment due to their characteristics.

A secondary zinc processing industry located in the stern part of country for recovery of electrolytic grade zinc m zinc ash / skimmings and copper from brass dross was ected for the present study. The secondary zinc production rted recently in India and the main sources of secondary c are scraps, drosses and fluxes. The present zinc smelter capacity in India is 1,69,000 tons per annum and secondary producers add about another 15,000 tons per annum[2]. At present, there are 83 non-ferrous recyclers in India and as per the High Powered Committee on Management of Hazardous Waste (HPCMHW), there are around 20 secondary zinc processing units in India with production capacity of 36,000 TPA. It is reported that approximately 0.5 million tons of lead-zinc slag is generated annually which can be used upto the extent of 45% as blending component for the manufacture of Portland Slag Cement[3]. The amount of hazardous waste sludge generated by the industry considered for the present study is around 10,000 tons per annum. As per the Hazardous Waste (Management, Handling & Transboundary Movement) Rules 2008[4], this waste falls under Schedule I, Process No. 6.1 of the Rules.

Materials and methods

The waste sludge samples were collected from a secondary zinc processing industry located in the western coastal region of the country. Three samples of secondary zinc waste sludge were collected from the disposal site of the industry. The raw materials and products were properly characterised for their physical, chemical and engineering properties. The physical properties included pH, density, morphology etc., while chemical characterisation included elemental analysis of waste constituents and TCLP studies and mineralogical phase determination. The engineering

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Rainwater Harvesting and Dengue

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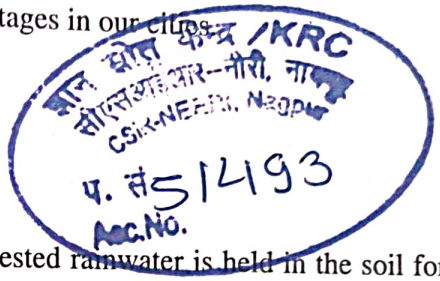
As a retired Environmental Health Chief (UN/WHO SEAsia Region) I got involved in rainwater harvesting in India through my Rotary Club a few years ago and my recent experiences have prompted the following observations. I find rainwater harvesting has three specific dangers to public health which get overlooked each year in our anxiety to meet drinking water shortages in our cities.



1. Dual control on water quality

Firstly, rainwater harvesting (RWH) in *urban* areas introduces a "dual quality" water supply to a city, one controlled by the local municipality and another by different members of the public who may not take control so seriously. Thus, in case of a public health problem in a part of the city, responsibility for water quality is not possible to fix without doubt. This is undesirable to allow.

2. Rainwater mixes with polluted groundwater

Secondly, all the harvested rainwater is generally considered too expensive to store in masonry or plastic tanks large enough to last for the whole following dry season until the next monsoon arrives. Hence, often only the drinking water needs (@2-10 L /person) are stored in tanks while the remaining quantity is allowed to overflow into the soil (assuming soil strata is hydrologically suitable for holding water) from where it is pumped up for use as and when required. Now, it is a well known fact that in almost all cities of the world sewer lines leak. Thus, the upper 3 or 4 meters depth of soil strata in most cities are likely to be polluted by sewage and perhaps some industrial wastes. This is precisely the strata in which the surplus harvested rainwater is held in the soil for later use. Is this not dangerous for health?

The local bodies in larger cities often know of this pollution potential and thus inform the public to use only the clean stored rainwater for potable purposes and use the rainwater held in the ground for non-potable purposes. But, here is where the mix-up sometimes occurs. The illiterate public (e.g., gardeners, servants, etc) may not distinguish between potable and non-potable supplies and plumbers also may on occasion unwittingly cross-connect the two types of supplies! Does this not constitute a definite health hazard?

3. All this and Dengue too?

Thirdly, rainwater harvesting undisputably opens up several sites for mosquito breeding. Besides malaria spread by the anopheles mosquito, we now have the Dengue fever spread by the Aedesaegypti mosquito in India. As this mosquito prefers to live in clean water, it tends to thrive in harvested rainwater.This problem was not present some years ago when rainwater harvesting was not done. Could rainwater harvesting be one of the *potential* causes for its rapid spread in Indian cities like Delhi and Mumbai? If so, it is a serious

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