iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 Issue: IX Month of publication: September 2019

DOI: http://doi.org/10.22214/ijraset.2019.9060

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue IX, Sep 2019- Available at www.ijraset.com

Utilization of Waste Water for Irrigation from the Site of National Thermal Power Corporation Limited Bhilai-3, Chhattisgarh

Manoj Kumar Ghosh
Associate Professor, Department of Chemistry, Kalinga University, Naya Raipur, Chhattisgarh

Abstract: Water is an indispensable natural resource on this earth on which all life depends. Here we are analyze the fly ash bund waste water from the site of steel authority india limited-national themal power corporation limited (NSPCL), bhilai-3 durg district of chhattisgarh, india was to utilize for irrigation should be recycled within the industry or it should be minimized outside the industry by dumping into the surface causes soil pollution. Thus we are collecting waste water samples from sixteen different location of bhilai-3 during Oct.2017–Sept.2018 and seventeen physico-chemical parameters were studied for its suitability in irrigation. The major important water quality indices like SAR(sodium absorption ratio), RSC(residual sodium carbonate), Mg/Ca and physicochemical analysis were investigated. It is observed that fly ash bound waste water found from the site of NSPCL is excellent for irrigation due to its SAR value was less than 10, salinity 755µs/cm and residual sodium carbonate value is more than 2.5 m mol/l.
Keywords: Waste Water, Irrigation, Fly-ash, Sodium Absorption Ratio

I. INTRODUCTION

On rapid increasing the population, development, urbanization and more economic growth will be generated excess of wastewater by the domestic, industrial and commercial sectors [1-5]. Although in the current era most of the developing country, do not have sufficient resources for the treatment of waste water. In india, studied have been carried out toward the management of fly ash disposal and its utilization[6-9]. Fly ash is used for the manufacturing of bricks in construction work but the rate of production is greater than consumption. The toxic elements present in the fly ash can contaminate soil, ground water and surface water. Therefore, effective water management plans are required for fly ash disposal[10] waste water. Fly ash is a major by-product of coal fired thermal power plants. It is defined as the fine residue resulting from the burning of ground or powdered coal in thermal power plants. Fly ash contains variety of substances of which trace metals are of special interest due to their cumulative build up, long life, and high toxicity to man, plants, and animals through air, water, and soil [11]. In India, nearly 90 mt of fly ash is produced per year and is mainly responsible for environmental pollution[12]. In thermal power plants large amount of water is used for generation of steam, cooling and disposal of ash to ash settling ponds. During this process solid, liquid and gaseous effluents are generated[13].Waste water from mining and other related industries are the most common source of water pollution and it is increasing day by day[14]. However the study would help to understand the nature of industrial effluent waters, assess the quality of effluent, locate the applicability of effluent and could promote the use of certain kind of effluent during fresh water crisis for irrigating crops[15]. In literature review, there is no comprehensive global inventory of the extent of non treated wastewater. Based on the information from the countries providing data on irrigated areas, it is estimated that more than 4-6 million hectares are irrigated with wastewater or polluted water[16-18]. To find out the efficient way of using this waste water other than conveying ash, a study was done to characterize the fly ash bund waste water and their utilization for irrigation. If the water is used for irrigation, one has to check its salinity. Salinity occurs through natural or human induced processes that result in the accumulation of dissolved salts in the soil water to an extent that inhibits plant growth. The main objectives of the study is to analyze the fly ash discharged waste water and its utilization for irrigation in bhilai 3, durg district chhattisgarh, india.

A. Study Area

India is situated in the latitude of 22° 00' N and longitudes of 77°00’E denote its geographical alignment. The specific latitude of India suggests its position in Northern Hemisphere. The terra firma of India is bounded by the Bay of Bengal, Arabian Sea, Pakistan, Bangladesh, Myanmar, Nepal, Bhutan and China. The current study area bhilai-3 durg district chhattisgarh, central india (figure:1). NSPCL is an industrial area and a part of bhilai-3 situated on the central of large fertile plain of chhattisgarh. It is situated between 21.21^0 N latitude and 81.38° E longitude, with a height of 452m on the Howrah-Mumbai NH-6 road. It is 28-35 km far away from its state main city raipur. Maroda sector water tank is the main source of NSPCL. To meet primarily captive power requirement of bhilai steel plant. NSPCL commissioned 2×250 MW coal based captive power plant–II at aundhi village of bhilai-3. From the plant, NSPCL is supplying balance power to the beneficiaries in the western region of India. The surface water quality of devbaloda, somni, ganiyari, aundhi, pachpedi, sirsakhurd, auri , purena and sirsakala is continuously fertile probably due to the disposal of industrial alkaline water and soils of the nearby fields around 10 Km radius are also being affected. Therefore, we have decided to analyze its waste water and tunnels for its utilization for irrigation. The study area of the proposed work is shown in the figure 1.

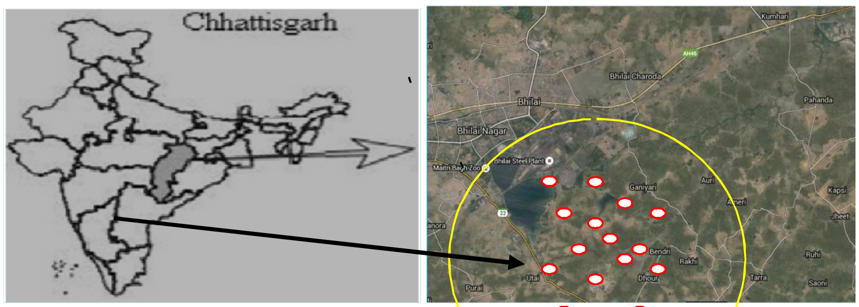

Fig. 1 Fly ash bund waste water locations of bhilai 3 in Chhattisgarh, India

II. MATERIALS AND METHODS

In the present study fly ash bund waste water samples were collected from the different sites around 20 Km radius of bhilai-3 during Oct.2017–Sept.2018 and seventeen water parameters were studied for its utilization in irrigation. Water samples were stored in sterilized one litre PVC bottles. All the chemicals were purchased from E. Merck of A.R. grade used without further purification. All physico-chemical parameters like Chloride, Sulphate, Phosphate, Calcium, Magnesium, Sodium, Carbonate, Bicarbonate, Turbidity, Hardness, Alkalinity, EC, pH and Total dissolve Solids was determined by using standard procedure[19-22]. SAR (Sodium Absorption Ratio) value was computed using the following formula

$$S.A.R. = \frac{Na^+}{\sqrt{\frac{1}{2}(Ca^{2+} + Mg^{2+})}}$$

Hence the relative activity of sodium cation in the exchange reactions of calcium and magnesium present in the soil. RSC(Residual Sodium Carbonate) can be calculated by this formula.

$$R.S.C = (CO_3^{2-} + HCO_3^-) - (Ca^{2+} + Mg^{2+})$$

Here the both concentrations are in part per million. If the RSC value is high due to presence of excess carbonates and bicarbonates, then water is excellent for irrigation. Here the magnesium and calcium ratio was computed by putting the both variable seasonal values. Analysis of fly ash bund waste water was done using the following standard procedure.

TABLE I. Analysis of Physico-chemical parameters by these methods(APHA-1995)

S. No.	Parameters	Methods
1	Chloride(ppm)	Argentometric titration
2	Sulphate (ppm)	Ion chromatography
3	Phosphate (ppm)	Spectrophotometric Method
4	Calcium(ppm)	Elico flame photometer
5	Magnesium(ppm)	Elico flame photometer
6	Sodium(ppm)	Elico flame photometer
7	Carbonate(ppm)	Ion chromatography
8	Bicarbonate(ppm)	Ion chromatography
9	Turbidity(NTU)	Digital Nephlo-Turbid meter-132
10	Hardness(ppm)	Titration with acid HCl
11	Alkalinity(ppm)	Titration with acid HCl
12	EC(µs/cm)	Systronic Conductivity Meter-304
13	pH	Systronics pH meter
14	TDS (ppm)	HM digital meter TDS-3

Fig. 2 A Photograph of waste water of bhilai-3 and its utilization for irrigation

III. RESULTS AND DISCUSSION

The physico-chemical parameters of fly ash bund waste water samples of NSPCL Bhilai-3 with their standard values prescribed by water quality indices (WQI) and Indian Standard (IS:11624-1986) are given in the table II. The mean results of the physiochemical analysis of the groundwater samples S_1 to S_{17}, collected from ten different locations in the range of 10 km are presented in table II.

TABLE II
Physico-chemical analysis of fly ash discharged waste water

S. No	Parameters	Oct-Dec.17	Jan-March18	April-June 18	July-Sept18
	Seasons	Post Monsoon		Pre Monsoon	Monsoon
1.	Chloride(ppm)	60	50	30	70
2.	Sulphate (ppm)	80	54	50	90
3.	Phosphate (ppm)	1.5	1.7	1.6	2.0
4.	Calcium(ppm)	121	171	162	126
5.	Magnesium(ppm)	76	81	79	80
6.	Sodium(ppm)	98	110	106	100
7.	Carbonate(ppm)	42	35	25	31
8.	Bicarbonate(ppm)	157	120	170	180
9.	Turbidity(NTU)	5.0	7.0	10	6.0
10.	Hardness(ppm)	170	160	180	210
11.	Alkalinity(ppm)	165	175	195	200
12.	EC(µs/cm)	680	670	650	755
13.	pH	8.8	9.4	9.2	9.0
14.	TDS (ppm)	480	410	360	490
15.	SAR	9.87	9.80	9.68	9.86
16.	RSC(m mol/l)	2	-97	-46	05
17.	Mg/Ca	0.62	0.47	0.48	0.63

Here the raito of Ca/Mg is shows the suitability of waste water for utilization in irrigation. Recommended level of the ratio should below than1.0 for effective use of water for irrigation. Table 2 indicates that the value ratio of Ca/Mg will be maximum in the july-sept.18 seasons and minimum in post monsoon season, as shown in figure 4 which indicate that maximum crops production in the month of oct-dec.17 and july-sept.18.

The residual sodium carbonate value was found to minimum in the month of jan-march18 and maximum in july-sept.18.The data shows that production of crops is maximum in the month oct-dec17 but the other season is not very suitable. Total dissolved solid was maximum found in the month of july-sept18 which shows the maximum availability of minerals in the monsoon season which is beneficial for irrigation but its low concentration in the month of oct-dec17 which is shown in the figure-5.Here the value of electrical conductivity was maximum in monsoon season and minimum in pre-monsoon season which indicate that the production of crops was more suitable for monsoon and post monsoon seasons as shown in the figure-6. Table IV also shows that the value of electrical conductivity was found to be in high salinity zone , thus waste water is excellent for irrigation. The fluctuation of pH found in waste water from 8.8 to 9.4 in the month of oct-dec17 and jan-march18. Most fly ash bund waters are generally alkaline due to presence of sufficient quantities of carbonates and bicarbonates. The value of pH change diurnally and seasonally due to variation in photosynthetic activity of the plants. Alkalinity of water is caused mainly due to presence of OH^-, CO_3^{2-} and HCO_3^- ions etc. In the fly ash bund waste water contains many other salts such as silicates, phosphates, borates etc. are present which contribute to alkalinity. The alkalinity of waste water was found high (200ppm) in the month of july to sept 18 (monsoon season) and low (165ppm) in the month of oct-dec17 (post monsoon season) which probably found due to the use of fertilizer in the soil.

We know that the excess concentration of sulfate (SO_4^{2-}) over chloride (Cl^-) ion is beneficial for irrigation because the latter develops much higher salt stress for plants' root than the SO_4^{2-} ion induced salinity[23-26]. Growing pulses with SO_4^{2-} enriched irrigation water was found beneficial by partial fulfillment of sulfur nutrition of the crops. But table II shows that the value of SO_4^{2-} and Cl^- ions were minimum in the month of april-june18 and maximum on july-sept.18 which indicate that maximum production of crops in monsoon season and minimum in the month of april-june18. The value of phosphate ion present in waste water was found 2.0 ppm in the month of oct-dec17.Calcium ion found maximum in the month of april-june18 and minimum in the month of oct.-dec17, which shows that the crops production increase in the month of april-june18. Magnesium ion was found maximum in jan-march18 and minimum in oct-dec17

. Table III

Classification of Water Quality Indices(WQI) and Indian Standards(IS) for Irrigation

S.No	Parameters	Water Class	IS:11624-1986	WQI
1.	SAR(Sodium Absorption Ratio)	Excellent	<10	<10
		Good	10-18	10-18
		Fair	18-26	-
		Poor	>26	>26
2.	RSC(Residual Sodium Carbonate)	Safe	<90	<75
		Moderately safe	90-180	75-150
		unsafe	>360	>150
3.	Magnesium/Calcium	Safe	-	<1.5
		Moderately safe	-	1.5-3.0
		unsafe	-	>3.0

Table IV

Categorization of water on the basis total dissolved solids and conductivity

Zone	Conductivity(µs/cm)	TDS(mg/lit.)
Very high salinity zone	2250-5000	1500-3000
High salinity zone	750-2250	500-1500
Medium salinity zone	250-750	200-500
Low salinity zone	<250	<2000

We know that sodium or alkalinity present in the waste water will be used for the irrigation. If the water used for irrigation contains high sodium and low calcium, then the cation exchange complex will be saturate with sodium, which shows that the destruction of soil. Here the value of SAR varies form 9.68 to 9.87 lowest value in the month of april-june 2018 and the highest in the month of oct-dec 2017, which is also shown in figure 3 which indicate that crops production was maximum in post-monsoon season.

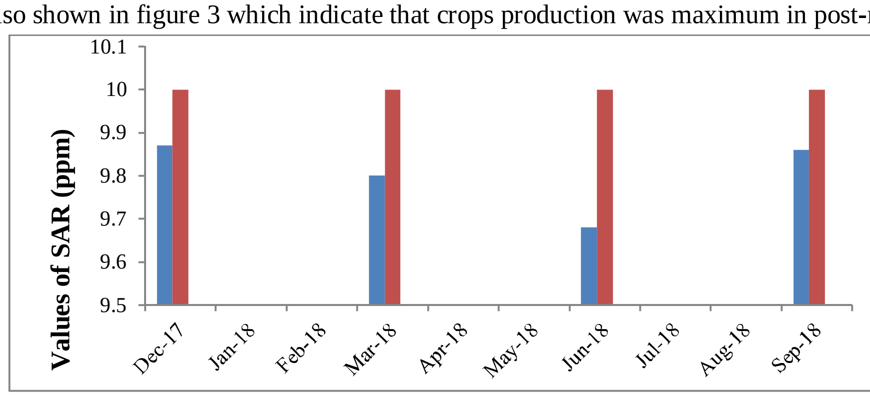

Fig.3 Flow Chart of Sodium Absorption Ratio value with Seasonal Variation

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue IX, Sep 2019- Available at www.ijraset.com

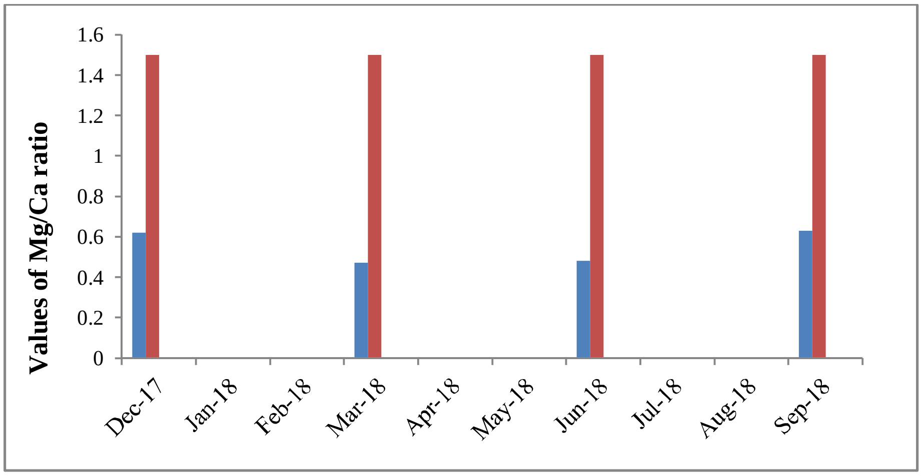

Fig. 4 Flow Chart of Magnesium/Calcium Ratio with Seasonal Variation

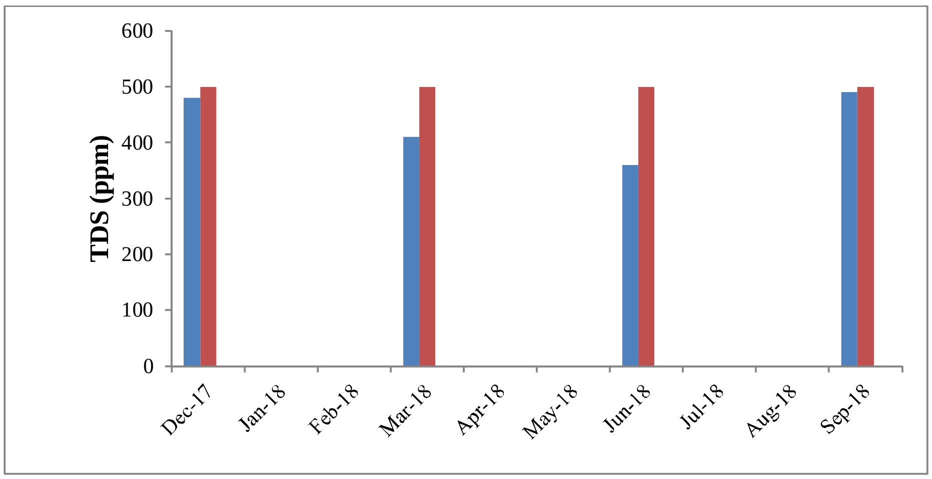

Fig.5 Flow Chart of TDS with Seasonal Variation

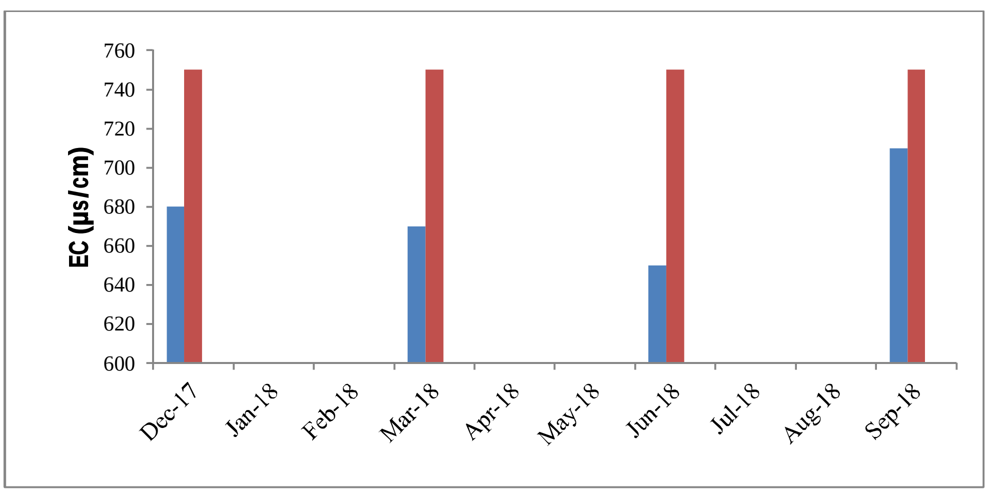

Fig.6 Flow Chart of Electrical Conductivity(µs/cm) with Seasonal Variation

If the water is used for irrigation, one has to check its salinity because salinity in agricultural requires excess of salts above the plant level. Salts present in the soil water may inhibit plant growth for two reasons:(i) The presence of salt in the soil solution reduces the ability of the plant to take up water and this leads to reduction in the growth rate. (ii) If excessive amount of salts enters the plant, there will be injury to cells in the transpiring leaves and this may cause further reductions in growth.

IV. CONCLUSIONS

Recycling of waste water will be supported by economic and environmental perspectives to substitute for some uses that do not need potable water quality and will contribute to nutrient recovery. It is concluded that all the values of physico-chemical characteristics of fly ash bound waste water found from the site of NSPCL is excellent for irrigation due to its SAR value was less than 10, salinity 755µs/cm and RSC value is more than 2.5 m mol/l. The water from the study area contains high calcium and low sodium, hence there is no destruction of soil structure. Thus, this water from ash bund overflow is very suitable for irrigation purpose.

V. ACKNOWLEDGEMENT

Author is thankful to Parthivi College of Engineering and Management for lab facilities and the reviewers who critical evalute this manuscript.

REFERENCES

[1] T. Asano, F. L.Burton,H. Leverenz, R. Tsuchihashi, and G. Tchobanoglous, Water Reuse: Issues, Technologies and Applications, McGraw-Hill, New York, 2007
[2] AATSE: Australian Academy of Technological Sciences and Engineering. Water recycling in Australia, Victoria, Australia, 2004.
[3] APHA: Standard methods for the examination water and wastewater analysis. (19th Eds.), American Public Health Association, , Washington DC, USA,1995
[4] R.S.Ayers, and D.W. Westcot, Water Quality for Agriculture. FAO Irrigation and Drainage Paper 29 (Rev. 1). Food and Agriculture Organization, Rome, Italy,1985.
[5] S.S.Bagchi, R.S. Subramaniam, and P.K. Khurana, Utilization Potential of Ash Bund Effluents for Irrigation Purposes, International Congress of Chemistry and Environment, indore, India,2005.
[6] D.B. Sorde, R.N. Jadhav, V. A. Khatik, S.T. Ingle, and S.B. Attarde, Extraction and Leaching of Heavy Metals from Thermal Power Plant Fly Ash and Its Admixtures, Polish J. of Environ. Stud. 19(6),1325-1330, 2010.
[7] A.D. Bartolomeo, L. Poletti, G. Sanchini, B. Sebastiani, and G. Morozzi, Relationship among parameters of lake polluted sediments by multivariate statistical analysis. Chemosphere,55(10), 1323-1329,2004.
[8] N.S. Bolan, D.C. Adriano and D. Curtin,Soil acidification and liming interactions with nutrient and heavy metal transformation and bioavailability. Advances in Agronomy,78,215-272, 2003.
[9] G.R. Chhatwal , M.C. Mehra, M. Satake , T.Katyal ,M. Katyal and T. Magahiro,(Eds.), Environmental Water Pollution and its Control, Anmol publication New Delhi,1989
[10] G.V. Deepthi, M. Gupta, Study of utilization of ash pond effluents for plantation within thermal power plants J. Chem. Phar. Res., 6(8),315-318,2014.
[11] M. Das, R.B. Upendra, H. Charkraborty, A. Kumar and K. kanan, Reuse of industrial effluent water -prospect and opportunities in agriculture perspective, directorate of water management, Research bulletin.46,1-33,2009.
[12] K. Donaldson, P.J. Borm , The Quartz Hazards: A Variable Entity Ann. Occup. Hyg. 42, 287-293,1998.
[13] H. Greenway, and R. Munns, Annual Review of Plant Physiology Physiology Mechanisms of salt-tolerance in non halophytes,31,149-190,1980.
[14] Indian Standards IS :11624–1986. Guidelines for the quality of Irrigation Water.
[15] V.A.Kumar, and M. Mathur, Management of fly ash in India: a perspective. In: Proc 3rd Int. Conf. on Fly Ash Utilization and Disposal, vol. 1(Central Board of Irrigation and Power, Fly Ash Mission, TIFAC, DST, New Delhi and NTPC Ltd., New Delhi), p.1-20,2003.
[16] Keraita, B. Jimenez, B and Dreschsel P., Extent and implications of agricultural reuse of untreated partly treated and diluted wastewater in developing countries, Agriculture, Veterinary Science, Nutrition and National resources, 3, 58, 15,2008.
[17] Land and plant nutrition management service., htpp://www. fao. org/ag / agl /agll/spush, 2008.
[18] V. Lazarova, and A. Bahri, Water Reuse for Irrigation: Agriculture, Landscapes, and Turf Grass, CRC Press, Boca,2005.
[19] P.Mathews and P. Roland,(eds). Global Atlas of Excreta, wastewater sludge and Biosolids Management : Moving forward the sustainable and welcome uses of a Global Resource, UN-Habitat, Nairobi, 632,2008.
[20] P.S. Minhas and R.K. Gupta, Quality of irrigation water: assessment management, Indian Council of Agricultural Research,103,1992.
[21] NEERI: National Environmental Engineering Research Institute, Sustainable development, Nagpur, p. 37-87,1988.
[22] M.Qadir and P.S. Minhas, Wastewater use in agriculture: Saline and sodic waters in S.W. Trimble (ed) Encyclopedia of Water Science, Taylor & Francis, New York, p. 1307–10,2008
[23] R. Reza. and G. Singh, Assessment of Heavy Metal Contamination and its Indexing Approach for River Water, International Journal of Environmental Science and Technology, 7,785-792,2010.
[24] H.S Sarkar, Fly ash: A Global player in utilization games of multifarious areas. In: Proc 3 Int. Conf. fly Ash Utilization and Disposal, vol. 1 (Central Board of Irrigation and Power, fly ash Mission, TIFAC, DST, New Delhi and National Thermal power Corporation Ltd., New Delhi), p.1-39,2003.
[25] C.S. Sharma, R.K. Nema, and S.N. Meyyanathan, Academic J. Cancer Res., 2(1),19-24,2009.
[26] M.R. Senapati, Fly ash from thermal power plants – waste management and overview, Current Science, 100(12), 25-30,2011.