UGC SPONSORED MINOR RESEARCH PROJECT

ON

REMOVAL OF HEAVY ELEMENTS FROM THERMAL POWER STATIONS BY BIOLOGICAL PROCESS

By

R. D. Raut
M.Sc., Ph. D.
Principle Investigator

Department of Chemistry

Jankidevi Bajaj College of Science
Wardha – 442 001

2015

Establishment Year : 1962 **Shiksha Mandal's**

Jankidevi Bajaj College of Science, Wardha

(A Linguistic Minority College)
Reaccredited 'A' Institution (CGPA 3.21), NAAC (UGC), Bangalore
College with Potential for Excellence, UGC, New Delhi
Star College Scheme by DBT Govt. of India, New Delhi

Office/Fax : (07152) 230515
Admn. Off. : (07152) 241696
Library : (07152) 255070
E-mail : jbsciencewardha@yahoo.co.in
Website : jbsw.shikshamandal.org

Jamnalal Bajaj Marg,
Civil Line
Wardha – 442 001
(Maharashtra)
Uni. College No. : 802
Jr. College No. : 07-01-003

CERTIFICATE

This is to certify that the work presented in this UGC sponsored Minor Research Projects entitled **"Removal of heavy elements from thermal power stations by biological process"** has been carried out by Dr. R. D. Raut in the Department of Chemistry, Jankidevi Bajaj College of Science, Wardha.

Date:- 03/03/2016

Principal

ACKNOWLEDGEMENT

I take an immense pleasure in expressing our whole hearted gratitude towards Shri Sanjayji Bhargwa Chairman , Shiksha Mandal Wardha, Dr. Om Mohodaya, Principal, Jankidevi Bajaj College of Science, Wardha for his keen interest, during the course of this work.

I would like to express my sincere thanks to University Grants Commission (WRO, Pune) for providing the necessary financial assistance and Rastrasant Tukdogi Maharaj Nagpur University Nagpur.

I am sincerely thankful to Dr. V. V. Shinde, Dr. V. M. Ghodki, Dr. P. D. Wankar, Prof. R. G. Jadhao, Dr. S. H. Bagade, Dr. R. D. Sontakke and Shri M. R. Girde for their kind help and co-operation.

I am also thankful to all our Departmental non-teaching staff for their providing all the necessary facilities available in the department in carrying out this work.

Wardha

Date: 03/03/16

R. D. Raut
(Principle Investigator)

Chapter IV

Conclusion

The removal efficiency of heavy metals was studied for lead, , cadmiuml and manganese using solutions of different concentrations for different time intervals. The decrease in metal concentration of the solution was noted over the period of 24 hours. The corresponding removal efficiencies were calculated and are reported in tables.

Removal of heavy metals by water Colocasia was studied for contact period of 0.5, 1.0, 2.0, 4.0, 8.0 and 24.0 hours. It is observed that removal of heavy metals increases with increased in contact time. The removal is rapid within half hour and then slowly decreases and become constant at the end of 24 hours. It is also seen that maximum removal take place within 4.0 hours and then removal is very slow and nearly constant at the end of 24.0 hours.

For studying the effect of pH on removal efficiency of water Colocasia, the plants were exposed to metal solution having 1 mg/L concentration at different pH from 2 to 10. The percentage removal of heavy metals during exposure period of 24 hours for different pH are already discuss and shown in table. The rate of removal is low in acidic pH 2 and alkaline pH 10. It is seen that water Colocasia absorbs 50 to 60 % heavy metals at pH 2 and pH 10 within half an hour and maximum absorption occurs at the end of 24 hours.

As the pH increases from 6.0 to 8.0 the removal efficiency also increases and maximum at the pH 8. It is seen that water Colocasia absorbs 60 to 70% metals at pH 6 and 70 to 80% metals at pH 8 within half an hour. At the end of 24 hours the percentage removal is nearly 90 % for all the heavy metals at pH 2 to 10. It is observed that at the end of 24 hours exposure, plants neutralise acidic pH from 2 to 5.5 alkaline pH from 10 to 8.0. It is also seen that rate of removal is lower in the beginning at pH 2 and pH 10, but as the contact period increases the removal is also increased. This may be due to neutralization of pH by water Colocasia during the exposure period.

For studying the effect of concentration on removal efficiency of water Colocasia , the plants were exposed to solution having different initial concentration of 1, 5, 10 and 20 mg/L and at pH 8. The absorption capacity of the plant decreases with increase in

Shiksha Mandal's

Jankidevi Bajaj College of Science

NAAC (UGC) Reaccredited 'A' Institution
(A Linguistic Minority College)
COLLEGE WITH POTENTIAL FOR EXCELLENCE
Star College Status by DBT Govt. of India

Office/Fax : (07152) 230515
Admn. Offi. : (07152) 241696
Library : (07152) 255070

Uni. College No.: 802
Jr. College No. : 07-01-003

Jamnalal Bajaj Marg
Civil Line,
WARDHA - 442 001
(Maharashtra)
E-mail : jbsciencewardha@yahoo.co.in
website : jbsw.shikshamandal.org

Ref No. J.B.C./237/2015-16

Date : 12/04/2016

To,

The joint Secretary,

University Grants Commission,

Western Region Office,

Ganesh Khind Pune-411007

Subject: Completion of Minor Project **File No. F-47-227/12 (WRO)**

Reference : Your letter Dated 20 Feb 2013.

Sir,

With reference to your office letter dated 15 March, following documents for settlement of MRP sanctioned to Prof. Dr. R. D. Raut (Principle Investigator) was sending.

1) Date of starting the project : 1 March 2013.

2) Date of completion of the project : 25 March 2015.

3) Utilization certificate : Original and attested Xerox copy is attached.

4) Statement of expenditure : Original and attested Xerox copies is attached.

5) Project completion report : Original

6) Assets certificate : Enclosed

7) Accession certificate : Enclosed

Dr. R. D. Raut

(Principal Investigator)

Dr. Om Mahodaya

Principal

PRINCIPAL
J.B. College of Science
Wardha

ज्ञान-विज्ञान विमुक्तये

Annexure-III

UNIVERSITY GRANTS COMMISSION
BAHADUR SHAH ZAFAR MARG
NEW DELHI – 110002

~~Annual~~/Final Report of the work done of the ~~Major~~ /Minor Research Project.

(Report to be submitted within 6 weeks after completion of each year).

1. Project report No. 1st/2nd/3rd/ Final **Final**
2. UGC Reference NO. **F-47-227/12 (WRO)**
3. Period of report: from **20 Feb 2013 to 25 Mar 2015**

Title of research project **Removal of heavy Elements from thermal power station by Biological process**

1. (a) Name of the Principal Investigator **Dr. R.D.Raut**

(b) Dept. And University/College where work has progressed

J. B. College of Science, Wardha.

---

2. Effective date of starting of the project **Mar. 2013**
3. Grant approved and expenditure incurred during the period of the report:

a. Total amount approved Rs. **90,000/-**

b. Total expenditure Rs. **92,045/-**

Report of the work done: (please attach a separate sheet)

Brief objective of the project **Removal of heavy Elements from thermal power station by Biological process**

---

iii. Work done so far and results achieved and publications, if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication.

....cont

International Journal of Researches In Biosciences, Agriculture & Technology | Feb. 2015 Special Issue- 3 | ISSN No. (Online) 2347-517X

Heavy Metal Pollution from a Thermal Power Station

R. D. Raut
J.B. College of Science, Ward
ravishankar.raut@gmail.com

Abstract :

The thermal power station situated near Chandrapur, India, releases fly ash into the environment and discharges effluent contaminated with fly ash and bottom ash through a main drain into the Erairiver. These fly ashes contain silicates, heavy metals and organic compounds. Thus, their discharge in the river affects the riverine water quality. In view of this the present study was undertaken. The concentration of heavy metal ions was determined in upstream and downstream of the river, thermal power station main drain and ash bund overflow to assess the heavy metal contamination level of the waters. Samples were collected from the selected sites at bi-monthly intervals over a period of one year and were analyzed for heavy metals Cu, Pb, Zn, Ni, Co, Cd, Mn and Cr using atomic absorption spectrophotometer. The study revealed that concentration of heavy metal ions was more in Erairiver downstream of the Thermal power station effluent drain, than upstream. It further revealed that the heavy metal content of the river water was within the standard permissible limits set for inland surface water.

Keywords : heavy metal ions, effluents, ash bund, thermal power station, fly ash

Introduction:-

The use coal for the generation of electrical energy in the thermal power station produced large amount of ash which was generally disposed by using water to the nearby areas. According to recently compiled statistics, approximately 280 X 10^6t of fly ash is Produce in the world every year by the combustion of coal[1] Coal fly ash consists primarily amorphous alumina silicates, heavy metals and organic compounds. Organic and inorganic constituents of coal ashes and slags may pose potential hazards to aquatic biota and humans[2]. The concentration of heavy metals increases in water around the thermal power station due to release of fly ash into environment and discharge of effluents contaminated with fly ash and bottom ash[3]. Water quality around the thermal power station depends on the ash disposal methods, amount of suspended solids and heavy metals[4]. The purpose of this paper was to determine the quantity of heavy metals in effluents, in freshwater region of upstream of the Erairiver and number of spots downstream of the power station and also in the overflow of ash bund of thermal power station situated near Chandrapur, India.

Material and Methods :-

Thermal power station is situated about 2 km towards north of Chandrapur. The gradation of coal used is E & F types. The Coal has calorific value of 3500-4500 kcal kg^{-1}. Its ash content is 30 to 40%,sulphur content 0.4 to 0.6% and moisture content 5 to 15%. Both units of the plant have modern electrostatic precipitator for precipitation of fly ash. The requirement of coal is nearly 7000t d^{-1} and production of ash is nearly 2800t d^{-1}. This ash is transported in the form of slurry to ash bund. Out of this ash 5 t d^{-1} in the form of fly ash is escapes from the electrostatic precipitor through chimney and spreads around an area of 1.32 km radius, depending on the wind velocity and direction.

Water samples were collected from the 4 selected sites at regular intervals over a period of one year, 5 time from each sites namely, (1) upstream and (2) downstream of Erai river, (3) power station main drain and (4) overflow of ash bund. The water samples from Erairiver were collected from 500m upstream and 500m down steam of discharge site of power station main drain of thermal power station. The samples were collected in 11 polythene bottles and were acidified with concentrate nitric acid and brought to the laboratory.

Each samples was then concentrated to 10ml volume by slow evaporation. The 20 ml of HNO_3: H_2SO_4 (1:3) was added to each sample. It was evaporated to near dryness. The residue was extracted with 50ml double distilled water. Elements have been analyzed as per the standard methods recommended by APHA (1985). The concentration of heavy metals, Cu, Pb, Zn, Ni, Co, Cd, Mn and Cr were determined using flame atomic absorption spectrophotometer (GBC mode 906 AAS) by atomizing aqueous samples in air acetylene flame, Hollow cathode lamps for individual metals were used to produce respective resonance line.

Result and Discussion:

It was seen that concentration of heavy metals were within Bureau of Indian standards of permissible limits set for industrial effluents and drinking water (Table 1) The concentration of heavy metals. Cu, Pb, Zn, Ni, Co, Mn and Cr were in the following order ; power station main drian> ash bund overflow >Erai river downstream >river water upstream. In upstream water Co, Cd, and Cr were be law detectable limits and rest of the heavy metals were in very low concentration. The heavy metal level increased at downstream of Erai river. It is attributed to the disposal of effluents to the river by the thermal power station (Table. 1).

The power station main drain showed high variation in the concentrations of Pb, Ni, Co, Cd and Mn the ranges were 48- 180, 14-120, 94-156, 9-28 and 16-102, ug 1-1, respectively. Such higher concentration of heavy metals in power station main drain as compared to the ash bund overflow water was mainly due to the discharge of waster from water treatment plant, machine washing cooling tower blow down and fly ash. These values are lower than that reported for chandrapur Thermal Power Station (CPCB, 1988- 89).

In Erairiver downstream Ni and Cr were in very low concentration in the range of 6.0- 9.0 and 1.0-2.0 ug 1-1 respectively. The concentrations of Pb and Cd were high, ranging from 10.0- 25.30 and 3.0-4.0 ug 1-1, respectively, which exceeded maximum permissible limits prescribed by WHO (1996) : Pb =10 ug 1-1and Cd= 3ug 1-1, the rest of the heavy metals below recommended standard for drinking water . In all the samples except Kanhan river upstream, the concentration of Cd exceeded maximum permissible limit prescribed by WHO (1996) :Cd=3.0 ug 1-1 Higher concentration of Cd recorded in power station main drain was in the range of 9.0-28.0 ug 1-1, Which might be due to the discharge of effluents of water treatment plant and fly ash. The concentration of Pb in Erai river downstream, power station main drain and ash bund overflow was in the range of 10.0-25.0, 48.0-180.0 and 41.0 -52.0 ug1-1, respectively. In all the samples concentration of Pb exceeded maximum permissible limit 10.01-1, prescribed by

WHO (1996) . In the study area, concentration of Mn was found below prescribed maximum permissible limit, i.e. 500ug 1-1 (WHO,1996). In ash bund overflow the heavy metals were having low concentration as compared to power station main drain , it was due to percolation of ash water and setting of ash at the bottom of the ash bund (ISS, 1983).

Table- 1- Concentration of heavy metals in fresh and waster- water of Thermal power Station (ug1 -1) ND-Not detectable

Elements	Erai river upstream	Erai river downstream	Power station main drain	Ash bund overflow
Copper	8.5- 9.5	11.0 -15.0	20.-50.0	13-55.0
Lead	5.7-6.4	10.0- 25.0	48.0-180.0	41.0-52.0
Zinc	3.0-4.4	11.0 -24.0	12.0 -44.0	46.0-28.0
Nickel	2.8 -3.6	6.0- 9.0	14.0 -120.0	11.0 -15.0
Cobalt	ND	5.0 -8.0	94.0-156.0	11.0 -17.0
Cadmium	ND	3.0 -4.0	9.0-28.0	3.0 -8.0
Manganese	3.6 -4.6	9.0 -43.0	16.0 -120.0	54.0 -92.0
Chromium	ND	1.0-2.0	7.0- 9.0	6.0-8.0

Conclusion:

The concentrations of all the heavy metal ions found in the area of power station main were within the bureau of Indian standards of permissible limits for industrial effluents prescribed by I.S.S. (1983). The concentration of heavy metals in the area of Erai river downstream was lower than the permissible limits prescribed by Indian standard (1983) but slightly higher as per WHO . This was attributed to the dilution effect of water. The water of Erai river is suitable for drinking purpose as per Indian Standard (1983) but not suitable as per WHO (1996) as its heavy metal content is slightly higher than its recommended standards. However, the water of Erai River is suitable for inland surface water and for irrigation purposes.

References:

1. **Hockely , D. and Sloot H.A.V,** Long term process in a stabilized coal waste block exposed to sea water. J .Envniron. Sci.Tech, 25 : 1409. 1991

2. **Harris W.R.andSilberman, D.**thim dependent leaching of coal fly ash by cheletaating agents. J .Envniron. Sci.Tech, 17:139, 1983.

3. **Nihan, C.T. Graydon J.W. and. Kirk D. W,** Utilizing coal fly ash as a land fill barrier material. J. Waster Management, 16: 587-595. 1996

4. **Sarangi, P. K and Mishra A.P. C,** Soil activites and yield in ground nut, ladies finger and redish in fly ash amended soil . J. Res. Ur. Chem. Environ , 2 (2) :7-9. 1998

5. **Hegade, B.A. and Patil T.M.**Utilisation of industrial wastewater in agriculture. J. poll Res. 2:37- 39 1983.

6. **Jain ,C.K.Bhatia K.S and Vijay T,** Ground water quality in a coastal region of Andhra Pradesh. J. Indian Environ. Hith. 39: 182- 192. 1997

7. **Nair, J.C. and Ganapathi S,** Water quality of the Bhadar river basin. J. Indian Environ. Hlth, 39: 197- 206. 1997