

Original Research Article

The Physiochemical Characteristics of Fly Ash Discharge Water Pond

Shikha Shrivastava*, Lekhika Shrivastava and Akanchha Singh

Government VYT PG Auto. College Durg C.G. India

*Corresponding author

ABSTRACT

Keywords

Fly ash,
Discharge water,
Temperature,
Hardness, BOD

The fly ash a byproduct from coal fired power plant is disposed off in a slurry form, from the power plants, in ash dykes. This slurry water is filtered and stored in a manmade, artificial pond known as discharge water pond. The water quality of this pond has not been studied till now, thus the aim of this study was to know about the different physiochemical parameters of this water.

Introduction

The fly ash is disposed off from the power plants in a slurry form in ash dykes. The excess water from the dykes is collected and stored in a man-made artificially constructed water pond known as fly-ash discharge water pond for disposal of excess water from ash dyke. Fly ash arises from the coal, its burning at very high temperature so naturally the elements supposed to be present in the coal. The general petrological analysis of coal presence the structure of coal as a combination of C, O, H, S, N, SiO₂, AlO₂, FeO₂, CaO, SO₃, MgO, K₂O, TiO₂ and Na₂O. So the chemical parameter decided to study in fly ash discharge pond were Mg, Ca, SO₃, Al, Fe, Si, K, Na, TiO₂, because the water coming in this pond is a filtered water from fly ash dyke which is in turn a product of coal. The study of fly ash has also been done by few workers with

different aspects but no one has reported qualities of this type of water. (Shrivastava 2006, 2007a, 2007b) It is a nascent, shallow pond and has only fly ash substratum in soluble & non-soluble form; thus it may have different water quality leading by the fly ash constituents in comparison to other ponds. Water quality of the pond directly affects the survival, physiology, growth and other life activities of fauna and, thus total population survival (Cherry D.S. et al., 1984) Though many innumerable workers are studying the different water quality but recently workers like Damotharan et al., 2010; Prasanna and Ranjan, 2010, Ravikumar.P2010., have studied different water bodies. But many few workers are assessing the water related to fly ash. Shrivastava(2006,), Tharot 2013 Srinivasan 1986. Water from this pond is used by the workers and local people for

bathing and other domestic purposes. Along these uses, fishes and some vegetation available in that pond were also used as food by local people. This water is then mixed in natural water body like rivers, lakes, sea water etc. Also stated by other workers. (Pervez S. and Pandey G.S. ; 1994). Fly ash discharge pond is connected from ash dyke through its inlet , thus this pond receives water from sole source the ash dyke , Thus becoming a pond which may have some occurrence that are very unlikely ,from the normal pond characteristics. Any previous study on this type of pond is completely lacking, thus we initiated the study of physiochemical properties in this type of pond. Though some studies had been done by previous workers on fly ash, but no report exists for this type of fly ash discharge water.

Material and Methods

Study area

The Fly ash discharge pond is located in Dhanras village In Korba district of Chhattisgarh state, India. This pond is a small, newly constructed shallow pond situated at downhill position near the ash dyke having depth of around 10 to 15 meters, receives water from ash dyke. During monsoon season run off water from nearby fields also mix with the rain water in this pond. The wind pattern in the region varies towards SSW in summer and NE in the rest of the year. The adjacent areas of ash pond continuously receives atmospheric fallout and wind- blown ash particles from the pond (Ash dyke).It has an irregular shape and size ,Initially it is shallow, but the depth keeps on increasing because its walls are raised regularly. This pond has an area of 6.1856 hectare situated at 22° 28' 55.00" latitude and 82° 38' 29.55" longitude.

Elevation (high 30 mt.). The different parameters studied were-

Physical parameters

Color- By Visual comparison method (APHA)

Odor- By Threshold test(APHA)

Turbidity- By Nephelometric method(APHA)

pH- By pH meter [in lab.] and by Litmus paper test in field (APHA ; Dhembare A.J.,2011)

Temperature- Temperature reading was taken by the Mercury bulb thermometer. (By Centigrade thermometer) by dipping it into water and allow to stabilize for 2 minutes removed and reading immediately recorded (APHA ; Dhembare A.J.,2011)

Conductivity- Conductivity of water sample was determined through conductivity meter. (APHA ; Dhembare A.J.,2011)

Total solids- By Titration method

Chemical parameters

Hardness- By EDTA Titration method (APHA ; Dhembare A.J.,2011)

Sulphate test- By Ion Chromatographic Method (APHA ; Dhembare A.J.,2011)

Iron test- By AAS method] - IS: 3025(P-2) 2004 Method

Silica- By AAS method – IS:3025(P-2) 2004 &(P-35)1988 Method

Aluminum- By AAS method - IS: 3025(P-2) 2004 Method

Potassium- By Flame Emission Photometric method - IS: 3025(P-2) 2004 Method (APHA; Dhembare A.J.,2011)

Sodium- By Flame Emission Photometric method - IS: 3025(P-2) 2004 Method (APHA ; Dhembare A.J.,2011)

TiO₂- By AAS method

Dissolved Oxygen- Winkler method, (APHA ; Dhembare A.J.,2011)

Biological Oxygen Demand - By 5 day BOD test , (APHA ; Dhembare A.J.,2011)

Chemical Oxygen Demand - By Closed Reflux Titrimetric method, (APHA ; Dhembare A.J.,2011)

Alkalinity- Determined by the methyl orange method (By Titration method)

Result and Discussion

Physiochemical Parameter of FADP (from November 2009 to July 2014)

The fly ash discharge water is the direct extraction from fly ash dykes ,being stored in a manmade artificial, the fly ash bricks lines this pond in Dhanras village in Korba district of Chhattisgarh state, India. The unique characteristics of FADP are- because it poses a stressed environmental condition to the fauna inhabitation in this pond are –

- 1 - Fly ash discharge pond is an artificially constructed pond with fly ash brick linings, and the bottom consists of settled fly ash only.
- 2- Size and shape of fly ash discharge pond is irregular. It depends upon the available land area and disposed ash quantity.
- 3 –The pond boundaries are raised after regular intervals, as per the need arises for water storage.
- 4 –Only fly ash bricks are used during its manufacturing and raising process.

Color

The color was metallic green when seen by naked eyes but the lab assessment of color shows the value of more than >5 hazels, while the fly ash is light gray in color and after mixing it in the water, the Slurry is also gray colored. But the filtered water from this slurry which is coming to the fly ash

discharge pond through inlet gates seems to be gray and milky white in downward movement. The FADP has a bottom substratum of grey colored fly ash which has seeped with filtered water. But the color of water body in the pond was found to be of >5 hazels. We can presume that Iron which is present in very small amount in this water, turns into Iron-oxide (green rusts), responsible for this color. Several species of bacteria, including *Shewanella*, *Geobacter sulfurreducens* and *Geobacter metallireducens* metabolically utilize solid iron oxide as terminal electron acceptor, reducing Fe (II) containing oxide. But we cannot agree to the presence of these bacteria as in our culture plates very few colonies were found and that too were almost colorless or pale (Bretschger O.et al., 2007).

Odor

Odor of any water body cannot be determined in absolute units as olfactory sense lacks precision and mathematical expression. Majority opinion of several observers was recorded. The intensity of the odor can be said as severe, medium or low. All the observers of our team ranked the smell pungent, medium and medium to low.

Taste

Taste requires contact with taste bud with water samples to determine palatability. Similar to odor, taste also does not has any mathematical expression .The panelist and 9 statements ranging from very favorable and very unfavorable were presented before them. The penal rating was 4.6 mg/m³ towards unfavorable.

Turbidity

Turbidity is the reduction of the transparency due to the presence of particulate matter such as clay silt, organic

matter or microorganisms, which causes like to be scattered and absorbed rather than transmitting through the sample. The mean of turbidity was found to be 106.0446 NTU (mean) for the period of study.

pH

pH was found to be 8.8321 (mean). though 7 is the best desirable number for pH for anthropogenic usages, but 8.8 is also considered good.

Temperature

Temperature appeared to have a greater affect on community stability than other elements in previous study of naturally occurring bacteria (R k Vuthery et al 1970) as studied in the ash basin drainage system of thermal discharge. (Cherry et al 1979) has reported the thermal load and high turbidity influence on aquatic system. As we can see from the table I-a,

Temperature of fly ash discharge pond was found to be 29.5714 °C in our study duration. Importance of temperature was studied as early as in 1970 studies, where it was reported that Temperature had a great affect on community stability than any other elements in naturally occurring bacteria (R.K. Vuthery et al., 1970) the ash basin drainage system of thermal discharge.

Conductivity

Conductivity of fly ash discharge pond was found to be 334.58 umho (mean)

Total solids

Total solids present in water of fly ash discharge pond were found to be 97.5 mg/l (mean) Fly ash arises from the coal, its burning at very high temperature so naturally the elements supposed to be

present in fly ash will be coming from those present in the coal itself.

The general petrological analysis of coal presence the structure of coal as a combination of C, O, H, S, N, SiO₂, AlO₂, FeO₂, CaO, SO₃, MgO, K₂O, TiO₂ and Na₂O (Vassilev1 S.V.,). So the chemical parameter decided to study in fly ash discharge pond were Mg, Ca, SO₃, Al, Fe, Si, K, Na, TiO₂, because the water coming in this pond is a filtered water from fly ash dyke which is in turn a product of coal.

Hardness

Hardness(Ca, Mg)- In our study we found the hardness of this water is quite high around to be 117.8929 mg/l (mean) for the period of study, minimum (75.16 mg/l) in year 2010 and maximum in year (169.29 mg/l) 2013. (Table number X)

Sulphate

Sulphate concentration was found to be 8.0857 mg/l (mean) for the period of study

Aluminum

Aluminum is the most abundant metal on earth and a major constituents of mineral and clay. as it is present in coal as it was expected to be present in fly ash discharge pond through fly ash as it is always found in fly ash samples (Alam and Akhtar 2012) in the water samples studied from FADP showed Al below detectable limit

Iron (Fe)

Fe has relatively high concentration in fly ash sites but the filtered water from these dykes coming in the fly ash discharge pond had the value of below detectable limit

through out the study period. But in the last sample its concentration was detected (216ppb).

Silica (Si)

In the water samples studied from FADP from 2009 to 2014 showed Si was found below detectable limit but the last sample taken showed a very low concentration (4011 silicon, and 10866 in silicate ppb)

Potassium (K)

K was found below detectable limit in our study period from 2009 to 2014 so this was excluded for the further analysis. but the last sample taken showed a very low concentration (14420 ppb) (Table number X).

Sodium (Na)

Na was found below detectable limit

TiO₂

It was not found (Table number X).

Dissolve Oxygen (DO)

The DO was continuously low. Low dissolve oxygen is generally due to discharge of organic load and decomposition by bacteria and fungi which decreases the dissolve oxygen content (Vidya and Yadav,2008). But in this case there is no untreated waste water being added to increase the organic load, thus the reason of low DO content are very different from the normal ponds or river. In our samples dissolved oxygen was found to be 5.6804 mg/l (mean) for the period of study

Biological Oxygen Demand (BOD)

Biological oxygen demand was found to be 3.6636 mg/l (mean).Curds 1993) showed a

relationship with ciliates and BOD, where ciliates lowers the BOD.

Chemical Oxygen Demand (COD)

Chemical oxygen demand was found to be 20.5571 mg/l (mean) for the period of study, minimum (17.00 mg/l) was in year 2009 and maximum (22.9 mg/l) was in year 2014. (Table number X).

Alkalinity

Alkalinity of fly ash discharge pond was found to be 29.9 mg/l (mean) for the period of our study; minimum (25.5 mg/l) was in year 2009-2010 and maximum (38 mg/l) in year 2012 – 2013. (Table number XII a)

Elements in FADP

The presence of fly ash constituent (Iron, Silica, Aluminum, Potassium, Sodium, TiO₂) in fly ash discharge water, some of these elements were tested from well equipped lab. by Coupled Plasma Mass spectrophotometer Table-In many workers have reported tumor and deformities in fly ash exposure to fish, but we could not find in the sample collected by us neither there was any previous work reported the presence of Se and Hg in fly ash of Dhanras. Aluminum was higher 1615 in FADP (maximum recommended 50-200 ppb) Arsenic was 7.4 ppb which was within the limit (10 ppb) in FADP. Lead was 8.6 ppb which was within the limit (15ppb) (EPA, Drinking Water Contaminants; ATSDR.). This pond has fly ash discharge water from ash dyke as its sole water source. The supply of water is also non continuous depending upon opening of inlet gate of pond. There is an outlet which allows water to flow in the nearby water body. Thus the water is not constantly still, but is moving sometimes where one of the two gates are open, otherwise the water is rarely in motion.

Table.1 The physicochemical parameters of fly ash discharge water

S.No.	Physiochemical parameters	Unit	Value
1	Color	Hazels	>5
2	Odour		Pungent
3	Taste		Non-objectionable
4	Turbidity	NTU	106.0446
5	pH		8.8321
6	Temperature	⁰ C	29.5714
7	Conductivity	mho	334.58
8	Total Solids	mg/l	97.5
9	Hardness	mg/l	117.8929
10	Sulphate	mg/l	8.0857
11	Dissolved Oxygen	mg/l	5.6804
12	BOD	mg/l	3.6636
13	Chemical Oxygen Demand	mg/l	20.5571
14	Alkalinity	mg/l	29.9
15	Aluminium	ppb	1615
16	Iron	ppb	522
17	Silica (Silicon, Silicate)	ppb	9392, 25443
18	Potassium	ppb	7820
19	Sodium	ppb	12700
20	TiO ₂	ppb	Not found

Table.2

S.No.	General Test	Unit	Results
1	Silica (Silicon,Silicate)	ppb	9392, 25443
2	Potassium	ppb	7820
3	Aluminum	ppb	1615
4	Iron	ppb	522
7	Sodium	ppb	12700
8	TiO ₂		Not found

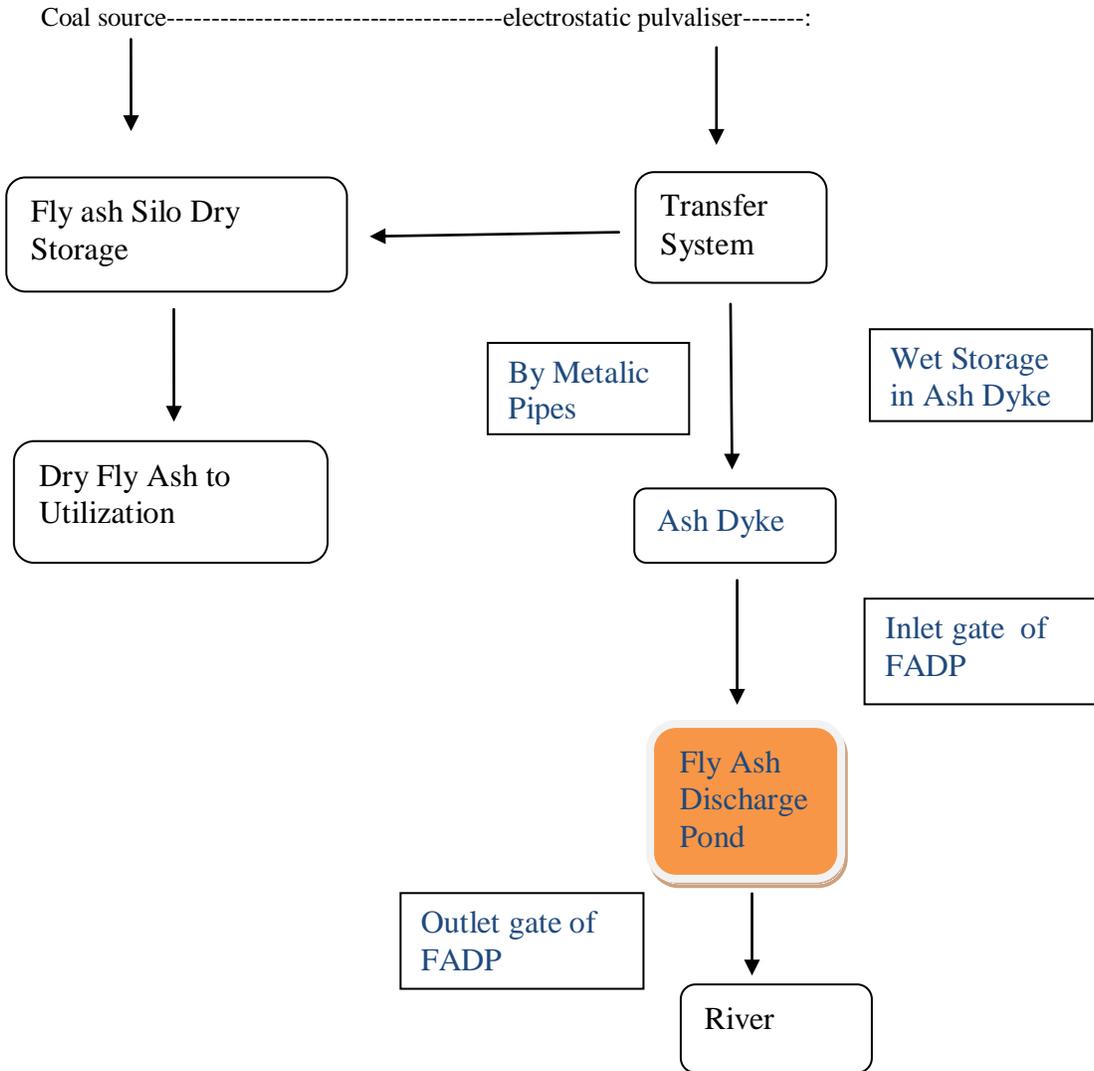


Fig.1 The water route in fly ash discharge pond



Turbidity of the fly ash discharge pond increases suddenly when its inlet gate was open due to discharge of fly ash particles with the flow, thus fluctuating unevenly. Surface tension of the fly ash discharge pond was different in comparison to natural pond water (Shrivastava S.2009). Sometimes multiple functional, interconnected fly ash discharge ponds may be constructed side by side and according to ash dyke discharge. Physiochemical properties of fly ash discharge pond are influenced by the constituent of fly ash and water quality used for making ash slurry. Temperature is also fluctuating and non-constant., which again makes difficult for introduced life forms to survive. pH is also fluctuating and non constant our study area. The bed of the pond is totally made of fly ash particles. This is in contrast to normal ponds, which have a very productive pond bed, where many producers inhabitate. But here the pond bed is made up of seeped fly ash from the ash dyke, where amount of ash is increasing continuously, making it least productive.

There is little supply of dead or decaying matter in this pond from the pond banks or ash Any previous study on this type of pond is completely lacking, thus we initiated the study of physiochemical properties in this type of pond. Though some studies had been done by previous workers on fly ash, but no report exists for this type of fly ash discharge water. Physiochemical parameters influence both vertical and horizontal migration of aquatic organisms and it affects the distribution, diversity and feeding. Its physiochemical properties depends on the quality of coal being used, the temperature to which the coal is burned, the quality of slurry water, bleaching powder quantity, and many anthropogenic activities. The unique quality of this type of pond has been discussed to some extent earlier (Srinivasan

S, 1986) and it is to be kept in mind that these qualities of water change from plant to plant and from different handling methods.

The BOD value though a component of chemical monitoring, but in reality it is based on biological process thus Regarded as an important aspect of biomonitoring Biological oxygen Demand (BOD) is an important parameter to the oxygen required to degradation of organic matter. , if we see the water quality according to BOD values (U.K.) Water quality BOD at 20OC mg/l, Very clean - less than 1, Clean - 1 - 2.5, Fairly clean- 2.5 –4, Poor - 6 to 10, Bad - 10-15, Very bad - 15-20 (Sharma S., Sharma P., 2010).In our study the BOD range from minimum 2.3 to maximum 5.5, proving the water to be fairly clean. Thus this water was found to be completely safe for human use.

Acknowledgement

The authors are thankful to UGC, Delhi, for providing necessary funds for the research work. Authors are thankful to authorities of ash dyke for the permission to work. Authors are thankful to Shiv analytical Bangalore for providing necessary help. Authors are also thankful to Govt. VYT College Principal and staff for providing lab facilities to complete the research work.

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