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# Detection of Fluoride Contamination in the Surface and Sub-Surface Water near Thermal Power Station

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***ABSTRACT:---****Exposure to higher amounts of fluoride can cause joint pain, restriction of mobility, and possibly increase the risk of some bone fractures. In the era of industrial advancement fluoride is mainly contributed through runoff and infiltration of chemical fertilizers in agricultural areas and liquid waste from industrial sources. Persistent use of fluoride contaminated coal in the Thermal Power plants can also heavily contribute fluoride in the surface and sub-surface water. A similar problem was reported from the neighboring areas of thermal power plant in north India where high concentration of fluoride is present in groundwater. Since there are no major studies in the recent past, the present study was carried out to understand the present status of surface and sub-surface water quality in this area. Water samples from 44 different locations around the power plant were collected in three cycles at an interval of six months and analyzed for fluoride concentration. The fluoride concentration in these samples ranged from 0.26 to 10.7 mg/l. About 14% of the samples were found in the desirable limit of 1 mg/l and suitable for human consumption. However, 39% of the samples were having less than the maximum limit of 1.5 mg/l but greater than 1 mg/l, and 47% of the samples possessed high concentration of fluoride, i.e., above 1.5 mg/l.*

***Keywords:*** *Fluoride; ash recovery system; dewatering; ash dyke; de-fluoridation technique*

## I. INTRODUCTION

In the era of industrial advancement fluoride is mainly contributed through runoff and infiltration of chemical fertilizers in agricultural areas and liquid waste from industrial sources [1]. Thermal power plants (TPP) generally dispose off thousands $m^3$ of thermal waste water in ash pond. Only a small fraction of such waste water is generally being recycled due to inadequate capacity of employed treatment plant. It may cause water logging in the area around thermal power stations. Seepage of this contaminated water increases the fluoride content in the surface and sub-surface water around TPP much above the permissible limit for public utility. For the purpose of investigation area around one of the TPP in north India was selected. A detailed study to establish the concentration of fluoride in surface and sub-surface water and the spread area of contamination around the TPP was carried out by Central Soil and Materials research Station, New Delhi [2]. Water samples from the areas around the TPP were collected and analysed in the laboratory.

## II. FIELD STUDY

Based on the inputs regarding severity of fluoride related problems from TPP authorities and the representatives of the neighboring villages a through investigation of the ash dykes and the villages in the surrounding area of TPP was planned. The investigation focused on seasonal monitoring of fluoride

- Analysis of water samples from various user points around TPP ($WS_U$).
- Analysis of water samples at entry and exit point of ash recovery system ($WS_{IORS}$),
- Analysis of water samples from excavated pits ($WS_P$)

## I. MATERIALS AND METHODOLOGY

Samples were collected from the TPP site and the surrounding area for determining fluoride content in them as per IS: 3025-1986 - Methods of Sampling and Tests (Physical and Chemical) for Water Used in Industry [3]. Details of water samples from various user points i.e. hand pump, tube wells etc. around TPP ($WS_U$), inlet and out let of ash recovery system ($WS_{IORS}$), excavated pits ($WS_P$) are presented in Table 1.

**Table 1 Details of sampling points for water samples**

| Water Sample No. | Locations of Sampling Point | Locations of Sampling Point w.r.t. TPP | Sample Type |
|---|---|---|---|
| **1** | Entry point of ash recovery system | Ash recovery system | **$WS_{IORS}$** |
| **2** | Exit point of ash recovery system | | |
| **3** | Ash recovery pond before treatment | | |
| **4** | Hand pump near Location A | Towards East | **$WS_U$** |
| **5** | Tube well for dewatering (near Location A) | | |
| **6** | Play ground (near Location A) | | |
| **7** | Raw water from Yamuna canal (near Location A) | | |
| **8** | Tube well (near Location A) | | |
| **9** | Location B (10 Km towards east) | | |
| **10** | Near School Ground (in the west) | Towards West | |
| **11** | Hand pump of School of another school (in the west) | | |
| **12** | Hand pump in a Village (location C) | | |
| **13** | At Location D ( 5 Km towards west of | | |
| **14** | At Location E ( 7 Km towards west of TPP ) | | |
| **15** | At Location F ( towards north of TPP ) | Towards North | |
| **16** | At Location G ( towards north of TPP ) | | |
| **17** | At Location H ( 6 km towards north of TPP ) | | |
| **18** | At Location I ( 10 Km towards north of TPP ) | | |
| **19** | Hand pump near the ash dyke towards south of TPP | Towards South | |
| **20** | At Location J ( 5 Km towards south of TPP ) | | |
| **21** | Pit No.1, ash dyke near location A | Water Samples from 7.5 m depth in the pits | **$WS_P$** |
| **22** | Pit No.2, 50 m inside the dyke from Pit 1 | | |
| **23** | Pit 3, 50 m inside from pit 2 (near agricultural fields) | | |
| **24** | Pit No. 4, 50 in away from the Pit No.3 | | |
| **25** | Pit No.5, 50 m from Pit no. 4 (near village) | | |
| **26** | Pit No.6, 100 m away from the Pit No.5 | | |

## 4.0 Experimental Methods

### 4.1 Determination of Fluoride Content in $WS_U$ , $WS_{IORS}$ and $WS_U$

Fluoride in the water samples was analysed by spectrophotometric method in which red colour of alizarin red dye is diminished by the presence of fluoride. The fluoride content is estimated based on decrease in the intensity of red colour. 17 $WS_U$, 3 $WS_{IORS}$ and 6 $WS_P$ collected from various locations around TPP were analysed and the result is presented as below in figure 2.

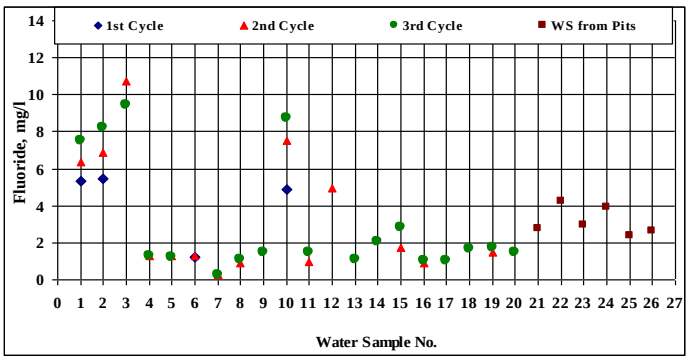


**Figure 1** Fluoride Content in $WS_U$ and $WS_{IORS}$ Collected from area around TPP

### 4.2 Soil samples

To determine fluoride content in subsoil layer, a pit of 3' was dug near location A. Soil sample and the water sample which was oozing out from it were collected and analysed for the fluoride contents (Table 2).

**Table 2:** Fluoride content in soil and water sample from a 3' deep pit at location A

| SI. No. | Sample | Fluoride in PPM |
|---|---|---|
| 1. | Water oozing out from pit | 1.12 |
| 2. | 1:10 Soil Water extract | 1.10 |

## 5.0 Discussion of Test Results

### 5.1 Water Samples

#### 5.1.1 Water Samples from various User Points around TPP ($WS_U$)

Out of 28 water samples collected from different user points around TPP only 5 samples falls within desirable limit, (1 mg/l), another 14 water samples lie between desirable to maximum permissible limit (1mg/l – 1.5 mg/l) and 9 samples exceed the maximum permissible limit as per IS 10500-1991(Fig. 1).

The fluoride contamination differed in all four directions. In the water samples collected from the areas in *the north* of TPP it ranged between 0.91 to 2.8 mg/l, in the areas *in south* of TPP it ranged between 1.45 to 1.49 mg/l, in the areas *in west* it ranged between 0.99 to 8.75 mg/l and in the *eastern region* it ranged between 0.26 to 1.46 mg/l.

On comparing the trend of fluoride contamination as observed in $1^{st}$ , $2^{nd}$ and $3^{rd}$ cycles it is observed that except for only one sample it increased with passing time. In the water samples collected from the areas in the north of TPP the increment ranged between 13 – 63 % from $2^{nd}$ till $3^{rd}$ cycle of observation. In the areas in south of TPP it was of the order of 20% between $2^{nd}$ and $3^{rd}$ cycle. For one sample collected from a school ground in the west of TPP the increment observed during the observation period of one and half year was upto 83%. However for other sample from the western area it ranged upto 47%. it ranged between 0.99 to 8.75 mg/l and in the eastern region it increased upto 17%.

#### 5.1.2 Water Samples at entry and exit point of ash recovery system ($WS_{IORS}$)

The fluoride content of all the 8 water samples is found to be very high (Fig. 1). It ranged between 5.35 to 10.7 mg/l. Observations indicate that the fluoride content increased substantially from December 2004 to l January 2006.

#### 5.1.3 Water Samples from excavated pits ($WS_P$)

The fluoride content of the water samples collected from the six pits excavated at different locations in the ash dykes was observed to be between 2.35 mg/l to 4.25 mg/l (Fig. 1).

**5.2 Soil Sample**

Fluoride in soil water extract and sub soil pit water was within normal limits of drinking water (1.0 PPM is desirable and 1.5 PPM maximum permissible limit) with respect to IS 10500-1991 (Table 2).

## 6.0 Conclusion

The fluoride ion content in the tube well water located in the immediate vicinity of the ash pond and slightly far off locations indicate significant amount of fluoride ion with higher concentration in west direction. The water from the ash recovery system is found to contain significantly high amount of fluoride ion. The entry and exit points of the ash recovery system have shown a shift towards the higher fluoride ion concentration. It is pertinent to point out that the equilibrium fluoride ion concentration is increasing since the de-fluoridation/ treatment method is not effective and incremental loads of fluoride ion from contaminating sources are contributing to this phenomena.

## 7.0 Suggested Remedial Measures

(i) PVC lining of ash pond
(ii) Up gradation of ash recovery system with effective De-fluoridation technique
(iii) Increasing the capacity of ash recovery system.
(iv) Improvement in drainage system.
(v) Due to repeated use, a constant equilibrium load of fluoride is maintained in fluoride rich recycled water. After 2-3 cycles recycled water should be properly treated and disposed off in to sewage channel and fresh water may be used.
(vi) Water quality of the area in the vicinity of thermal Power Plant should be regularly monitored.

## 8.0 Further Studies

Further studies for identification of the source of fluoride contamination has been undertaken.

## 9.0 Acknowledgement

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