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# Physico-chemical Evolution of Water Quality at Pithampur Industrial Area during 2015-2016

**Atul M.Thakkar[1], Paras Tak[2], Madhaw Singh Chouhan[3], Naman Patel[4]**

[1]Astral Institute of Technology and Research, Madhya Pradesh, India

[2, 3]Pacific Academy of Higher Education and Research University, Udaipur Rajasthan, India

[4]MP Pollution Control Board, Indore, Madhya Pradesh, India

**Abstract:** ***Water quality is a critical factor for assessment the pollution level. The aim of this study is to find out the quality of water (River, pond, nallahs and tube wells). It has been found that the quality of fresh water in Pithampur Industrial area is deteriorated due to Industrial effluents direct discharge in River and on to the Land. In this study different parameters were analyzed. This study is helpful to make a proper environmental planning in Pithampur "Detroit of India".***

**Keywords**: Pithampur Industrial area, Effluent, Drinking Water Contamination, Nallahs, River, Pond, Ground water

## 1. Introduction

Water is an essential element of nature for the sustenance of life on the planet earth. It is available in the forms as surface water and sub-surface water or groundwater. Water pollution is a major problem in the global context. Surface water is predominantly used for public water supply systems. However, the rapid growth of population and the resultant increased demand of water, necessitated for the usage of groundwater to augment the existing water supply systems, in most of the cities in the country. Secondly, the growing urbanization and industrialization and the consequent pollution of surface water sources, also increased the necessity of using groundwater for various domestic and industrial purposes. Groundwater is occupying a major portion of water supply for both domestic and industrial purposes nowadays, it is highly essential that, its quality should match the domestic water standards. It is generally assumed that ground water is safe (free from pathogens) and does not contain harmful constituents. But this belief is not true under all circumstances. The unscientific disposal of human and animal wastes is found to be the main anthropogenic activity that has lead to the contamination of ground water with micro-organisms, nitrates, etc.

Water quality is determined by different factors which may be categorized as physical, chemical, biological etc. All these factors affect water quality as well as the distribution, reproduction of different aquatic organisms like fish etc. Because, all living organisms can tolerate certain range of these parameters. Major deviations from these ranges can affect seriously on body functions of aquatic organisms.
In most of the industrial cities, the indiscriminate disposal of industrial wastes on to the land is resulting in the deterioration of groundwater quality due to the leachates from these wastes

The problem of water pollution is more specific and serious because it remains localize to certain extent and the possibility of dilution remain low as compared to air pollution. The study area, catering the needs of about 1000 medium & large scale industrial unit (chemical, soya, drug, automobile, polymer & textile industries).

In the Pithampur industrial area there is no proper drainage system, which may become a major problem for drinking water contamination in future as number of industries increasing day-by-day. The industries are also having residential areas that generate domestic waste & the discharge was going as such because of no drainage system. [1], [2], [5], [6], [7], [8], [9], [10].

### 1.1. Study Area

Pithampur is a town of District Dhar lays in the Malwa region of west Madhya Pradesh in central India. The District Dhar surrounded by the districts of Ratlam to the north, Ujjain to the northeast, Indore to the east, Khargone to the southeast, Barwani to the south, and Jhabua to the west. It is part of the Indore and division of Madhya Pradesh. Pithampur is a large industrial area under the Dhar District. The town is located 908 ft above the sea level. Pithampur has close proximity to Indore. Presently called the 'Detroit of India', and once called the 'Detroit of India', Pithampur houses major industries and companies of Madhya Pradesh. There are 4 Sector and 2 Special Economic Zone (SEZ) in Pithampur Industrial area.

**Figure 1:** Map Showing the Pithampur Industrial Area

## 2. Material and Method

### 2.1 Site Selection for Sampling

For the present study, there were five Surface water (02 river water, 01nallahs water, 02 lake water) and three ground water sources were selected. The selection of the sampling points was based on the survey and accessibility of the sampling sites during the year 2015-2016. These locations were:

a) **Nallah water at Sector-I, Pithampur (Distt.-Dhar):** This site was situated at near VE Commercial Industries Ltd., Industrial Area, Sector 1, Pithampur.
b) **Angred River D/S, Pithampur (Distt.-Dhar):** This site is situated at Achna Village. Here is confluence point of River Angred and River Chambal.
c) **Sanjay Jalashay, Pithampur**: This pond is situated in the vicinity of Pithampur Industrial Area and is alongside the Agra-Mumbai National Highway No.3. A few villages are present in the vicinity of this sampling location also indicating a little probability of waste water discharge in the pond. It is main water supply source of the Pithampur area.
d) **Bagdoon Talab:** This pond is situated in the Vijay Nagar colony Sector. Many industries were situated around this pond. This pond indicating high probability of waste water discharge in the pond.
e) **Tube well water at Vishwas Nagar, Pithampur (Distt.-Dhar):** This Tube well was in the Vishwas Nagar, Pithampur. This site were representing the ground water source and was selected because it was nearby the industries.
f) **Hand pump water at Vill-Kheda, Pithampur (Distt.-Dhar):** This Hand pump was in the Vill.-Kheda, Pithampur. This site was representing the ground water source and was selected because it was nearby the major polluting industries.
g) **Tube well water at Sagour Kuti, Pithampur (Distt.-Dhar):** This site was situated in the Sagoure Kuti near industrial area, Sector -3.
h) **River Chambal (5 kms D/s) (Distt.-Dhar):** This site was situated at Ghatabillod, which is a town of District Dhar. National Highway 47 and State Highway 31 passes through Ghatabillod.

### 2.2 Sampling Frequency

Madhya Pradesh has 03 distinct season's viz. winter, summer, and the monsoon. The samples were collected ones time in each season's viz. in winter, summer and rains from all the sampling locations simultaneously. One sample was collected from each location in each season and total of 24 samples were collected from the eight locations in a year. Table 1 shows the sampling details and sites.

**Table 1:** Description of sampling locations

| *Sample code* | *Location name* | *Coordination* |
|---|---|---|
| S-1 | Nallah water at Sec-I, Pithampur | 22.610982, 75.673471 |
| S-2 | Angred River D/S, Pithampur | 22.584491, 75.544668 |
| S-3 | Sanjay Jalashay | 22.592833, 75.673002 |
| S-4 | Bagdoon Talab | 22.639180, 75.587340 |
| S-5 | Tube well water at Vishwas Nagar, Pithampur (Distt.-Dhar) | 22.593799, 75.693370 |
| S-6 | Hand pump water at Vill-Kheda, Pithampur (Distt.-Dhar) | 22.607699, 75.623740 |
| S-7 | Tube well water at Sagor Kuti, Pithampur (Distt.-Dhar) | 22.606850, 75.683788 |
| S-8 | River Chambal (5km) (Distt.-Dhar) | 22.660570, 75.520437 |

### 2.3 Analysis Protocols and Lab Methods of Analysis

Samples were collected directly in pre-washed and rinsed, polyethylene/glass containers identified for Respective parameters. Stipulated procedure was followed for washing of sample containers. Field parameters like Temperature, pH and dissolve oxygen, which are non conservative and could not be preserved, were analyzed immediately after collection was per standard procedure. Samples were analyzed based on the standard procedures of water analysis of bacteriological and physicochemical parameters [3], [4].

Total 13 parameters were analyzed during the study period. The methods of these parameters are:

#### 2.3.1 Temperature
One of the most important factors is temperature. Dissolve Oxygen is influenced by this factor.

#### 2.3.2 pH Test
pH was measured on a logarithmic scale between 1 and 14 with 1 being extremely acid, 7 neutral and 14 extremely basic. The largest variety of freshwater aquatic organisms prefers a pH range 6.5 to 8.0. Samples were tested with Universal Indicator and with pH meter.

#### 2.3.3 Specific Conductivity
This is a measure of the capability of a solution such as water in a stream to pass an electric current. This is an indicator of the concentration of dissolved electrolyte ions in the water. It doesn't identify the specific ions in the water. However, significant increases in conductivity may be an indicator that polluting discharges have entered the water. Higher conductivity will result from the presence of various ions including nitrate, phosphate, and sodium. Samples were tested in Conductivity meter. The basic unit of measurement for conductivity is micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µS/cm).

#### 2.3.4 Total Hardness
Total hardness is computed by sum of temporary hardness and permanent hardness. The sources of hardness of water is chiefly due to the dissolve of $OH^-$, $HCO^{3-}$, $Cl^-$ and $SO_4^-$ ion of $Ca^{2+}$, $Mg^{2+}$, $Fe^{2+}$ and $Mn^{2+}$. The usual signs of a hard

water supply are scaling inside kettles, poor lathering of soaps and scum. Hard water is formed when water passes through or over limestone or chalk areas and calcium and magnesium ions dissolve into the water.

**2.3.5 Dissolved Oxygen**

Dissolved oxygen is oxygen gas molecules ($O_2$) present in the water. Plants and animals cannot directly use the oxygen that is part of the water molecule ($H_2O$), instead depending on dissolved oxygen for respiration. Oxygen enters streams from the surrounding air and as a product of photosynthesis from aquatic plants. Consistently high levels of dissolved oxygen are best for a healthy ecosystem.

Dissolved oxygen was measured in mg/L
0-2 mg/L : not enough oxygen to support life.
2-4 mg/L : only a few fish and aquatic insects can survive.
4-7 mg/L : good for many aquatic animals, low for cold water fish.
7-11 mg/L : very good for most stream fish.

**2.3.6 C.O.D.**

C.O.D. is a measure of the oxygen required for the chemical oxidation of organic matter with the help of strong chemical oxidant. High COD may cause oxygen depletion on account of decomposition of microbes to a level detrimental to aquatic life. COD determination has an advantage over BOD determination in that the result can be obtained in about 5 hours as compared to 5 days required for BOD test.

**2.3.7 B.O.D.**

Biochemical oxygen demand, is a bioassay procedure that measures the dissolved oxygen (D.O.) consumed by bacteria from the decomposition of organic matter. The B.O.D. analysis is an attempt to simulate by a laboratory test the effect that organic material in a water body will have on the DO in that water body.

**2.3.8 Heavy Metals**

In this study there are six metals were analyzed namely- Iron (Fe), Manganese (Mn), Lead (Pb), Chromium (Cr), Copper (Cu), Zinc (Zn). Digestion of Samples for the Analyses of metals in the laboratory, the samples was filtered through Whatman 0.45 µm membrane filter paper. One hundred milliliters of the filtered water was mixed with 5 mL concentrated nitric acid ($HNO_3$) and 5 mL concentrated sulphuric acid ($H_2SO_4$). To allow the acids to become concentrated, the mixture was heated until the volume was reduced to about 15 to 20 mL. The digested sample was allowed to cool to room temperature. It was then filtered through Whatman's 0.45 µm filter paper. The final volume was adjusted to 100 mL with double distilled water and stored for analysis.

**Table 2:** Water quality parameters and analytical methods for water source evaluation

| *S.No* | *Parameters* | *Unit* | *Test Method* |
|---|---|---|---|
| 1 | Temperature | ˚C | Thermometer |
| 2 | pH | - | pH meter |
| 3 | B.O.D. | mg/L | Three day incubation and titration of initial and final D.O. |
| 4 | Dissolved Oxygen | mg/L | Winkler Method |
| 5 | Chemical Oxygen Demand | mg/L | Open Reflux Method |
| 6 | Sp.Conductivity | mg/L | Conductivity meter |
| 7 | Total Hardness | mg/L | EDTA Titration |
| 8 | Heavy Metals | mg/L | Atomic Absorption Spectroscopy |

## 3. Result and Discussion

### 3.1. Temperature

In the present study the temperature value were measured on the spot and it ranged between 19˚C to 31˚C. The minimum temperature value recorded in S-5 and S-7 in winter season and the maximum Temperature value recorded in S-1 in summer season, as shown in graph- 2.

### 3.2. pH value

It is an important factor that determines the suitability of water for various purposes, including toxicity to plants and animals. In the present study the pH range were found between 7.0-8.2. The minimum pH values were found in S-1, S-5, S-7 (surface water) in winter season, and the maximum in S-4 (surface water) in winter season. As shown in graph- 3.

### 3.3. Specific Conductivity

In the present study S-1 sampling station (Ground water) in summer season showed higher values of Electrical conductance and Increasing levels of conductivity and cations are the products of decomposition and mineralization of organic materials. The minimum conductivity found in S-3 sampling station (surface water) in rainy season as shown in graph -4.

### 3.4. Total Hardness

In the present study the value of Total Hardness were found in range between 100mg/L- 1000 mg/L. The minimum value of Hardness was showed in S-3 sampling station and maximum in S-7. In rainy season S-2, S-4, S-5, S-6 crosses the desirable limit of Hardness (200 mg/L) and S-7 water sample cross the permissible limit of Hardness (600 mg/L) as prescribed in Indian standard. In summer season S-2, S-4, S-5, S-8 crosses the desirable limit of Hardness (200 mg/L) and S-6 and S-7 water samples cross the permissible limit of Hardness (600 mg/L) as prescribed in Indian standard. In rainy season S-5 and S-6 water samples crosses the desirable limit of Hardness (200 mg/L) and S-7 water sample cross the permissible limit of Hardness (600 mg/L) as prescribed in Indian standard. As shown in graph -5.

### 3.5. Dissolve Oxygen

In the present study the concentration of D.O. were found in range between 2.3 mg/L- 6.3 mg/L The minimum D.O. were found in S-2 (surface water) water sample, in summer session and maximum in S-8(surface water) water sample in winter session. In all sampling station D.O. were found in good concentration. As shown in graph -6.

### 3.6. Biological Oxygen Demand

B.O.D. concentrations were found between 0.6 mg/L-120 mg/L. The minimum concentrations were found in S-6, S-7 (ground water) in winter session and S-6 and S-7 in rainy session. Maximum concentrations were found in S-1(Nallahs water) in summer session. The S-1 water samples exceed limit of B.O.D. in all session. As shown in graph- 7.

### 3.7. Chemical Oxygen Demand

In this present study the concentration of C.O.D. were found in range between 7.21mg/L -710 mg/L The minimum C.O.D. were found in S-8 water sample which is surface water and maximum in Nallahs water (S-1) in summer session. As shown in graph- 8.

### 3.8. Metals

#### 3.8.1 Iron

The iron concentration ranges from BDL to 0.390 mg/L In all sampling stations the concentration of Fe were found under limit except S-1 water sample which cross the desirable limit (0.03 mg/L) as prescribed Indian Standard. As shown in graph -9.

#### 3.8.2 Manganese

Concentration obtained for manganese lies in the range BDL to 0.298 mg/L S-1 in rainy season, S-2 in summer, S-1, water samples cross the desirable limit (0.1mg/L) ands-1 in summer season cross the permissible limit. It is far less than the permissible limit (0.3 mg/L) as prescribed by Indian Standards for Drinking Water. As shown in graph -10.

#### 3.8.3 Lead

Lead concentration of water samples varies from not detectable to 0.01 none of the samples crossed the desirable limit of Lead (0.01 mg/L), as prescribed by Indian Standards for Drinking Water. As shown in graph- 11.

#### 3.8.4 Copper

The desirable limit of Copper is 0.05mg/L Copper concentrations were found only two sampling sites. None of the water sample crossed the limit as prescribed in Indian standard (0.05 mg/L). As shown in graph- 12.

#### 3.8.5 Chromium

It is found that none of the water samples show the Cr concentration crossed the desirable limit (0.05 mg/L) as prescribed in Indian standard. As shown in graph- 13.

#### 3.8.6 Zinc

The desirable limit for zinc is 5.0 mg/L as prescribed by Indian Standards for Drinking Water. The concentration for zinc varies from BDL to 0.810 mg/L the maximum concentration of 0.810 mg/L is obtained for S-1 in summer session. As shown in graph -14. The graphical representation of different parameters at all the eight sampling locations is shown in Figure 2 to 14.

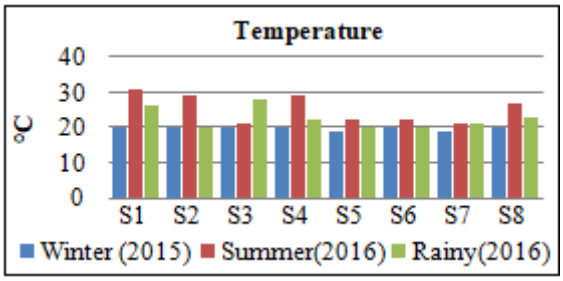


**Figure 2:** Season wise graphical comparative of Temperature from S1-S8 for the year 2015-2016

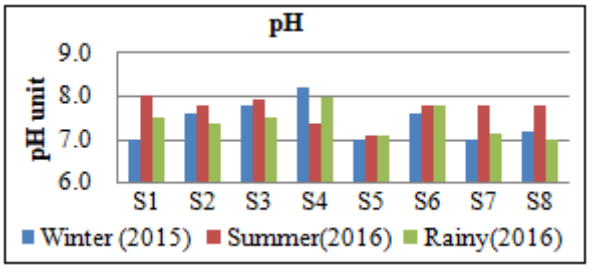


**Figure 3:** Season wise graphical comparative of pH from S1-S8 for the year 2015-2016

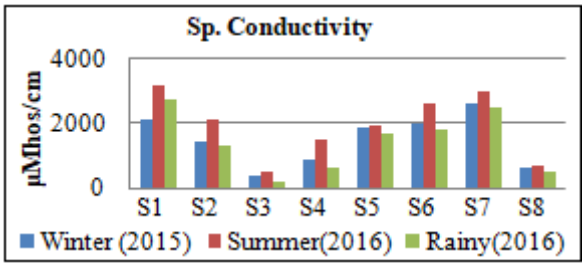


**Figure 4:** Season wise graphical comparative of Sp. conductivity from S1-S8 for the year 2015-2016

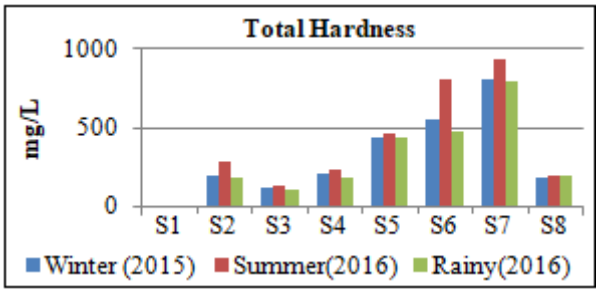


**Figure 5:** Season wise graphical comparative of Total Hardness from S1-S8 for the year 2015-2016

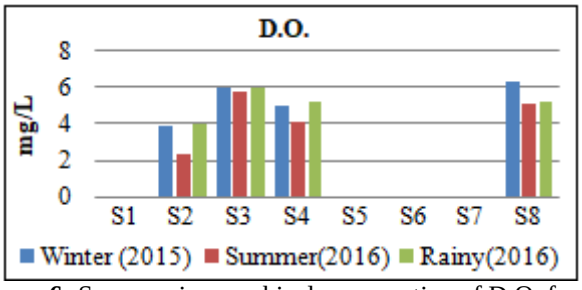


**Figure 6:** Season wise graphical comparative of D.O. from S1-S8 for the year 2015-2016

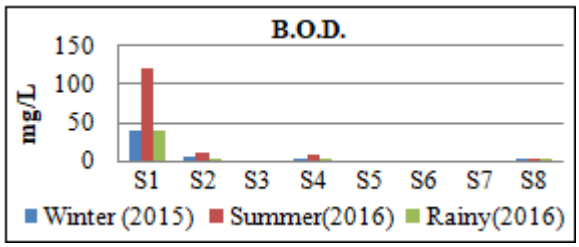


**Figure 7:** Season wise graphical comparative of B.O.D. from S1-S8 for the year 2015-2016

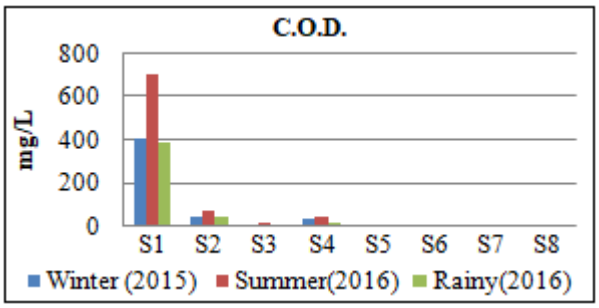


**Figure 8:** Season wise graphical comparative of C.O.D. from S1-S8 for the year 2015-2016

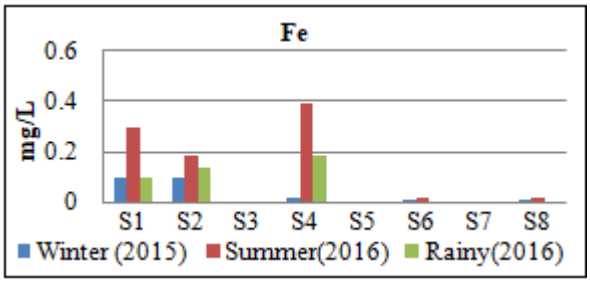


**Figure 9:** Season wise graphical comparative of Fe from S1-S8 for the year 2015-2016

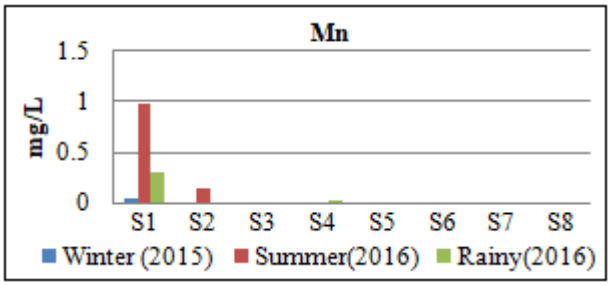


**Figure 10:** Season wise graphical comparative of Mn from S1-S8 for the year 2015-2016

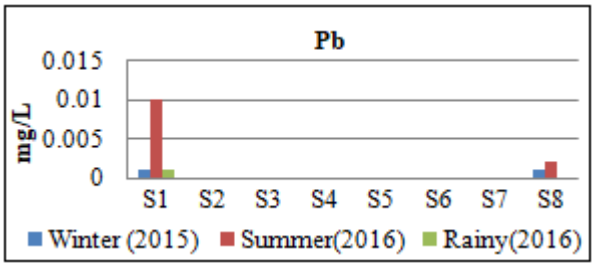


**Figure 11:** Season wise graphical comparative of Pb from S1-S8 for the year 2015-2016

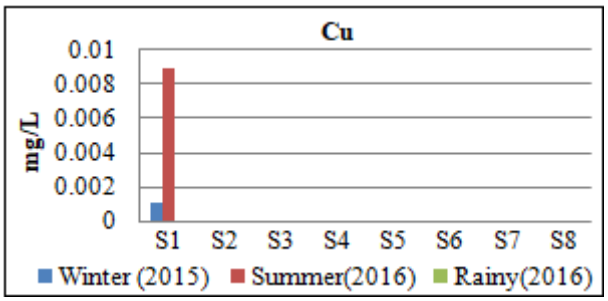


**Figure 12:** Season wise graphical comparative of Cu from S1-S8 for the year 2015-2016

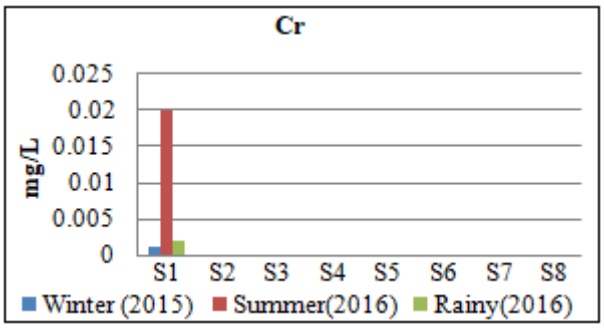


**Figure 13:** Season wise graphical comparative of Cr from S1-S8 for the year 2015-2016

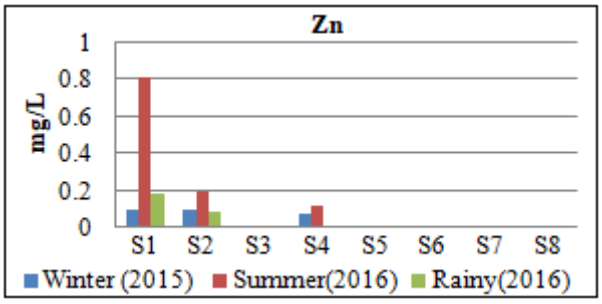


**Figure 14:** Season wise graphical comparative of Zn from S1-S8 for the year 2015-2016

## 4. Conclusion

Nallahs carries large amount of effluents from adjacent Industries which in turn spoil the water quality of River Angared and River Chambal causing unfavorable changes in physicochemical Parameters.

In the present investigation, in surface water, wide range of variations was recorded in Specific Conductivity, Biological Oxygen Demand (B.O.D.), Chemical Oxygen Demand (C.O.D.) and Heavy metals.

It is observed that the quality of surface water is being spoiled because of different Nallahs joining to the River. The Ground Water has also been contaminated; wide range of variations was recorded in ground water study, which is presented in graphs.

From the present analysis data, it can be concluded that Surface water and Ground Water of the Pithampur Industrial area is being deteriorated.

## 5. Acknowledgement

The Authors are thankful to Dr. D.K. Wagela, Senior Scientist and Lab. Head of Madhya Pradesh Pollution Control Board, Indore for their time to time valuable guidance to do the above investigations.

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