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# Selective Characterisation and Microbial Analysis of Industrial Hazardous Effluents in Rayalaseema Region (A.P - INDIA)

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## ABSTRACT

*The present research investigation is mainly aimed at selective characterisation of industrial hazardous effluents specifically solid wastes in Kurnool district of Rayalaseema region, Andhra Pradesh. The effluents from specified industries of the region contaminate the water, soil and atmosphere in the vicinity of selected locations of industrial belt. The hazardous solid effluent samples were collected from industrial belt of Kurnool district by following standard procedures. The research study is focused on investigating Physico-Chemical parameters like pH, EC, TDS, TH, TA, $SO_3^{2-}$, $HCO_3^{2-}$, $Cl^-$, $SO_4^{2-}$, $PO_4^{3-}$, Na, K, $Ca^{2+}$ and $Mg^{2+}$. The results indicate that quality parameters exceeding the permissible limits and posing challenge to environment protection. The collected solid effluent samples in contaminated soil were characterized for identification of bacteria.*

**Keywords:** Total dissolved solids (TDS), Physico-Chemical parameters and Hazardous Effluents.

## INTRODUCTION

The Rayalaseema region in Andhra Pradesh comprising of four districts viz., Anantapur, Chittoor, Kadapa and Kurnool. In every district there are some major industries like Cement, Sugar, Paper, Cotton, Mining, Dairy Products, Pig Iron and Alkali Chemicals etc., the effluents from these contaminate water and atmosphere, therefore the contaminated environment will have disastrous effects on human beings, plants and animals of the region. The extensive indiscriminate pollution caused by some industrial hazardous wastes may even impair the use of the river for irrigational purposes in this region. Indiscriminate discharge of untreated industrial effluents on land has irreversibly contaminated the ground water sources. The perusal of literature reveals that significant research work has been carried out on Physico-Chemical characterisation of industrial hazardous wastes (solid and liquid effluents) in addition to microbial analysis of contaminated soil samples [1-10]. The analysis of hazardous waste is of paramount importance. Sampling of hazardous wastes include collection of different physical forms of wastes like solids, semi-solids, sludges, slurries, liquids etc., The reported studies also indicates that solid effluent samples becoming increasingly contaminated due to domestic and industrial wastes.

Further more, Identification/Characterisation of industrial hazardous wastes and proper management of hazardous in techno-economic manner by following statutory mandate of Environment Protection Agency

(EPA) in the Rayalaseema region is considerable significant area of research interest from the environmental protection point of view. The Alkali Chemicals and Cement industries in the district of Kurnool, Rayalaseema region, Andhra Pradesh, India having important in the rural economy of the state. The solid effluents discharged by these industries have posed the threat to the ecological balance of rural area around. Keeping this fact in a view, the author in present research investigation mainly focused on studying Physico-Chemical parameters of collected solid effluents from respective industries and microbial analysis of hazardous effluents.

## MATERIALS AND METHODS

The details of sampling code and the sampling locations are presented in table 1. Containers made of polythene were employed for sampling of industrial solid effluent samples for analysis as per the standard procedures [11]. The solid effluent samples were analyzed for Physico-Chemical parameters which include pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Total Alkalinity (TA), Total Hardness (TH), Ca, Mg, Chloride, Sulphate, Phosphate, Na and Potassium ratio. Industrial solid effluent samples were analyzed by pH meter (Global-DPH 505, India-Model) and conductivity measured by the digital conductivity meter (Global-DCM-900-Model), TDS determined from the relation

TDS = Electrical conductivity (EC) x 0.64

Total Hardness, Total Alkalinity and Chloride were estimated by Titrimetry. Sulphate measured by Spectrophotometer (Vissican 167, Systronics), Na and K by Flame photometry (Systronics). The solid effluent samples were analyzed for physic-chemical parameters and the analytical data is presented in tables 2, 3 respectively.

**Table 1**. Details of collected Samples (Industrial Effluents)

| Industrial Effluents | Name of the Industry | Address of the Industry | Sample Type |
|---|---|---|---|
| **Sample - 1** | Sri Rayalaseema Alkalis & Allied Chemicals Pvt. Ltd. | Gondiparla, Kurnool | Solid |
| **Sample – 2** | Sri Rayalaseema Alkalis & Allied Chemicals Pvt. Ltd. | Gondiparla, Kurnool | Solid |
| **Sample - 3** | Sri Rayalaseema Hi-strength Hypo Pvt. Ltd. | Gondiparla, Kurnool | Solid |
| **Sample - 4** | Sri Rayalaseema Alkalis & Allied Chemicals Pvt. Ltd. | Gondiparla, Kurnool | Solid |
| **Sample - 5** | Sri Jayajyothi Cement Industry Pvt. Ltd. | Banaganapalle, Kurnool | Solid |

**Table 2.** Physico-Chemical characteristics of Industrial Solid Effluents

| S.No. | PARAMETERS | S-1 | S-2 | S-3 | S-4 | S-5 |
|---|---|---|---|---|---|---|
| 1 | pH | 9.1 | 8.3 | 8.5 | 8.3 | 8.8 |
| 2 | Temperature | $^0$C | $^0$C | $^0$C | $^0$C | $^0$C |
| 3 | Colour | | | | | |
| 4 | Conductivity (µ mhos/cm) | 777 | 2860 | 1330 | 2060 | 1320 |
| 5 | Total Solids at 105$^0$C (mg/lit) | - | - | - | - | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 6 | Total Suspended Solids at105$^0$C (mg/lit) | - | - | - | - | - |
| 7 | Total Dissolved Solids at105$^0$C (mg/lit) | 497.28 | 1830.4 | 851.2 | 1318.4 | 844.8 |
| 8 | Alkalinity (mg/lit) | 600 | 600 | 600 | 500 | 700 |
| 9 | $OH^-$ (mg/lit) | BDL | BDL | BDL | BDL | BDL |
| 10 | $CO_3^{2-}$ (mg/lit) | 200 | 200 | 200 | 200 | 200 |
| 11 | $HCO_3^-$ (mg/lit) | 400 | 400 | 400 | 300 | 500 |
| 12 | Chloride (as $Cl^-$) (mg/lit) | 106.35 | 177.25 | 141.8 | 141.8 | 106.35 |
| 13 | Fluoride (as F) (mg/lit) | - | - | - | - | - |
| 14 | Sulphate $SO_4^{2-}$(mg/lit) | 64.3 | 249.7 | 100.0 | 208.6 | 101.4 |
| 15 | Hardness (as $CaCO_3$) (mg/lit) | 300 | 900 | 300 | 500 | 500 |
| 16 | Calcium Hardness (as $CaCO_3$) (mg/lit) | 200 | 700 | 200 | 300 | 300 |
| 17 | Magnesium Hardness (as $CaCO_3$) (mg/lit) | 100 | 200 | 100 | 200 | 200 |
| 18 | $Ca^{+2}$ (mg/lit) | 80 | 280 | 80 | 120 | 120 |
| 19 | $Mg^{2+}$ (mg/lit) | 24.4 | 48.8 | 24.4 | 48.8 | 48.8 |
| 20 | Phosphate (mg/lit) | BDL | BDL | BDL | BDL | BDL |

BDL = Below detectable limit

**Table 3.** Analysis of Na & K ratio

| Industry | Na mg/L | K mg/L |
|---|---|---|
| Sample-1 | 29.36 | 2.54 |
| Sample-2 | 32.36 | 12.88 |
| Sample-3 | 23.97 | 3.41 |
| Sample-4 | 27.86 | 4.63 |
| Sample-5 | 23.70 | 4.68 |

## RESULTS AND DISCUSSION

**pH:** pH levels of the solid effluent industrial samples range from 8.3-9.1 indicating slight alkaline nature. Though the pH levels are within the permissible limits (6.5-8.5) of IS: 10500-1992, the solid samples are found to be with slight to moderate alkaline nature.

**Electrical Conductivity (EC):** Electrical Conductivity values of solid effluent samples range from 777-2860 µmhos $cm^{-1}$.

**Total Dissolved Solids (TDS):** The Total dissolved Solid levels of solid effluent samples range from 497.28-1830.4 mg $L^{-1}$ of IS: 10500-1992 and the levels of four industrial solid samples are within the permissible limit while the sample 2 exceeded the permissible limits. Due to higher levels of TDS, the industrial solid sample loses palatability and may cause gastro intentional irritation.

**Total Hardness (TH):** The Total Hardness levels of industrial solid effluent samples range from 300-900 mg $L^{-1}$ and exceeded the permissible limit (300 mg $L^{-1}$) of IS: 10500-1992. Sample 2 indicate that the exceeded the permissible limit. The value indicates that the industrial solid effluents lie under classification of very hard nature and may cause encrustation in water supply structure and adversely affect on domestic use.

**Total Alkalinity (TA):** The Total Alkalinity values of industrial solid effluent samples range from 500-700 mg $L^{-1}$ and the levels exceeded the desirable limit (200 mg $L^{-1}$) IS: 10500-1992.

**Carbonate ($CO_3^{2-}$):** The Carbonate levels of solid industrial effluent samples range from 200 mg $L^{-1}$.

**Bicarbonate ($HCO_3^-$):** Bi Carbonate Alkalinity of industrial solid effluent samples range from 400-500 mg/l and the levels are permissible limit (500 mg $L^{-1}$) of IS: 10500-1992.

**$Ca^{2+}$ and $Mg^{2+}$:** The solid industrial effluent samples calcium ion concentration ranging from 80-280 mg $L^{-1}$. The Calcium ion levels exceeded the permissible limit (75mg $L^{-1}$) of IS: 10500-1991. Magnesium levels in industrial solid effluent samples range from 24.4-48.8 mg/l, Mg levels of Sample 2, Sample 4 and sample 5 is exceeded the permissible limits (30mg $L^{-1}$) of IS: 10500-1992. The higher levels of Ca and Mg may be due to the seepage of industrial and domestic water or due to cationic exchange with Sodium.

**Chloride:** Chloride level in industrial solid effluent samples range from 106.35-177.25 mg $L^{-1}$. chloride levels of within the permissible limit (250 mg $L^{-1}$) of IS:10500-1992.

**Sulphate:** Sulphate levels in industrial solid effluent samples range from 64.3-249.7 mg $L^{-1}$. Out of 5 solid effluent samples 2 solid effluent samples were observed with sulphate exceeded the permissible limits (200 mg $L^{-1}$) of IS: 10500-1992.

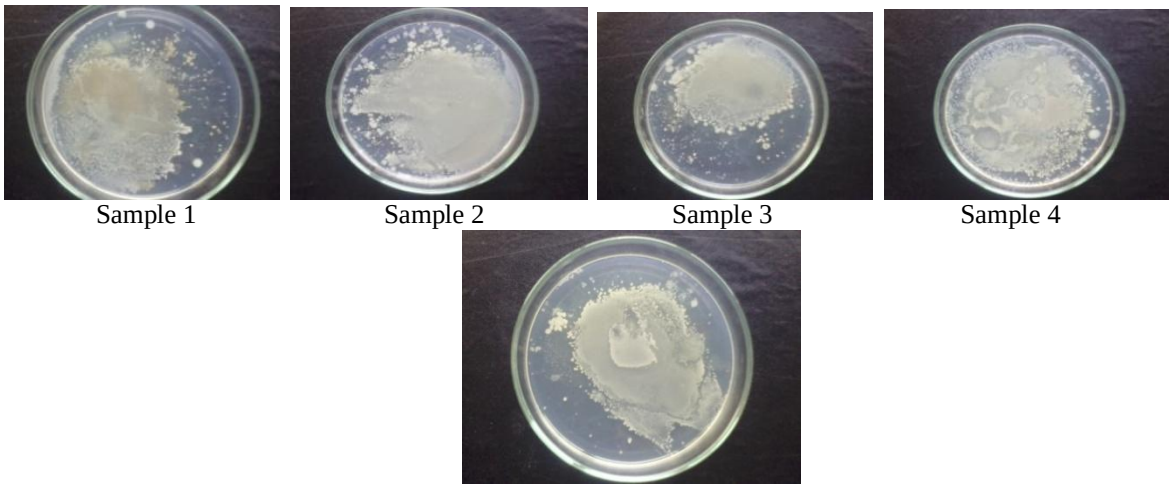
**Phosphate:** Industrial solid effluent samples Phosphate values are observed at BDL.

**Na and K ratio:** Sodium ion concentration in industrial solid effluent samples collected range from 23.70 – 32.36 mg $L^{-1}$ and Potassium levels of industrial solid effluent samples range from 2.54 – 12.88 mg $L^{-1}$. The higher levels of Na and K may also indicate the leaching and dissolution of secondary salts in the pore spaces.

**Bacterial Analysis**

**Materials:** The industrial solid effluent samples were collected in sterilized containers [12] and immediately transported to the laboratory for the bacterial analysis. The Most Probable Number (MPN) technique was employed for the Coliform count in industrial solid effluent samples [13, 14].

Further the industrial solid effluent samples were analyzed for microbial analysis and the details of the analytical data is presented in table 4 and the identified bacteria are presented in photographs (Fig.1).



Sample 1 Sample 2 Sample 3 Sample 4

Sample 5

**Figure 1.** Bacterial Colonies photographs

**Table 4.** Characterization of Industrial solid effluent Samples for Bacteria

| Sample No | Bacterial species identified |
|---|---|
| 1. | *Bacillus spps* (Gram+ , Spore forming Bacteria) |
| 2. | *Bacillus spps* (Gram+ , Spore forming Bacteria) |
| 3. | *Bacillus spp, Clostridium spps* |
| 4. | *Staphylococcus spp, Bacillus spp, Pseudomonas spp* |
| 5. | *Bacillus spps* ( Gram+ , Spore forming Bacteria ) |

- Bacillus spps (gram+), Sprote forming Bacteria were identified after 24 h of incubation at $37^0$C in the effluent solid sample -1 and sample-2 collected from Sree Rayalaseema Alkalies and Allied Chemicals Ltd., Gondiparla village, Kurnool district.
- Bacillus spps, Clostridium spps were identified after 24 h of incubation at $37^0$C in the solid effluent sample-3 collected from Sree Rayalaseema High-strength Hypo Ltd., Gondiparla village, Kurnool district.
- Staphylococcus spp, Bacillus spp, Pseudomonas spp were identified after 24 h of incubation at $37^0$C in the solid effluent sample-4 collected from Sree Rayalaseema Alkalies and Allied Chemicals Ltd., Gondiparla village, Kurnool district.
- Bacillus spps (gram+, Spote forming Bacteria) were identified after 24 h of incubation at $37^0$C in the solid effluent sample - 5 collected from Sri Jayajyothi Cement and Mining Industry, Banaganapalli, Kurnool district.

After incubation colonies are formed on nutrient agar media. Bacterial isolated from colonies and identification bacteria shown in table 4. Pink colour colonies are formed in EMB agar media after incubation at $37^0$C for 24 - 48 h. Bacteria isolated from colonies 1 are gram negative (-ve), motile.

## APPLICATIONS

These studies are useful to know how far the Industrial effluents are polluted and to know the quality of effluent.

## CONCLUSIONS

The selective characterization of industrial effluents in the study region with respect to important parameters has been investigated by employing standard procedures. The obtained results indicate that quality parameters exceeding the permissible limits and posing threat to environmental protection. The identification and characterization of industrial hazardous wastes (solid effluents) by following statutory mandate of Environment Protection Agency (EPA) in the Rayalaseema region is considerable significant area of research interest from the environmental protection point of view. Effective monitoring of equality parameters is frequently suggested to safe guard the health of the public residing in the surroundings of the polluted site.

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