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# Determination of physico-chemical properties of different industrial wastewater of Hyderabad, India

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## Abstract

*In recent years with industrial and agricultural development, human has increasingly caused serious environmental damages on water, leading to the global shortage of water. Due to high toxicity, high concentration and complicated composition of wastewater from manufacturing agrochemicals and pharmaceuticals, its treatment and purification have become one of the biggest challenges. Reclamation and reuse of effluents and industrial wastewater is occupying major place in the field of water resources management. The present study investigated physico-chemical parameter of the industrial effluent, collected from the Jeedimetla effluent Treatment Plant (JETL). Laboratory experiments were carried out with the aim of studying physico-chemical parameter of industrial wastewater. The observed values of different physico-chemical parameters like pH, Temperature, Electrical conductivity, (EC) Turbidity, Total hardness (TH), Total alkalinity (TA), Total acidity, Dissolved Oxygen (DO), Total dissolved solids (TDS), Sulphates, Nitrate nitrogen, Nitrite nitrogen, Chlorides, Phosphate (ortho phosphate + inorganic phosphate), and Salinity of samples were compared with standard values.*

**Keywords:** Physico-chemical, Reclamation, industrial effluents, COD, BOD.

## Introduction

In recent years with industrial and agricultural development, human has increasingly caused serious environmental damages on water, leading to the global shortage of water. Due to high toxicity, high concentration and complicated composition of wastewater from manufacturing agrochemicals and pharmaceuticals, its treatment and purification have become one of the biggest challenges. Reclamation and reuse of effluents and industrial wastewater is occupying major place in the field of water resources management. The present study investigated physico-chemical parameter of the industrial effluent, collected from the Jeedimetla effluent treatment plant (JETL). Laboratory experiments were carried out with the aim of studying physico-chemical parameter of industrial wastewater. The observed values of different physico-chemical parameters like pH, Temperature, electrical conductivity, (EC) turbidity, total hardness (TH), total alkalinity (TA), total acidity, dissolved oxygen (DO), total dissolved solids (TDS), sulphates, nitrate nitrogen, nitrite nitrogen, chlorides, phosphate (ortho phosphate + inorganic phosphate), and salinity of samples were compared with standard values.

Jeedimetla industrial area is one of the important industrial areas situated in Hyderabad/Secunderabad. It posses many industries of various types like engineering, manufacturing, chemical production as well as chemical processing units, pharmaceutical units, etc. therefore this industrial area is heavily polluted all around. Although JETL plant is situated taking care of the effluents of the industries in the area, a need is there to understand the pollution status of this particular area. Water is the liquid of life and very important requirement for industrial as well as daily life. Due to the rapid growth of urbanization and industrialization, much sewage water is disposed of, that generates fair chance of ground water pollution[1].

Such effluents are now considered as available and economical resources for a variety of applications. The term "wastewater reclamation" refers to appropriate treatment by which wastewater is rendered suitable for re-use (agricultural and landscape, irrigation, industrial water supply, groundwater recharge[2], wetland reinforcement, and even direct or indirect use in the water supply network). In the developed countries, water from treated sewage is re-used principally for irrigation, while in the developing countries it is used exclusively for that purpose.

**Industrial wastewater and its properties:** Almost all industries discharge water containing wastes from some stage of their manufacturing process, but industrial wastes are not same in every case. It differs from industry to industry. For example, the wastes from pulp and paper industries mainly contain carbohydrates. Waste from dairies, tanneries and slaughter houses are rich in nitrogen. Plants manufacturing detergents, explosives, plastics, fertilizers, insecticides are producing chemical waste. Metal plating wastes are highly toxic as they are found to contain cyanides, hexavalent chromium and nickel. The amount of pollution is generally expressed in terms of

parameters such as pH, suspended solids, total dissolved solids, acidity, COD, BOD, alkalinity etc.

In the present investigation the various parameters (color, odor, pH, electro conductivity, temperature, total dissolved solids (TDS), acidity, alkalinity, phenolphthalein alkalinity, total hardness, Mg hardness, Ca hardness, DO, salinity, turbidity, sulphates, nitrogen (Nitrite, and Nitrate), chlorides of six wastewater samples from Jeedimetla industrial area were analyzed. Among these six samples, sample-1 ($S_1$) is Bulk drug manufacturing industry wastewater, sample-2 ($S_2$) is Pharmaceutical wastewater, sample-3 ($S_3$) is Chemical processing industry wastewater sample-4 ($S_4$) Paint manufacturing Industry wastewater, sample-5 ($S_5$) drugs (vaccine) manufacturing industry waste water and Sample-6 ($S_6$) electroplating industry wastewater.

## Materials and methods

The water samples used in the investigation were· collected in plastic bottles from JETL. During sampling temperature was determined using thermometer· respectively. The laboratory analyses of samples were done using APHA· standard methods. Titrimetric· method was used for the determination of total Alkalinity and Acidity. Jackson candle method was used for determining Turbidity, whereas EDTA· Titrimetric method was used for total hardness analysis[3-5].

## Results and discussion

The physical and chemical characterization presented below is valid for most wastewater, including all type of agro and chemical processing industries. The experimental details of water analysis are presented in Table- 1 to 6.

**Table-1:** Analysis Report of (Sample-1) Bulk drug industrial wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL· | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | Dark black |
| 02 | Odour | --- | --- | ---- | --- | --- | Foul and pungent |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 29 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 6.78 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 3.40 |
| 06 | Acidity | ppm | | | | | 210 |
| 07 | Alkalinity | ppm | 200 | 600 | | | 1620 |
| 08 | Total hardness | ppm | 300 | 600 | 300 | 600 | 1110 |
| 09 | Ca hardness | ppm | --- | --- | --- | --- | 570 |
| 10 | Mg hardness | ppm | --- | --- | --- | --- | 540 |
| 11 | TDS | ppt | --- | --- | --- | --- | 2.28 |
| 12 | Dissolved oxygen | ppm | 2 | 6 | --- | --- | 0 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 320 |
| 14 | salinity | gm/L | --- | --- | --- | --- | 2.8 |
| 15 | O-phosphate | µg/10ml | | | | | 96 |
| 16 | Inorg. phosphate | µg/10ml | | | | | 42 |
| 17 | Total phosphates | µg/10ml | | | | | 145 |
| 18 | Chlorides | mg/L | | | | | 69.12 |
| 19 | Sulphate | mg/ml | | | | | 0.2 |
| 20 | fluoride | mg/L | | | | | 3 |
| 21 | sulphites | ppm | | | | | 4 |
| 22 | chromium | mg/L | | | | | nil |

**Table-2:** Analysis Report of (Sample-2) Pharmaceutical wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL· | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | Grayish white |
| 02 | Odour | --- | --- | ---- | --- | --- | Foul and pungent |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 30 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 6.68 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 7.48 |
| 06 | Acidity | ppm | | | | | 110 |
| 07 | Alkalinity | ppm | 200 | 600 | | | 460 |
| 08 | Total hardness | ppm | 300 | 600 | 300 | 600 | 1370 |
| 09 | Ca hardness | ppm | --- | --- | --- | --- | 610 |
| 10 | Mg hardness | ppm | --- | --- | --- | --- | 760 |
| 11 | TDS | ppt | --- | --- | --- | --- | 4.83 |
| 12 | DO | ppm | 2 | 6 | --- | --- | 2.3 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 200 |
| 14 | salinity | gm/L | --- | --- | --- | --- | 6.0 |
| 15 | O- phosphate | µg/10ml | | | | | 46 |
| 16 | Inorg.phosphate | µg/10ml | | | | | 22 |
| 17 | Total phosphates | µg/10ml | | | | | 68 |
| 18 | Chlorides | mg/L | | | | | 24.9 |
| 19 | Sulphates | mg/ml | | | | | 0.5 |
| 20 | fluoride | mg/L | | | | | 8 |
| 21 | sulphites | ppm | | | | | 0 |
| 22 | chromium | mg/L | | | | | 4 |

**Table-3:** Analysis Report of (Sample-3) chemical processing industrial wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL· | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | yellow |
| 02 | Odour | --- | --- | ---- | --- | --- | Foul and pungent |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 30 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 8.32 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 4.98 |
| 06 | Acidity | Ppm | | | | | 30 |
| 07 | Alkalinity | Ppm | 200 | 600 | | | 600 |
| 08 | Total hardness | Ppm | 300 | 600 | 300 | 600 | 910 |
| 09 | Ca hardness | Ppm | --- | --- | --- | --- | 260 |
| 10 | Mg hardness | Ppm | --- | --- | --- | --- | 650 |
| 11 | TDS | Ppt | --- | --- | --- | --- | 3.27 |
| 12 | DO | Ppm | 2 | 6 | --- | --- | 2.3 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 150 |
| 14 | salinity | g/L | --- | --- | --- | --- | 4.1 |
| 15 | O- phosphate | µg/10ml | | | | | 126 |
| 16 | Inorg.phosphate | µg/10ml | | | | | 48 |
| 17 | Total phosphates | µg/10ml | | | | | 174 |
| 18 | Chlorides | mg/L | | | | | 18.6 |
| 19 | Sulphates | mg/ml | | | | | 2 |
| 20 | fluoride | mg/L | | | | | 2.6 |
| 21 | sulphites | Ppm | | | | | 0 |
| 22 | chromium | mg/L | | | | | 25 |

**Table-4:** Analysis Report of (sample-4) Paint manufacturing industry wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL· | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | Whitish orange |
| 02 | Odour | --- | --- | ---- | --- | --- | Petrol smell |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 30 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 6.4 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 8.13 |
| 06 | Acidity | Ppm | | | | | 360 |
| 07 | Alkalinity | Ppm | 200 | 600 | | | 1440 |
| 08 | Total hardness | Ppm | 300 | 600 | 300 | 600 | 760 |
| 09 | Ca hardness | Ppm | --- | --- | --- | --- | 540 |
| 10 | Mg hardness | Ppm | --- | --- | --- | --- | 220 |
| 11 | TDS | Ppt | --- | --- | --- | --- | 5.26 |
| 12 | DO | Ppm | 2 | 6 | --- | --- | 3.4 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 240 |
| 14 | salinity | g/L | --- | --- | --- | --- | 4.1 |
| 15 | O- phosphate | µg/10ml | | | | | 14.6 |
| 16 | Inorg. phosphate | µg/10ml | | | | | 1.9 |
| 17 | Total phosphates | µg/10ml | | | | | 17 |
| 18 | Chlorides | mg/L | | | | | 16.4 |
| 19 | Sulphates | mg/ml | | | | | 0.96 |
| 20 | fluoride | | | | | | 4.8 |
| 21 | sulphites | Ppm | | | | | 0 |
| 22 | chromium | mg/L | | | | | 15 |

**Table-5:** Analysis Report of (sample-5) chemical and drug synthesis industry wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | Brownish yellow |
| 02 | Odour | --- | --- | ---- | --- | --- | Foul and pungent |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 32 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 7.33 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 4.53 |
| 06 | Acidity | Ppm | | | | | 30 |
| 07 | Alkalinity | Ppm | 200 | 600 | | | 600 |
| 08 | Total hardness | Ppm | 300 | 600 | 300 | 600 | 910 |
| 09 | Ca hardness | Ppm | --- | --- | --- | --- | 260 |
| 10 | Mg hardness | Ppm | --- | --- | --- | --- | 650 |
| 11 | TDS | Ppt | --- | --- | --- | --- | 3.27 |
| 12 | DO | Ppm | 2 | 6 | --- | --- | 2.3 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 150 |
| 14 | salinity | gm/L | --- | --- | --- | --- | 4.1 |
| 15 | O- phosphate | µg/10ml | | | | | 98 |
| 16 | Inorg. phosphate | µg/10ml | | | | | 44 |
| 17 | Total phosphates | µg/10ml | | | | | 142 |
| 18 | Chlorides | mg/L | | | | | 28 |
| 19 | Sulphates | mg/ml | | | | | 2 |
| 20 | fluoride | mg/L | | | | | 6 |
| 21 | sulphites | Ppm | | | | | 0 |
| 22 | chromium | mg/L | | | | | 0.2 |

**Table-6:** Analysis Report of (sample-6) Electroplating industry wastewater.

| S.No | Parameter | Units | Drinking Water WHO Standard | | Drinking Water Indian standards | | Experiment values |
|---|---|---|---|---|---|---|---|
| | | | HDL | MPL | PL | EL | |
| 01 | Colour | --- | --- | --- | 10 | 50 | Brownish yellow |
| 02 | Odour | --- | --- | ---- | --- | --- | Foul and pungent |
| 03 | Temperature | $^{O}C$ | --- | --- | --- | --- | 32 |
| 04 | pH | --- | 6.5-8.5 | No relaxation | 6.5- 8.5 | 6.5- 9.2 | 6.2 |
| 05 | Electrical conductivity | | --- | --- | --- | --- | 6.32 |
| 06 | Acidity | Ppm | | | | | 60 |
| 07 | Alkalinity | Ppm | 200 | 600 | | | 400 |
| 08 | Total hardness | Ppm | 300 | 600 | 300 | 600 | 1100 |
| 09 | Ca hardness | Ppm | --- | --- | --- | --- | 600 |
| 10 | Mg hardness | Ppm | --- | --- | --- | --- | 500 |
| 11 | TDS | Ppt | --- | --- | --- | --- | 3.42 |
| 12 | DO | ppm | 2 | 6 | --- | --- | 2.16 |
| 13 | Turbidity | NTU | --- | --- | --- | --- | 96 |
| 14 | salinity | gm/L | --- | --- | --- | --- | 4.82 |
| 15 | O- phosphate | µg/10ml | | | | | 56 |
| 16 | Inorg.phosphate | µg/10ml | | | | | 92 |
| 17 | Total phosphates | µg/10ml | | | | | 148 |
| 18 | Chlorides | mg/L | | | | | 24 |
| 19 | Sulphates | mg/ml | | | | | 0.8 |
| 20 | fluoride | mg/l | | | | | 12 |
| 21 | sulphites | ppm | | | | | 0.1 |
| 22 | chromium | mg/L | | | | | 17 |

HDL: Highest Desirable Limit, MPL: Maximum Permissible, PL: Permissible Limit, EL: Excessive Limit.

**Colour:** The characteristics of wastewater can be assessed by the colour of water. Degree of decomposition and time of collection can be interpreted by the colour of wastewater. The color code can be given as follows: i. Light brown colour: 6 hours (no decomposition of wastewater), ii. Light to medium Gray: started decomposition, iii. Dark gray to black: wastewater is typically septic, extensive bacterial decomposition started under anaerobic conditions. The blacking of wastewater, which indicates the formation of various sulphides (particularly ferrous sulphide).

In present investigation all the six composite samples were more contaminated and having different colors. Sample-1 is in dark black in colour due to presence of high amount of magnesium, calcium and other heavy metal compounds. Sample-2 is grayish white in colour due to hardness and sample-3 is in pale yellow in color remaining samples were light whitish in colour due to some detergent activities.

**Odour:** In recent years, there is an increase in public awareness about the pungent odours released from these wastewater treatment plants. The people are becoming less tolerant of objectionable odours, because many industries and wastewater treatment plants were established near residential and commercial areas. Due to rapid growth of industrialization, the amount of wastewater generated is increasing and to treat this wastewater, lot of time is required. The ageing of wastewater leading to biologically/ bacterial decomposing under anaerobic conditions is resulting in increased odour production. In present investigation, except sample-3 and 6, remaining samples sample-1, 2, 4 and sample-5 which was found to be smelling foul and pungent due to presence of active pharmaceutical ingredients (API), drug intermediates, organic substances (such as phenols, alcohols, ester, aldehydes, ketones) and other toxic compounds like ammonia, amines, sulphate, and other similar compounds found in these wastewater. The sample-4 and 5 were little corrosive and pungent in odour.

**Table-7:** Unpleasant Odours in some Industries wastewater[6].

| S.No | Industries | Origin of Odours |
|---|---|---|
| 01 | Cement works, Lime kilns | Acrolein, amines, mercaptans, dibutyl sulphide, $H_2S$, $SO_2$ etc |
| 02 | Pharmaceutical Industries | Fermentation produces |
| 03 | Food Industries | Amines, Sulphides, Mercaptans |
| 04 | Rubber Industries | Sulphides, Mercaptans |
| 05 | Textile Industries | Phenolic compounds |
| 06 | Paper and Pulp industries | $H_2S$, $SO_2$ etc |
| 07 | Organic compost | Ammonia, Sulphur Compounds |

**Temperature:** The wastewater will relatively have high temperature in comparison to the water supplies. The temperature of the wastewater, depends on the various industrial activities, varies from season to season and from process to process. It is essential and efficient to treat the wastewater at room temperature. The tested wastewater samples were collected from Jeedimetla effluent treatment plant in plastic bottles and transferred to laboratory. During this process, the temperature may have reduced, to avoid this problem temperature measured at sampling point and all the samples showed the temperature ranging between 28 to 33$^{o}$C.

**pH:** pH plays a vital role in wastewater treatment technologies. The analysis of pH plays an important role in treatment process such as coagulation, neutralization, precipitation and other biological based processes. pH ranges of all samples lies between 6.5 to 8.3 because of there is difference in industrial activities. The trends towards alkalinity is observed in the samples and quality of wastewater will adversely affect the surrounding environment, if there is no proper treatment before releasing into surrounding water bodies and the soil.

**Total solids:** The total solids in wastewater consist of the insoluble or suspended solids and the soluble compounds dissolved in water. The suspended solids content is found by drying and weighing the residue removed by filtering to the samples. The results of TDS of different collected wastewater samples shown in Table-1 to 6.

**Inorganic chemicals:** The principal chemical test includes free ammonia, organic nitrogen, nitrites, nitrates, organic phosphorus and inorganic phosphorus, chlorides. Other tests, such as sulphates, pH, alkalinity, acidity, hardness are performed to assess the suitability of reusing treated wastewater and in controlling the various treatment processes[7]. Trace elements, which include some heavy metals, are not determined routinely, but trace elements may be a factor in the biological treatment of wastewater.

**Alkalinity:** According to WHO standards HDL and MPL of for total alkalinity is 200-600 ppm. All samples analyzed for alkalinity. Except sample-2 remaining samples (sample -1, 3, 4, 5 and sample- 6) are out of MPL of WHO standards. Alkalinity of sample-1 is greater than hardness it indicates the presence of basic salts- sodium and potassium in addition to those of calcium and magnesium. Alkalinity of sample -2 and sample -3 lower than hardness due to presence neutral salts of calcium and magnesium.

**Total hardness:** According to WHO standards, HDL and MPL of total hardness is 300-600 ppm. All the samples analyzed for total hardness and they are out of MPL of WHO standards due to sulphates, chlorides and nitrates of calcium and magnesium.

**Dissolved oxygen:** According· to WHO· standards, HDL· and MPL of dissolved oxygen is 2-6 ppm. Some samples show

deviation from this value which may be due to pollution at the sample sites.

**Heavy metal discharges:** Several industries discharge heavy metals, it can be seen that of all of the heavy metals, chromium is the most widely used and discharged to the environment from different sources, as shown in Figure-1. Many of the pollutants entering into aquatic ecosystem (eg: Chromium, Mercury. Lead, pesticides and herbicides) are very toxic to living organisms. They can lower reproductive success, prevent proper growth and development, and even cause death[8].

**Figure-1:** Discharging of various industrial effluents without any pre-treatment into environment.

**Table-8:** Heavy metals found in Major industries (Bond and Straub, 1974)[9].

| Name of the Industry | A | As | Cd | Cr | Hg | Pb | Ni | Zn | C |
|---|---|---|---|---|---|---|---|---|---|
| Pulp and Paper mill | X | X | X | √ | √ | √ | √ | √ | √ |
| Organic chemicals manufacturing industries | √ | √ | √ | √ | √ | √ | X | √ | X |
| Alkalis, Chlorine | X | √ | √ | √ | √ | √ | X | √ | X |
| Fertilizers | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| Petroleum refining industries | √ | √ | √ | √ | X | √ | √ | √ | √ |
| Steel manufacturing | X | √ | √ | √ | √ | √ | √ | √ | √ |
| Air craft plating, finishing | √ | X | √ | √ | √ | X | √ | X | √ |
| Flat glass, cement | X | X | X | √ | X | X | X | X | X |
| Textile mills | X | X | X | √ | X | X | X | X | X |
| Tanning | X | X | X | √ | X | X | X | X | X |
| Power plants | X | X | X | √ | X | X | X | X | X |

The above Table-8, indicating that almost in all industry waste water contains a large amount of chromium and it is discharging into various water resources without any pretreatment. The experimental results of collected samples also have shown a huge amount of chromium in six different wastewater samples.

## Conclusion

The movement of pollutants with ground water in the downstream direction worsened the hydrological system and increased the possibility of geo accumulation of pollutants. Open wells and dug wells have become useless and metals increased by 5-10 times of permissible limits. From the results obtained, it can be concluded the waste water samples cannot be used for any purpose of irrigation and other activities concerned with the ecosystem. The water samples have to be treated before they are disposed into the environment. It can be concluded that Fluoride and chromium plays a vital role in polluting the water due to the existence of paint manufacturing industries and electronic chip manufacturing units existing in the studied samples.

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