Section A-Research paper
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Physico-Chemical Analysis of Wastewater Discharge from Various Industries of Jaipur

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Abstract
Within an overall water resources management system, integrated wastewater management is critical for responsible environmental use and affordable service provision. Water sanitation and hygiene deficiencies account for approximately 7.5% of all deaths in India. The effective use of treated effluent for gardening and industries can save potable water, which can be adequately utilised in draughts in states such as Rajasthan, where underground water is the primary source of water supply. The city has enough sewage treatment plants (STPs) to handle the amount of wastewater generated. This article has attempted to understand the current available system for dealing with water scarcity issues effectively and to suggest that no sustainable solution is likely to emerge until an integrated approach that includes socio-political reasons for wastewater pollution is achieved.

KeywordWaste water , Jaipur , Industry , Physico chemical, Industries, industrial effluents, Pollution.

Introduction
In India, despite the fact that the industrial revolution has enabled humans to advance further over the last two centuries, aquatic contamination by industrial discharges has been one of the most serious environmental concerns. The advancement of science and technology has resulted in the growth and spread of

heavy industries, which has resulted in industrial pollution. During series of processes, the water comes into contact with harmful chemicals, heavy metals, inorganic wastes and even organic sludge [1]. These are either dumped into rivers or other bodies of water, resulting in the accumulation of a large amount of industrial waste in them. This has an impact on the state of our environment as well as the health of humans, plants, and animals.

Several factors contribute to the success of industry development, the most important of which are labour force and natural resources. Because Uttar Pradesh has abundant reserves of coal, dolomite and gems, diaspore, sulphur, magnesite pyrophallite, silica, sand, and limestone, many industries have flourished. [2]

Rajasthan, in particular, faces the same problem with greywater, blackwater, and faecal sludge disposal. The Rajasthan government has significantly increased its investments in centralised sanitation infrastructure in the state over the last decade or so, augmented by funding from the central government under various schemes and loans from the Asian Development Bank. These centralised sanitation systems are mostly found in towns with populations greater than 5 lakh people; however, projects are also being implemented in smaller towns throughout the state. [3]

Rajasthan is located in an arid (60%) and semi-arid (40%) region. The average rainfall in the arid region is less than 400 mm, while in the semi-arid region it ranges from 550 mm to 800 mm. Even when no meteorological drought is declared, the annual precipitation over most of the state is insufficient, resulting in a permanent agricultural drought. The west of the Aravalli range is experiencing a rapid and significant decrease in rainfall, making it the most arid region of Rajasthan. The state's average annual rainfall is 490 mm, with local averages ranging from 100 mm in Jaisalmer's northwest to over 1,000 mm in Jhalawar. [4] Approximately 85% of total rainfall falls during the southwest monsoon, with the remainder falling during winter as a result of passing western disturbances over the region.

Jaipur City (Longitude: 95°24' E; latitude: 27°18' N), the capital city of Rajasthan (INDIA), is one of the country's fastest growing cities, undergoing rapid urbanisation and industrialization. Urbanization has led to immense pressure on ground water resources and has resulted in quality deterioration of ground water as well. [5]

Impact of industrial effluents on human health

The main sources of aquatic pollution are industrial discharges. Depending on the type of industry, various pollutants are released into the environment directly (industrial outlets) or indirectly (domestic sewages) as a result of various anthropogenic activities, which can pose a serious threat to human health. Wastewater from various industries contains high levels of organic pollutants and toxic components such as heavy metals, pesticides, polychlorinated biphenyls (PCBs), dioxins, poly-aromatic hydrocarbons (PAHs), petrochemicals, phenolic components, and so on. If discharged directly into the aquatic medium, these are hazardous to surrounding water bodies, human health, and aquatic life [6]. When industrial effluent containing heavy metals (Cr, Pb, Hg, Ni, Cu, Zn, As, Cd, etc.) enters the aquatic ecosystem, biomagnification occurs through the food chain. Toxicology research has advanced our understanding of heavy metal toxicity and its negative effects on human health, including developmental retardation, cancer, kidney damage, endocrine disruption, immunological disorders (autoimmunity), and even death.

Sources of pollution

Pollutants are generally emitted from three major sources:

1. sewage discharged into the river;
2. industrial effluent discharged into the river without pretreatment; and
3. surface runoff from agricultural land containing chemical fertilisers, pesticides, insecticides, and manures.

Characteristics of wastewater

Water has different properties depending on where it comes from. Industrial wastewater with municipal or domestic wastewater characteristics can be discharged together. If industrial wastewater is discharged with domestic wastewater, it may require some pretreatment. Because the characteristics of wastewater differ from industry to industry, different treatment processes are required. [7]

- Physical
    - The salt content is indicated by electrical conductivity (EC).
    - Total Dissolved Solids (TDS) are inorganic salts and trace amounts of organic matter dissolved in water.
    - Suspended solids (SS) are solid particles that are suspended (but not dissolved) in water.
- Chemical

- Dissolved Oxygen (DO) denotes the amount of oxygen dissolved in water.
- Biochemical oxygen demand (BOD) is the amount of oxygen required by aerobic microorganisms to decompose organic matter in a water sample over a specified time period.
- The chemical oxygen demand (COD) is the oxygen equivalent of a sample's organic matter content that is susceptible to oxidation by a strong chemical oxidant.
- TOC (Total Organic Compound) o NH4-N and NO3-N indicate dissolved nitrogen (Ammonium and Nitrate, respectively).
- Total Kjeldhal Nitrogen is a measure of ammonia nitrogen that is organically bound.
- Total-P represents the total amount of phosphorous in a sample.

- Biological
  - Total coliforms (TC) is a broad indicator of potential water contamination because it includes faecal coliforms as well as common soil microorganisms.
  - Faecal coliforms (FC) are an indicator of faecal matter contamination in water. The bacteria Escherichia coli, or E. coli, is a common lead indicator.
  - Helminth analysis searches for worm eggs in water.

Review of Literature

Grover et al. (1988)[8] investigated the physicochemical characteristics of the Sone River. Chatterjee et al. (1981)[9] investigated the biotic community of the Kali River in Aligarh. Badola and Singh (1981)[10] conducted a similar study in the Alaknanda River. Similarly, Nair et al. (1989)[11] investigated the Neyyar river, and Deshmukh et al. (1984)[12] investigated the Kanhan river in Nagpur. None of the rivers studied above were reported to be pollution-free. This is particularly repugnant in a country like India, where rivers are revered as Goddesses.

Mahdi et al.[13] conducted a combined anaerobic-aerobic system for textile wastewater treatment in 2007. Textile manufacturing uses a significant amount of water in its manufacturing processes. Water is primarily used in the dyeing and finishing processes of textile establishments. When both the volume generated and the composition of the effluent are considered, the textile industry wastewater is rated as the most polluting of all industrial sectors. In their study, a combined anaerobic-aerobic reactor was run continuously to treat textile wastewater. Cosmo balls were used as growth media for microorganisms in an anaerobic reactor. The impact of pH, dissolved oxygen, and organic changes on the nitrification and denatrification processes was studied. The results showed that over 84.62% ammonia nitrogen and approximately 98.9% volatile suspended solid (VSS) removal efficiency could be achieved. Dissolved oxygen (DO) and pH were found to have only minor effects on the nitrification process, with only 3% of pH changes achieved for each 10% removal of nitrogen.

Fayza et al. conducted a study on chemical industrial wastewater treatment in 2004[14]. A building and construction chemicals factory as well as a plastic shoe manufacturing factory were investigated. The wastewater from the two factories is discharged into the public sewerage system. The wastewater discharged from the building and construction chemicals factor was highly contaminated with organic compounds, according to the findings. COD and BOD averaged 2912 and 150 mg02/l, respectively. Phenol concentrations of up to 0.3 mg/l were found. Chemical treatment with lime and ferric chloride proved effective, producing effluent with characteristics that were within Egyptian permissible limits. In the other factory, industrial wastewater was mixed with domestic wastewater to reduce the organic load. The COD, BOD values after mixing reached 5239 and 2615 mg02/l. The average phenol concentration was 0.5 mg/l.

Today, great strides have been made in producing portable water from wastewater. In recent years, regardless of the receiving stream's capacity, a minimum treatment level has been required before discharge permits are granted (Peavy, Rowe, and Tchobanoglous, 1985)[15]. Currently, the emphasis is shifting from centralised systems to more sustainable decentralised wastewater treatment (DEWATS), particularly in developing countries such as Ghana, where wastewater infrastructure is inadequate and traditional methods are difficult to manage (Adu-Ahyia and Anku, 2010)[16].

Traditional wastewater treatment methods include activated sludge, trickling filters, and rotating biological contactors. Temperature sensitive trickling filters and Rotating Biological Contactors remove less BOD, and trickling filters are more expensive to build than activated sludge systems. Activated sludge systems are much more expensive to operate because energy is needed to run pumps and blowers (National Programme on Technology Enhanced Learning (NPTEL), 2010)[17].

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Objectives

- To study physico-chemical parameters of groundwater of Jaipur city
- To study waste-water treatment unit operations and processes
- To study Wastewater Treatment Plant
- To study physico-chemical parameters and heavy metals in water

Research Methodology

This research study used a qualitative design that included interviews, observations, and documents. Rather than determining cause and effect, qualitative research provides an understanding of a situation or phenomenon by telling the story. A close reading and detailed analysis of secondary sources is required in order to apply the analytical and descriptive methods to the research. It is critical to obtain additional perspectives in order to expand on the textual analysis, which would necessitate close reading analysis of a few secondary materials. A close reading and detailed analysis of secondary sources is required in order to apply the analytical and descriptive methods to the research. It is critical to obtain additional perspectives in order to expand on the textual analysis, which would necessitate close reading analysis of a few secondary materials.

Result and Discussion

Table 1 shows the recommended guidelines for permissible limits of physicochemical parameters and heavy metals in water for the sustenance of a better and healthier life for flora and fauna, as more than 95% of industries are established along rivers or aquatic ecosystems. [18]

Table 1 shows the upper and lower allowable limits for some physicochemical parameters and heavy metals in water.

S No.	Parameters	Unit	Minimum permissible limit	Maximum permissible limit
1.	pH		6.5	8.5
2.	Conductivity	µS cm^{-1}	200	1000
3.	Turbidity	NTU	1	5
4.	Colour	TCU	5	15
5.	Total Dissolve Solid	mg L^{-1}	200	600
6.	Dissolved Oxygen	mg L^{-1}	3.5	5.0
7.	Hardness	mg L^{-1}	220	600
8.	Nitrate	mg L^{-1}	-	45
9.	Sulphate	mg L^{-1}	200	400
10.	Phosphate	mg L^{-1}	-	5
11.	Chloride	mg L^{-1}	250	1000
12.	Alkalinity	mg L^{-1}	200	600
13.	Total Ammonia	mg L^{-1}	-	0.5
14.	Mercury	mg L^{-1}	-	0.001
15.	Arsenic	mg L^{-1}	-	0.01
16.	Cadmium	mg L^{-1}	-	0.003
17.	Lead	mg L^{-1}	-	0.001
18.	Iron	mg L^{-1}	-	0.01
19.	Copper	mg L^{-1}	-	1.0
20.	Chromium	mg L^{-1}	-	0.05

Figure 1 depicts how the level of contamination in rivers rises as industries and populations expand. River contamination in relation to population and industrialization [19]

The samples collected were analyzed for temperature, PH, total solids, total dissolved solids, total suspended solids, dissolved oxygen, BOD, COD, dissolved CO2, Alkanality, solids and hardness. The techniques and methods followed for collection preservation, analysis and interpretation are those given by Rain water and Thatcher 1960 and E Brown 1970.

Table-2 Physico - chemical Parameters of Effluent Samples collected from industrial religion of Jaipur, Rajasthan.

S. No.	Parameters	Site 1 Industrial Area 22 GODAM Electrical Industry	Site 2 Engineering Industry VKI area	Site 3 Paper Industry Sanganer	Site 4 Dye Industry Sanganer
1.	PH	7.20±0.002	7.04±0.02	8.44±0.02	8.50±0.02
2.	Temp °c	29.4	34.8	32.3	30.4
3.	EC $_{s/m}$	78.6	51.2	33.6	98.7
4.	DO $_{mg/lit}$	4	2	2	0
5.	BOD $_{mg/lit}$	225	590	84	186
6.	COD $_{mg/lit}$	703	1811.7	262	649.8
7.	Alkalinity $_{mg/lit}$	715.5	397.5	450	371
8.	Hardness $_{ppm}$	880	620	930	880
9.	TS $_{mg/lit}$	273	190	202	315
10.	TDS $_{mg/lit}$	150	155	120	250
11.	TSS $_{mg/lit}$	123	96	75	65

The experimental data on physicochemical properties of water samples collected from different industrial region of Jaipur is represented in table 2.
Temperature of waste water emerging from industrial area may affect soil texture, if directly thrown on to the land. It may increase the microbial activity and may decrease fertility of soil. [20] Moreover if waste water effluents are directly emitted to water it may harm to water living organisms. The temperature of samples varies from 29.4 ^{o}c to 34.8 ^{o}c.
PH is the measure of Acidity or Alkalinity of water determinations of PH of water is helpful in treatment of waste water, by chemically adjusting PH, removal of toxic metal can be carried out. All studies samples posses slightly Basic to the highly Basic.
Electrical conductivity gives idea about the number of dissolved salts present in it.EC varies from 33.6 $_{ms/cm}$ to 98.7 $_{ms/cm}$ to USPH standard.
TDS content in water is measured of salinity. A high content of dissolved salts content affects density of water, influences osmoregulation of fresh water in organism, reduces solubility of gases and otility. Water can be classified based on the concentration of TDS (reference) drinking (up to 500 $_{mg/lit}$) useful for irrigation (up to 2000 $_{mg/lit}$) is not useful for irrigation and drinking (up to 3000 $_{mg/lit}$). In all the collected samples of industry total dissolved solids content is very less. Similarly TSS and TS values are reported. [21]

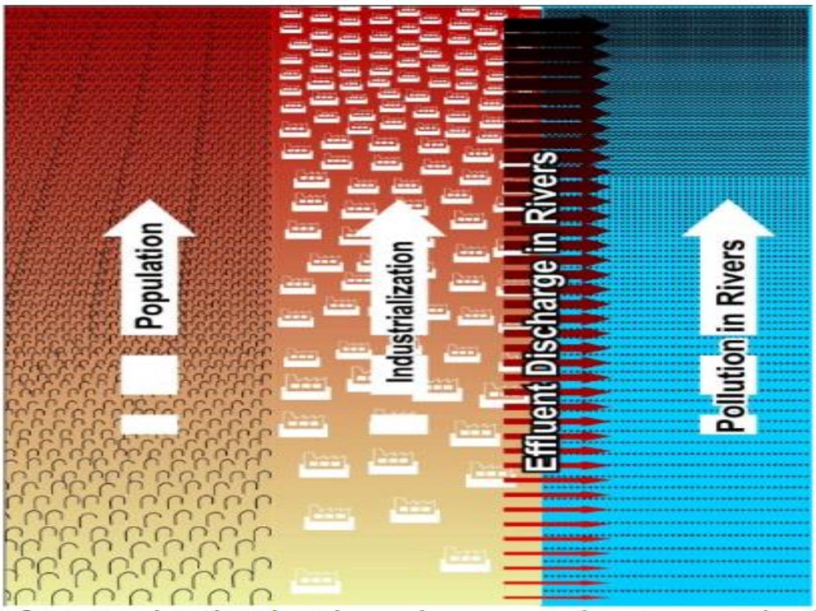

Figure 1 shows how the level of contamination in rivers is rising as industries and populations expand. River pollution as a result of population growth and industrialization

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The sewage treatment plant in Jaipur is inspected on a regular basis. Staff performed a routine checkup, as shown below.

Figure 2: A routine check performed by Jaipur's sewage treatment plant staff.

Waste water is classified as domestic, industrial, or stormwater runoff, as shown in the figure below.

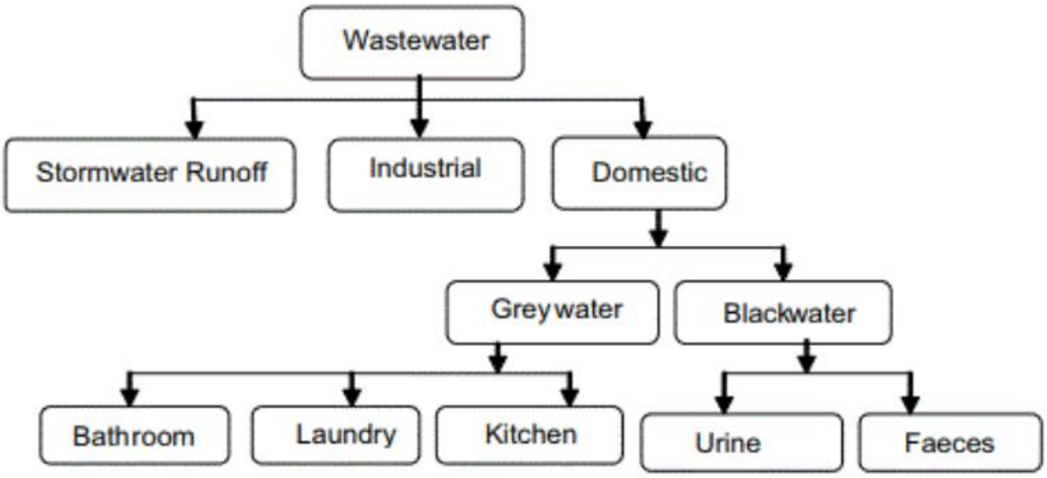

Fig. 3 Types of Wastewater

There are conventional and non-conventional wastewater treatment methods that have been proven and discovered to be effective in wastewater treatment. When compared to non-conventional wastewater treatment methods, conventional methods have a relatively high level of automation. Pumping and power requirements are common. They require skilled labour to operate and maintain the system. [22]

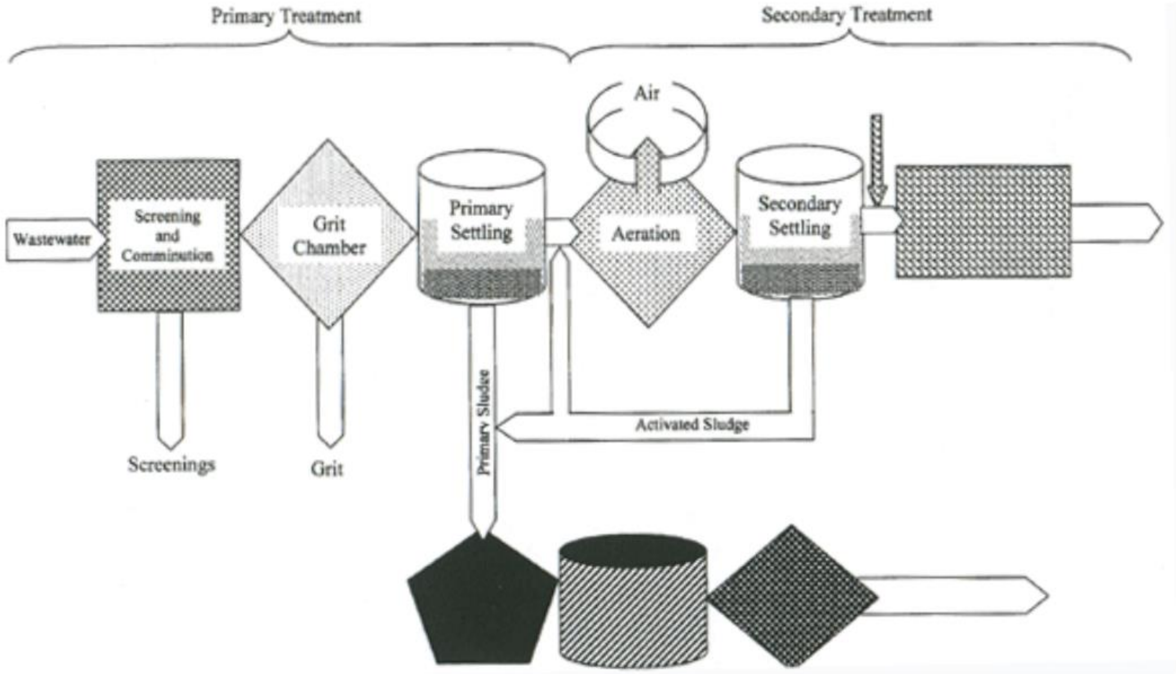

Fig. 4 Typical Wastewater Treatment Plant

Table 1 shows the operations and processes of a waste-water treatment unit.

Physical unit operations	☐ Screening ☐ Comminution ☐ Flow equalization ☐ Sedimentation ☐ Flotation ☐ Granular-medium filtration
Chemical unit operations	☐ Chemical precipitation ☐ Adsorption ☐ Disinfection ☐ DE chlorination ☐ Other chemical applications
Biological unit operations	☐ Activated sludge process ☐ Aerated lagoon ☐ Trickling filters ☐ Rotating biological contactors ☐ Pond stabilization ☐ Anaerobic digestion ☐ Biological nutrient removal

Waste-water treatment methods can be divided into three categories: physical, chemical, and biological processes. The unit operations included in each category are listed in Table 1 below.

Table 2 shows the physicochemical parameters of Jaipur's groundwater.

CODE	pH	EC	TDS	TH	SAR	Na%
J-4	7.72	1149	611.50	175.15	6.58	71.55
J-6	7.9	791	445.00	75.06	6.73	79.60
J-10	7.4	2540	1435.14	735.56	2.63	33.10
J-12	7.73	587	296.69	225.18	1.07	26.53
J-13	9.78	345	239.46	40.04	4.47	78.17
J-14	7.84	1596	785.64	600.48	1.65	25.59
J-17	7.56	2550	982.57	845.64	0.81	12.53
J-18	8.03	1130	654.79	150.12	6.75	73.51
J-19	7.76	1704	961.63	400.31	5.89	59.69
J-21	7.56	2430	1112.60	685.52	2.19	30.23
J-24	7.93	540	275.85	150.10	1.88	43.80

Water classification is based on the 1979 IAH (International Association of Hydrogeologists) principle. Total equivalents of cations and anions were assumed to be 100%, and ions with more than 20% (meq/L) were considered in the classification. Table 2 lists additional physicochemical parameters.

Conclusion

To meet the needs of an expanding human population, industries have expanded in tandem, but this has created a serious problem. Accidental discharges and/or inadequate management of untreated effluent are major global concerns, with potentially disastrous consequences for aquatic organisms exposed to these discharges. The majority of the world's water quality has deteriorated, though the situation in India is more severe. Indian philosophers believe that "thought of a person depends on the type of food and water to which he is fed". Wastewater can and must be treated in order to maintain a safe environment and promote public health. There are conventional and non-conventional wastewater treatment methods, and the selection of one should be based on factors such as the characteristics of the wastewater, whether from a municipality or industry (chemical, textile, pharmaceutical, etc.), technical expertise for operation and maintenance, cost implications, and power requirements, among others.

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