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# Wastewater Management: Chemical Analysis and Remedies for Churu District of Rajasthan

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**ABSTRACT:** Wastewater treatment is a process which removes and eliminates contaminants from wastewater and converts this into an effluent that can be returned to the water cycle. Once returned to the water cycle, the effluent creates an acceptable impact on the environment or is reused for various purposes (called water reclamation).<sup>[1]</sup> The treatment process takes place in a wastewater treatment plant. There are several kinds of wastewater which are treated at the appropriate type of wastewater treatment plant. For domestic wastewater (also called municipal wastewater or sewage), the treatment plant is called a Sewage Treatment. For industrial wastewater, treatment either takes place in a separate Industrial wastewater treatment, or in a sewage treatment plant (usually after some form of pre-treatment). Further types of wastewater treatment plants include Agricultural wastewater treatment and leachate treatment plants, for Churu district of Rajasthan.

### I. INTRODUCTION

Processes commonly used in wastewater treatment include phase separation (such as sedimentation), biological and chemical processes (such as oxidation) or polishing. The main by-product from wastewater treatment plants is a type of sludge that is usually treated in the same or another wastewater treatment plant.<sup>[2]:Ch.14</sup> Biogas can be another by-product if anaerobic treatment processes are used. Treated wastewater can be reused as reclaimed water. The main purpose of wastewater treatment is for the treated wastewater to be able to be disposed or reused safely. However, before it is treated, the options for disposal or reuse must be considered so the correct treatment process is used on the wastewater, for Churu district of Rajasthan.

Wastewater treatment plants may be distinguished by the type of wastewater to be treated. There are numerous processes that can be used to treat wastewater depending on the type and extent of contamination. The treatment steps include physical, chemical and biological treatment processes.

Types of wastewater treatment plants include:

- Sewage treatment plants
- Industrial wastewater treatment plants
- Agricultural wastewater treatment plants
- Leachate treatment plants

Sewage treatment plants, for Churu district of Rajasthan

Sewage treatment (or domestic wastewater treatment, municipal wastewater treatment) is a type of wastewater treatment which aims to remove contaminants from sewage to produce an effluent that is suitable to discharge to the surrounding environment or an intended reuse application, thereby preventing water pollution from raw sewage discharges.<sup>[5]</sup> Sewage contains wastewater from households and businesses and possibly pre-treated industrial wastewater. There are a high number of sewage treatment processes to choose from. These can range from decentralized systems (including on-site treatment systems) to large centralized systems involving a network of

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pipes and pump stations (called sewerage) which convey the sewage to a treatment plant. For cities that have a combined sewer, the sewers will also carry urban runoff (stormwater) to the sewage treatment plant. Sewage treatment often involves two main stages, called primary and secondary treatment, while advanced treatment also incorporates a tertiary treatment stage with polishing processes and nutrient removal. Secondary treatment can reduce organic matter (measured as biological oxygen demand) from sewage, using aerobic or anaerobic biological processes. A large number of sewage treatment technologies have been developed, mostly using biological treatment processes. Design engineers and decision makers need to take into account technical and economical criteria of each alternative when choosing a suitable technology.<sup>[6]:215</sup> Often, the main criteria for selection are: desired effluent quality, expected construction and operating costs, availability of land, energy requirements and sustainability aspects. In developing countries and in rural areas with low population densities, sewage is often treated by various on-site sanitation systems and not conveyed in sewers. These systems include septic tanks connected to drain fields, on-site sewage systems (OSS), vermifilter systems and many more. On the other hand, advanced and relatively expensive sewage treatment plants in cities that can afford them may include tertiary treatment with disinfection and possibly even a fourth treatment stage to remove micropollutants.[1,2,3]

Industrial wastewater treatment plants,for Churu district,Rajasthan

Industrial wastewater treatment describes the processes used for treating wastewater that is produced by industries as an undesirable by-product. After treatment, the treated industrial wastewater (or effluent) may be reused or released to a sanitary sewer or to a surface water in the environment. Some industrial facilities generate wastewater that can be treated in sewage treatment plants. Most industrial processes, such as petroleum refineries, chemical and petrochemical plants have their own specialized facilities to treat their wastewaters so that the pollutant concentrations in the treated wastewater comply with the regulations regarding disposal of wastewaters into sewers or into rivers, lakes or oceans.<sup>[8]:1412</sup> This applies to industries that generate wastewater with high concentrations of organic matter (e.g. oil and grease), toxic pollutants (e.g. heavy metals, volatile organic compounds) or nutrients such as ammonia.<sup>[9]:180</sup> Some industries install a pre-treatment system to remove some pollutants (e.g., toxic compounds), and then discharge the partially treated wastewater to the municipal sewer system.<sup>[10]:60</sup>

(Most industries produce some wastewater. Recent trends have been to minimize such production or to recycle treated wastewater within the production process. Some industries have been successful at redesigning their manufacturing processes to reduce or eliminate pollutants.<sup>[11]</sup> Sources of industrial wastewater include battery manufacturing, chemical manufacturing, electric power plants, food industry, iron and steel industry, metal working, mines and quarries, nuclear industry, oil and gas extraction, petroleum refining and petrochemicals, pharmaceutical manufacturing, pulp and paper industry, smelters, textile mills, industrial oil contamination, water treatment and wood preserving). Treatment processes include brine treatment, solids removal (e.g. chemical precipitation, filtration), oils and grease removal, removal of biodegradable organics, removal of other organics, removal of acids and alkalis, and removal of toxic materials.[5,7,8]

Agricultural wastewater treatment plants, for Churu district,Rajasthan

Agricultural wastewater treatment is a farm management agenda for controlling pollution from confined animal operations and from surface runoff that may be contaminated by chemicals in fertilizer, pesticides, animal slurry, crop residues or irrigation water. Agricultural wastewater treatment is required for continuous confined animal operations like milk and egg production. It may be performed in plants using mechanized treatment units similar to those used for industrial wastewater. Where land is available for ponds, settling basins and facultative lagoons may have lower operational costs for seasonal use conditions from breeding or harvest cycles.<sup>[12]:6-8</sup> Animal slurries are usually treated by containment in anaerobic lagoons before disposal by spray or trickle application to grassland. Constructed wetlands are sometimes used to facilitate treatment of animal wastes.

Nonpoint source pollution includes sediment runoff, nutrient runoff and pesticides. Point source pollution includes animal wastes, silage liquor, milking parlour (dairy farming) wastes, slaughtering waste, vegetable washing water and

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firewater. Many farms generate nonpoint source pollution from surface runoff which is not controlled through a treatment plant.

Leachate treatment plants, for Churu district, Rajasthan

Leachate treatment plants are used to treat leachate from landfills. Treatment options include: biological treatment, mechanical treatment by ultrafiltration, treatment with active carbon filters, electrochemical treatment including electrocoagulation by various proprietary technologies and reverse osmosis membrane filtration using disc tube module technology.<sup>[13]</sup>

## II. DISCUSSION

### Unit processes

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The unit processes involved in wastewater treatment include physical processes such as settlement or flotation and biological processes such as oxidation or anaerobic treatment. Some wastewaters require specialized treatment methods. At the simplest level, treatment of most wastewaters is carried out through separation of solids from liquids, usually by sedimentation. By progressively converting dissolved material into solids, usually a biological floc or biofilm, which is then settled out or separated, an effluent stream of increasing purity is produced.<sup>[2][14]</sup>

### Phase separation

Phase separation transfers impurities into a non-aqueous phase. Phase separation may occur at intermediate points in a treatment sequence to remove solids generated during oxidation or polishing. Grease and oil may be recovered for fuel or saponification. Solids often require dewatering of sludge in a wastewater treatment plant. Disposal options for dried solids vary with the type and concentration of impurities removed from water.<sup>[15]</sup>

### Sedimentation

Solids such as stones, grit, and sand may be removed from wastewater by gravity when density differences are sufficient to overcome dispersion by turbulence. This is typically achieved using a grit channel designed to produce an optimum flow rate that allows grit to settle and other less-dense solids to be carried forward to the next treatment stage. Gravity separation of solids is the primary treatment of sewage, where the unit process is called "primary settling tanks" or "primary sedimentation tanks".<sup>[16]</sup> It is also widely used for the treatment of other types of wastewater. Solids that are denser than water will accumulate at the bottom of quiescent settling basins. More complex clarifiers also have skimmers to simultaneously remove floating grease such as soap scum and solids such as feathers, wood chips, or condoms. Containers like the API oil-water separator are specifically designed to separate non-polar liquids.<sup>[17]:111-138</sup>

### Biological and chemical processes[9,10,11]

#### Oxidation

Oxidation reduces the biochemical oxygen demand of wastewater, and may reduce the toxicity of some impurities. Secondary treatment converts organic compounds into carbon dioxide, water, and biosolids through oxidation and reduction reactions.<sup>[18]</sup> Chemical oxidation is widely used for disinfection.<sup>[19]</sup>

#### Biochemical oxidation (secondary treatment)

This small secondary clarifier at a rural sewage treatment plant is a typical phase separation mechanism to remove biological solids formed in a suspended growth or fixed-film bioreactor. Secondary treatment (mostly biological wastewater treatment) is the removal of biodegradable organic matter (in solution or suspension) from sewage or similar kinds of wastewater.<sup>[20]:11</sup> The aim is to achieve a certain degree of effluent quality in a sewage treatment plant suitable for the intended disposal or reuse option. A "primary treatment" step often precedes secondary treatment,

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whereby physical phase separation is used to remove settleable solids. During secondary treatment, biological processes are used to remove dissolved and suspended organic matter measured as biochemical oxygen demand (BOD). These processes are performed by microorganisms in a managed aerobic or anaerobic process depending on the treatment technology. Bacteria and protozoa consume biodegradable soluble organic contaminants (e.g. sugars, fats, and organic short-chain carbon molecules from human waste, food waste, soaps and detergent) while reproducing to form cells of biological solids. Secondary treatment is widely used in sewage treatment and is also applicable to many agricultural and industrial wastewaters.

## Chemical oxidation

Advanced oxidation processes are used to remove some persistent organic pollutants and concentrations remaining after biochemical oxidation.<sup>[17]:363-408</sup> Disinfection by chemical oxidation kills bacteria and microbial pathogens by adding hydroxyl radicals such as ozone, chlorine or hypochlorite to wastewater.<sup>[2]:1220</sup> These hydroxyl radical then break down complex compounds in the organic pollutants into simple compounds such as water, carbon dioxide, and salts.<sup>[21]</sup>

## Anaerobic treatment

Anaerobic wastewater treatment processes (for example UASB, EGSB) are also widely applied in the treatment of industrial wastewaters and biological sludge.

## Polishing

Polishing refers to treatments made in further advanced treatment steps after the above methods (also called "fourth stage" treatment). These treatments may also be used independently for some industrial wastewater. Chemical reduction or pH adjustment minimizes chemical reactivity of wastewater following chemical oxidation.<sup>[17]:439</sup> Carbon filtering removes remaining contaminants and impurities by chemical absorption onto activated carbon.<sup>[2]:1138</sup> Filtration through sand (calcium carbonate) or fabric filters is the most common method used in municipal wastewater treatment.<sup>[12,13]</sup>

Water chemistry analyses are carried out to identify and quantify the chemical components and properties of water samples. The type and sensitivity of the analysis depends on the purpose of the analysis and the anticipated use of the water. Chemical water analysis is carried out on water used in industrial processes, on waste-water stream, on rivers and stream, on rainfall and on the sea.<sup>[1]</sup> In all cases the results of the analysis provides information that can be used to make decisions or to provide re-assurance that conditions are as expected. The analytical parameters selected are chosen to be appropriate for the decision making process or to establish acceptable normality. Water chemistry analysis is often the groundwork of studies of water quality, pollution, hydrology and geothermal waters. Analytical methods routinely used can detect and measure all the natural elements and their inorganic compounds and a very wide range of organic chemical species using methods such as gas chromatography and mass spectrometry. In water treatment plants producing drinking water and in some industrial processes using products with distinctive taste and odours, specialised organoleptic methods may be used to detect smells at very low concentrations.

## III. RESULTS

### Types of water

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#### Environmental water

Samples of water from the natural environment are routinely taken and analysed as part of a pre-determined monitoring programme by regulatory authorities to ensure that waters remain unpolluted, or if polluted, that the levels of pollution are not increasing or are falling in line with an agreed remediation plan. An example of such a scheme is the harmonised monitoring scheme operated on all the major water/lake systems in the Churu district of Rajasthan.<sup>[2]</sup> The parameters analysed will be highly dependent on nature of the local environment and/or the

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polluting sources in the area. In many cases the parameters will reflect the national and local water quality standards determined by law or other regulations. Typical parameters for ensuring that unpolluted surface waters remain within acceptable chemical standards include pH, [15,17] major cations and anions including ammonia, nitrate, nitrite, phosphate, conductivity, phenol, chemical oxygen demand (COD) and biochemical oxygen demand (BOD).

### Drinking water supplies

Surface or ground water abstracted for the supply of drinking water must be capable of meeting rigorous chemical standards following treatment. This requires a detailed knowledge of the water entering the treatment plant. In addition to the normal suite of environmental chemical parameters, other parameters such as hardness, phenol, oil and in some cases a real-time organic profile of the incoming water as in the River Dee regulation scheme.

### Industrial process water

In industrial process, the control of the quality of process water can be critical to the quality of the end product. Water is often used as a carrier of reagents and the loss of reagent to product must be continuously monitored to ensure that correct replacement rate. Parameters measured relate specifically to the process in use and to any of the expected contaminants that may arise as by-products. This may include unwanted organic chemicals appearing in an inorganic chemical process through contamination with oils and greases from machinery. Monitoring the quality of the waste water discharged from industrial premises is a key factor in controlling and minimising pollution of the environment. In this application monitoring schemes analyse for all possible contaminants arising within the process and in addition contaminants that may have particularly adverse impacts on the environment such as cyanide and many organic species such as pesticides.<sup>[3]</sup> In then nuclear industry analysis focuses on specific isotopes or elements of interest. Where the nuclear industry makes waste water discharges to rivers which have drinking water abstraction on them, radio-isotopes which could potentially be harmful or those with long half-lives such as tritium will form part of the routine monitoring suite in Churu district.

### Methodology

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To ensure consistency and repeatability, the methods use in the chemical analysis of water samples are often agreed and published at a national or state level. By convention these are often referred to as "Blue book"s.<sup>[4][5]</sup>

Certain analyses are performed in-field (e.g. pH, specific conductance) while others involve sampling and laboratory testing.<sup>[6]</sup>

The methods defined in the relevant standards can be broadly classified as:[18,19]

- Conventional wet chemistry including the Winkler method for dissolved oxygen, precipitation, filtration for solids, acidification, neutralisation, titration etc. Colourimetric methods such as MBAS assay which indicates anionic surfactants in water and on site comparator methods to determine chlorine and chloramines. Nephelometers are used to measure solids concentrations as turbidity. These methods are generally robust and well tried and inexpensive, giving a reasonable degree of accuracy at modest sensitivity.
- Electro chemistry including pH, conductivity and dissolved oxygen using oxygen electrode. These methods yield accurate and precise results using electronic equipment capable of feeding results directly into a laboratory data management system
- Spectrophotometry is used particularly for metallic elements in solution producing results with very high sensitivity, but which may require some sample preparation prior to analysis and may also need specialised sampling methods to avoid sample deterioration in transit.

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- Chromatography is used for many organic species which are volatile or which can yield a characteristic volatile component of after initial chemical processing.
- Ion chromatography is a sensitive and stable technique that can measure lithium, ammonium  $\text{NH}_4$  and many other low molecular weight ions using ion exchange technology.
- Gas chromatography can be used to determine methane, carbon dioxide, cyanide, oxygen, nitrogen and many other volatile components at reasonable sensitivities.
- Mass spectrometry is used where very high sensitivity is required and is sometimes used as a back-end process after gas liquid chromatography for detecting trace organic chemicals.

Depending on the components, different methods are applied to determine the quantities or ratios of the components. While some methods can be performed with standard laboratory equipment, others require advanced devices, such as inductively coupled plasma mass spectrometry (ICP-MS).

### Research

Many aspects of academic research and industrial research such as in pharmaceuticals, health products, and many others relies on accurate water analysis to identify substances of potential use, to refine those substances and to ensure that when they are manufactured for sale that the chemical composition remains consistent. The analytical methods used in these area can be very complex and may be specific to the process or area of research being conducted and may involve the use of bespoke analytical equipment, in Churu district.

### Forensic analysis

In environmental management, water analysis is frequently deployed when pollution is suspected to identify the pollutant in order to take remedial action.<sup>[7]</sup> The analysis can often enable the polluter to be identified. Such forensic work can examine the ratios of various components and can "type" samples of oils or other mixed organic contaminants to directly link the pollutant with the source. In drinking water supplies the cause of unacceptable quality can similarly be determined by carefully targeted chemical analysis of samples taken throughout the distribution system.<sup>[8]</sup> In manufacturing, off-spec products may be directly tied back to unexpected changes in wet processing stages and analytical chemistry can identify which stages may be at fault and for what reason.<sup>[20]</sup>

## IV. CONCLUSION

Drinking water quality standards describes the quality parameters set for drinking water. Although drinking water standards frequently are referred to as if they are simple lists of parametric values, standards documents also specify the sampling location, sampling methods, sampling frequency, analytical methods, and laboratory accreditation AQC. In addition, a number of standards documents also require calculation to determine whether a level exceeds the standard, such as taking an average. Some standards give complex, detailed requirements for the statistical treatment of results, temporal and seasonal variations, summation of related parameters, and mathematical treatment of apparently aberrant results.<sup>[21]</sup>

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