AQUATRON®- FPSTAR

Revolutionary & Disruptive Technology

For Hazardous Leachate Treatment

Livprotec

RESTORING EARTH'S HEALTH

CONTENTS

Abstract

Due to the escalating global population and urbanisation, there has been a notable surge in the generation of waste*. In 2016, the world produced 2.01 billion metric tons (BT) of municipal solid waste (MSW), with projections indicating an increase to 2.59 BT by 2030 and 3.40 BT by 2050 [1]. Approximately 50% of MSW generated worldwide is disposed of in dumpsites and landfills, leading to significant environmental and health repercussions attributable to leachate and greenhouse gas emissions. Despite the challenges posed by inefficient treatment of landfill leachate, existing technologies have fallen short of meeting the requisite standards. This report delves into the adverse effects of landfill leachate, the challenges encountered by conventional methods, and introduces our innovative technology – **Aquatron – FPSTAR (Fine Particle Shortwave Thrombotic Agglomeration Reactor)** - as a comprehensive solution. This disruptive solution offers a comprehensive approach to wastewater management, transforming it from a harmful waste into a valuable resource.

* Here, waste refers to the untreated and discarded materials after primary use.

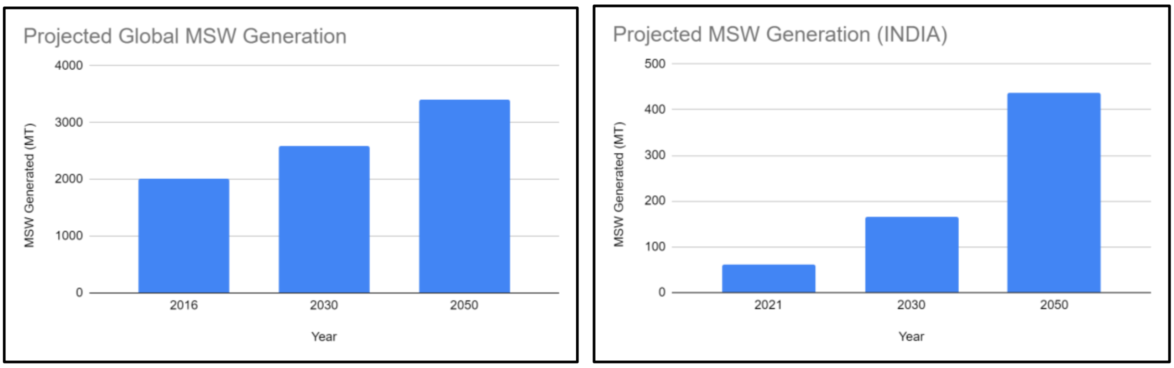
Keywords

Municipal Solid Waste (MSW), Landfill, Leachate, Biological process, Physico-chemical process, Reverse Osmosis (RO), FPSTAR, RFOD, Boom Tower, AQUATRON.

1. Introduction

Waste generation is steadily increasing due to continuous industrialization, urbanisation, and population growth. The global population has witnessed substantial growth, surging from 3.1 billion in 1960 to nearly 7 billion in 2010, with projections indicating a further increase to 9.3 billion by 2050 [2]. This demographic expansion significantly contributes to the generation of a substantial volume of municipal solid waste (MSW), which amounted to 2.01 billion metric tons (BT) in 2016, with projections indicating an increase to 2.59 BT by 2030 and 3.40 BT by 2050.

India, with a population of 1.41 billion in 2021[3], generated an average of 0.16 million tonnes (MT) of MSW per day. A study featured in the Journal of Urban Management, 2021 reveals an annual generation of 62 MT of waste, which is projected to increase to 165 MT by 2030 and further to 436 MT by 2050[4].



(a) (b)

Figure 1: Projection of MSW generation (a) globally (b) India

To effectively address these substantial volumes of waste in an environmentally sustainable manner, the imperative lies in the implementation of advanced technologies and the formulation of more rigorous policies. The existing waste management system falls short in efficiency and readiness to confront the impending surge in waste generation anticipated in the coming years.

Presently, out of the daily waste generation of 0.16 MT, 0.15 MT (95.4%) undergoes collection. However, only 0.079 MT (50%) of the waste undergoes proper treatment, while 0.029 MT (18.4%) is relegated to landfill disposal, and the remaining 0.050 MT (31.6%) of waste remains unaccounted for [5]. Notably, a significant portion of these unaccounted wastes is disposed into open dumpsites on the outskirts of the city because of the relative low cost and low-technical requirement.

India currently struggles with approximately 1924 landfills and around 3184 dump sites. These dump sites lack the requisite engineering to manage waste without posing harm to the environment or the nearby population. Furthermore, improperly managed landfills can result in diverse health issues and environmental hazards.

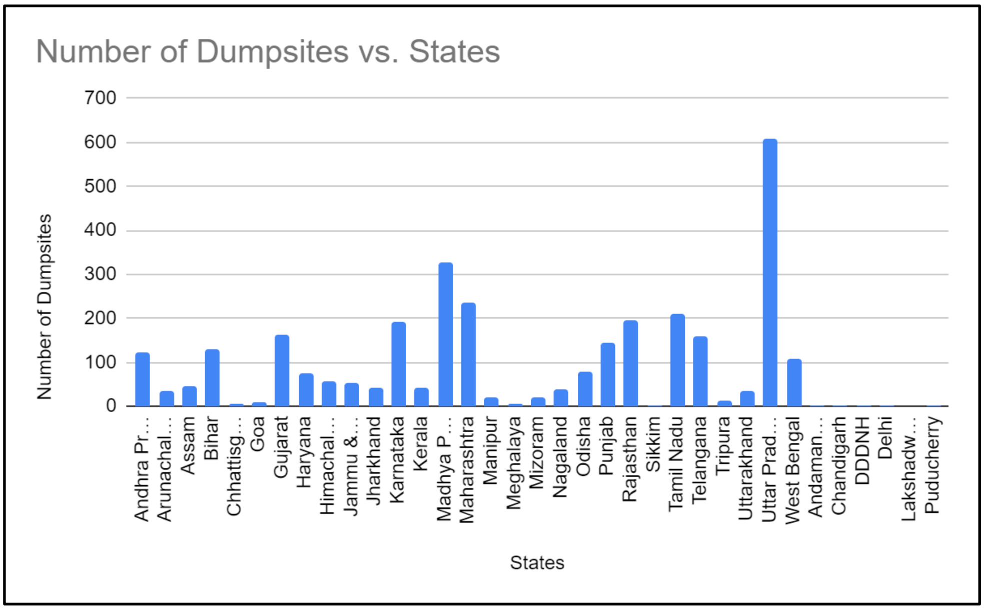


Figure 2: State wise details of dumpsites

So, this report delves into the intricacies of the challenges associated with landfills, examines the shortcomings of existing technologies, and elucidates how they fail to address the presented challenges. Additionally, it highlights the Aquatron - FPSTAR technology as a viable solution for current and future waste management issues.

2. Landfill & Associated Challenges

2.1 What is a landfill?

Ideally, a landfill is a designated space intended for the disposal of waste materials that cannot be recycled or repurposed. However, the prevailing reality in many countries depicts landfills as indiscriminate dumping grounds for various types of waste, spanning from household waste to commercial and industrial waste. Generally, landfills are meticulously designed and engineered to facilitate the isolation of deposited waste from the surrounding environment, thus preventing soil and groundwater contamination.

2.2 The challenges associated with landfills

While landfills are conventionally designed and engineered with the aim of safeguarding the environment and the public from deposited waste, the reality is that a significant number of landfills function more as mere dumpsites. These sites often lack proper engineering to safely manage the disposed waste, thereby transforming them into potential hazards.

There are two major concerns related to landfill - landfill gas emissions and leachate generation.

2.2.1 Landfill Gas (LFG) Emissions

As waste deposited in landfills undergoes decomposition, it generates gases such as methane and CO_2, both of which are classified as greenhouse gases [6]. Methane is approximately 25 times more potent than CO_2 in contributing to global warming and climate change. It has been reported that globally, 13% of methane emissions originate from landfills [7]. These gases, being highly flammable, can lead to fires and explosions within landfills when present in high concentrations.

In addition to their impact on climate patterns, the release of these gases into the atmosphere contributes to air pollution, leading to respiratory and cardiovascular diseases. Therefore, urgent measures are imperative to mitigate and control the emissions of these greenhouse gases from landfills.

2.2.2 Leachate Generation

The highly contaminated wastewater that is formed in the landfill when the waste is subjected to physico-chemical and biological processes is called leachate [9]. It is formed by the percolation of water through landfill and the inherent water present in the waste. This formed leachate, resembling a toxic soup, has a variable composition depending on factors like climate, age of landfill, type of waste etc.

When leachate is not adequately collected and treated, it poses the risk of infiltrating groundwater, leading to contamination. It was found that the groundwater near landfills exhibits a high concentration of dissolved solids, imparting a brackish quality, making it unfit for drinking and contributing to health problems [7], particularly gastrointestinal issues. Leachate infiltration also disrupts the soil's composition, impacting its quality and fertility for agriculture or plantations [8].

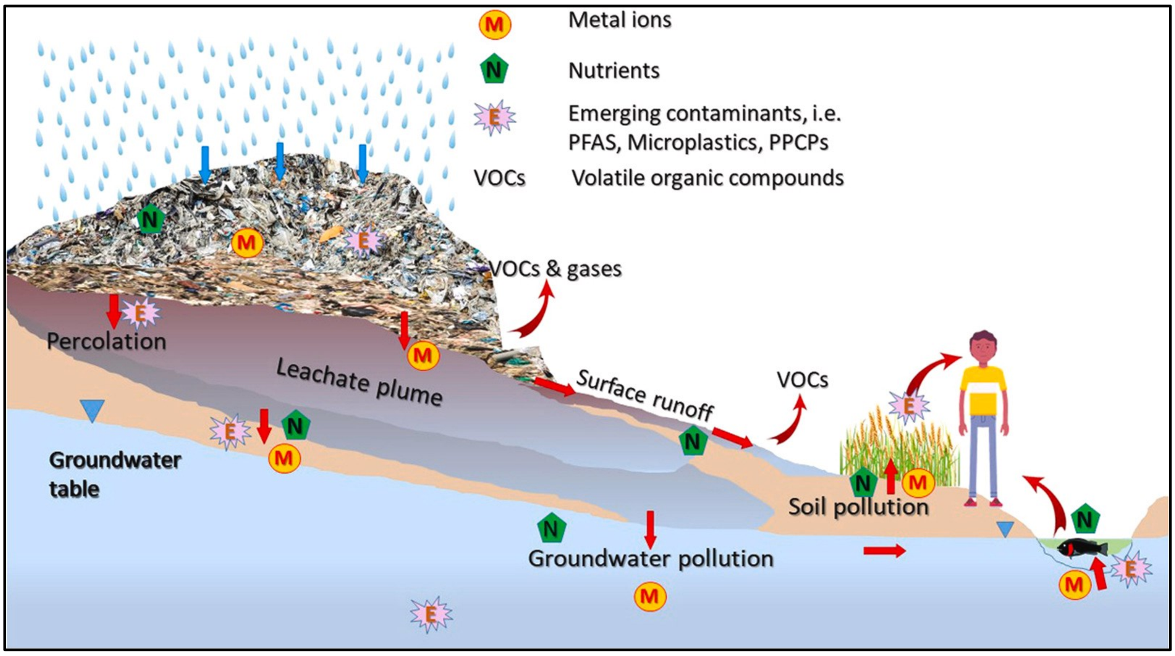


Figure 3: Schematic diagram of groundwater and soil contamination by landfill leachate (Source: https://doi.org/10.1016/j.jhazmat.2021.126627)

Moreover, the presence of organic chemicals like chloroform, benzene, toluene, etc., in leachate can result in skin and eye irritations, as well as contribute to health issues such as dry skin, pigmentation, rashes, and allergies. A comprehensive study identifies 133 toxic chemical substances in leachate, posing risks of cancer, genetic mutations, or birth-related problems.[10] Consequently, it is essential to treat leachate in a sustainable manner that safeguards the environment and human health.

3. Leachate Composition

Leachate, the liquid found in the base of the landfills, usually exhibits a distinctive unpleasant odour, and appears blackish brown in colour [14]. Typically, it contains toxic matter, suspended solids or other dissolved components assimilated from the dumped waste and contains heavy metals, salts, nitrogen compounds and various types of organic materials.

Unlike other types of wastes, the quality and nature of leachate is very dynamic as it is influenced by a range of parameters, including the type and composition of the waste, operational practices, climatic conditions, hydrogeology, and landfill age [12]. These leachates are characterised by conventional parameters like chemical oxygen demand (COD), total organic carbon (TOC), biochemical oxygen demand (BOD), suspended solids, pH, ammonia ($NH4^+$-N) and heavy metal concentrations [11].

Based on the age of landfills, the leachate is generally classified into three categories: young leachate (less than 5 years old), medium leachate (5-10 years old), and old leachate (more than 10 years old) [13]. It was reported that the young leachates exhibit a higher BOD and COD, along with lower pH levels. The BOD peaks between 6 months to 2 years marked by anaerobic fermentation to fatty acids, resulting in decreased pH [15].

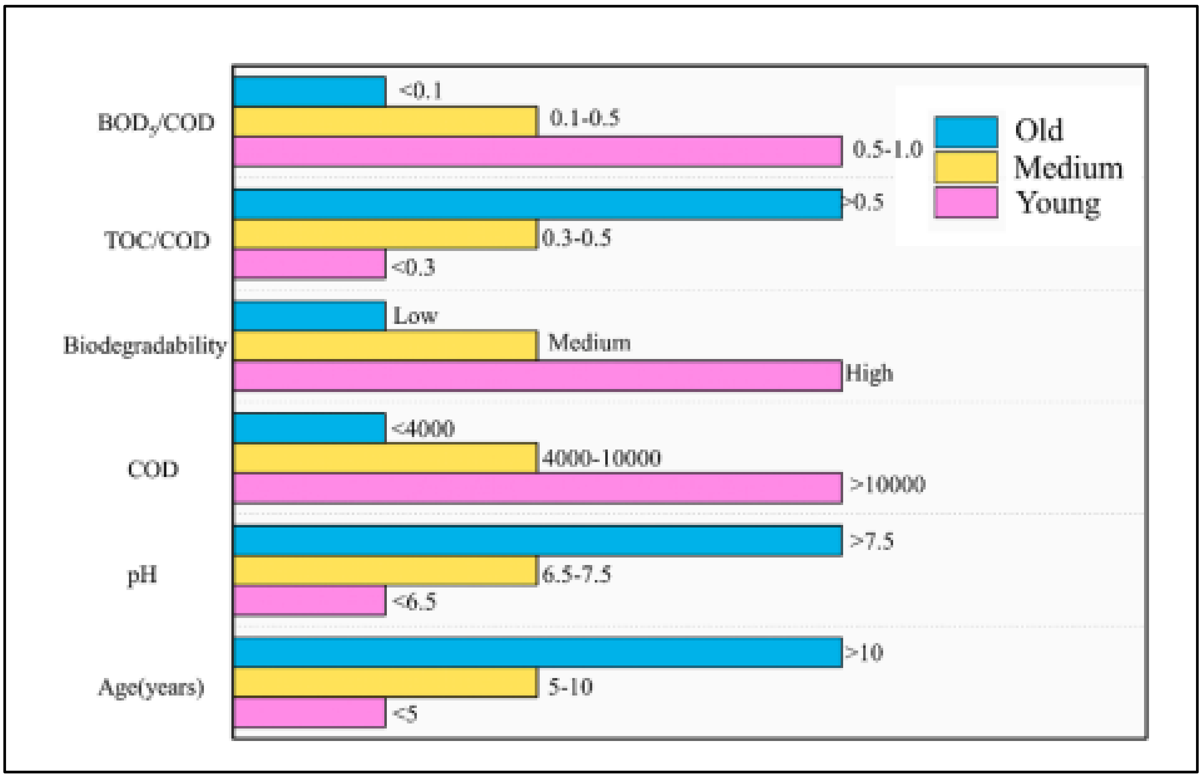


Figure 4: Changes in landfill leachates classification with age

(Source: https://doi.org/10.1016/j.watres.2021.117525)

As the landfill leachate ages to more than 6 years, the BOD values decline as wastes stabilise through continuous degradation. Accumulated acids get reduced to carbon dioxide and methane by methanogenic bacteria, consequently reducing the acidity or increasing the pH. This phase is characterised by relatively lower COD but higher concentrations of ammonium nitrogen and methane. (Refer Table 1)

Table 1: Landfill leachate classification versus age (Source: https://doi.org/10.1155/2010/270532)

Type of leachate	Young	Medium	Old
Age (years)	<5	5-10	>10
pH	<6.5	6.5 - 7.5	> 7.5
COD (mg/L)	>10000	4000-10000	<4000
BOD_5/COD*	0.5-1.0	0.1-0.5	<0.1
Organic Compounds	80% volatile fatty acids (VFA)	5%–30% VFA + humic and fulvic acid	Humic and fulvic acids
Ammonia nitrogen (mg/L)	<400	N.A	>400
TOC/COD	<0.3	0.3–0.5	>0.5
Kjeldahl nitrogen (g/L)	0.1-0.2	N. A	N. A
Heavy metals (mg/L)	Low to medium	Low	Low
Biodegradability	High	Medium	Low

* BOD_5 - Biological Oxygen Demand for 5 days

4. Current Technologies For Leachate Treatment

The diverse and variable composition of leachate poses significant challenges in its treatment. Various technologies, encompassing biological and physico-chemical processes, are employed globally. Biological processes are favoured for their cost-effectiveness and operational simplicity, but they are effective only when the leachate BOD > 10000 mg/L, common in landfills of age 0-2 years. However, the presence of higher concentrations of substances like cyanide, chromium, nickel can impede the microorganisms responsible for ammonia removal [16]. The effectiveness of biological processes diminishes with increasing landfill age due to low BOD and elevated ammonia concentrations.

Physico-chemical treatment methods are generally utilised when ammonia removal is necessary, offering operational simplicity and faster reaction rates. However, they are inefficient in organic matter removal. In addition to these techniques, membrane technology is employed for leachate treatment. While it effectively eliminates colloids, suspended materials, and achieves a 98% removal of COD and ammoniacal nitrogen, it comes with high costs and energy requirements. Also, the membrane gets choked, sometimes within few hours of operation, making it practically not feasible.

Consequently, the choice of the most suitable technology depends upon factors such as landfill age, its specific nature, and composition. Table 2 provides a concise overview of various technologies, including their advantages and disadvantages.

Table 2: Different leachate technologies employed globally.

Type of treatment	Technology	Advantages	Disadvantages	Results
Biological	Activated sludge	More intensive treatment than lagoons.	Difficulty in sludge separation. Microbial inhibition due to high conc. of ammoniacal nitrogen.	40% COD removal
	MBBR	Solves sludge separation problems. Withstands high ammoniacal nitrogen content.	Higher cost.	60–81% COD removal
	Biological filters	Ease of operation.	Clogging problems in case of high organic load.	44% COD removal, 60% BOD removal, 15% $N{-}NH_3$ removal
	Membrane Bioreactors (MBR)	Efficient sludge separation. Intensive treatment. Lower area demand. High robustness.	Membrane fouling.	89% COD removal, 92% BOD removal, 97% $N{-}NH_3$ removal
Physico-chemical	Coagulation-flocculation	Operational simplicity. Best used as pre-treatment for biological and/or polishing processes.	Need for periodic adjustment to operational conditions. Generation of excessive sludge; secondary pollution; pH dependent	Low COD removals (10–50%)
	Precipitation	Allows the recovery of byproducts in the form of fertilisers. Lower costs compared to other physical-chemical processes. Faster than biological processes	High demand for precipitating agents. Efficiency of the process is conditioned to narrow pH ranges.	Ammonia removals close to 90%, but ineffective in reducing organic matter
	Stripping	Efficient ammonia removal processes even at high initial concentrations.	The efficiency of the process is conditioned by high temp and pH values. High energy	Effective in removing ammonia (89–99.5%) but has low COD

			demand and chemical inputs.	removals
	Micro- and ultrafiltration	Effective pre-treatment to remove suspended solids.	Limitations in the removal of low molecular weight recalcitrant compounds.	COD removal around 20%, total nitrogen 88% and suspended solids >99.9%
	Nanofiltration	Operational stability. Higher flow and less energy requirement when compared to reverse osmosis processes.	Membranes have limited useful life (around 5 years) Periodic cleaning processes are required.	Removals of 65% and 50% COD and ammonia nitrogen, respectively.
Physico-chemical/ Membrane	Reverse osmosis	Robust and effective process for polishing leachate.	Greater energy requirement among the available membrane separation processes.	Contaminant removal greater than 99.6%
	Advanced oxidative processes	Effective in degrading recalcitrant compounds. Lower operating costs if used as pre-treatment or polishing. Effective in increasing leachate biodegradability.	High energy demand and chemical inputs. Possibility to form by-products of greater toxicity.	COD removals of less than 50% in ozonation processes.

As illustrated in Table 2, each processing technology has its own advantages, shortcomings, and applicability. The integration of various treatments for landfill leachate combines the strengths of individual treatments, overcomes their respective weaknesses, and has demonstrated enhanced efficiency at lower costs [13].

However, there is currently no universally applicable or feasible technology that works efficiently or is optimised for all leachate compositions. Consequently, there exists a necessity to develop a cost-effective treatment technology that can be tailored to various leachate concentrations, efficiently removing all toxic chemicals in a sustainable manner.

5. Aquatron – FPSTAR Technology For Leachate Treatment

Aquatron is the next generation water recovery system that works on the **patented Fine Particle Shortwave Thrombiser Agglomeration Reactor (FPSTAR) technology** (Indian Patent: 338589 International Patent: WO2015151112 – PCT/IN2014/000206). The technology redefines the wastewater treatment sector by employing the **principles of physics** to treat wastewater instead of the conventional biological or chemical processes.

Using principles of shortwave resonance, Aquatron-FPSTAR technology can effectively separate impurities from wastewater and recover water even from the toughest of the effluents such as landfill leachates. The technology can breakdown the impurities present into their elemental state, and subsequently recover water to meet reusable standards without any hazardous sludge formation.

The technology achieves Zero Liquid Discharge (ZLD) and Zero Discharge of Hazardous Chemicals (ZDHC) without any reliance on energy-intensive evaporators. This innovative approach promotes the circular economy of water, significantly reduces the water footprint, mitigates risks associated with non-compliance to environmental regulations, and ensures water security.

5.1 Working Principle

FPSTAR technology works on the principles of physics, specifically on the principle of resonance. Each element in the periodic table possesses a specific Frequency of Disassociation (SFoD), the frequency at which elements disassociate from compounds to a stable elemental state.

Leachate, regardless of its composition, is essentially a combination of water and dissolved chemical compounds, composed of elements from the periodic table. When it is exposed to SFoDs corresponding to the elements present in it, the elements undergo disassociation from their compound state to stable elemental states. That's what happens in Aquatron, our water recovery system built on FPSTAR technology.

An elemental analysis is done prior to the commencement of the process to understand the elemental composition of the wastewater. Aquatron uses high intensity Electron Dipole Spin Resonance Frequency (EDSRF), which is tuned to the Specific Frequency of Disassociation (SFoD) in the shortwave range of the radio spectrum, produced at millions of cycles per second. As the wastewater/effluent passes through a series of special resonating columns/ boom towers housing the antennas, programmed to generate the various SFoD-EDSR frequencies specific to the elements found in the wastewater, it resonates the atoms in the fine particles, causing them to lose or gain electrons and become charge less particles, or equilibrium state.

These disassociated elements separate out from the water when subjected to microgravity conditions using continuous free fall. Under free-fall conditions, heavy elements agglomerate due to the Van der Waals force of attraction and settle down as sludge. Gaseous elements such as nitrogen and elements in the halogen group are released as gas from the top of the boom tower. Depending on their concentration, these gases are either released directly into the atmosphere or trapped and treated before release.

The processed water obtained can undergo further purification via sand filtration, activated carbon filters, ultra-fine filtration, etc. It then undergoes a final and unique filtration step, Reduction Facilitated Osmosis Diffusion (RFOD), which operates on the same mechanism as nutrient/water absorption in our bodies, to meet required standards. The final output is clean water of reusable quality without the formation of hazardous sludge. The sludge formed contains impurities largely in their elemental form, and depending on the nature of the wastewater, it can be used as a fertiliser or can be subjected to resource recovery. The typical Aquatron plant setup is shown in figure 5.

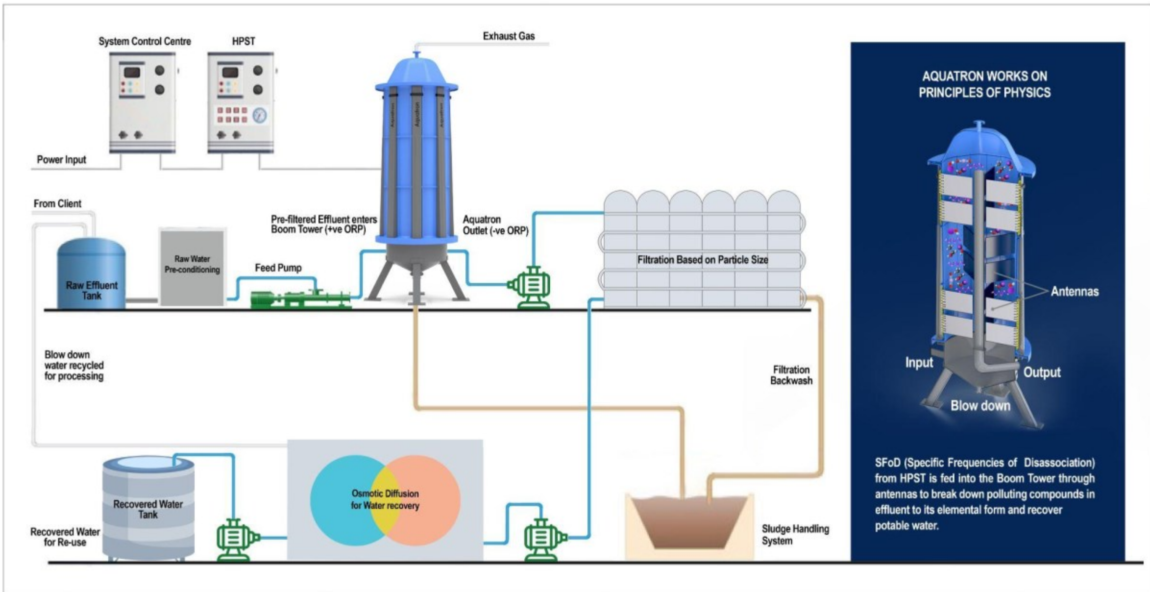


Figure 5: Schematic diagram of a typical Aquatron plant setup.

5.2 Reduction Facilitated Osmotic Diffusion (RFOD)

The final stage of the Aquatron FPSTAR technology is yet another innovation, aimed at recovering water of superior quality while utilising less energy. It utilises the same principles of water/nutrient reabsorption in our bodies.

It was observed that in our bodies, the water absorption that happens in kidneys, tissues or cells are not just by simple diffusion but by water selective channels. While simple diffusion is of low capacity and bidirectional, this selective reduction mediated water channel is of high capacity and has great selectivity for water.

By adopting and utilising this principle, RFOD filtration system enables higher water recovery rates having superior water quality, at much reduced pressure compared to conventional RO systems.

5.3 Key Benefits Of Aquatron

Aquatron - FPSTAR technology redefines the water recovery sector by treating the wastewater and reclaiming clean water of reusable standards at a low cost of ownership, with a reduced energy and water footprint. The technology is futuristic and has multi-fold benefits from a business perspective as well as from an environmental standpoint.

The key highlights of the technology are listed below:

- **Zero Liquid Discharge (ZLD):** Aquatron is capable of achieving ZLD without relying on energy-intensive evaporators, offering a more sustainable approach to effluent treatment.
- **High-Quality Water Recovery For Reuse:** Aquatron can ensure recovery of clean, reusable water, which can be reused in the process or can be used for other purposes like irrigation etc as per the requirements.
- **Low Power Consumption:** Aquatron consumes relatively less power (approximately 6 to 12 kWh/m^3), contributing to lower energy costs.

- **Fully Automated Operation**: Utilising SCADA, Aquatron operates with minimal human intervention, reducing maintenance and operational costs.
- **Space Efficiency:** Aquatron requires less space compared to conventional technologies, making it suitable for installation in areas with limited space availability.
- **Chemical/Microbe-Free Process:** Aquatron utilises the principles of shortwave resonance to recover clean water, without relying on chemical/ biological processes.
- **Non-Hazardous Sludge Production:** The sludge produced by Aquatron largely contains impurities in elemental form, making it non-hazardous and eliminating the need for hazardous sludge disposal costs.
- **Resource Recovery:** Aquatron allows for the recovery of resources from the sludge, which can be utilised for various industrial purposes, further enhancing its recyclability and sustainability.
- **Modular Design:** The modular nature of Aquatron allows for extension or expansion of the plant as per requirements, offering flexibility and scalability.
- **Retrofittable:** Aquatron can be retrofitted to the existing conventional ZLD water treatment systems, thereby reducing the overall capex.
- **Reduced Energy & Water Footprint:** Aquatron operates solely on electricity and consumes less power compared to conventional methods and achieves ZLD thereby reducing energy as well as water footprint respectively.
- **Regulatory Compliance:** Aquatron is designed to comply with norms and regulations ensuring that treated effluent meets required standards.

These key features of the technology, combined with its low cost of ownership, position Aquatron as a cost-effective and sustainable solution. Aquatron effectively treats complex wastewater, making it an ideal choice for wastewater treatment and water recovery needs.

5.4 General & Performance Metrics Of Aquatron

Table 3: General metrics of Aquatron plant

Parameters	Estimated Quantities
Total quantity of wastewater processed per day	30 KLD to MLD*
Type of wastewater that can be treated	Wastewater of any type and complexity. It can treat from contaminated groundwater to the complex effluent, landfill leachate.
Total quantity of water recovered per day	80% (Out of 20%, 10% will be in recirculation, and other 10% will be lost along with sludge and natural evaporation) However, exact permeate and recirculation volume will be tuned/ established at site while achieving ZLD.
Type of recovered water	Reusable water as per the requirement.
Estimated discharge (Sludge) per day	Max 0.5 kg per m^3 depending on the effluent quality. (Blow down)
Operation	Continuous

Power Consumption (kWh per m^3)	5 – 15 kWh/ m^3 depending on effluent quality.

* Aquatron plants are modular in nature and have flexibility for expansion as per requirement.

Table 4: Performance metrics of Aquatron plant

Constituents	Percentage Removed (max)
Suspended Solids	99%
Dissolved Solids	As per drinking water standards
Oil /Grease / Hydrocarbons	99%
Heavy Metals	99%
Hardness	90%
Bacteria /Fungus / Algae / Larvae and their spores	100%
Chemical Oxygen Demand (COD)	96%
Biological Oxygen Demand (BOD)	96%
Carbon, Ammonia and Sulphur Compounds	99%
Nitrites and Fluorides	96%
Ammoniacal Nitrogen	99%
Colour	99%
Odour	98%

5.5 Comparison Of Aquatron With Conventional Technologies

The other conventional technologies that are used for water treatment involve the use of chemicals or microorganisms. The chemical processes used for treatment exposes the environment to harsh chemicals leading to secondary pollution whereas the biological processes are less efficient especially when dealing with inorganic wastes.

Table 5: Comparison between Aquatron-FPSTAR technology and Conventional technologies

Technology	ETP with Aquatron	ETP with Conventional technologies
Process	Based on principles of physics	Chemical and/or Biological processes
Uptime	Highly redundant in nature. Each module can handle 30 to 60 m^3/day. Based on input, the required number of modules can be operated. Complete shutdown is not required. Hence, uptime of Aquatron technology is high.	Most of the pre-treatment processes, primary and secondary processes are not modular. Failure due to shock load, mechanical failure or any other may cause the entire plant to shut down. Hence it results in downtime impacting the treatment.
Efficacy	Same setup can be used for different effluent with updated inputs in software as it works on the principle of the physics, utilising SFODs.	Need special design for different effluents. Heavy metals will be in a concentrated form (either in sludge or in concentrated reject).

Odour	The entire system is fully enclosed. There will be no foul smell inside the plant area.	Mostly open tanks are used for primary and secondary treatments which leads to foul smell.
Retrofitting	Can be retrofitted to existing non-working treatment plants.	Entire new setup needs to be installed.
Capacity increment	Modular in nature allowing the flexibility for expansion upon need.	Increasing the capacity in the existing plants is always a challenge.
Space requirement	No need for aeration tanks. Settling tank is also very compact in size. Typical required area for 100 KLD plant is 10 X 15 m^2. Can be retrofitted to existing ETP/STP.	Usually needs exhaustive physico-chemical processes, biological oxidation, and clarification as a part of pre-treatment resulting in large area for plant setup.
Sludge disposal	Non-hazardous sludge, largely in elemental form, is produced.	Need special treatment for the hazardous and concentrated sludge disposal.
Operational cost and complexity	Fully automated. Can be stopped and started at any time depending on the load. One headcount required per shift. Uses only electricity for treatment.	Needs manual management, needs continuous operation even on very little load and is manpower intensive. Uses chemicals for treatment.

6. Past Projects

After assessing the plant operation and studying the various aspects of wastewater and its interaction with Aquatron as a system, we went into commercial production from 2018 and successfully completed many plants in a variety of industries.

One of our projects involved collaborating with a pioneering organisation in India's waste technology park. This facility specialises in processing municipal solid waste into valuable products. While managing significant daily volumes of municipal waste, they encountered a specific challenge: the formation of leachate from the 20-acre landfill. Seeking a technology that is both sustainable and cost-effective, aligning with forward-looking environmental policies and regulations, they approached us for a solution.

After the initial analysis, an Aquatron Plant of 50 KLD capacity was installed which efficiently processed the formed leachate, yielding reusable water.

The entire operation is automated and requires only one operator to oversee the plant's operations. The water recovery process consumes about 6 to 7 units of electricity for recovery of 1000 litres of water. And the sludge generated in the purpose is repurposed as fertiliser, contributing to the reduction of sludge disposal costs. Detailed results are presented in Table 6.

Using Aquatron technology, they effectively converted the toxic leachate into reusable water, making a noteworthy impact on environmental conservation, adhering to policies and protocols, and reducing cost requirements for the company.

Table 6: Test Reports On Leachate Treatment

Parameters	Raw Leachate	Aquatron + RFOD Permeate (Final Treated Water)
Colour	Greenish Black	Clear
Odour	Objectionable	Agreeable
pH	8.1	6.5
TDS	9980 mg/L	50 mg/L
COD	1379 mg/L	4 mg/L
BOD	560 mg/L	< 1 mg/L
Lead (Pb)	0.03 mg/L	< 0.01 mg/L
Chromium (Cr)	0.04 mg/L	0.02 mg/L
Nickel (Ni)	0.13 mg/L	0.01 mg/L

P.S. Please note that only the major parameters are showcased here. A complete report based on IS 10500:2012 standards was conducted and attached to this document.

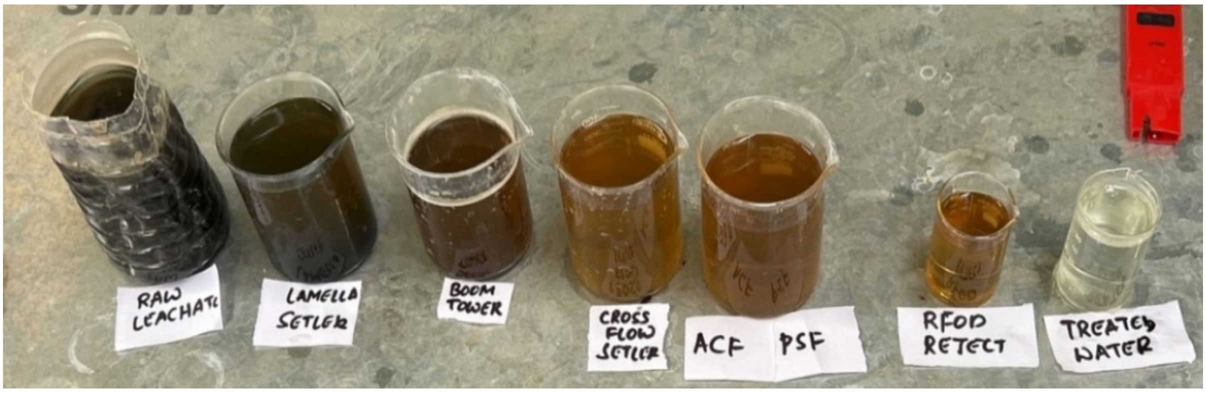


Figure 6: Samples obtained after every treatment stage.

7. Conclusion

This report emphasises the urgent requirement for a sustainable yet cost-effective waste treatment solution that can be implemented on a commercial scale. Existing technologies fall short in effectively managing the current waste generation and are ill-equipped to handle the anticipated surge in waste production in the coming years. Therefore, there is a critical need for a disruptive technology capable of overcoming the challenges posed and bridging the existing gaps in waste management.

With our Aquatron - FPSTAR technology, it is possible to break down waste of any nature into its non-toxic elemental form, eliminating its threat to the environment. Moreover, this technology has the potential for the recovery of valuable raw materials and the purification of water to reusable standards, offering a comprehensive solution for both current and future waste management challenges. Collaboratively, we can reduce the water footprint and reverse the environmental damage inflicted.

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Complete Report

Raw Effluent Full Report

Analytical Research & Metallurgical Laboratories Pvt. Ltd.

TEST REPORT

Report/Order. No.	:	202300420	Date: 02.02.2023
Total Pages	:	Two	Page : 01 of 02
Customer	:	Scalene- Energy Water Corporation Limited	
	:	S-card-Campus, Seegehalli Main Road,	
		Virgo Nagar Post, Bangalore 560049	
Requested by	:	Mr Oommen Thomas	
Product Tested	:	Raw water	
Sample identification	:	Raw land fill Leachate sample	
Reference	:	E mail dt 20.01.2023	
Date of sample receipt	:	21.01.2023	
Sampling, if any	:	N. A.	

Chemical Analysis

Test started on	:	23.01.2023	Test completed on :01.02.2023
Specification	:	Not Specified	Test method : As below

Test Parameters	Unit	Results	Test Method
pH	-	8.1	IS3025 (P-11) 1983
Colour	Visual	Greenish Black	IS3025 (P-04) 1983
Odour	-	Objectionable	IS3025 (P-04) 1984
Total Suspended Solids	mg/l	860	IS3025 (P-15) 1984
Particulate size of suspended solids	mg/l	Passes 850 mesh	IS3025 (P-16) 1984
COD	mg/l	1379	IS3025 (P-58) 2006
BOD	mg/l	560	IS3025 (P-44) 1993
Sulphides	mg/l	<1	IS3025 (P-24) 1986
Nitrates Nitrogen	mg/l	446	APHA 23rd Edn 2017 4500 A
Free Ammonia NH3	mg/l	110	IS3025 (P-34) 1988
Ammonical Nitrogen as NH3	mg/l	432	IS3025 (P-34) 1988
Total Kjaldhal Nitrogen	mg/l	866	IS3025 (P-34) 1988
Oil & Grease	mg/l	<10	IS3025 (P-39) 1991
Arsenic as As	mg/l	<0.01	IS3025 (P-2) 2004
Mercury as Hg	mg/l	<0.001	IS3025 (P-2) 2004
Lead as Pb	mg/l	0.03	IS3025 (P-2) 2004
Hexavelent chromium	mg/l	<0.1	APHA 23rd Edn 2017 3500 b
Total Chromium	mg/l	0.04	IS3025 (P-2) 2004
Cyanide	mg/l	<0.01	IS3025 (P-27) 1986
Cadmium as Cd	mg/l	<0.01	IS3025 (P-2) 2004

ARML/F/008/Issue/2/amend/01

A101 & A102, KSSIDC Complex, Block II, Electronics City Phase I, Bangalore – 560100
Tel: 080-28528304, E mail: info@arml.in : Website: www.arml.in

Analytical Research & Metallurgical Laboratories Pvt. Ltd.

Report/Order. No.	:	202300420	Date: 31.01.2023
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Nickel as Ni	mg/l	0.13	IS3025 (P-2) 2004
Copper as Cu	mg/l	0.01	IS3025 (P-2) 2004
Iron as Fe	mg/l	4.7	IS3025 (P-2) 2004
Total Residual chlorine	mg/l	<0.1	IS3025 (P-26) 1986
Selenium as Se	mg/l	0.06	IS3025 (P-2) 2004
Nickel as Ni	mg/l	0.13	IS3025 (P-2) 2004
Fluoride	mg/l	<0.1	IS:3025(P-60)2008
Phosphates as P	mg/l	16.2	IS3025 (P-2) 2004
Phenolic compounds (as C6H5OH)	mg/l	<0.1	IS:3025(P-43) 1992
Manganese as Mn	mg/l	0.48	IS:3025(P-2)2004
Vanadium as V	mg/l	0.02	IS:3025(P-2)2004
Sulphates as SO4	mg/l	993	IS:3025(P-24) 1986
Total Dissolved Solids	mg/l	9980	IS:3025(P- 16) 1984
Turbidity	NTU	9.6	IS:3025(P- 16) 1984

Remarks : *Nil*

Authorized Signatory

------------------ **End of the Report** --------------------

Terms and Conditions:

1. The results listed above pertain only to the tested samples and applicable parameters.
2. Sampling is not done by us unless otherwise specified
3. Samples which are degradable will be disposed immediately after testing and others will be disposed one month from the date of issue of test report unless otherwise specified.
4. Total liability of our lab is limited to the invoice amount
5. This report is not to be reproduced either wholly or in part and cannot be used as evidence in the Court of Law
6. Any discrepancies in the test report to be reported within 30 days.
7. Customer shall be responsible for all the errors, disputes, losses or damages arising out of report(s) made using test procedures provided by the customer.

ARML/F/008/Issue/1/amend/1

A101 & A102, KSSIDC Complex, Block II, Electronics City Phase I, Bangalore – 560100
Tel: 080-28528304, E mail: info@arml.in : Website: www.arml.in

Final Treated Water Full Report

Analytical Research & Metallurgical Laboratories Pvt. Ltd.

TEST REPORT

Report/Order. No.	:	202300421	Date: 02.02.2023
Total Pages	:	Three	Page : 01 of 03
Customer	:	Scalene- Energy Water Corporation Limited	
	:	S-card-Campus, Seegehalli Main Road, Virgo Nagar Post, Bangalore 560049	
Requested by	:	Mr Oommen Thomas	
Product Tested	:	Water Sample	
Sample identification	:	Final treated water obtained from Leachate	
Reference	:	E mail dt 20.01.2023	
Date of sample receipt	:	21.01.2023	
Sampling, if any	:	N. A.	

Chemical Analysis

Test started on : 23.01.2023 Test completed on : 01.02.2023

Specification : IS 10500: 2012 Test method : As below

Test Parameters	Unit	Results	Requirement (Acceptable Limit)As per 10500: 2012	Test Method
Colour	Visual	Colourless	Clear	IS:3025(P-4) 1983
Odour	-	Agreeable	Agreeable	IS:3025(P-5) 1983
pH value	-	6.5	6.5-8.5	IS:3025(P- 1 1)1983
Taste	-	Agreeable	Agreeable	IS:3025(P-7 & 8)1984
Turbidity	NTU	<0.1	1 max	IS:3025(P- 10) 1984
Total dissolved solids	mg/l	50	500 max	IS:3025(P- 16) 1984
Aluminium (as Al)	mg/l	<0.01	0.03 max	IS: 3025(P-2) 2004
Ammonia (as total ammonia-N)	mg/l	<0.1	0.5 max	IS:3025(P-34) 1988
Anionic detergents (as MBAS)	mg/l	<0.1	0.2 max	Annex K of IS 13428
Barium (as Ba)	mg/l	0.02	0.7 max	IS:3025(P-2)2004
Boron (as B)	mg/l	0.26	0.5 max	IS:3025(P-2)2004
Calcium (as Ca)	mg/l	2	75 max	IS:3025(P-2)2004
Chloride (as Cl)	mg/l	9	250 max	IS:3025(P-32) 1988
Copper (as Cu)	mg/l	<0.01	0.05 max	IS:3025(P-2)2004
Fluoride (as F)	mg/l	<0.1	1 max	IS:3025(P-60)2008
Free residual chlorine	mg/l	<0.1	0.2 min	IS:3025(P-26) 1986
Iron (as Fe)	mg/l	0.13	0.3 max	IS:3025(P-2)2004
Magnesium (as Mg)	mg/l	0.8	30 max	IS:3025(P-2)2004

ARML/F/008/Issue/1/amend/1

Analytical Research & Metallurgical Laboratories Pvt Ltd

Report/Order. No.	:	202300421	Date: 31.01.2023
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Manganese (as Mn)	mg/l	<0.01	0.1 max	IS:3025(P-2)2004
Mineral oil	mg/l	<0.1	0.5 max	IS : 3025(P-39) 1991
Nitrate (as NO3)	mg/l	1	45 max	IS:3025(P-34) 1988
Phenolic compounds (as C6H5OH)	mg/l	<0.001	0.001 max	IS:3025(P-43) 1992
Selenium (as Se)	mg/l	<0.01	0.01 max	IS: 3025(P-2) 2004
Silver (as Ag)	mg/l	0.02	0.1 max	IS:3025(P-2)2004
Sulphate (as SO4)	mg/l	0.7	200 max	IS:3025(P-24) 1986
Sulphide (as H2S)	mg/l	<0.05	0.05 max	IS:3025(P-29) 1986
Total alkalinity (as CaCO3)	mg/l	47	200 max	IS:3025(P-23) 1986
Total hardness (as CaCO3)	mg/l	15	200 max	IS:3025(P-21) 1983
Zinc (as Zn)	mg/l	<0.01	5 max	IS:3025(P-2)2004
Cadmium (as Cd)	mg/l	<0.001	0.003 max	EPA 200.8
Cyanide (as CN)	mg/l	<0.05	0.05 max	IS:3025(P-27) 1986
Lead (as Pb)	mg/l	<0.01	0.01 max	IS:3025(P-2)2004
Mercury (as Hg)	mg/l	<0.001	0.001 max	EPA 200.8
Molybdenum (as Mo)	mg/l	<0.05	0.07 max	IS:3025(P-2)2004
Nickel (as Ni)	mg/l	0.01	0.02 max	IS:3025(P-2)2004
Polychlorinated biphenyls	mg/l	BDL of 0.0005	0.0005 max	APHA 23rd Edn 2017 (P-6630C)
Polynuclear aromatic hydrocarbons (as PAH)	mg/l	BDL of 0.0001	0.0001 max	APHA 23rd Edn 2017 (P-64408)
Total arsenic (as As)	mg/l	<0.01	0.01 max	IS:3025(P-2)2004
Total chromium (as Cr)	mg/l	0.02	0.05 max	IS:3025(P-2)2004
Residual Pesticides				
Atrazine	µg/l	BDL of 0.1	2 max	UsEPA-525.2/LCMS
Aldrin	µg/l	BDL of 0.03	0.03 max	USEPA 508
Dieldrin	µg/l	BDL of 0.03	0.03 max	USEPA 508
Gamma-HCH (Lindane)	µg/l	BDL of 0.1	2 max	USEPA 508
Phorate	µg/l	BDL of 0.1	2 max	USEPA.8141A/LCMS
Alachlor	µg/l	BDL of 0.1	20 max	UsEPA-525.2/LCMS
Alpha HCH	µg/l	BDL of 0.01	0.01 max	USEPA 508
Chlorpyrifos	µg/l	BDL of 0.1	30 max	USEPA-525.2
Delta HCH	µg/l	BDL of 0.04	0.04 max	USEPA 508
DDT (op & pp -Isomers of DDT. DDE & DDD)	µg/l	BDL of 0.1	1 max	USEPA 508
Endosulfan (a B and sulphate)	µg/l	BDL of 0.1	0.4 max	USEPA 508

ARML/F/008/Issue/1/amend/1

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Trihalomethanes:

Methyl Parathion	µg/l	BDL of 0.1	0.3 max	USEPA-8 14 1A/LCMS
Monocrotophos	µg/l	BDL of 0.1	1 max	USEPA-8 141A/LCMS
2,4 - Dichlorophenoxyacetic acid	µg/l	BDL of 0.1	30 max	USEPA 515.1/LCMS
Isoproturon	µg/l	BDL of 0.1	9 max	USEPA-532/LCMS
Beta HCH	µg/l	BDL of 0.04	0.04 max	USEPA 508
Butachlor	µg/l	BDL of 0.1	125 max	USEPA-525.2/LCMS
Ethion	µg/l	BDL of 0.1	3 max	USEPA-8141A/LCMS
Malathion	µg/l	BDL of 0.1	190 max	USEPA-8 14 1A/LCMS
a) Bromoform	mg/l	BDL of 0.05	0.1 max	APHA 23rd Edn 2017 (P-62328)
b) Dibromochloromethane	mg/l	BDL of 0.05	0.1 max	
c) Bromodichloromethane	mg/l	BDL of 0.05	0.06 max	
d) Chloroform	mg/l	BDL of 0.05	0.2 max	

Microbiology

Total coliform	MPN/100 ml	Not detected	Shall not be detectable	IS:1622-2003
E.coli	MPN/100 ml	Not detected	Shall not be detectable	IS:1622-2003

BDL -Below Detection Limit

Note: The Residual free chlorine test is applicable only when water is chlorinated.

Remarks : The above Tested parameters meets the requirements as per IS 10500 : 2012

Authorized Signatory

------------------ **End of the Report** --------------------

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