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Analysis of Medical Waste Water Through Soil Aquifer Treatment

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Abstract: *Soil Aquifer Treatment (SAT) emerges as a promising sustainable approach for the remediation of medical wastewater. This study investigates the efficacy of SAT in treating medical wastewater, focusing on its ability to remove pharmaceutical compounds, pathogens, and organic pollutants. Through a comprehensive literature review and experimental analysis, various parameters influencing SAT performance are evaluated, including hydraulic loading rates, soil characteristics, and wastewater composition. Results indicate that SAT can efficiently reduce pharmaceutical concentrations, with degradation rates influenced by soil properties, microbial activity, and wastewater characteristics. Moreover, pathogen removal efficiencies demonstrate the potential of SAT to mitigate microbial risks associated with medical wastewater discharge. To treat waste water vertical method is used with various soil profiles . The black, red, mixed red and black soils are used to treat the medical waste water. We have taken the 4 pipes in each pipe have taken variouetupes of soil profiles to treat water with an length (120 CM). After treating the waste water the results are calibrated in the table number 1 and table number 2. The results are compared with treated and untreated water, from that treated soil profiles black soil is suitable for using the water for gardening and planting purposes comparison is done in the table no 2 with standard values (Heavy metals test) of waste water sample and black soil. Further research is recommended to optimize system design, operation, and monitoring protocols for widespread implementation of SAT in medical wastewater treatment practices with black soil.*

Keywords: SAT, Vertical Method, Horizontal Method, Medical Wastewater

I. INTRODUCTION

Soil aquifer treatment (SAT) is a widely studied method for wastewater treatment and groundwater recharge. Studies often focus on its effectiveness in removing contaminants, its impact on groundwater quality, and the optimal conditions for its application in different environments. Additionally, groundwater analysis studies examine various parameters such as groundwater level, quality, and flow dynamics to understand aquifer behaviour and ensure sustainable management practices.

Treating medical wastewater using soil aquifer treatment can remove contaminants like pathogens, pharmaceuticals, and organic compounds. The soil acts as a natural filter, breaking down pollutants and allowing clean water to recharge aquifers. However, the effectiveness depends on factors like soil type, hydraulic conductivity, and the specific contaminants present. Testing and monitoring are crucial to ensure the process meets regulatory standards and doesn't harm groundwater quality. Characterization of SAT: Soil aquifer treatment (SAT) involves evaluating its effectiveness in treating wastewater by assessing factors such as contaminant removal efficiency, changes in water quality parameters, microbial activity, and system sustainability. By understanding these aspects, stakeholders can optimize SAT performance and ensure its suitability for wastewater treatment applications while safeguarding environmental and public health. Characterization Of Treated Wastewater: Analyze the treated wastewater to determine the extent of colour removal, as well as the effect on other water quality paraments such as pH, chemical oxygen demand (COD), and total suspended solids (TSS). Comparison With Other Treatment Process: SAT offers a sustainable and cost-effective approach to wastewater treatment, its suitability depends on factors such as the quality of the wastewater, site-specific conditions, and regulatory requirements. Conventional treatment processes provide faster results but may

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require higher capital and operational costs and have a greater environmental footprint. The choice between SAT and other treatment processes depends on the specific needs and constraints of each situation. Natural SAT relies on passive processes, while artificial SAT involves controlled infiltration for specific purposes. Both methods contribute to sustainable water management and aquifer recharge.

Vertical Method (Artificial Method):

Vertical Soil Aquifer Treatment (SAT) is a wastewater treatment method where treated effluent is percolated vertically through unsaturated soil layers. This process helps remove contaminants before the water reaches the groundwater. The vertical method involves constructing infiltration basins or trenches to allow the controlled flow of wastewater through the soil, promoting biological and physical treatment. It's a sustainable approach to wastewater management, enhancing water quality before it reaches the aquifer.

II. LITRATURE SURVEY:

Ashata Sahya, Saheb Rao Sonkamble, Mahesh Jampani, Alwal Narsing Rao a, Priyanie Amerasinghe cla, "Field site soil aquifer treatment shows enhanced wastewater quality: Evidence from vadose zone hydro-geophysical observations" -2023.

Domestic sewage genesis and its treatment have become a major environmental Concern especially in developing countries, which require nature-based energy efficient waste water treatment alternative SAT is also known as infiltration process waste water effluent passes through the vadose zone to recharge. The underlying aquifer system, help to long storage of water effluent passes vadose zone to recharge aquifer. The physical methods electrical resistivity thermograph (ERT) has been predominantly applied for contamination study and solid waste characteristics before land filling mining. The field site sat system has been that that quantifies the vadose zone potentially in removing the organic, inorganic and microbial contaminants. The oxide vadose zone could not facilitate at the anaerobic condition and availability of organic.

Chol D.T. Abel a, Saroj K. Sharma a, Selamwit A. Mersha a, Maria D. Kennedy a "Influence of intermittent infiltration of primary effluent on removal of suspended solids, bulk organic matter, nitrogen and pathogens indicators in a simulated managed aquifer recharge system".

The passage underscores the critical need for sustainable wastewater treatment and reuse technologies, particularly in regions facing water scarcity due to factors like population growth and urbanization. Soil Aquifer Treatment (SAT) emerges as a cost-effective solution, utilizing soil layers for further treatment of wastewater effluent. The study utilized primary effluent (PE) from the Harnaschpolder wastewater treatment plant in the Netherlands, subjected to meticulous preparation steps before application in the laboratory-based SAT system. Notably, suspended solids (SS) removal was evaluated at varying depths and wetting/drying cycles, revealing consistently high removal rates irrespective of the cycle duration. The study found no significant difference in Suspended Solids removal under continuous or intermittent primary effluent application, with over 70% of Suspended Solids content removed primarily through straining mechanisms. Additionally, dissolved organic carbon (DOC) removal ranged from 50% to 60%, showing resilience to changes in hydraulic loading rate(HLR) and wetting/drying cycles. These findings underscore the efficacy and reliability of the SAT system in removing contaminants from Primary Effluent, offering promising implications for sustainable wastewater treatment and reuse practices.

Imma Bortone, Alessandro Erto, Armando Di Nardo, Giovanni F. Santonastaso c, Simeone Chianese c, Dino Musmarr "Pump-and-treat configurations with vertical and horizontal wells to remediate an aquifer contaminated by hexavalent chromium",

Groundwater contamination is one of the most serious environmental problems. In particular chromium is found to be in groundwater and it is polluted from past decades and it is relevantly found both soil and water. The pump and treatment method are used for removal of chromium in contaminated water by absorption onto a activated carbons. And it is absorbed that 40% of cr is removed in this method. The vertical method is used, compared to horizontal method because it is time varying period compare to vertical.

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Kavyashree H. N, D.P. Nagaraj Appa, P. Shiva Keshava Kumar "Treatment of Wastewater by Soil Aquifer Treatment (SAT) in Conjunction with Natural Adsorbent".

Developing the environment sustainable Technology for the available water and wastewater to getting a reuse of water for the water problems. In this technology the soil / amplifier-based system is in conjunction with natural adsorbent. In this they the banana peel as there adsorbent. The banana peel was collected and washed several times in tap water and with distilled water. The washed peel is sun dried for week. Then crush into small pieces and kept 24hours of drying in oven at 80*C. After that peel will the moisture with in it. The colour will change from yellow to brownish as observed. Then dried material was finely ground and screened in 150-212mm sieves.

III. SAT

Soil Aquifer Treatment (SAT) is an artificial groundwater aquifer recharge option. Water is introduced into the groundwater through soil percolation under controlled conditions. Soil aquifer treatment is either used to artificially augment the groundwater in order to withdraw freshwater again at a later stage or as a barrier to prevent saltwater or contaminants from entering the aquifer. During percolation, natural soil filtration occurs and the water enters the aquifer where mixing and possibly some other physical and chemical reactions may occur. This method can be used with reclaimed water (treated blackwater) or relatively little polluted water (e.g. pre-treated greywater or stormwater). Natural SAT relies on passive processes, while artificial SAT involves controlled infiltration for specific purposes. Both methods contribute to sustainable water management and aquifer recharge.

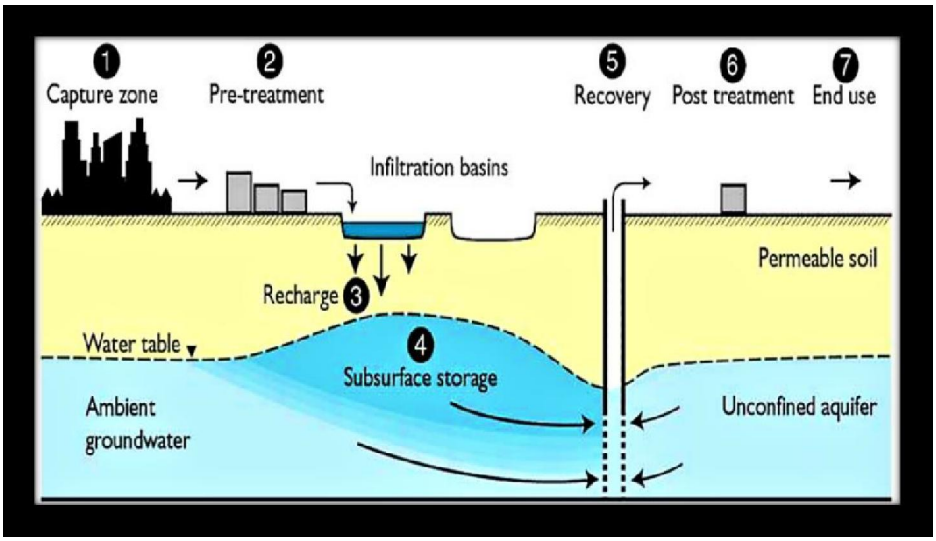

Fig 1: Process of Soil Aquifer Treatment

Methods of Soil Aquifer Treatment:

- Vertical Method
- Horizontal Method

In the soil aquifer treatment for treating medical waste water vertical method is used.

Vertical method:

Vertical Soil Aquifer Treatment (SAT) is a wastewater treatment method where treated effluent is percolated vertically through unsaturated soil layers. This process helps remove contaminants before the water reaches the groundwater. The vertical method involves constructing infiltration basins or trenches to allow the controlled flow of wastewater through the soil, promoting biological and physical treatment. It's a sustainable approach to wastewater management, enhancing water quality before it reaches the aquifer.

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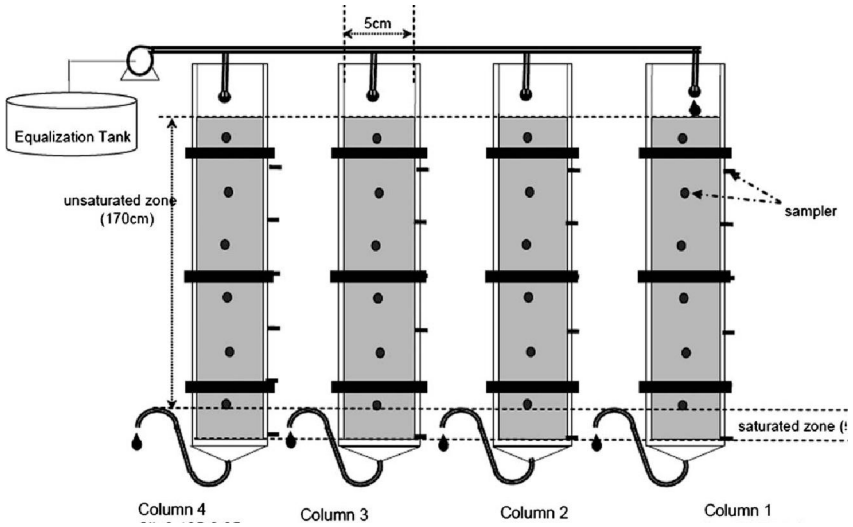

Fig 2: vertical method (Artificial Method).

Combination of soil profiles:

- Red soil
- Black soil
- Red soil and black soil
- Mixed red and mixed black soil

Results After Treating the Waste Water with Various Soil Profiles by Vertical Method (SAT).

Parameters	Untreated Sample, (mg/L)	RS WS, (mg/L)	BS WS, (mg/L)	(BS +RS) WS, (mg/L)	(MBS + MRS +RS +BS) WS, (mg/L)
pH	7.12	6.95	7.01	6.09	7.68
Iron Fe	0.42	0.44	0.39	1.9	4.14
Copper cu	0.11	0.32	0.25	0.35	0.52
Zinc Zn	0.15	1.24	0.9	1.5	8.48
Nickel Ni	0.42	0.08	0.25	0.9	2.14
Lead Pb	BDL	0.06	0.03	0.1	0.64
Manganese Mn	0.02	0.12	0.2	0.7	1.48
Chromium Cr	0.06	0.12	0.05	0.25	0.66
Cadmium Cd	0.03	0.10	0.02	0.49	0.74
BOD	150	56	50	75	120

Table no 1: Result of Both Untreated and Treated Water

BDL (Below Detection Limit), **RSWS** (Red Soil Water Sample),**BSWS** (black soil water sample),**(BS +RS) WS** [(black soil +red soil)water sample], **(MBs + MRS +RS +BS) WS** [(mixed black soil + mixed red soil +red soil + black soil) water sample].

IV. CONCLUSION

The analysis of medical wastewater treatment through soil aquifer treatment (SAT) using the vertical method reveals promising outcomes. This approach efficiently reduces contaminant concentrations in medical wastewater by facilitating percolation through soil layers, allowing for physical, chemical, and biological processes to remove pollutants. The vertical SAT method demonstrates effectiveness in removing pathogens, organic matter, and nutrients, thus safeguarding groundwater quality and minimizing environmental contamination risks. Moreover, its sustainability and cost-effectiveness make it a favourable solution for medical wastewater treatment, particularly in areas with limited

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access to conventional treatment options. Overall, the analysis underscores the potential of the vertical SAT method as a viable and environmentally sound approach to addressing the challenges of medical wastewater management.After performing various field iterations is found that the different soil profile yields different results while conducting tests on medical wastewater collected from VIMS Ballari. The treated wastewater is recommended for 'Gardening' and 'Cleaning Purpose'. When the different iteration compared with various standards of water used for Gardening and Cleaning Purpose shows that water treated with Red Soil and Black Soil show promising results. That results are disused below under compared with standards of treated wastewater.

Table 2: Comparing Treated Wastewater with Water Standards

Sl.no	Name of heavy metals	Standards of treated wastewater in mg/L	Black soil water sample
1.	Chromium	0.05	0.05
2.	Iron	0.3	0.39
3.	Nickel	NA	0.25
4.	Manganese	0.5	0.2
5.	Zinc	15	0.9
6.	Cadmium	0.01	0.02
7.	Lead	0.1	0.03

this shows that the treated water from black soil shows maximum similarities with the water required for gardening and cleaning. Further studies on combinations of different soil profile are suggested for future works.

REFERENCES

[1]. Ashata Sahya, Saheb Rao Sonkamble, Mahesh Jampani, Alwal Narsing Rao a, Priyanie Amerasinghe cla, "Field site soil aquifer treatment shows enhanced wastewater quality: Evidence from vadose zone hydro-geophysical observations". (https://doi.org/10.1016/j.jenvman.2023.118749).

[2]. Chol D.T. Abel a, Saroj K. Sharma a, Selamwit A. Mersha a, Maria D. Kennedy a b. "Influence of intermittent infiltration of primary effluent on removal of suspended solids, bulk organic matter, nitrogen and pathogens indicators in a simulated managed aquifer recharge system". (https://doi.org/10.1016/j.ecoleng.2013.12.045).

[3]. Caterina Levantesi a, Rosanna La Mantia b, Costantino Masciopinto b, Uta Böckelmann c 1, M. Neus Ayuso-Gabella d, Miquel Salgot d, Valter Tandoi a, Emmanuel Van Houtte e, Thomas Wintgens f, Elisabeth Grohmann c 2. "Quantification of pathogenic microorganisms and microbial indicators in three wastewater reclamation and managed aquifer recharge facilities in Europe". (https://doi.org/10.1016/j.scitotenv.2010.07.042).

[4]. Gilboa Arye, Ishai Dror, Brian Berkowitz. "Fate and transport of carbamazepine in soil aquifer treatment (SAT) infiltration basin soils". (https://doi.org/10.1016/j.chemosphere.2010.09.062).

[5]. Imma Bortone, Alessandro Erto, Armando Di Nardo, Giovanni F. Santonastaso c, Simeone Chianese c, Dino Musmarr "Pump-and-treat configurations with vertical and horizontal wells to remediate an aquifer contaminatedby hexavalent chromium", (https://doi.org/10.1016/j.jconhyd.2020.103725).

[6]. Julie A. LaBar, Robert W. Nairn "Characterization of trace metal removal products in vertical flow bioreactor substrates at the Mayer Ranch Passive Treatment System in the Tar Creek Superfund Site",(https://doi.org/10.1016/j.chemosphere.2018.01.134).

[7]. Kavyashree H. N, D.P. Nagaraj Appa, P. Shiva Keshava Kumar "Treatment of Wastewater by Soil Aquifer Treatment (SAT) in Conjunction with Natural Adsorbent".

[8]. Saroj K. Sharma, Maria D. Kennedy "Soil Aquifer Treatment For Wastewater Treatment And Reuse", in April 2017 (https://doi.org/10.1016/j.ibiod.2016.09.013).

[9]. Suqing Wu a 1, Hong Wang a 1, Chun Zhen Fan a, Weili Zhou a, Sheng Bing He a b, Xiang Yong Zheng c. "Intermittent operating characteristics of an ecological soil system with two-stage water distribution for wastewater treatment". (https://doi.org/10.1016/j.chemosphere.2018.10.014).

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[10]. Tor Kristian Stevik a, Geir Ausland a, Petter Deinboll Jenssen a, Robert L Siegrist b. "Removal of E. coli during intermittent filtration of wastewater effluent as affected by dosing rate and media type". (https://doi.org/10.1016/S0043-1354(98)00413-8).

[11]. Takashi Asano a, Joseph A Cotruvo b c, "Groundwater recharge with reclaimed municipal wastewater: health and regulatory considerations". (https://doi.org/10.1016/j.watres.2004.01.023).

[12]. Van Cuyk, R Siegrist, A Logan, S Masson, E Fischer, L Figueroa. "Hydraulic and purification behaviours and their interactions during wastewater treatment in soil infiltration systems". (https://doi.org/10.1016/S0043-1354(00)00349-3).