"Treatment Of Pharmaceutical Waste Water By Rotating Biological Contractor"

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ABSTRACT: Rotating Biological Contactor is a type of attached growth biological waste water treatment unit mostly used in the waste water treatment units. In secondary stage of treatment process where we will use methods like trickling filters or activated sludge process but Rotating Biological Contactor provides 8 to 10 times higher level of treatment facility. Rotating Biological Contactor consists simple design, high reliability, and low energy consumption. It contains series of rotating discs to support the biological growth with help of sustainable organic matters, which consists of 5 parallel designed discs for their rotating process in waste water treatment unit. With arrangement of merging the 60% of wastage. where 40% of circular portion of rotating discs may rotate with the respective rpm based values with constant flow of wastage. In the ecological system of life cycle every biotic and abiotic will discard the toxic elements disbursement in atmosphere. The absorb particles while circular rotating discs may absorb 60% of merged toxic elements with that the continues and intermittent rotation may cause huge impact in clearing of toxic elements in wastewater such that the organic and sustainable may cause zero impact to the surrounding environment to absorb particulate matters like nitrogen compounds, carbon compounds, sulphates, zinc, oxygen compounds and some of the heavy metals. Its efficiency depends on the hydraulic retention time, disc submerged in wastewater, disc rotating speed. It is mostly used for nitrification, denitrification, phosphorus removal process in waste water treatment.

Keywords:*Biological Waste Water, Biological Growth, Particulate Matters, Compounds, Hydraulic Retention Time, Parameters, Nitrification*

I. INTRODUCTION

In current generations, the disposal of pharmaceutical wastewater has become a critical concern due to its complex composition and potential environmental consequences. To address this challenge, innovative treatment methods are necessary to design like sustainable treatment units i.e The Rotating Biological Contractor (RBC's) emerges as a promising solution for that critical consequences , this innovation aims to explore the feasibility and efficiency of Rotating Biological Contractor unit. This technology of treatment to undesired liquid wastewater for treating of pharmaceutical hazardous wastewater. So Rotating Biological Contractor works on the principle of sustainable sanitation system, which operates the mobilizing growth of microbial activities so the growth of microbes will be reduced due to excessive organic concentrations by utilizing microorganisms attached to a rotating medium to break down organic and inorganic pollutants, offering an environmentally friendly in cost-effective option.

The primary goal of this research to achieve efficient pollutant removal from pharmaceutical wastewater. By utilizing the rotational biological movement in their 60% of merged medium. The Rotating Biological Contractor maximizes the contact between microbial growth and hazardous wastewater, facilitating the breakdown of pharmaceutical compounds and organic matter. Moreover, Rotating Biological Contractor proves to be cost-effective, requiring less energy and maintenance compared to conventional wastewater treatment methods, thus increasing the level of zero carbon foot print in the environment for their operational costs and pharmaceutical activities. The Environmental Sustainability is another key aspect to address by Rotating Biological Contractor technology. Through the promoting biological activity using the absorbents, to reduce the chemical additives, thereby minimizing the environmental excessive parameters in treating the toxic elements which with holds the activity of treatment processes. Additionally, compliance with regulatory standards is essential for pharmaceutical companies to discharge their hazardous waste into the natural resources. This research aims to demonstrate the ability of Rotating Biological Contractor to meet their requirements, ensuring environmental responsibility.

Furthermore, the scalability and adaptability of Rotating Biological Contractor technology make a huge impact to secure the environment by protecting from the undesired objects by using phenomenal processes in treatment technology. It suitable for various hazardous wastewater treatment facilities in their compositions, providing flexibility for different pharmaceutical manufacturing facilities. Through rigorous experimentation and analysis,

this project intends to provide valuable insights into the effectiveness and practicality of using Rotating Biological Contractor for treating pharmaceutical wastewater in any season. The successful implementation of Rotating Biological Contractor technology can significantly contribute to mitigating the environmental impact of pharmaceutical production and ensuring sustainable water management practices.

By testing and studying the Rotating Biological Contractor, this project wants to show that it's a good way to clean dirty water from drug factories. If it works well, it can help make drug factories cleaner and safer for the environment.

II. OBJECTIVES

- To review current approaches to the design of Rotating Biological Contractor.
- To review oxygen transfer theory as applied to the Rotating Biological Contractor.
- To develop an oxygen transfer model capable of accommodating typical design variations and problems of scale-up.
- To develop a process model incorporating BOD and dissolved oxygen predictions suitable for use as an aid for design and performance evaluation.

III. MATERIALS

AQUARIUM Aquariums in civil engineering are essential for studying hydraulic processes, testing stormwater management, and designing aquatic habitats, specifically using the Rotating Biological Contractor for treating pharmaceutical water.

Fig1. Aquarium

BEARING: Circular bearings, a critical component in civil engineering, support structures, reduce friction, and facilitate movement, enabling a 19mm shaft to rotate freely with the assistance of a DC motor, thereby enhancing functionality in infrastructure projects.

Fig2. Bearing

DISC : Circular discs, crucial in civil engineering, perform tasks such as concrete cutting and grinding, being 8 inches in diameter with a 1-inch center hole, spaced 100mm apart on a shaft, supporting thermocol and aiding in construction and maintenance activities in this research.

Fig3. Disc

SHAFT: The research utilizes a 36-inch iron shaft with a 19mm diameter, connecting to bearings, a reducer, and a motor, to position and rotate discs in water at specified RPM, facilitating mechanical functions.

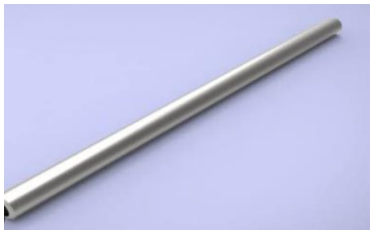


Fig4. Shaft

MOTOR: The 12V DC motor used in this experiment rotates the shaft at the required RPM, contributing to various engineering applications.

Fig5. Motor

BATTERY : The 12V rechargeable battery with a capacity of 7.2AMP provides the required energy to the motor and RPM controller for their operation in this experiment.

Fig6. Battery

REDUCER : The plastic reducer, connecting the shaft and motor gear tightly, is crucial for controlling the motor's speed as required in engineering applications involving pipes or ducts of different sizes.

Fig7. Reducer

STAND : The wooden stand, measuring 23x21x18cm, plays a crucial role in placing the motor securely in position, ensuring support, stability, and vibration absorption in engineering applications, enhancing safety and functionality.

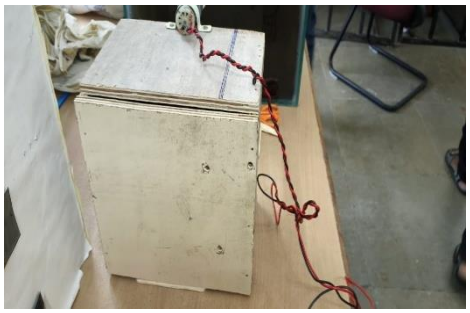


Fig8. Stand

WIRES : The 1sqmm copper wire, crucial in engineering, connects the reducer, battery, and various electrical functions in engineering applications motor to supply power, conducting electricity and facilitating.

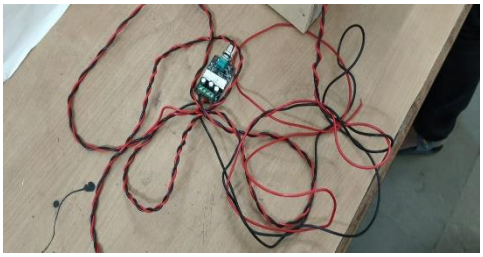


Fig9. Wires

THERMACOAL : The 8-inch circular thermocol separates the discs and facilitates the application of biological powders on four sections in engineering applications such as insulation and prototyping.

Fig10. Thermacol

CLOTH : The gum-coated cloth covers the four sections of discs and thermocol, facilitating the application of neem leaf powder, lemon peel powder, Tulasi powder, and charcoal powder for engineering purposes.

Fig11. Cloth

GEAR : The aluminum gear, with an outer diameter of 16mm and inner diameter of 8mm, connects the motor shaft and reducer, facilitating energy transmission and shaft rotation with the help of the motor in engineering applications involving power transmission, speed control, and torque amplification

Fig12. Gear

CLAMP : The stainless steel clamp, an indispensable tool in engineering, resists the twisting movement of motors, helping to hold them securely in position across various industries like manufacturing, construction, automotive, electronics, and woodworking.

Fig13. Clamp

NEEM LEAF POWDER, LEMON PEEL POWDER, CHARCOAL POWER, TULASI POWDER : These sustainable materials, with medicinal properties, are applied on the setup to purify pharmaceutical wastewater by reducing contaminants like BOD, COD, nitrates, phosphates, and total dissolved solids.

Fig 14: CHARCOAL POWER

Fig15.Tulasi

Fig16. Neem powder

fig 17: lemon peel powder

IV. Basic Concept of RBC Technology

The rotating biological contactor (RBC) bioreactor is a wastewater treatment system utilizing rotating discs to support a microbial biofilm, submerged partially in wastewater. Made of corrosion-resistant materials like plastic, the discs facilitate microorganism attachment and biofilm formation, aiding in organic matter breakdown as they rotate and expose the biofilm to oxygen for enhanced microbial activity and wastewater treatment. The wastewater enters a tank or channel containing RBC discs, where microorganisms in the biofilm remove contaminants, and the treated water is discharged. RBC efficiency depends on factors like bioreactor size, disc speed, and microbial population, making it suitable for low to moderate organic loads in municipal, industrial, and remote wastewater treatment. RBCs use rotating discs to support a fixed-film biological community, contrasting with the suspended-growth microbial culture method in the activated sludge process (ASP). ASP aerates wastewater with microorganisms consuming organic matter, nitrogen, and phosphorus, followed by separation and discharge. Both RBC and ASP have pros and cons, with RBCs shown in Figure 13 to have advantages in wastewater treatment, particularly in nitrification

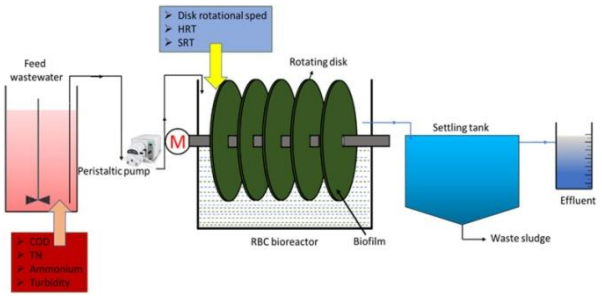


Fig : 18 schematic diagram of an RBC bioreactor.

RBCs are robust and handle influent fluctuations well, making them suitable for diverse wastewater treatment settings. In contrast, ASPs are sensitive to influent changes and may require additional steps or adjustments for optimal performance. RBCs have a simple design, minimal maintenance needs, and require less space than ASPs, making them cost-effective and easier to operate. They also offer better odor control and produce less sludge, reducing handling and disposal requirements. provides a comparison of ASP and RBC bioreactors across various operating parameters

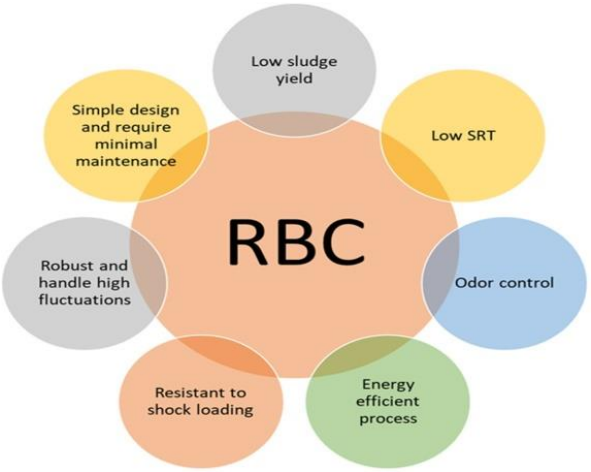


Figure19. RBC process advantages for waste water treatment.

a.Design Considerations

RBCs use cylindrical discs on a horizontal shaft, rotating slowly through wastewater to promote biofilm growth, with design parameters like disc diameter, spacing, shaft speed, and HRT tailored for specific wastewater treatment needs, as outlined in Figure 20

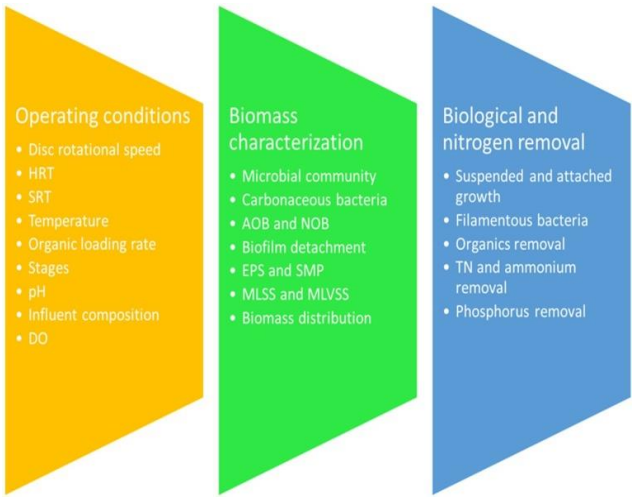


Figure 20. Performance evaluation of an RBC based on operating conditions, biomass characteristics and biological and nitrogen removal performance.

b. Disc Rotational Speed

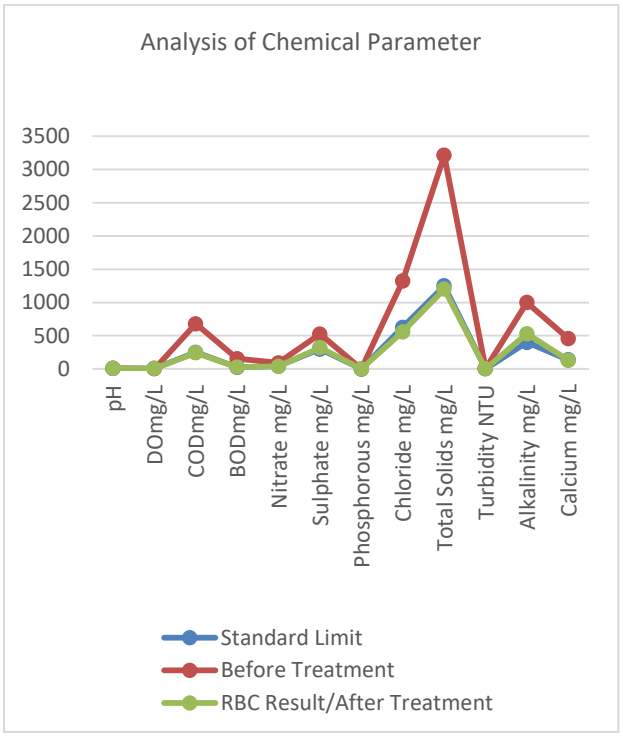
The rotational speed of RBC discs influences biofilm shear stress, oxygen transfer, and nutrient mass transfer to microorganisms, with optimal speeds ranging from 1 to 10 RPM depending on wastewater treatment needs. This speed affects biofilm thickness, oxygen availability, and shear forces, impacting treatment performance, biomass detachment, energy consumption, maintenance, noise, and vibration, necessitating careful selection within the recommended range of 2 to 5 RPM for optimal RBC operation.

Results:

Performing Test-I : (29-02-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 1: Analysis of Chemical Parameter

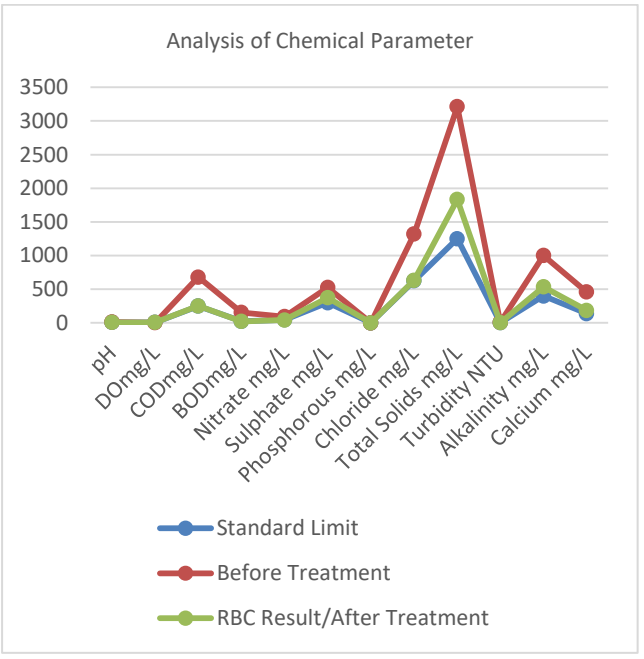
Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr. No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	7.3	N/A
2	DO	7.25	2	7.2	mg/L
3	COD	250	680	243	mg/L
4	BOD	25	155	28	mg/L
5	Nitrate	45	92	38	mg/L
6	Sulphate	300	526	320	mg/L
7	Phosphorous	0.09	0.986	0.0986	mg/L
8	Chloride	625	1320	558	mg/L
9	Total Solids	1250	3211	1200	mg/L
10	Turbidity	2.5	8	3.8	NTU
11	Alkalinity	400.00	1000	530	mg/L
12	Calcium	138	458	130	mg/L



Graph 1 : Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC set**rforming Test-II** : (01-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 2: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr.No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	6.8	N/A
2	DO	7.25	2	7.1	mg/L
3	COD	250	680	252	mg/L
4	BOD	25	155	22	mg/L
5	Nitrate	45	92	44	mg/L
6	Sulphate	300	526	373	mg/L
7	Phosphorous	0.09	0.986	0.092	mg/L
8	Chloride	625	1320	633	mg/L
9	Total Solids	1250	3211	1833	mg/L
10	Turbidity	2.5	8	3.62	NTU
11	Alkalinity	400.00	1000	535	mg/L
12	Calcium	138	458	185	mg/L

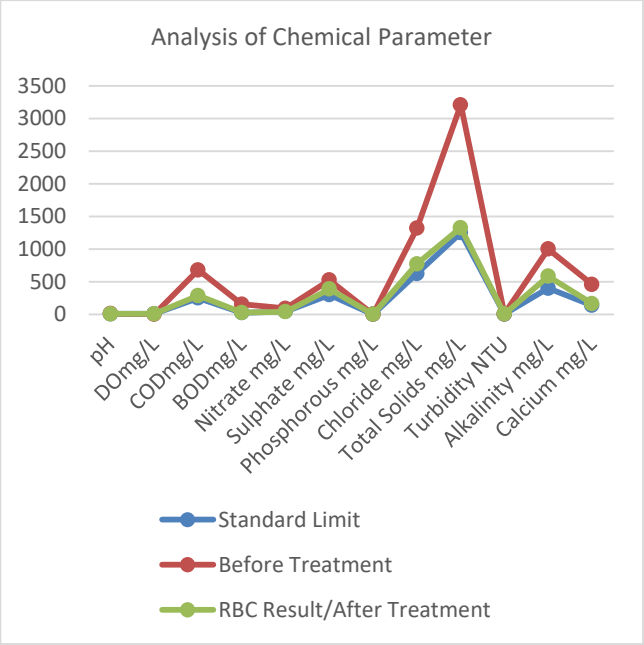


Graph 2 : Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC setup

Performing Test-III : (08-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 3: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr.No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	7.42	N/A
2	DO	7.25	2	6.8	mg/L
3	COD	250	680	286	mg/L
4	BOD	25	155	27.6	mg/L
5	Nitrate	45	92	40	mg/L
6	Sulphate	300	526	388	mg/L
7	Phosphorous	0.09	0.986	0.088	mg/L
8	Chloride	625	1320	772	mg/L
9	Total Solids	1250	3211	1328	mg/L
10	Turbidity	2.5	8	4.3	NTU
11	Alkalinity	400.00	1000	585	mg/L
12	Calcium	138	458	165	mg/L

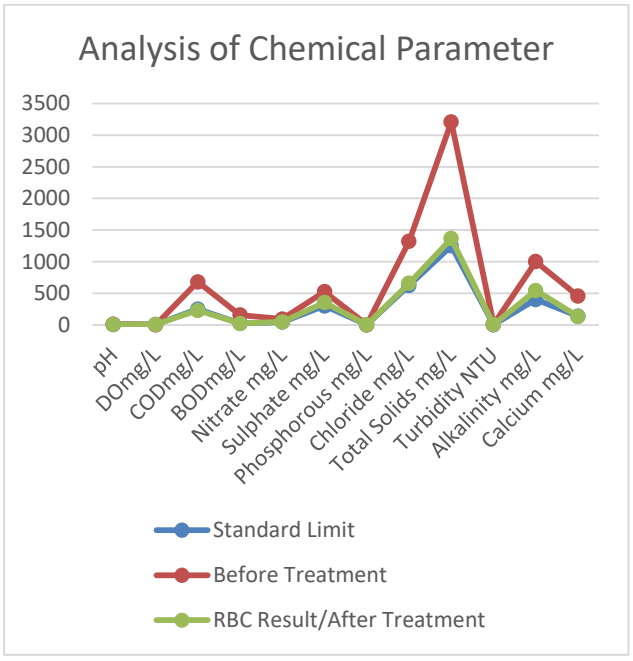


Graph 3: Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC setup

Performing Test-IV : (15-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 4: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr.No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	6.55	N/A
2	DO	7.25	2	7.6	mg/L
3	COD	250	680	228	mg/L
4	BOD	25	155	22.3	mg/L
5	Nitrate	45	92	47.3	mg/L
6	Sulphate	300	526	352	mg/L
7	Phosphorous	0.09	0.986	0.096	mg/L
8	Chloride	625	1320	658	mg/L
9	Total Solids	1250	3211	1365	mg/L
10	Turbidity	2.5	8	4.32	NTU
11	Alkalinity	400.00	1000	542	mg/L
12	Calcium	138	458	132	mg/L

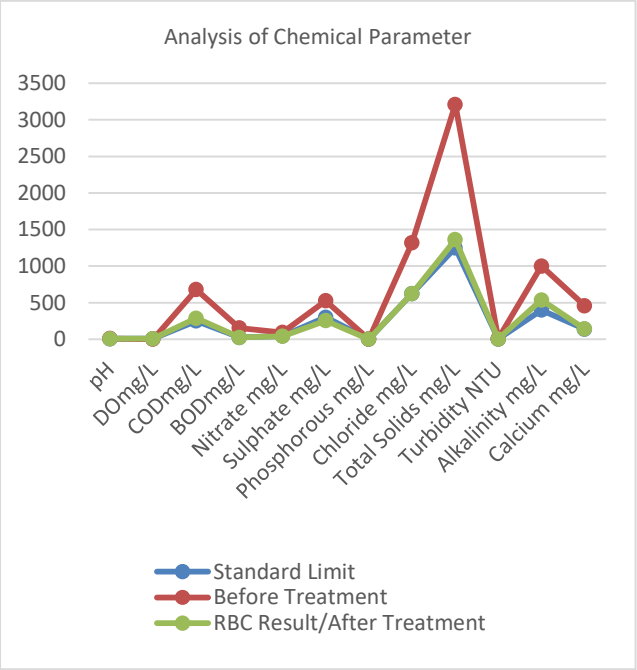


Graph 4 : Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC setup

Performing Test-V : (22-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 5: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr.No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	7.32	N/A
2	DO	7.25	2	7.92	mg/L
3	COD	250	680	288	mg/L
4	BOD	25	155	26.3	mg/L
5	Nitrate	45	92	41.6	mg/L
6	Sulphate	300	526	256	mg/L
7	Phosphorous	0.09	0.986	0.0856	mg/L
8	Chloride	625	1320	625	mg/L
9	Total Solids	1250	3211	1363	mg/L
10	Turbidity	2.5	8	3.9	NTU
11	Alkalinity	400.00	1000	538	mg/L
12	Calcium	138	458	142	mg/L

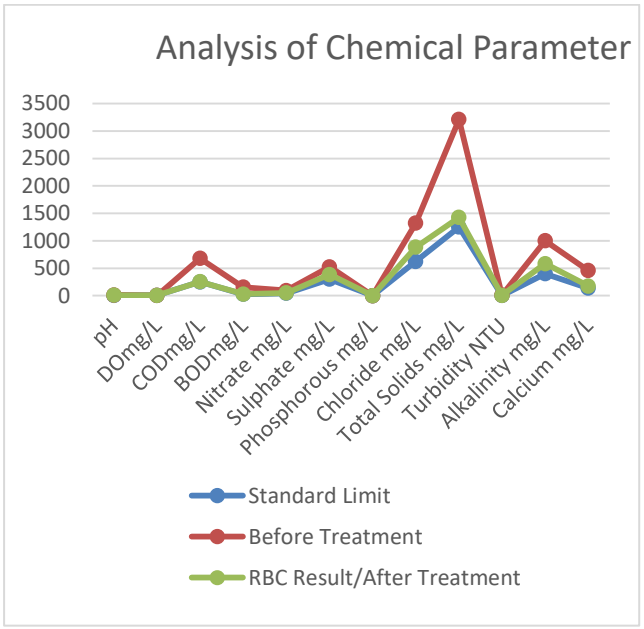


Graph 5 : Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC setup

Performing Test-VI : (30-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 6: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor					
Analysis of Chemical Parameter					
Sr.No	Parameters	Standard Limit	Before Treatment	RBC Result/After Treatment	UNITS
1	pH	7	11	7.65	N/A
2	DO	7.25	2	6.5	mg/L
3	COD	250	680	253	mg/L
4	BOD	25	155	28.6	mg/L
5	Nitrate	45	92	48.3	mg/L
6	Sulphate	300	526	386.2	mg/L
7	Phosphorous	0.09	0.986	0.0922	mg/L
8	Chloride	625	1320	885	mg/L
9	Total Solids	1250	3211	1426	mg/L
10	Turbidity	2.5	8	4.7	NTU
11	Alkalinity	400.00	1000	584	mg/L
12	Calcium	138	458	176	mg/L

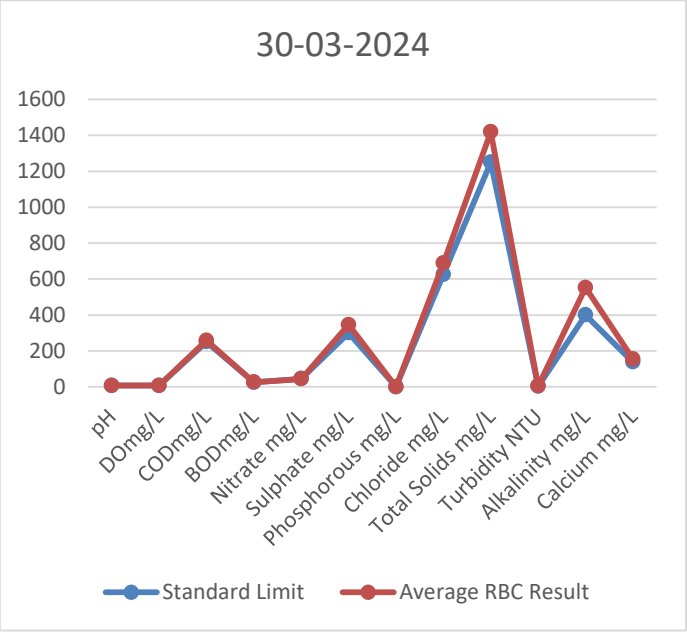


Graph 6 : Graphical representation of standard limit of portable water, before and after treating of wastewater in RBC setup

OVERALL ANLYSIS OF TESTED SAMPLE RESULTS WHICH PROVES BY THE MECHANISM OF RBC's: (30-03-2024)- Analysis of Chemical Parameter of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor

Table 7: Analysis of Chemical Parameter

Treatment of Pharmaceutical Wastewater by the mechanism of Rotating Biological Contractor								
Analysis of Chemical Parameter								
Sr.No	Parameters	RBC Result/After Treatment						
		week 1(29-02-2024)	week 2(01-03-2024)	week 3(08-03-2024)	week 4(15-03-2024)	week 5(22-03-2024)	week 6(30-03-2024)	Average RBC Result
1 1	pH	7.3	6.8	7.42	6.55	7.32	7.65	7.17
2 2	DO	7.2	7.1	6.8	7.6	7.92	6.5	7.19
3 3	COD	243	252	286	228	288	253	258.33
4 4	BOD	28	22	27.6	22.3	26.3	28.6	25.80
5	Nitrate	38	44	40	47.3	41.6	48.3	43.20
6	Sulphate	320	373	388	352	256	386.2	345.87
7	Phosphorous	0.0986	0.092	0.088	0.096	0.0856	0.0922	0.09
8	Chloride	558	633	772	658	625	885	688.50
9	Total Solids	1200	1833	1328	1365	1363	1426	1419.17
10	Turbidity	3.8	3.62	4.3	4.32	3.9	4.7	4.11
11	Alkalinity	530	535	585	542	538	584	552.33
12	Calcium	130	185	165	132	142	176	155.00



Graph 7 : Graphical representation of standard limit of portable water, Average after treating of wastewater in RBC setup

OVERVIEW OF RBC's RESULT ANLYSIS

Hence we proved that the organic rotational body which consist of natural absorbents to neutralize the toxic elements present in the pharmaceutical hazardous wastewater , the day of conventional the treatment methodology includes many techniques to treat the untreated water which may use excessive energy's like electricity for the treatment, the process of rotational prototype which makes huge impact in the generosity of today's generation, one of the most likeliest design combat which rotates in the given rpm values, Hence list mechanism for the ambience of treated equipment.

The subjective methodology any untreated toxic hazardous wastewater will be treated by the phenomenal prototype design hence this kind of prototype can be put into depth of drainage, canal ways.

For the phenomenal flow of drainage, canal water the instrument which maintains to provide electricity by adhering mechanism of dynamo.

The objective of the process is to provide implemented message to the society-not to discard any toxicity based objects into society, if so the society will affect n number of imbalanced lifecycle.

The RBC which indicates biological actions against the toxicity for maintaining their permissible limits, hence the proactive of treated effluent will change their internal reactions day by day, the change of reactions which includes variable heavy metals, those kind of heavy metals can't be neutralized sometimes.

For better tomorrow of the society and environment we suggest to adopt the conventional source of treatment facilities without harming the nature, such that RBC may provide well result in the conventional form comparing all treatment facility.

Conclusion:

RBCs have been widely used in the wastewater treatment industry due to their high treatment efficiency, low operating cost, and ease of operation. In addition, RBCs have the potential to play a crucial role in achieving sustainable environmental performance. RBCs contribute to the reduction of greenhouse gas emissions. As RBCs are aerated systems, they provide oxygen to the microorganisms that break down the organic matter in the wastewater.

RBC's promote water conservation. As RBCs are efficient in removing pollutants from wastewater, the treated water is reused for non-potable purposes such as irrigation, landscaping, and toilet flushing. This reduces the demand for freshwater resources and promotes water conservation. Discharging untreated or poorly treated wastewater into water bodies severely impacts aquatic ecosystems and public health. RBCs effectively treat wastewater and remove pollutants, such as organic matter, nitrogen, and phosphorus, before discharging them into the environment, thus reducing the negative impact of wastewater on water quality. RBCs produce sludge as a by-product of the wastewater treatment process. The sludge is further processed into biosolids and used as a nutrient-rich fertilizer for agriculture or land rehabilitation.

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