Review on Advancement in Treatment of Industrial Wastewater by Effluent from Different Sources

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Abstract- While the people have benefited from the industrial sector's recent rapid development, it has also produced copious amounts of effluent that contain harmful elements including hydrocarbons, nitrogen, phosphorus, and heavy metals that have a disastrous effect on both the environment and human health. While industrial effluent treatment is seeing technological breakthroughs, there is a growing body of research focusing on hybrid systems that can recover resources from wastewater in a feasible, cost-effective, and time-saving manner.

The main objective of this paper is to examine, suggest, and discuss the various industries' processes and products, the amount of effluents they produce, the most cutting-edge theoretical and scientific advancements in treatment techniques to get rid of toxic substances and disintegrating matter, as well as the difficulties and future directions in these developments. The review's conclusions evaluate novel environmentally friendly technologies, offer insight into the effectiveness of removing contaminants, and help understand how different treatment combinations break down harmful substances.

We are gravely concerned about the emergence of novel technology for the treatment of wastewaters from diverse industries. While a large number of research papers have been published on waste water pollution control studies, relatively little research has been done on the treatment of wastewater from the different industry, particularly with regard to the design and development of industrial effluent treatment plants (ETP) systems. The study project will also benefit from the recycling and reuse of water and sludge from other industries.

Keywords: Industrial growth, Environmental degradation, Resource recovery, Challenges and perspectives, Recent developments, Hybrid/integrated system effluent Treatment Plants (ETP)

INTRODUCTION

The efficacy of the older treatment methods, which were developed from an authoritative point of view, is declining, which eventually causes the effluents to accumulate more and more. The difficulties brought on by the earlier techniques have decreased with the introduction of new ones. Wastewater treatment plants are designed to meet the safety standards for treated wastewater by substantially enhancing the water quality. In addition to removing suspended solids from the water, which can taint rivers and obstruct water flow in channels and pipes after deposition, various treatment techniques lower the concentration of pollutants in the water. Additionally, according to the Biological Oxygen Demand (BOD), it reduces the amount of organic waste that can decompose.

In order to get rid of pollutants enough to provide drinkable water, wastewater treatment is necessary. To increase the treatment plant's efficiency, some influent factors must be managed, hence these parameters must be taken into account during the design process. The adoption of appropriate purification/treatment systems with high removal efficiency for contaminants is necessary for environmental protection because of the uncontrolled entry of wastewater effluent into the environment and the transit of toxins into anthropoid systems. Economically speaking, efficient wastewater treatment helps minimize needless water scarcity and save water. The purpose of this study is to provide an overview of the efficaciousness of various companies' wastewater treatment systems in eliminating contaminants. considering the features of wastewater and the locations of the pertinent businesses, wastewater treatment is necessary in order to reduce contaminants to a level that allows for the production of drinkable water.

1.1Industrial growth and its impact of effluent

An important factor in a nation's economic growth is industrial development. Since chemical fertilizers, pesticides, weedicides, and other industrial products are essential for enhancing productivity and advancing science and technology, industrial evolution is required for the revitalization of agriculture. A severe lack of capital is the main problem facing the Indian economy. Constructive and indirect wealth can help industry make more money, which can be used to spur expansion and improvement. Trade advances as a result of industrialization. Regarding global commerce, the creation of import substitutes, and export advertising are required to cover the balance of payments imbalance brought up by industrial development. Decisions about how to improve energy systems and energy policy must take the environmental effects of electricity production and use into account. all methods of producing electricity, as well as every link in the fuel chain that has an impact—both good and bad. The actual energy needs of the nation and societal values must be taken into account during the decision-making phase of the process.

1.2Statistical inference on global industrial growth:
Figure 1 is the graphical representation of industrial widening of BRIC countries in recent decade (2012–2021) which interprets that there are several industries that conceals these countries with reference to their imports which is unable to give over in terms of trade development. The key finding is that life science industrial products ranks high marketing rate (~ 70%) and at the same time, generating greater amounts of toxic effluents (Devi Prasad Dash et al. 2021). COVID-19 influences the industrial broadening of BRIC countries that leads to 50% reduction in their growth, however, yet shows superior global average. The worldwide industrial production is intensified by the reports that quarterly explored the circumstances of the global industrial development and its outlook. This outline deals with structural changes in the course of industrial growth such as:Brief series of economic crisis since early 2000sExtensive crisisProlonged crisis overcoming Assailing national liability Stagnation and setback of industrial growth leading to a static total propensity.

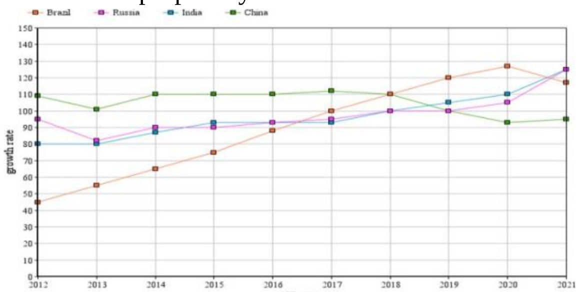

Fig.1.1 Statistical data on global industrial growth

Statistical data on global industrial growth (Radulescu IG et al. 2021, Christina Majaski. 2020, Svetlana Gusarova. 2019, Rachel S Salzman. 2021) (Standard of Fig. 1 is improved including caption) (source)
And also, the time from the outbreak of the world economic crisis and depicts the essentially changed process of the crisis overcoming. Industrial production in the MIST (Mexico, Indonesia, South Korea, Turkey) countries with a 6% share of machinery exports are evolving after stagnation and decline in the first quarter of 2020 and has its basis in the period after the global economic crisis. China's industrial production increases by 9% yearly and those of India by 3.4% and Russia by 2% per annum. In the previous global economic crisis of 2008, China had bit alleviated the slump in industrial growth in industrialized countries (Avunduk et al. 2019). On the other hand, no OECD (Organization for Economic Co-operation and development) data are available for Brazil and India for the first quarter of 2020.

1.3Critical environmental impacts
Unconstrained industrial wastewater is the probable origin of spontaneous release of hazardous substances into the environment. It has been identified that wastewater generated by various industries leads to health effects such as cancer, immune function disorders, lung and respiratory diseases (Upadhaya et al. 2017). State Inspectorate for Environment Protection (PIOS) reported that, about 60% of wastewater creates potential or actual threat to public health and the environment. For safer and reliable wastewater management, risk assessments such as hazard identification, exposure assessment and risk characterization are to be considered (Buczyńska et al. 1999).Generally, industrial effluent carries certain disease-causing bacteria such as E.coli, Salmonella etc., that leads to cholera, typhoid fever and other allergic symptoms (Tiffon C et al. 2018).

In recent years, there have been the development of a disease namely byssinosis, is a fatal disease caused to the people working in textile industry on account of excessive exposure to cotton dust. Myeloid leukemia, a disease majorly caused to workers in organic chemical industry due to their over exposure of formaldehyde without much safety measures taken in prior (Gaur VK et al. 2020). "Asthma-like syndrome" is a nonallergic respiratory condition that is identical clinically to asthma but is not associated with persistent airway inflammation or airway hyper reactivity. As the pulmonary deterioration can often be detected only by cross-shift testing, it can be difficult to document this in a typical clinic setting (Etim MA et al. 2021). The cross-shift decline in FEV1 is generally less than 10% but can be between 10 and 15%. It is most common in swine confinement workers, up to 10% acutely, but can also be seen in grain workers of agricultural industry. This project present work is on advancement of effluent treatment processes

Table 1.2Analysis of different physico-chemical parameters of dairy effluent physico-chemical analysis of

Parameter	In 11 April	IN 11may
Temperature (^{0}C)	25	27
Turbidity (NTU)	20	20
T.D.S.(ppt)	1.1	1.77
Salinity(ppt)	1.2	1.75
Conductivity(m/s)	3.26	359
pH	8.8	7.4
BOD(mg/l)	28.55	28.45
colour	colourless	colourless

Table 1.3: Analysis of Physico-Chemical Parameters of Tannery Effluents (Treated and Untreated Samples) leather industry

Parameters	Untreated Effluents	Treated Effluents
Colour	Black	Greenish Black
pH	3.21	4.04
Conductivity(S-1)	1.00	0.60
Temperature (^{0}C)	38 ^{0}C	39.5 ^{0}C
TS (mg/L)	60000	49300
TDS (mg/L)	34200	28600
Total Acidity (mg/L)	2300	1500
Calcium (mg/L)	196	160.32
OD (mg/L)	0	0
COD (mg/L)	2500	2200
Chloride (mg/L)	4200	4900

Table 1.4Mean value of physicochemical parameters of three pharmaceutical industrial effluents

Physicochemical parameter	Effluent A	Effluent B	Effluent C	FEPA[a]	USPEPA[b]	WHO[c]
pH	7.2	4.7	7.1	6.0-9.0	6.5-8.5	6-9.5
Colour	purple	colourless	yellow	NS	NS	NS
conductivity	199.0	299.0	413.0	NS	NS	NS
salinity	0.02	O.O3	O.O3	NS	NS	NS
COD	80.0	90.0	110.0	NS	NS	NS
BOD	22.0	40.0	60.0	50	NS	NS
TDS	134.0	200.0	277.0	2000	500	<1200

MATERIAL AND METHOD

In the realm of industrial wastewater treatment, various methods are employed depending on the type and concentration of pollutants, as well as regulatory requirements. Here are a few different methods:

1. Physical Treatment Methods:
   - Screening: Removes large solids through physical barriers like screens or sieves.
   - Sedimentation: Allows heavier particles to settle at the bottom of a tank, separating them from the water.
   - Filtration: Passes water through various filters to remove suspended solids.
2. Chemical Treatment Methods:
   - Coagulation/Flocculation: Addition of chemicals to destabilize particles, allowing them to clump together for easier removal.
   - Precipitation: Chemicals are added to induce precipitation of dissolved pollutants, forming insoluble solids that can be separated.
   - Neutralization: Adjusting pH levels using chemicals to neutralize acidic or alkaline wastewater.
3. Biological Treatment Methods:
   - Activated Sludge Process: Uses microorganisms to consume organic matter in wastewater, converting it into carbon dioxide, water, and biomass.
   - Biological Filters: Wastewater passes through beds of media populated by microorganisms that break down pollutants.
   - Constructed Wetlands: Utilizes natural processes in wetland ecosystems to treat wastewater, with plants and microorganisms removing pollutants.
4. Advanced Treatment Methods:

- Membrane Filtration: Uses semi-permeable membranes to physically separate pollutants from water.
- Reverse Osmosis: Applies pressure to force water through a semi-permeable membrane, removing dissolved solids.
- Advanced Oxidation Processes (AOPs): Utilizes powerful oxidants like ozone or hydrogen peroxide to degrade persistent pollutants.

Advanced effluent treatment methods

Advanced effluent treatment methods are sophisticated techniques used to further treat wastewater beyond conventional methods, particularly when dealing with highly complex or contaminated effluents. Here are some advanced methods:

1. Membrane Bioreactors (MBR): MBR combines biological treatment with membrane filtration. It uses membranes to separate solids from the treated wastewater, producing high-quality effluent suitable for reuse or discharge.
2. Electrocoagulation (EC): EC involves the use of electric current to destabilize and coagulate contaminants in wastewater, facilitating their removal through processes like flotation or sedimentation. It's effective for treating heavy metals, oils, and suspended solids.
3. Advanced Oxidation Processes (AOPs): AOPs utilize powerful oxidants such as ozone, hydrogen peroxide, or ultraviolet (UV) light to break down organic and inorganic pollutants into harmless byproducts. They're particularly useful for treating recalcitrant compounds and emerging contaminants.
4. Activated Carbon Adsorption: Activated carbon is highly effective in adsorbing organic pollutants, odors, and trace contaminants from wastewater. It's often used as a polishing step in tertiary treatment or for specific pollutant removal.
5. Ion Exchange: Ion exchange resins are employed to selectively remove ions from wastewater by exchanging them with ions of similar charge in the resin. It's useful for removing specific ions like heavy metals or nutrients.
6. Forward Osmosis (FO) and Reverse Osmosis (RO): FO and RO are membrane-based processes used for desalination and removal of dissolved solids from wastewater. They're capable of producing high-purity water suitable for various applications.
7. Nanofiltration (NF): NF is a membrane filtration process that operates on a finer scale than microfiltration and ultrafiltration. It's effective for removing divalent ions, organic matter, and small particles from wastewater.
8. Biological Nutrient Removal (BNR): BNR processes utilize specialized microbial communities to remove nutrients like nitrogen and phosphorus from wastewater, reducing the risk of eutrophication in receiving water bodies.

These advanced methods offer enhanced efficiency, higher removal rates, and greater flexibility in treating challenging wastewater streams, contributing to improved environmental protection and resource conservation.

CONCLUSION

- Sufficient experimental with effluent of specific industries.
- Eco friendliness must be assured.
- More efficiency must be paid to the most advancement methods.
- Effluent treatment must be ultimate technology and economically worried.
- It's a vital step in safeguarding our environment, protecting our health, and ensuring sustainable development.
- In our conclusion, an ETP, or effluent treatment plant, is a crucial element in maintaining environmental health and sustainability. By managing industrial waste effectively, ETP plants play a significant role in protecting our ecosystem from harm, promoting a healthier future for all.
- The Effluent and Emission Summary is a description of estimated waste emissions include source, temperature, pressure, discharge quantity, and content of major effluents and emissions, discharging frequency, as well as recommended treating methods for waste gas, waste water and solids.
- Industrial effluent treatment is an important part of protecting the environment and public health. By using the right methods, industries can effectively treat their effluent and prevent it from contaminating the environment.

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