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WASTE WATER TREATMENT METHODS FROM CONVENTIONAL TO NEW EMERGING TECHNOLOGIES: A STUDY

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ABSTRACT

Diminishing water resources and increasing awareness about the quality and cleaniness of water has alarmed the treatment methodologies. To ensure public health and awareness, the need arises to focus on new better technologies like membrane separation processes, adsorption, advance oxidation technology from the conventional techniques like floatation, sedimentation, coagulation and flocculation. This paper review various treatment methods available for treating water , their principles, main applications and development. The limitation and use of technologies has been discussed for the present scenario and future research needs.

Key words *–* ***Adsorption, A.O.Ps, froth floatation ,MSPs, Sedimentation ,Water treatment.***

I. INTRODUCTION

Water is an essential element for human and environment. From last few years, shortage of clean water resources has been caused due to increasing rate of population and industrialization. Discharge of industrial effluents made water harmful for human, animals and aquatic life , therefore to resolve the problem and meet "zero waste" scheme [1] standards of waste water emission have been developed by the National Environment Protection Department according to the local conditions and requirements. It is mandatory to meet the strict requirements for the emission of waste water for better and safe environment. The conventional waste water treatment methods became less effective to meet the safety requirements for public health and environment . The greater awareness and diminishing clean water resources motivated public desire for better quality water [2].The pollutants present in waste water are colours, heavy metals, biological waste, pesticides, suspended particles, toxic compounds etc. which can cause serious problems. Dye waste water can cause asthma, irritation, skin rashes, allergy, dermatitis, cancer and mutations in human [3]. Discharge of potentially harmful pollutants make municipal and industrial waste water unfit for reuse, thus in view to suppress the worsening effect of clean water shortage, development of various advance and efficient low cost treatment technologies have been demonstrated to treat the waste water as the earlier treating methods like sedimentation, coagulation, filtration and precipitation proved to be less effective in treating waste water to present desired limit.

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II. VARIOUS TREATMENT METHODS.

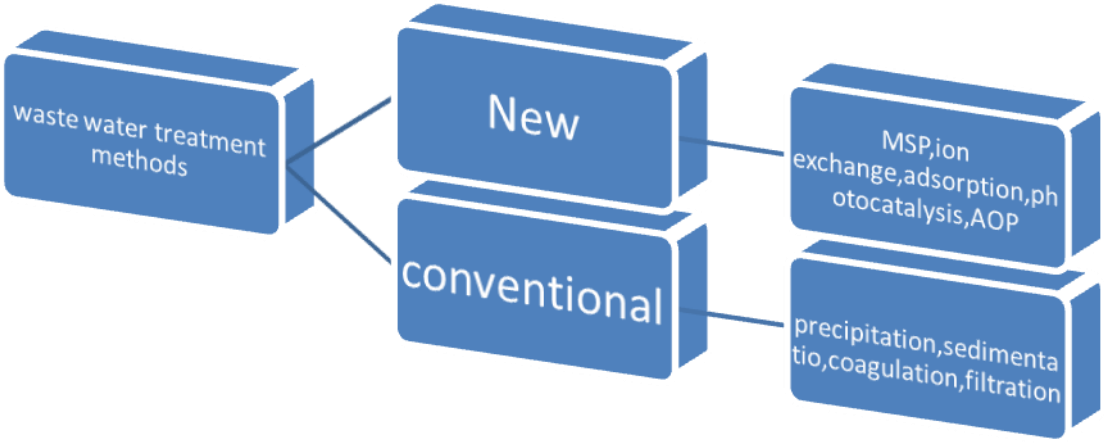

FIG-1- (WASTE WATER TREATMENT METHODS)

Detailed view of conventional treatment methods

Coagulation, flocculation, sedimentation is one of the most used methods in conventional treatment processes [4]

2.1. Sedimentation

Out of the earliest methods possible, sedimentation process helps in removing suspended solids from water , this can be done by the help of various forces gravity, centrifugal or electromagnetism acting on them .Under the action of forces, particle in suspension settle out of fluid in which they are entrained.

2.2. Coagulation and flocculation

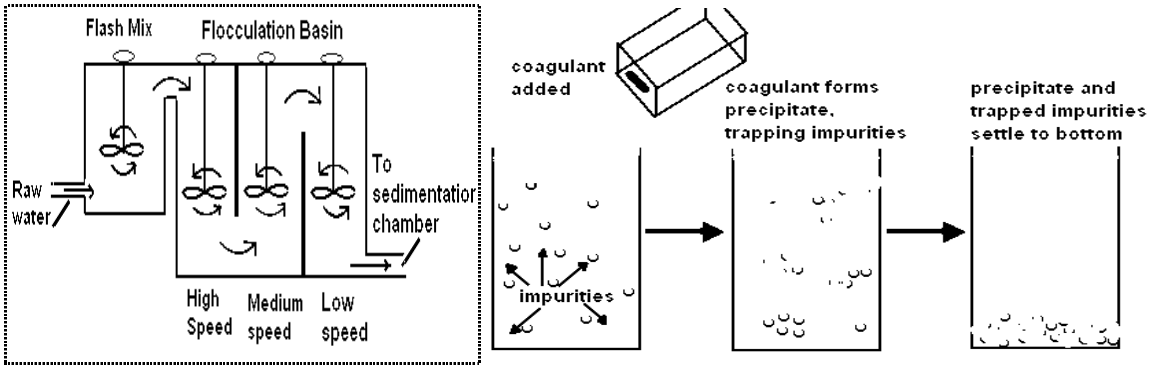

FIG2- (FLOCCULATION AND COAGULATION PROCESS)

This is the process of adding coagulant to water solution in order to destabilize colloidial suspension. Coagulants are usually inorganic or organic cationic coagulants because the colloide normally bring negative charges, further flocculation is the process of particle aggregation. Fine particles clump together resulting into the formation of flocs. The floc then float to the top of the liquid or either settle to the bottom of liquid ,thereby increasing the sedimentation.

2.3. Precipitation

IJARSE
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The formation of precipitates from the solution occur when the concentration of a compound exceeds its solubility from supersaturated solution .Chemical reaction may occur during the formation of precipitate. precipitant are the chemicals that causes the formation of solids or precipitates. After sedimentation, precipitation is followed.

2.4. Froth flotation process

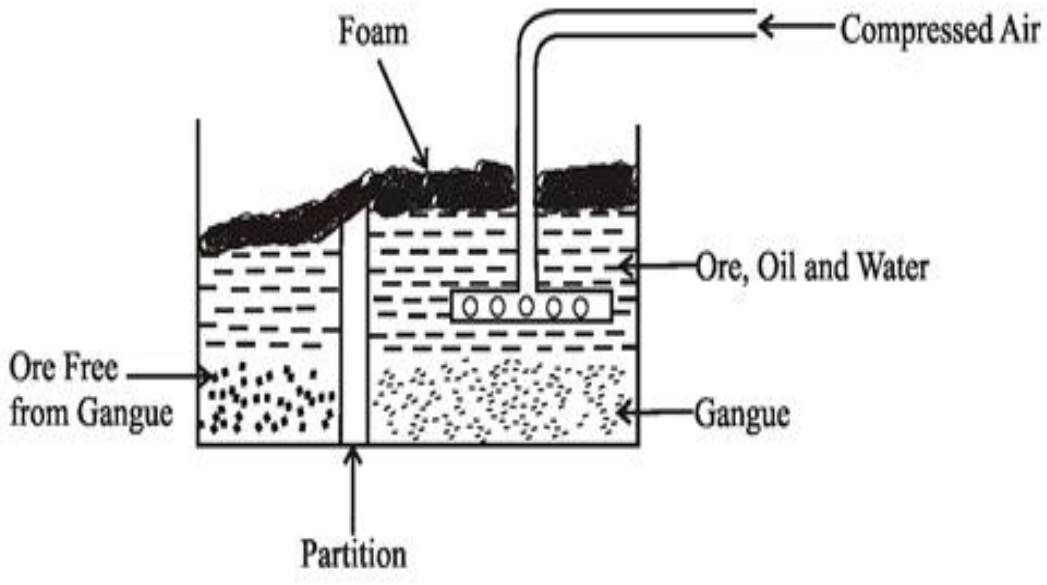

FIG3- (FROTH FLOTATION PROCESS)

This method removes the fibre from waste water. Under the effect of interfacial tension, buoyancy of bubble rising, hydrostatic pressure and variety of other forces, the microbubble adhere to tiny fibers. Due to its low density , mixture float to the surface so that oil particles are separated from water.

Present adopted methodologies:

2.5. Membrane separation processes

After the conventional method ,the emerging membrane separation process for treating waste water proved to be very effective .This method uses the membranes micropores to filter and membrane selective permeability is the driving force for separation, the membrane act as a semi permeable barrier and separation occurs by the membrane controlling the rate of movement of various molecules between two phases. This process requires less energy in comparison to conventional methods as heating is not required in membrane separation technology. The limitation involved is requirement of special equipment, membrane fouling problem and high investment [5]

2.5.1 Reverse Osmosis

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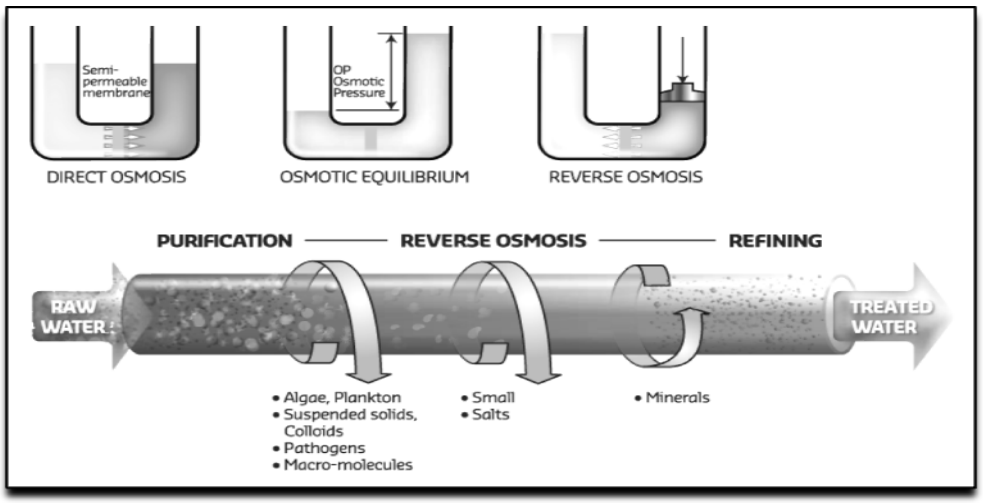

FIG4- (REVERSE OSMOSIS PROCESS)

The process permits the removal of all mineral salts, reactive dyes, ions and molecule from waste water. The water is deionize by subjecting it under hydrostatic pressure greater than osmotic pressure through semi permeable R.O. membrane. The R.O membrane have retention rate of 90%.

2.5.2. Nanofiltration

This is recent membrane filtration technology. Nanofiltration membrane retain low molecular weight organic compounds, divalent ions, large monovalent ions and hydrolyzed reactive dyes [6] .This is pressure related process, separation takes place based on molecular size .Nanofiltration removes nearly all bacteria and viruses, most organic matter, divalent ions and upto 90% of monovalent ions. A nanofiltration membrane is capable of removing contaminants down to 0 .1 microns in size. It uses less energy and offer high flux rates than R.O system.

2.5.3 Ultrafiltration

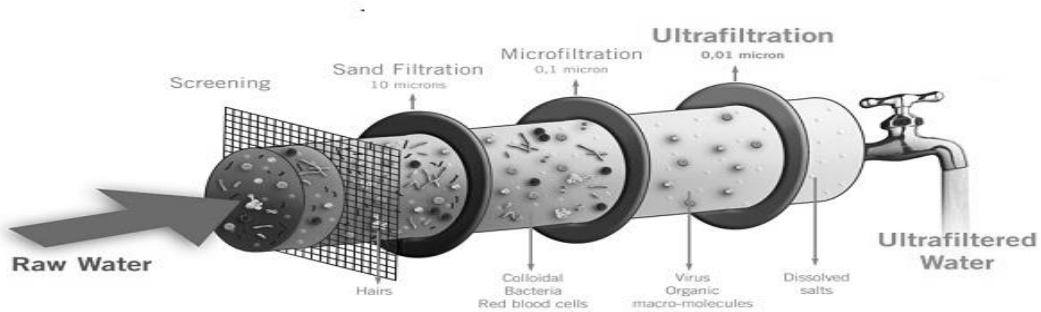

FIG5- (ULTRAFILTRATION PROCESS)

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The process is pressure driven separation process that separates the particulate matter from soluble components. This process is used to separate high molecular weight compounds from feed stream. Its aperture is about 1nm-.05um. It serves as a pretreatment before R.O process and other.

2.5.4. Microfiltration

It can be used as pretreatment for nano-filtration or reverse-osmosis. The microfiltration membrane consist of various materials like polysulfone,Zro_2 and carbon .Its aperture is about 0.1-1um [6]. This process is used to separate microorganisms and suspended particles from process liquid.

2.6. Advanced Oxidation Technology

The interest of academic and industrial communities is growing day by day in A.O.P's. The water treatment by this process constitutes various areas like [7]

1) Treatment of industrial waste discharge including textile dye house water, pulp and paper industry ,distillery, oilfield and others.
2) Hospital and slaughter Waste treatment
3) Municipal Waste Water treatment plant effluents
4) Removal of organic micropollutants.
5) Removal of heavy metals like arsenic and chromium from water.

AOP's application implement new process, concept and technology with the benefit for waste water treatment in terms of energy and operational cost. AOP's is characterized by the production of OH radicals. This hydroxyl radical leads to the destruction of pollutants as OH radicals are the strongest oxidizing and reactive species. It provides great potential to treat the waste water. AOP's include heterogenous and homogenous photocatalysis based on solar radiations, U.V Irradiations, Ozonation, Fenton's reagent, Ultrasound (US) and wet air oxidation. There are different ways for OH radicals production according to the required treatment.

Different AOP's include [8]-

UV/H_2O_2

UV/O3

O3/H2O2

UV/O3/H2O2

Fe2+ / H2O2

UV/ Tio2 / H2O2

Heterogenous photocatalysis

Thus by combining ozone, hydrogen peroxide, UV and heterogenous photocatalyst , many AOP's have been formed which serve efficiently in oxidizing the organic contaminants and thus make them harmless as comparison to the individual process.

IJARSE
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2.7. Adsorption

Adsorption plays key role amongst various technologies. The processes are being employed for chemical, biochemical and purification processes. It is one of the easiest decolorization technique and cost effective method [9]. Adsorption is the process of adhesion of atoms, ions or molecules to the surface of liquid or solid phase rather than bulk. In this process, adsorbate film formed on the surface of adsorbent. Researchers have investigated many potential adsorbents which are low cost and naturally available like flyash [10] rice husk ,hair, cotton waste [11]wheat shell [12],biomass ,sugarcane bagasse , wheat husk [13].wood, coconut shell[14], fruit stones , these adsorbents have low adsorption capacity, ACs can be produced from carbonaceous material and can be prepared from chemical activation and physical activation .Chemical activation can be done by treating it with concentrated sulphuric acid to increase the efficiency of adsorptionvarious fruit shell or naturally available adsorbents like walnut shell [15],neem and other can be activated. ACs relates to materials with high surface area and porosity contributing to high adsorptive capacity [16].Characterization of adsorbent can be done by various techniques FT-IR, SEM, TEM, XRD [17] to check quality of adsorbent. Batch Equilibrium study: Adsorption studies can be done by batch method at various known temperature. The influence of various parameters like effect of initial concentration, contact time ,adsorbent dosage, pH [18] is observed. Various Isotherms models [19, 20] and kinetic models are applied for best fitting of data and the results observed explain the mechanism and theory of adsorption studies.

III. SUMMARY

The conventional and advanced waste water treatment techniques have been reviewed. The increasing environmental problems has created the need for more efficient technologies. Conventional processes such as sedimentation, filtration ,precipitation do not efficiently treat waste water and other environmental pollutants. M.S.Ps played important role in waste water treatment process like RO process. Microfiltration(MF), Ultrafiltration(UF), Nanofiltration(NF) technologies proved to be very beneficial and emerging. To improve membrane processes, more effective fouling control strategies, module design and membrane integrity management have been paid attention. A.O.Ps are in development stage and an interesting field of research because of its potential as environmental friendly and sustainable treatment technology to meet with zero waste scheme. Adsorption processes are also commercialized. Variety of effective adsorbents are explored, both batch and column study are carried out for research purposes and for scale up of processes. Adsorption is low cost, easy and effective technique for waste water treatment. However, research is carried out by researchers continuously in the field to create a safe, secure and healthy environment.

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