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A Review Article of Nanoparticles; Synthetic Approaches and Wastewater Treatment Methods

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Abstract:- *In Modern century the water demand is most facing challenge in the world, resulting from global progress and weather variation, require modern knowledge and methods to ensure the clean water safety and its supply for drinking. The adaptation of new and novel nanotechnology offers the opportunities to ensure the water purification process. The growth of cost and stable resources for supplying the drinking water at suitable level is the basic requirement of industries. Pollutant water treatment tools is unproductive for supplying sufficient clean water because the growing demand are linked with severe different health recommendations and impurities. The highly resourceful methods are giving the reasonable mixture to pollutant water assessment that does not depend on compacted systems. These have applications of the produced nano scales particles as effective adsorbents agent for eliminating the contaminated type material. The membrane separation tools incorporated with nanoparticles display a composite photo catalytic nature membrane containing vast potential to treat the different organic toxins in effluents. There were lot minerals, agro and clays and wastes have role in eliminating the metal waste product from the industrial effluents and natural water due to their ecological aspects. This conceptual review show current improvements in nanotechnology field special in the water treatment by using different nanomaterials, their fundamental properties, application, and mechanisms; as their benefits and limitations compared to present methods, few emerging tasks and some more quality base research require for their commercialization.*

***Key Words*: Waste water treatment, TiO2 material, Nanoparticles, Nano Catalyst, Nano Rode, Pollutants**

1. INTRODUCTION

The water is the dynamic and energetic element in human life. Recently, the reported statement is that the world population suffers from the fresh/surface drinking water. So, the world has severe challenges regarding to the pure water because the accessible supplies of the water are reducing due to many factors such as population growth, extended droughts and competing burdens from several users [1-3]. So there is an urgent need to develop a novel technology to fulfill the affordable and clean water requirement for human being. The healthy body need clean and germ free water to maintain the life cycle. In some countries like Pakistan, Bangladesh and India there are water born disease; special drinking water. Recently, scientists are using several methods for the water treatment to make it healthy for consumers. The commonly methods are physical and chemical such as chlorine and its related derivatives treatment, ultrasonic irradiation [4], reverse osmosis, ultraviolet light [5], boiling method, activated carbon based treatment etc. Today the nanotechnology is growing rapidly due to unique physical and chemical features of different nanomaterial. This type of technology increased a fantastic incentive due to their ability of conversion of the different metal into small sized. The Nano science called the study about the small things and the nanomaterial have large surface area to its volume as compared to other bulk material which helpful in catalysis [6-8] and medicine [9-13]. A nano range meter is approximately one billion and it denoted by size of the ten H-atoms are in straight line. Nanotechnology is manipulating matter at the very nanoscale level (down to 1/100,000 the width of a hair of human) in order to create progressive materials and efficient products with great potential to change the world [14]. It has ability to control and operate individual atoms and molecules. It has interdisciplinary nature, such as in the field of chemistry, physics, geothermal study, biology, and material science. The nanomaterial size is always less than 100nm (Figure 1). It contains high surface areas and adsorption characteristics due to having the diverse reactive surface sites and random surface regions [15]. The method that a crack produces at high scale, the bulk substances is not similar to the crack propagation as where particle size and crack are both comparable like Choi et al. [16] study different application of different scientific methods to fabricate nano shaped titanium oxide (TiO_2) catalysts material. This kind of product can be useful in the photo catalytic procedure with novel features of great porosity (46%) and surface area (147 m2/g) , pore-size distribution range is from 2- 8 nm, homogeneity without pinholes and cracks, minute crystallite size (9nm) and active crystal phase for improvement in water treatment. These kinds of photo-catalysts of TiO_2 were proficient for the usage of dyes. Nanotechnology was invented by the Taniguchi (1974) as "Nano-technology generally consists of the consolidation, separation, processing and deformation of the materials by single atom or molecule" [17]. Generally, nanotechnology tools are assessing, modeling, imaging, and the manipulating the substance at small scale. The nanoparticles has vital role to the modification, production, and shape of the different structures which are playing role in manufacturing zone like in environmental applications [18-20].

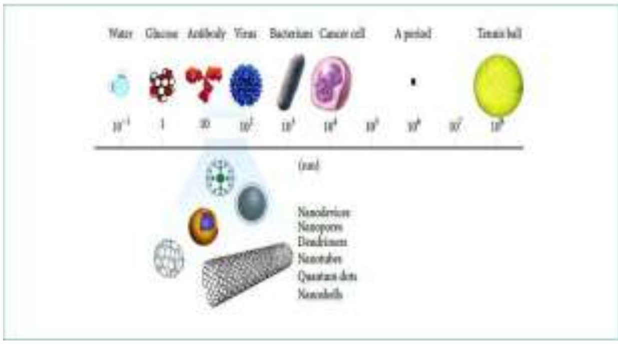

Figure 1; Different Size of Nanoparticle [67].

The impurity in water contains toxic metal like Ag(I), Ni(II), As(V), Cu(II) ,As(III)] , Hg(II) is creating an ecological problems[21]. To attain the ecological detoxification, several techniques like ion exchange, reverse osmosis, precipitation, flotation, electrochemical mechanism, oxidation processes and evaporation are commonly used. The nanostructured tools such as carbon nanotubes, C/Fe nanoparticles, magnetic nanoparticle, small structured iron zeolite, silver cyclodextrin composites, photo catalytic nanoparticles, nano filtration base membranes and active silica nanoparticles can be used to eliminate the toxic metals, some chemical discharges, sediments, charged based nanoparticles, some bacterial species and dangerous pathogens. [22]. Scientists categorized the nanoscale materials like purposeful materials for purification like metal based nanoparticles, dendrimers, zeolites and carbon base nanomaterial [23]. These can be effectively worked to the purification and treatment of water. Recently, the emerging field nanotechnology is best source to solve the water challenges (quality & quantity) around the world [24]. The nanomaterial e.g. carbon nanotubes (CNTs) and another called dendrimers are more effective treatment processes than other new methods because they have the remarkable adsorption characters [25-26]. There were a lot methods reported to solve different issues of water to ensure its safety and constancy as shown in table.

Table 1: Some Nanoparticles with their application

Nanoparticles	Nature of Removed Pollutant
Nano catalyst	Different Pesticides Azodyes, etc
Bioactive nanoparticle	Removal of Bacteria, fungi
Carbon nano tubes(CNT)	Organic Pollutant
Nano Structural catalytic	Organic pollutants

Different opportunities and tasks of using the nano sized materials in the purification and treatment of the surface, ground and industrial waste-water; the streams are problem as concern. The nanotechnology is helpful in curing diseases like renovating body tissue [27], killing toxic organisms [28].

2. SYNTHETIC APPROACHES FOR NANOPARTICLES

The nano materials are unstable in the nature, its production practices are essential for the practical uses. There were several systems are present to yield different type of nanomaterial. It can be formed with the help of larger structures (top down approach as shown in figure 2) in the presence of ultrafine grinder's technique or vaporization and lasers method. For complex and composite material, scientists usually choose to produce the nanostructures with the help of bottom-up method assembling it to the make complex arrangements with valuable properties. 'Layer by layer' based deposition technique is; the double layer membranes may be helpful for the analysis of the protein that produced through the layer of sodium based silicate and poly (allylamine hydrochloride) on metal i.e. calcinations of gold by heating system. The lipid double layer might be linked to silicate layers and it helpful identification of the proteins [29]. Rivero et al. [30] stated production of nanoparticles with diverse shape, size and dye (orange, violet, green) effective integration into the polyelectrolyte multi-layer films by using the layer-by-layer (LbL) method.

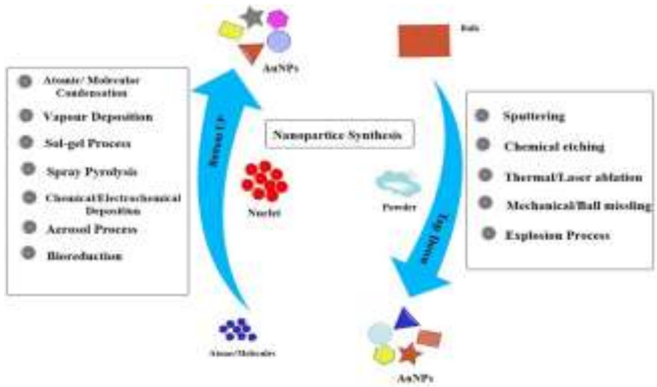

Figure 2; Synthesis approaches of Nanoparticles [68]

Zhao et al. [31-32] made film with multi-layer which contain the nanoparticles of silver and polycation poly (dialyldimethylammonium chloride) (PDDA) following analogous systems. The nanoparticle has fundamental role in the maintenance of temporal stability during the biocompatible fibers production. During that specific synthetic procedure crystallization is effective strategy. The nano particles & rods of gold with another shape were formed by using dead oat by incubation with aqueous solution of gold ions [33]. The gold or silver nanoparticles formed by using the fungi and bacteria [34]. The gas phase and sol-gel scheme are major synthesis methods belong to nanoparticles. Nanoparticles having diameters range from 1-10 nm with surface derivatization, crystal structure, and containing highly monodispersity and it treated with the gas-phase method and other effective sol-gel method. The fresh crystalline substance growth was relying on smaller size particles produced through the condensation or evaporation in inert-gas environment [35-36]. Several aerosol systems stated to develop a better fabrication of the nanoparticles

[37-38]. The self-assembly method, influence of the chemical and physical conditions like pH, solute concentrations and temperature can be induce the molecules to another fibrous nanostructures [39]. The 'Polymerosomes' is superior kind of the nanomaterial containing the immense potential in the perspective of waste water purification. The hydrophobic and hydrophilic groups present in polymerosomes produce a layer on copolymers that is useful in absorbent diversity of different molecules at varied pH values [40]. However, these copolymers are used for the treatment of toxic material from the different nature of water bodies.

3. WATER TREATMENT METHODS

This unit reveals most capable information of technology where nanomaterial components serve as water treatment. The adsorption method is very helpful technique for the removal of toxic waste from water. Use of different type nanoparticles as an adsorbent in purification of the various toxic water in several forms such as nano composite, catalytic membrane, bioactive nanoparticles, catalytic, biomimetic membrane, polymeric thin film composite etc. The some organic compounds are absorbed with the help of CNT than actuated morphology based carbon [41]. The organic chemical containing hydroxyl group, amide and carboxylic groups form the H- bond with carbon nanotubes surface [42]. The commonly CNT contain greater adsorption level of metal ions [43-45]. The nano level metal oxides such as Al_2O_3, iron oxides, TiO_2, are low cost adsorbents for the radio nucleides and heavy metals [46-48]. Dendrimers is a polymeric nanomaterial which is able to eliminate the organics wastes & some heavy metals [49]. The smaller size membranes are a specific membranes modified with the nano fibers which used to eliminate micro size units with greater exclusion rate and having lower fouling tendency from aqueous medium phase [50]. Recent studies shows that nanotechnology has motivated in producing multifunction film through using nanomaterials like the inorganic and polymeric based membranes called the nanocomposite membranes. Addition of the metal based different oxide nanoparticles (silica, alumina and TiO_2) to specific polymeric films has been presented to natural membrane fouling resistance, water absorptivity and surface hydrophilicity [51].

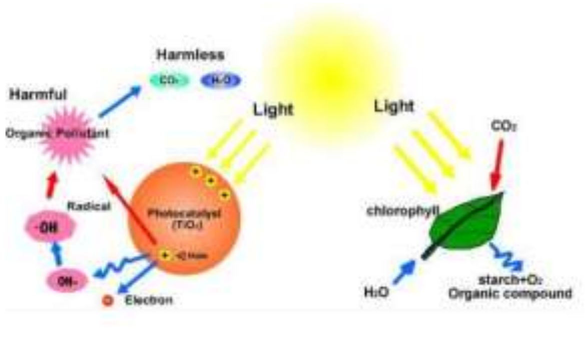

Figure 3; The Removal of Pollutants by using TiO2 material [69]

The nano-TiO2 inorganic nature membranes or improved form of nanoTiO2 is applicable efficiently for the deprivation of pollutants like chlorinated based compounds [52]. The TiO_2 applications on polyethylene and slurry of TiO2 mixture has verified by polymer based membrane for degradation in pharmaceuticals respectively [53-54]. In shortly the TiO2 is effective material to eliminate the pollutants as shown in figure 3.The Fe_2O_3 and TiO_2 nano composite is incorporated inside the ultrafiltration membranes effectively lower the polluting load and enhanced permeate flux [55]. Alumina-zirconia-titania is clay base membrane layered with compound Fe_2O_3 particles was experimentally lower carbon well than non-coated material membrane increasing the degradation of the natural containing organic matter [56-57]. So, the ceramic nanocomposite of CNTs & TiO2 enhanced the membrane permeability and its photo catalytic activity [58-60]. Antimicrobial nanomaterials like small sized silver are fixed to prevent the attachment of bacterial and its development on the surface of biofilm [61-62]. It deactivates the viruses and commonly they can lower the bio-fouling nature [63]. Growths of thin layer base nanomaterial mostly focus on uniting the materials into the thin film nanocomposite via doping on surface modification. The membrane permeability effect of nanomaterial, its selectivity focus on the variability, quantity & dimension of nanoparticles [64-65].The application of nano fibrous based composites having membranes for the organic waste treatment is partial and other stand-alone system (Figure 4) planned for eliminating whole kinds of pollutants containing bacteria, heavy metals, viruses and impure ions. Nano catalysts are also very important role in removing the impurities from the water due to their remarkable aspects. Because the presence of greater surface volume area and their morphology, the zero-valent metal, effective semiconductor base materials and other its bimetallic nanoparticles are considered in water purification as raise catalytic movement on the surface. The degradation and reactivity increase of different environmental toxins such as organo chlorine, herbicides etc.

Silver nanoparticles might be produced through using bacteria named; Bacillus cereus. This strain showing diverse absorptions of the silver salt deliberates with analytical tools i.e. Energy Dispersive spectroscopy (EDS), High Resolution Transmission Electron Micrography (HRTEM) and X-ray diffraction (XRD). Prakash et al. [66] have described Cellulose acetate and MgO nano based particles. The fibers of cellulose acetate surrounded with nanoparticles of Ag against the spores and bacteria.

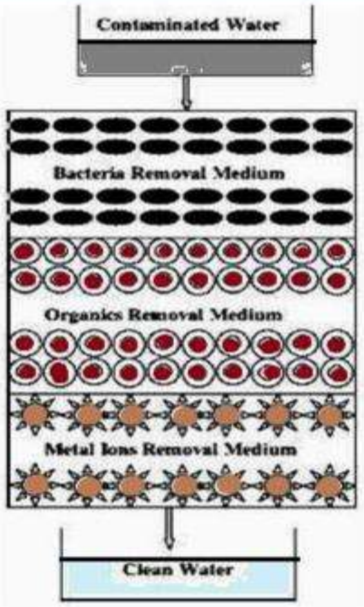

Figure 4; Schematic scheme of Nano fibrous media and membrane filters to remove the pollutants from the wastewater [70]

4. CONCLUSION

The field nanotechnology is deliberated to modern period, material linked to subject essentially unidentified to the folk's due to its modern technology. Very soon the nano sized type materials approaches have play significant role at large scale to purify the water from pollutants. Therefore nanoparticles were dominant process to reduce the toxin metal from water with great efficiency. Metal nanoparticles are appropriate to remove several toxin metals such as Arsenic (As). The metal nanoparticles are cheap and easy to run and control, with cheerful future for its further application. The metal nanoparticles properties report the challenges in many countryside areas where are absence of different resources and suitable technology for the water purification. This is generally for minor scale water purification systems. It aiding between 500-1000 people and is an emerging ideal developing the technology to make availability for unpolluted and germ free water to rural zones.

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