

RESEARCH ARTICLE

ROLE OF QUANTUM DOT'S (QDS) IN SEA WATER TREATMENT- REVIEW ARTICLE

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Abstract

The high concentration of salt present in sea water leads to the unsuitability for domestic and irrigation purposes. It is essential to treat the water bodies to meet the worlds demand. The objective of the study was to gives a detailed discussion about the desalination methods and different types of QDs were involved, examining their salt removing efficiency and degrading capacity, the selectivity and sensitive detection of various chemicals and organismspresent in the sea water.

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Introduction:-

Water is a crucial and vital component for the existence of the living organisms in this universe. There are several factors that contaminate the water resources. Unimaginable amount of toxic chemicals are discharged from various manufacturing plants into the water bodies ^{1,2}. All those pollutants blended with ground and surface water harms the wellness of humans and the ecosystem. Moreover, Clean and pure water is the back bone for the human's healthy life. Thus, it is necessary to treat the polluted water for various purposes such as drinking, irrigation and industrial processes. Researchers adopt several treatment methods to afford the clean and pure water³. Discharging of contaminants even in low concentration pollute the water and soil drastically⁴. The types of pollutants are differing from one another based on their specific characteristics hazardous and carcinogenic effect⁵. Phenol and phenolic compounds are the major pollutants discharged from the industries⁶. These organic pollutants deplete the dissolved oxygen and present a danger to human health⁷.

It is an acceptable fact that the heavy metals are non-biodegradable and toxic to human. These heavy metals are the most probable that cause carcinogenic effects on living organisms, thereby, creating a change in gene expression of the existing normality. They combine very easily with dependent protein of a body creating an oxidative stress in organisms⁹. Nevertheless, the extensive use of organophosphorus compounds in agricultural fields leached into water bodies cause toxic effects on accumulation that drastically reduce the quality of water of the underlying areas. There are traces of pesticides seen on the surface water which contaminates the drinking water potential⁹. Oil pollution is the major concern of contamination in marine waters. The spillage of petrochemicals and oil with mixing up of industrial and urban discharges contributes to the toxicity of marine waters¹⁰. Most industries require a good amount of clean water for its functional attributes, yet the discharge of these industries causes side effects to health and there of the adjoining water table has a seepage of ionic pollutants of fluoride and arsenide¹¹.

Owing to this, the quality of the water is declined and it is desirable to inhibit the contaminants by exploitation of affordable and high efficiency water treatment technologies.

Moreover, the most permeative challenge should be preserve the existing fresh water bodies to meet the growing water demands¹² and in the next forty years the demands on water will increase gradually due to global population ¹³.

Therefore, it is essential to find other water bodies to meet the requirement of clean water. Seawater as huge resource of water needs to be desalinated and treated to furnish fresh water. Desalination and sea water treatment are found to be potential solutions. Therefore, enormous research activities have been developed to transform the sea water into fresh water.to the development of technologies to claim fresh water from seawater or wastewater.

It can be achieved by better water treatment technologies like adsorption, RO purification, UV purification, coagulation and floatation. The working principle of these technologies differs from one another in terms of degree of pollutants, maintenance and operation. During the last two decades significant quantity of research is focussed on the potential application of quantum Dots in water treatment emerged and ignited tremendous research interest due to its unique properties.

Quantum Dots:

The semiconductor nano crystals are newly emerging nano materials best known as Quantum Dots (QD) which have large surface to volume ratio, zero dimensional specific inorganic metals with nano scale size particles having optical and electronic properties in which the excitation of electrons between valence band to conduction band is confined in three spatial directions, which has an ability to produce extreme bright fluorescence that helps to detect the single particle ^{14, 15, 16}. However, this quantum confinement effect, the outstanding property that increase of band gap energy with decreasing of nanoparticle diameter below certain value makes the quantum dot as artificial atoms and the measure of the energy gap depends on the size of QDs ^{17, 18}. It can be said that, very few number of atoms in QDs separates the energy levels in considerable degree, results the existence of atomic like wave functions.

Graphene QDs:

Fluorescent carbon based nano material possessing unique electronic properties along with large surface area, reducing and oxidizing ability recognized graphene as a most important component in novel sensing platforms ^{19, 20}. The electronic properties of graphene has given an origination of graphene based sensors that can detect charge changes in different concentration media there by, helping in identification of surface functional groups and adsorbates at small level ²¹. Undoubtedly, in these QDs one can identify abundance surface groups which are capable of strong photoluminescence (PL). The most effective light effect of PL is always for a discussion. Since the observed PL center have Quantum confinement effect conjugated domains and surface edge state encompassed within the structure. The unified effects of the above two states are taken for agreater impecunious of the study of grapheme QDs²².

The UV region of the visible light is the focus of absorbing graphene QDs. The concept of photoluminescence (PL) is stable within the UV light yet, it shows weak photo-bleaching ²³. This effect may be due to surface state and quantum size effect of the PL emission in grapheneQDs. It has to be understood that the influence of single or multi layers in graphene QD is taken into concern ²⁴, as a PL can also be quenched through selective doping of specific cations, anions or chemical groups ^{25,26}. Collaborating these features, it is evident that graphene QDs serve as effective sensors for PL detection by "turn-off" model. Further, graphene QDs with intrinsic structures exhibit different selective quenching phenomena there by, making it possible to detect various ions and chemical groups. This concept denote the fact that within the blue green region of the spectrum a striking energy band of PL characteristic of graphene QD is observed ²⁷.

Sea water treatment:

The nano particles present in sea water shows increased level of flux of water with the power to resist the salinity and foul. In this condition interfacial polymerization forming thin film nano membrane was made possible. Here in, the dispersion capacity determines the quality of such formation. It has been observed that there was effective water flux and a salt rejection at 0.04 wt/v % of N-GOQDs with 3 to 8 nm size. It was noted that the addition of very less concentration of the Polyamide thin film nanocomposites into the QDs drastically enhances the water permeability thrice in Reverse Order desalination technique.However the increase in concentration of NGQDs decreases the salt rejection and water permeability to certain degree ²⁸. Furthermore, increase in concentration changes the polyamide structure reducing the water permeability and salt rejection ²⁹. It can be considered as an effective technique for high water reclamation creating contaminants resistant with low energy consumption on using Forward Osmosis for

desalination. At the same time, the biofoulcondition of sea water suppresses the working efficiency of the process i.e. FO reducing the rate of salt removal ^{30, 31, 32}. The antifouling property and antibacterial activity can be increased by using modified polyamide with GQDs ³³.

It should be considered that in Forward Osmosis (FO) technique an appropriate draw solution should be selected for greater significance and efficiency of the sea water. A reference to Na-CQDswith size 3.5nm was done as it serve as a potential draw solute with the dispersion rate was 0.5 g/ml having osmolality of 4350 mOsm /kg at 53.6 atmalong with high FO water flux of 29.8 $\text{Lm}^{-2} \text{ h}^{-1}$. This was taken to be of higher quality than the other draw solute. The condition of high water flux in sea water can be attained by nanoparticles with limited size but having prominent hydrophilicity. A state of high water flux 3.5 $\text{Lm}^{-2}\text{h}^{-1}$ was performed by the polymer poly(sodiumstyrene-4-sulfonate-co-n-isopropylacrylamide). Additionally the same polymer regenerated the draw solution. The dispersion of nanoparticles in this process was controlled by sunlight. For instance, solar light aggregates the heterodimer upon irradiation creating a condition of increased dispersion rate ^{34, 35}.

A secondary state of the tendency of the dye removal was observed which depends on the molecular weight of the coloured pollutants in sea water. It's here, the use of tannic acid was brought in focus. The composite structure of tannic acid (TA) thin Film seems to separate the coloured components and polyvalent components at low pressure bringing down the economic impact of desalination. Further, the very smooth surface of the membrane enhances the antifouling property of sea water. Increasing the concentration of TA/GQDs helps to increase the, zeta potential and there by water permeability of sea water³⁶. Another method using the fabrication of hydrophobic membrane using C-18 CQDs along with and cotton fabric which consisting of (2,4-diisocyanate) was a shift of higher assimilation for desalination. This enhances very high rate of oil - salt water separation independent of acidity or alkalinity due to the high contact angle 165.1 ± 2.08 ° of the element used. This process was analysed on surface wettability of the sea water. Interestingly, it has been identified that the high desalination ability can be measured through the conductivity which decreases from 0.12 to 019 mS.cm⁻¹. This brings in the formation of covalent bond there by preventing the contamination of surroundings nano particles in sea water³⁷. Among the varied fabrication preferable one was the electro spinning. This is considered very effective due to high surface techniques. most area, surface porosity and hydrophobicity being present in the particles. The electro spinning technique exhibit a comparative analysis on salt rejection quality for PolyvinylideneFluoride(PVDF) membranes with varying concentration of GQDs through by Air Gap Membrane Distillation (AGMD) along with GQD3P exhibits 18.43 kg/m²h which runs for 60 hrs and at the same time GQD2P shows 6.42 kg/m²h of water flux for the same process in relevance to sea water³⁸. An another reference to this concept has been identified using mesoporous structured imprinting microspheres SiO₂@QDs@ms-MIPs which recognize the presence of blue pigment algae phycocyaninfluorescent sea waterwhen it comes to the use of Molecularly Imprinted Polymers (MIP's) which exhibit low impact. The (MIP) exhibits low impact, cost effective and high stable conditions on usage. It has been found that the fluorescent intensity purely depends on the concentration of the algae and the presence of phycocyanin in those algae was identified by MIP's. At the same time, the lower or higher pH 7.5 directly affects the rebinding of phycocyanin³⁹. At this stance, a paper based analytical devicecan also be used to detect phycocyanin in marine water which forms meisenheimer complex with CdTe OD which is available on paper leading to the transfer of energy. During the transfer of energy, electrons are transferred during the process of absorption and the fluorescence quenching that helps to detect the protein molecule of the algae. It was analysed scientifically that the energy state of the algae decides the fluorescence emission. Further. Fluorescence quenching was high for pycocyanin than algae spirulina and algae as detected in phycoerythrin in paper @QDs@ PC-MIP⁴⁰. The major breakthrough is identified on using UF-NF dual membrane that lowers the size of QDs to less than 20nm. In the same context it can be reported that the reverse salt flux of 1.41 g m⁻² h⁻¹ was exists using 0.5 M MgCl₂ as a draw solution in GQDs fabricated TFC.⁴¹

Conclusion:-

The performance of QDs on the desalination of sea water and the removal of contaminants in sea water was discussed, and their functioning and fabrication methods were compared. Comparatively, electro spinning technique was more desirable than other techniques and the draw agent used in FO desalination technique made it cost effective than RO desalination. Additionally Graphene QDs have shown highest quality effluents removal towards the contaminants.

Conflict of interest:

Nil

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