Nanotechnology for water purification

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To purify our drinking water, we need to remove contaminants including those that are much too small to see (tiny microbes and chemicals). While large-scale water treatment plants work well, there are times /places/ situations where we don't have access to these facilities and need to purify our water at the point of use. Nanotechnology is providing some new ways to purify our water at the point of use (better filters to remove tiny microorganisms and prevent filter- fouling).

Nanotechnology refers to a broad range of tools, techniques and applications that simply involve particles on the approximate size scale of a few to hundreds of nanometers in diameter. Particles of this size have some unique physicochemical and surface properties that lend themselves to novel uses. Indeed, advocates of nanotechnology suggest that this area of research could contribute to solutions for some of the major problems we face on the global scale such as ensuring a supply of safe drinking water for a growing population, as well as addressing issues in medicine, energy, and agriculture.

There are several nanotechnology approaches to water purification currently being investigated and some already in use. Water treatment devices that incorporate nanoscale materials are already available, and human development needs for clean water are pressing. Any of the above methods can be combined depending on the type of contaminated water and prospective purpose (Fig.1) (Stackelberg *et al*., 2004).

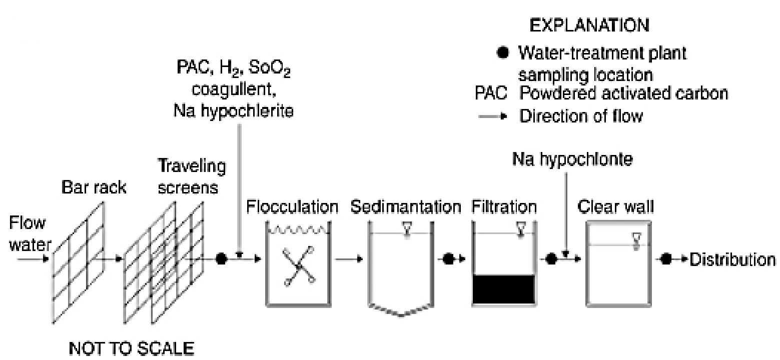

Figure 1: schematic diagram showing physical and chemical processes used in drinking-water-treatment plant.

These methods work well, but recent notorious anthropogenic pollutants (result of modern human life style) pose a challenge to purify/treat the contaminated water. Table 1 summarizes major limitations associated with conventional methods.

Table1 : Major Limitations Associated with Conventional Water Purification Methods

Conventional Methods	Limitations
Distillation	Most contaminants remain behind and require high amounts of energy and water. Pollutants with boiling point >100°C are diffcult to remove
Chemical transformation	Excess reagents are required. Product may be a low-quality mixture and cannot be released into environment. Inactive in harsh conditions. This is not highly selective method
Coagulation and flocculation	This is a complex and less-efficient method and requires alkaline additives to achieve optimum pH
Biological treatment	Microorganisms are sensitive to environmental factors and difficult to control. Intermediates damage the microbial cells. This is not cost effective. Time consuming
Ultraviolet treatment	Expensive method and inactivated by water cloudiness and turbidity. Ineffective for heavy metals and other nonliving contaminants removal
Reverse osmosis	This method removes minerals from water which is unhealthy, and the treated water will be acidic. This method cannot remove volatile organics, chemicals, chlorine, chloramines and pharmaceuticals. Requires high energy
Nanoflteration	This technique requires high energy, and pretreatment. Limited retention for salts and univalent ions. Membrane fouling will occur with limited lifetime and expensive
Ultrafltration	This method will not remove dissolved inorganics. Requires high energy. Susceptible to particulate plugging and diffcult to clean
Microfltration	Cannot remove nitrates, fluoride, metals, sodium, volatile organics, color, and so on. Requires regular cleaning. Membrane fouling will occur. Less sensitive to microbes, especially virus
Carbon flter	Cannot remove nitrates, fluoride, metals, sodium, and so on. Clogging occurs with undissolved solids. Susceptible to mold. Requires frequent changing of flters

The impurities that nanotechnology can tackle depend on the stage of purification of water to which the technique is applied, the team adds. It can be used for removal of sediments, chemical effluents, charged particles, bacteria and other pathogens. They explain that toxic trace elements such as arsenic, and viscous liquid impurities such as oil can also be removed using nanotechnology.

The main advantages of using nanofilters, as opposed to conventional systems, are that less pressure is required to pass water across the filter, they are more efficient, and they have incredibly large surface areas and can be more easily cleaned by back-flushing compared with conventional methods.

Nanofilters may be relatively simple; it is believed that future generations of nanotechnology-based water treatment devices will capitalize on the properties of new nanoscale materials.

Diatoms are single cell algae composed of silica. They represent one of the most outstanding natural materials with exceptional structural, mechanical, optical, photonic and chemical properties optimized through millions years of evolution. The unique nano and micro silica structures of the material combined with its availability as a low cost mineral from diatomaceous earth are attractive for solving many of today's environmental, energy and health problems.

So **diatom nanotechnology** provides a comprehensive overview of the material and its uses. The explore the broad range of their applications in nanotechnology including nanofabrication, optical biosensors, gas sensors, water purifications, photonics, drug delivery, batteries, solar cells, supercapacitors, new adsorbents and composite materials.