Presentation

on

"EFFECTIVENESS OF DRINKING WATER TREATMENT PLANT IN ANTIBIOTICS REMOVAL"

Submitted by:

Arun Giri(2011CEV2852)

Kuldeep Kumar Kanauzia(2011CEV2860)

Vivek Joshi(2011CEV2833)

Topics to be covered

- Introduction
- Antibiotics selected for the removal
- Their removal processes
- Table for comparing removal efficiencies
- Conclusion

Task contribution per group member

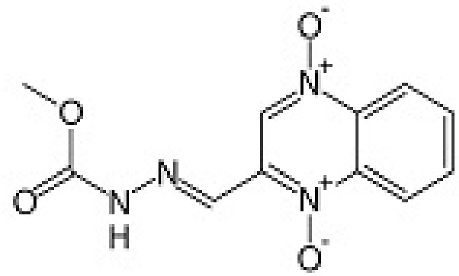
- Study of Carbadox and its removal processes- Arun Giri
- Study of Sulfachlorpyridazine and its removal processes- Kuldeep Kumar Kanauzia
- Comparison of removal processes of the two selected antibiotics- Vivek Joshi

Introduction

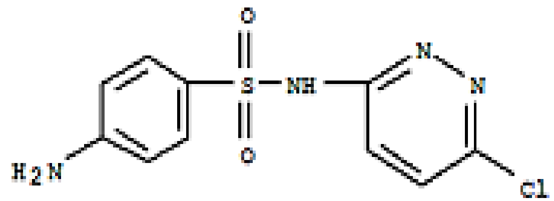
- Recent studies have determined that a variety of antibiotics are present in surface and groundwater .
- This occurs, in part, from the discharge or disposal of antibiotics from medical, municipal, and agricultural sources.
- Generally biological treatment processes have been shown to be ineffective in the removal of antibiotics.
- Some combined chemical/biological treatment processes appear to be more effective.

Antibiotics selected for the removal

- Carbadox($C_{11}H_{10}N_4O_4$)
  molecular weight = 262.224



- Sulfachlorpyridazine($C_{10}H_9ClN_4O_2S$)
  molecular weight = 284.719



Processes for the removal of antibiotics

Metal Salt Coagulation:

- Coagulation is the process by which chemicals are added to water to cause destabilization of colloidal particles, allowing aggregation through flocculation, followed by sedimentation
- Antibiotics are not likely to be effectively removed via the coagulation process with alum or iron salts.

Powdered Activated Carbon Sorption:

- Calgon WPH Pulv PAC is commonly used in drinking water treatment plants for the removal of Carbadox and sulfachlorpyridazine, taste and odor compounds.
- In drinking water, the percent removal of each of the antibiotics ranged from 57 to 97% and 81 to 98% for PAC dosages of 10 and 20 mg/L, respectively.
- The results show that PAC sorption provides a viable means with which to treat these pharmaceuticals at common PAC dosages.

Chlorination:

- Chlorination experiments were conducted at a chlorine concentration of 1 mg/L as Cl_2 in drinking water.
- From the results of these experiments, reaction times required for 50 and 90% removal 0.50 and 0.90 respectively were determined for the studied compounds.
- Chemical oxidation of organic compounds using free chlorine as the oxidant can often lead to chlorinated by-products.

Ultraviolet Photolysis:

- Analysis of the ultraviolet photolysis results requires comparison with UV dosages commonly utilized in disinfecting water.
- These dosages are on the order of 100 times greater than the aforementioned typical disinfection dosage.

Reverse Osmosis:

- Reverse osmosis was examined using a low-pressure reverse osmosis system with a cellulose acetate membrane.
- Reverse osmosis is not usually economical and hence is not common in most municipal drinking water plants.

Table for percentage removal by various processes for both antibiotics

PROCESS	Percentage removal (antibiotics 1)	Percentage removal (antibiotics 2)
Metal salt coagulation	No significant removal	No significant removal
Powdered activated carbon sorption	57 to 97%	81 to 98%
Chlorination	50- 90%	50-90%
Ultraviolet photolysis	40-70%	45- 80%
Reverse Osmosis	90.2%	90.2%

Conclusion

- Common drinking water treatment processes were examined under typical plant conditions with respect to their ability to remove antibiotics from drinking water.
- Powdered activated carbon effectively removed the antibiotics at typical plant dosages.
- Overall, the results of this study suggest that control of the studied antibiotics can be achieved at surface water treatment plants with common treatment steps, i.e., carbon sorption and oxidation with ozone or chlorine species.
- Further work is needed on the removal of other antibiotics and pharmaceuticals in conventional drinking water treatment plants

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Thank you

Nano-Technology for Water Purification – Nano Silver and Titanium Dioxide

TERM PAPER

CEL-795: Water and Wastewater Technologies

Coursework at IIT Delhi, 2011-12 Session

Presented by:

Aasif Mujtaba 2011CEV2842
Chandresh Kumar 2011CEV2855
Javaid Ahmad Kurpal 2011CEV3066
J.K. Bassin 2010CEZ8738

November 11, 2011

Importance of Water

884 million	people lack access to safe water supplies — approximately one in eight people
6 kilometres	is the average distance African and Asian women walk to fetch water
3.6 million	people die each year from water-related diseases
98 per cent	of water-related deaths occur in the developing world
84 per cent	of water-related deaths are in children ages 0–14
43 per cent	of water-related deaths are due to diarrhoea
65 million	People are at risk of arsenic poisoning in the Bangladesh, India and Nepal area

- Disease causing bacterial contamination is ubiquitously present in any water body, removal from the drinking water is an essential task.
- Removal or inactivation of pathogenic microorganism is a demanding task in any water treatment process. These pathogens can be inactivated by using physical, biological and chemical means.
- Safest and at the same time effective antibacterial material is still under exploration for the disinfection of water.

Water Safety

- Public Water Supplies assumed greater importance with the progressive increase in urbanisation. Potentially great advantages → Convenience, health benefits deriving from washing & cleaning. BUT Risk to health → Large No. of people if contamination occurs.
- It is recognised that the key to microbiologically safe drinking water is the exclusion of fecal contamination.
- Outbreaks of cholera and typhoid in the 19th and the early 20th centuries led to the wide-spread use of filtration to treat water supplies followed by the gradual introduction of the use of chlorine, usually on an intermittent basis, from 1910 onwards.
- The Croydon typhoid outbreak in 1937 led to continuous chlorination of water being used almost universally on PWS.

Today, most PWS contain disinfectant, normally chlorine, at a low level at consumer's tap to protect against contamination.

However, the ill-effect is formation of DBPs.

AND thus, search for better options is continuing

Nano Technology

- Nano science refers to the science & discipline and nano technology refers the applied part of it including the engineering to control, manipulate and structure the matter at an unimaginably small scale: ***nano scale*** – also referred to as 'atomic' or 'molecular' scale which is 100 nm or smaller.
- This capability also simultaneously gives us the ability to build materials and devices or shapes and products on that scale.
- Because of the brevity in operation, smarter and lighter products can be made from the molecules of the same matter with every atom in its specified place through 'positioned assembly' or 'self assembly'.
- The matter displays unimaginably different qualities when manipulated and structured at nano scale. ***It produces different products when assembled at that scale***.
- This is what is the future unleashed by the nanotechnology revolution.

NANO-PARTICLES (Ag, TiO_2) and NANO-FILTRATION CAN BOTH BE USED EFFECTIVELY FOR WATER TREATMENT <u>(POU)</u>

Conventional and Nanobased WTT

- Conventional water-treatment technologies include filtration, ultraviolet radiation, chemical treatment and desalination, whereas the nano-enabled technologies include a variety of different types of membranes and filters based on carbon nanotubes, nanoporous ceramics, magnetic nanoparticles and other nanomaterials.
- Separation membranes with structure at the nanoscale can also be used in low-cost methods to produce potable water. In a recent study in South Africa, several polymeric nanofiltration and reverse osmosis membranes were tested for the treatment of brackish groundwater.
- The tests showed that nanofiltration membranes can produce potable water from the brackish groundwater. As expected, the reverse osmosis membranes removed about 99% of all the solutes, but the concentrations of essential nutrients, such as calcium and magnesium ions, were reduced to levels that were below the specifications of the World Health Organization standard for drinking water. The product water therefore had to be spiked with these nutrients to provide drinking water of the required quality.

(Nanotechnology and the challenge of clean water, Thembela Hillie & Mbhuti Hlophe, *Nature Nanotechnology* **2**, 663 - 664 (2007) Published online: 21 October 2007 | doi:10.1038/nnano.2007.350)

Nano-technology based Products being developed for Water Applications

Product	How it works	Importance	Developer
Nanomesh waterstick	A straw-like filtration device that uses carbon nanotubes placed on a flexible, porous, material	The waterstick cleans as you drink. Doctors in Africa are using a prototype and the final product will be made available at an affordable cost in developing countries	Seldon Laboratories, United States
World filter	Filter using a nanofibre layer, made up of polymers, resins, ceramic and other materials, that removes contaminants	Designed specifically for household or community-level use in developing countries. The filters are effective, easy to use and require no maintenance	KX Industries, United States
Pesticide filter	Filter using nanosilver to adsorb and then degrade three pesticides commonly found in Indian water supplies	Pesticides are often found in developing country water supplies. This pesticide filter could provide a typical Indian household with 6000 litres of clean water over one year	Indian Institute of Technology in Chennai, and Eureka Forbes Limited, India

Product	How it works	Importance	Developer
Nanosponge for rainwater harvesting	A combination of polymers and glass nanoparticles that can be printed onto surfaces like fabrics to soak up water	Rainwater harvesting is increasingly important to countries like China, Nepal and Thailand. The nanosponge is much more efficient than traditional mist-catching nets	Massachusetts Institute of Technology, United States
Nanorust to remove arsenic	Magnetic nanoparticles of iron oxide suspended in water bind arsenic, which is then removed with a magnet	India, Bangladesh and other developing countries suffer thousands of cases of arsenic poisoning each year, linked to poisoned wells	Rice University, United States
Desalination membrane	A combination of polymers and nanoparticles that draws in water ions and repels dissolved salts	Already on the market, this membrane enables desalination with lower energy costs than reverse osmosis	University of California, Los Angeles and NanoH2O
Nanofiltration membrane	Membrane made up of polymers with a pore size ranging from 0.1 to 10nm	Field tested to treat drinking water in China and desalinate water in Iran, using this membrane requires less energy than reverse osmosis	Saehan Industries, Korea

Nanomaterial v/s Contaminant Removed

Nanomaterial utilized	Contaminants removal	Adsorption capacity	Product life(in l)	Product price
Silver nanoparticle s supported on alumina	Pesticides and halogenated organics	100 mg Chlorpyrifos per g silver nanoparticles	6000	$30
Titania nanoparticles	Arsenic and disinfection	12–15 g As(V) and 3- –4 g As(III) per kg of adsorbent	–	–
Iron oxide nanoparticles	Heavy metals including arsenic, lead, chromium, zinc, copper	–	3800–11,400	$50
Electropositive alumina nanofibers on a glass filter substrate	Disinfection, natural organic matter, turbidity, salt, radioactivity, heavy metals	–	–	$3–10 per m^2, $75 per filter
Hydrous iron oxide nanoparticles on polymer substrate	Arsenic, vanadium, chromium, uranium	38 mg of Arsenic per g of adsorbent	–	$0.07–0.20 per 1000 l (amortized)
Membrane filters based on ceramic nanopowder supported on alumina	Disinfection	–	–	–

Ref: T. Pradeep, Anshup (2009). Noble metal nanoparticles for water purification: A critical review. Thin Solid Films, 517, 6441–6478

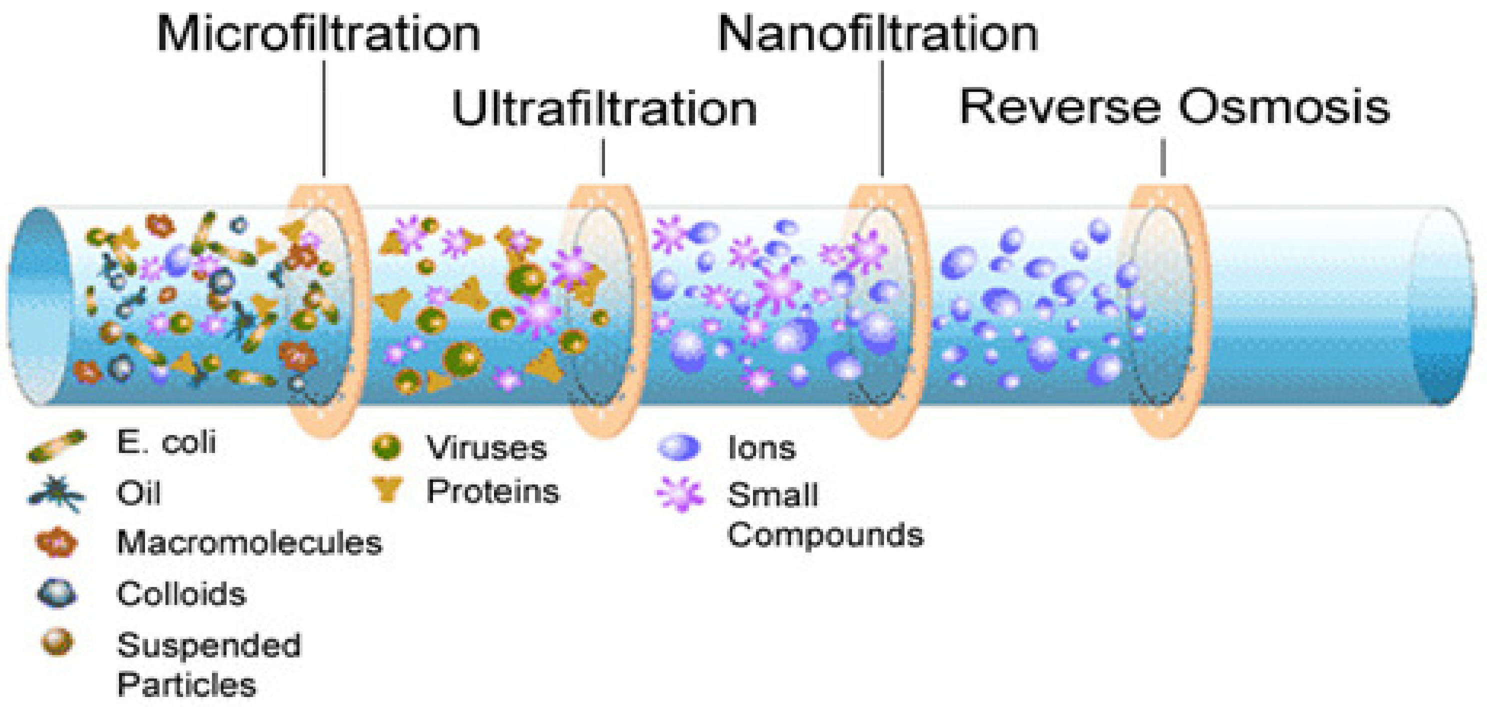
Nano-filtration

Filter type	Pore Size, µm	Operating Pressure	Types of Materials Removed
MF	1.0-0.01	<30	Clay, bacteria, large viruses, suspended solids
UF	0.01-0.001	20-100	Viruses, proteins, starches, colloids, silica, organics, dye, fat
NF	0.001-0.0001	50-300	Sugar, pesticides, herbicides, divalent anions
RO	< 0.0001	225-1,000	Monovalent salts

- Nano-filters are close in size to RO filters, but cost much less to run
- And special properties of nano-sized particles can be exploited!
  - *We can design new nano-filters that catch particles smaller than they would catch based on size alone*
- Scientists are exploring a variety of methods to build new nano-membranes with unique properties to filter in new and different ways

A Series of Filtrations Increases Efficiency

- Filters can be sequenced from large to small pore size to decrease fouling
  - They must still be cleaned regularly to remain usable



Bactericidal Properties of Silver

- Application of silver nanoparticles has ushered in a new approach to the application of silver antimicrobial agents.
- Several investigations have been carried out examining the bactericidal effect of nanoparticles and their applications in the plastics, health, textile, and paint industries.
- Compared with silver ions, silver nanoparticles are long lasting, and are subject to controlled release. In comparison with bulk silver, they are low cost with a controllable release rate of silver ions.
- Nanoparticles are expected to play a crucial role in the food industry, **water disinfection**, and **other applications related to disinfection** (Yaohui Lv et al., 2009).
- Inhibitory effect of Ag^+ → is due to its ***sorption to the negatively charged bacterial cell wall***, ***deactivating cellular enzymes***, ***disrupting membrane permeability***, and ultimately leading to ***cell lysis*** and death.

Table 2 Summary of silver nanoparticles toxicity to other microorganisms

Strain	Silver nanoparticles	Size (nm)	Key aspects	Reference
Fungi				
A. niger	Myramistin® stabilized silver nanoparticles	10[a]	MIC were found to be 5 mg/L	(Vertelov et al. 2008)
	Silver nanoparticles stabilized in hyper branched polymers	1.4–7.1[b]	Formation of inhibition zones around silver nanoparticles inoculated spots in agar plates	(Zhang et al. 2008)
S. cerevisiae	Myramistin® stabilized silver nanoparticles	10[a]	MIC were found to be 5 mg/L	(Vertelov et al. 2008)
T. mentagrophytes	Silver nanoparticles	3[b]	IC_{80} between 1 and 4 mg/L	(Kim et al. 2008a, b)
C. Albanicas	Silver nanoparticles	3[b]	Silver nanoparticles inhibited micelial formation, which is responsible for pathogenicity	(Kim et al. 2008a, b)
	Silver nanoparticles	3[b]	Antifungal activity may be exerted by cell membrane structure disruption and inhibition of normal budding process	(Kim et al. 2009a, b)
	Silver nanoparticles coated on plastic catheters	3–18[b]	Catheter coated with silver nanoparticles inhibited growth and biofilm formation.	(Roe et al. 2008)
Yeast (isolated from bovine mastitis)	Silver nanoparticles	13.4[b]	MIC estimated between 6.6 nM and 13.2 nM	(Kim et al. 2007)
P. citrinum	Silver nanoparticles stabilized in hyper branched polymers	1.4–7.1[b]	Formation of inhibition zones around silver nanoparticles inoculated spots in agar plates	(Zhang et al. 2008)
Viruses				
Hepatitis B virus	Silver nanoparticles	10[b]	Inhibition of virus replication	(Lu et al. 2008)
HIV-1	Silver nanoparticles	16.19 ± 8.68[b]	Only 1–10 nm nanoparticles attached to virus restraining virus from attaching to host cells.	(Elechiguerra et al. 2005)
Syncitial virus	Silver nanoparticles		44% inhibition of Syncitial virus infection	(Sun et al. 2008)
Algae				
C. reinhardtii	Silver nanoparticles	10–200[a]	EC_{50} for the photosynthetic yield was found in 0.35 mg/L of total silver content after 1 h of exposure	(Navarro et al. 2008)

Titanium Oxide Nano-particles

- Titanium oxide (TiO_2) is an important non-toxic pigment used in the manufacture of many everyday substances such as paints and cosmetics.
- It exists mainly as three crystalline polymorphs – anatase (tetragonal), rutile (tetragonal) and brookite (orthorhombic).
- In the past 20 years, TiO_2 nanoparticles have become important due to their numerous applications. TiO_2 has excellent photocatalytic oxidative properties that depend on the crystallinity and crystal form. The photocatalytic activity of TiO_2 is used for cleaning polluted air and water.
- It also exhibits some unique dielectric and chemical properties that can be utilized in various technological and engineering applications such as ceramic membranes, humidity sensors, gas sensors, absorbents and pigments. (Keshwani et al 2010)

Bactericidal & Viricidal Properties

- Titanium oxide photo catalyst have been widely studied for their environmental applications in the past several decades because of their high chemical stability, good photo activity, relatively low cost, and non toxicity.
- However the photo catalytic activity is limited to only UV light, seriously limiting its solar efficiency.
- To overcome this limitation, both chemical and physical modification approaches were developed to extend band-edge of TiO_2 into visible light region.
- Nanostructured photocatalyst showed very fast degradation in organics, bacteria, spores and virus and thus have great potential in water disinfection (Savage et al, 2009).

Metal Removal Properties

- Heavy metals pose threat to human health and ecosystems because of their potentially high toxicity. Unlike organic pollutants, heavy metals do not undergo biological degradation and tend to accumulate in the organisms, thereby eventually enter the food chains (Kunjia et al, 2008).
- The metals of concern in our present study are **lead** and **Arsenic**.
- Many methods have been used to remove metals from water and waste-water, mainly by chemical precipitation, ionic exchange, membrane separation, biosorption, adsorption process, etc (Recillas et al, 2011).
- Among various techniques applied for heavy metals removal from water, adsorption and ion exchange are the widely used options. The traditional materials employed for both techniques display little or insufficient specific sorption affinity toward toxic metals.
- Adsorption is evolving as a front line of defense.
- The main advantage of using Titanium oxide materials compared to conventional materials is the high surface area, which means a large space for the development of chemical reactions, physic interchanges, etc (Recillas et al, 2011).

Nanoscale Titanium Dioxide Photocatalysts

- Titanium dioxide functions as both a photocatalytic reducing agent and an adsorbent, and it is used for both in-situ and ex-situ water treatment. In the presence of water, oxygen, and UV radiation, titanium dioxide produces free radicals that decompose a variety of contaminants into less toxic carbon compounds.
- Nanoscale titanium dioxide provides larger surface area and faster photocatalysis than larger titanium dioxide particles.
- Titanium dioxide is available in nanopowder form for use in suspensions or granular media filters. It is also available in several other forms, including, but not limited to, coatings for fixed membranes, nanocrystalline microspheres, and composite membranes with silica.

Contaminants Removed

- Titanium dioxide breaks down almost all organic contaminants.
- It is also super-hydrophilic and, therefore, able to adsorb biological contaminants and heavy metals, including arsenic.
- Its effectiveness is influenced by the quality of the titanium dioxide, the UV intensity, the water's pH, the oxygen supply, and the concentration of contaminants

Ref: Background paper of Workshop on Nanotechnology, Water & Development, Chennai, 10-12 Oct 2006

Titanium Oxide Nanoparticle Adsorbent

- Adsorbsia™GTO™ is a granular adsorptive media from Dow Chemical Company that removes arsenic from water through the combined oxidative and adsorptive properties of titanium oxide. It is designed for small and mid-sized systems or POU applications.

Contaminants Removed

- Under typical conditions, Adsorbsia™ has been shown **to remove 12 to 15 grams of arsenic (V) and 3 to 4 grams of arsenic (III) per kilogram of media.**
- In addition to pH, removal efficiency is also not affected by the presence of sulfate, phosphate, iron, chlorine, or other anions in the water. Since it is not affected by chlorine, Adsorbsia™ can be combined with disinfection to eliminate biological contaminants. Removal efficiency may be affected, however, by the amount of arsenic that is present in the water, the ionic form of the arsenic, competing impurities and ions, and the design of the equipment. Adsorbsia™ is also said to remove viruses and bacteria.

Ref: Background paper of Workshop on Nanotechnology, Water & Development, Chennai, 10-12 Oct 2006

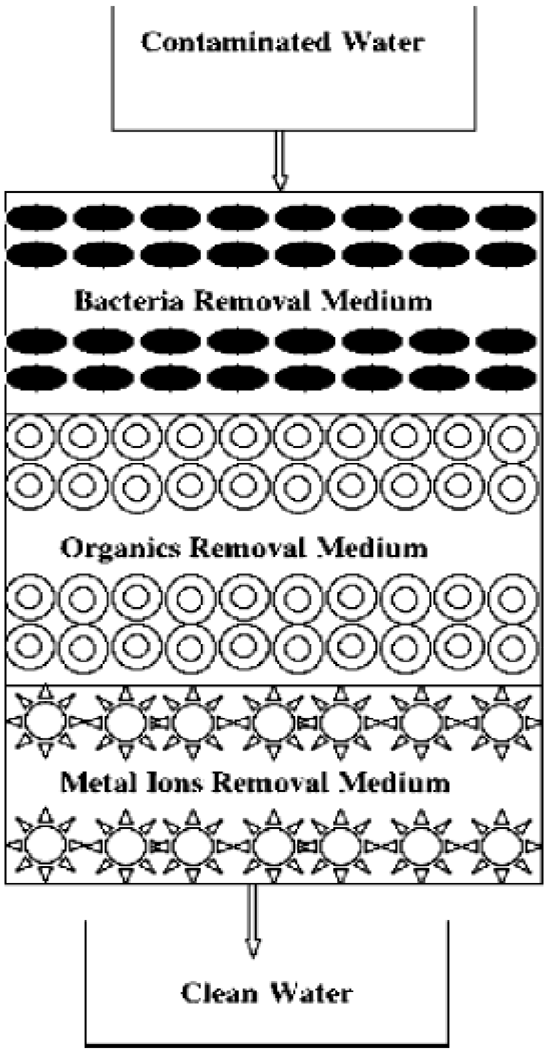


Figure 3. Schematic of a composite nanomaterial packed-bed reactor for purification of water contaminated by mixtures of (i) metal ions, (ii) organic solutes and (iii) bacteria.

- Kabra et al. (2004) have recently reviewed the utilization of photocatalysts in the treatment of water contaminated by organic and inorganic pollutants.
- They documented the successful use of TiO2 nanoparticles to
  i. degrade organic compounds (e.g. chlorinated alkanes and benzenes, dioxins, furans, PCBs, etc.) and
  ii. reduce toxic metal ions [e.g., Cr(VI), Ag(I) and Pt(II)] in aqueous solutions under UV light.

Ref: Nora Savage and Mamadou S. Diallo. (2005). Nanomaterials and water purification: Opportunities and challenges. Journal of Nanoparticle Research, 7: 331–342, DOI 10.1007/s11051-005-7523-5

Water Management through Nano tech Applications: Potential in India

Major Challenges	Solutions offered by the Nano technology
Conserving water	Conserving water is as important as increasing the supply of usable water. Nanotech has immense potential in this area since this precision technology has strategic solutions to control waste of water flowing through canals through better linings and coatings, better drip and sprinkler systems, more efficient coatings to stop seepage in household and industrial water systems and less requirement of back flush in filtration systems.
Preserving essential nutrients in water like calcium etc	Nanotech based filters can precisely select the substances and hence retention of essential ones will be possible
Measuring and monitoring contaminants at the trace level	Nano filters can analytically and effectively measure and monitor contaminants like arsenic, mercury and others even at the trace level, unlike the conventional ones which can measure only the concentrated high level contaminants.
New possibilities	Nano science enables various strategic applications as under: Purification applications, ranging from high purity semiconductor and medical uses through home drinking water. Remediation of both waste water and polluted ground water. Desalination applications, including both sea water and brackish water

CONCLUSION

- Pathogenic, disease causing, bacterial contamination is almost always present in any water body, and its removal from the drinking water is an essential task for water suppliers.
- Removal or inactivation of pathogenic microorganism is achieved using a variety of techniques such as chlorination, ozone disinfection, which however, leave harmful reaction products in the product water consumed by users. Some of these reaction products are even carcinogenic and may lead to onset of cancer in vulnerable group.
- It is, thus, necessary to develop better and safer techniques for drinking water disinfection. Use of nano-technology, particularly Ag & TiO_2 nanoparticles has been examined.
- Some of the techniques have high potential to become technology of the future for water purification and research needs to devoted for development of purification methods applicable at domestic, community and public water supply levels.

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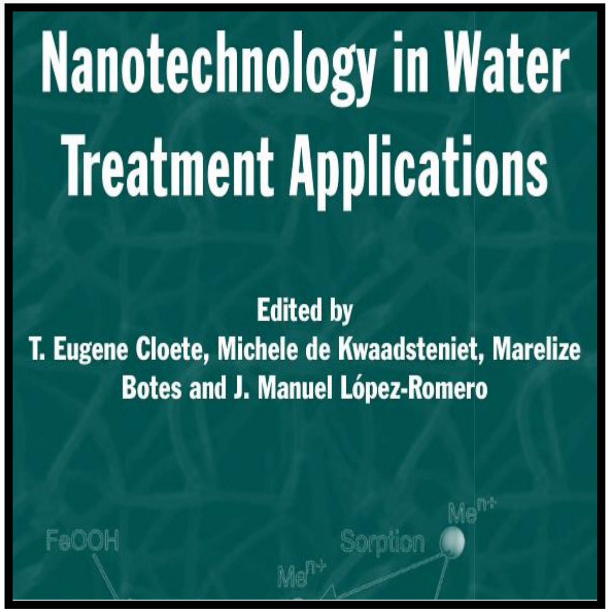
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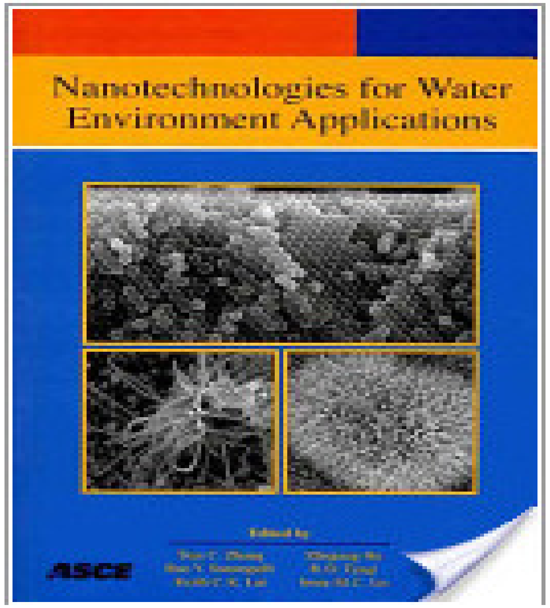
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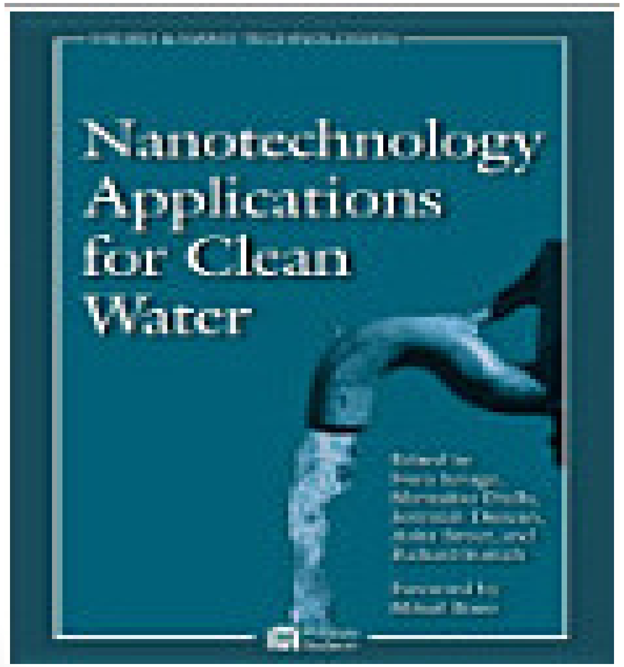
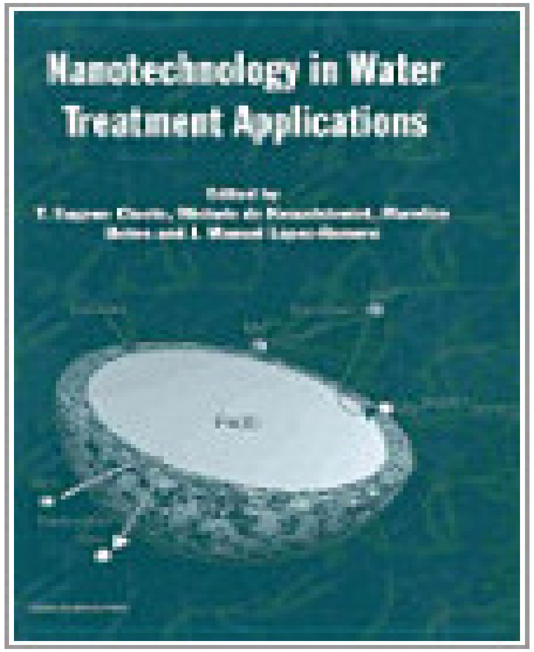

Nanotechnology
Applications
for Clean
Water


Nanotechnology in Water
Treatment Applications

Group Contribution

- **Aasif Mujtaba** – Introduction to nanotechnology usage for water Treatment, Application of Various nano materials, Introduction of Silver Nanoparticle and its varius properties
- **Chandesh Kumar** – Introduction to Titanium nanoparticle, Properties of Titanium nanoparticle
- **Javaid Ahmad Kurpal** – Application and efficiency of titanium Nanoparticle.
- **J.K.Basin-** Application of Silver Nanoparticle in microbial and metal removal, Practical Usage of Silver Nanoparticle

EFFECTIVENESS OF DRINKING WATER TREATMENT PLANTS IN REMOVING NANO PARTICLES FROM WATER

By I… NTAL)

VA…

RIT…

ABHISHEK SINGH CHAUHAN

PRAFUL T. SONKAMBLE

SUBMITTED TO
DR. ARUN KUMAR

NANO PARTICLES

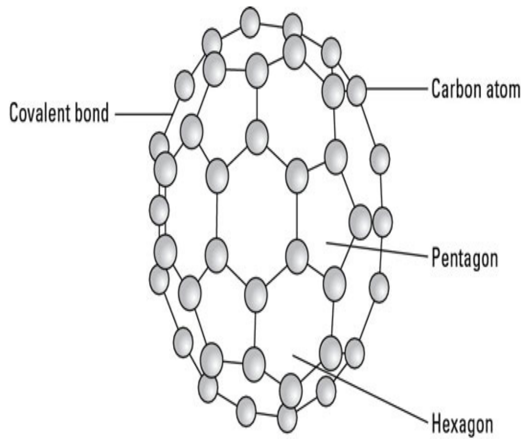
- Nano particle is defined as particle having at least one dimension less than 100nm.
- Their classification as per size is

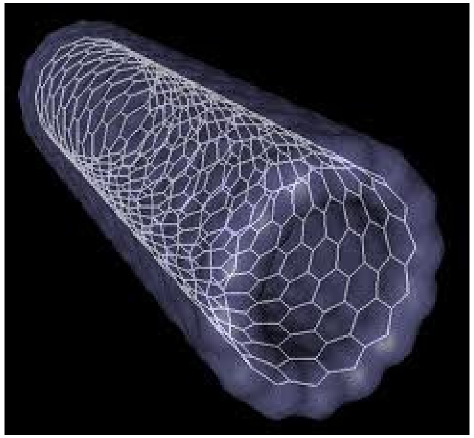
classification	Dia (nanometers)
coarse particles	10,000 and 2,500
Fine particles	2,500 and 100
Ultrafine particles, or nanoparticles	100 and 1

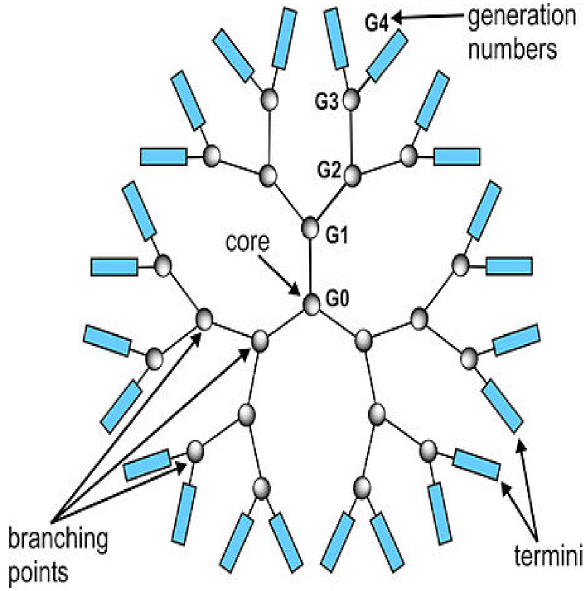
- Their are two types of nano particles -
  1. Environmental
  2. engineered/manufactured.
- Environmental nano particles are mainly metal oxides and metal sulphides .
- Engineered nanoparticles are those which are snythetically manufactured .

ENGINEERED NANO PARTICLE

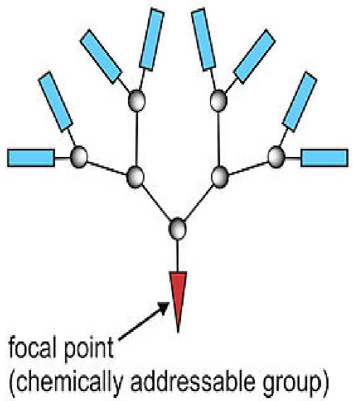
- There are 4 types of engineered nano particles :
- Carbon based (fullerenes) - consist of buckyballs(spherical shape) and nano tubes(cylindrical shape) are two most common carbon based nano particles .
- Metal based – metal oxides , quantum dots , nanogold and nano silver come under this category . Once they enter environment , they could release metals , which may be toxic to organisms .
- Dendimers – is a large molecule comprising of many nano polymers .
- Composites – are mixture of nano particles or nanoparticles attached to large molecules .







DENDRIMER



DENDRON

PROPERTISE OF NANOPARTICLE

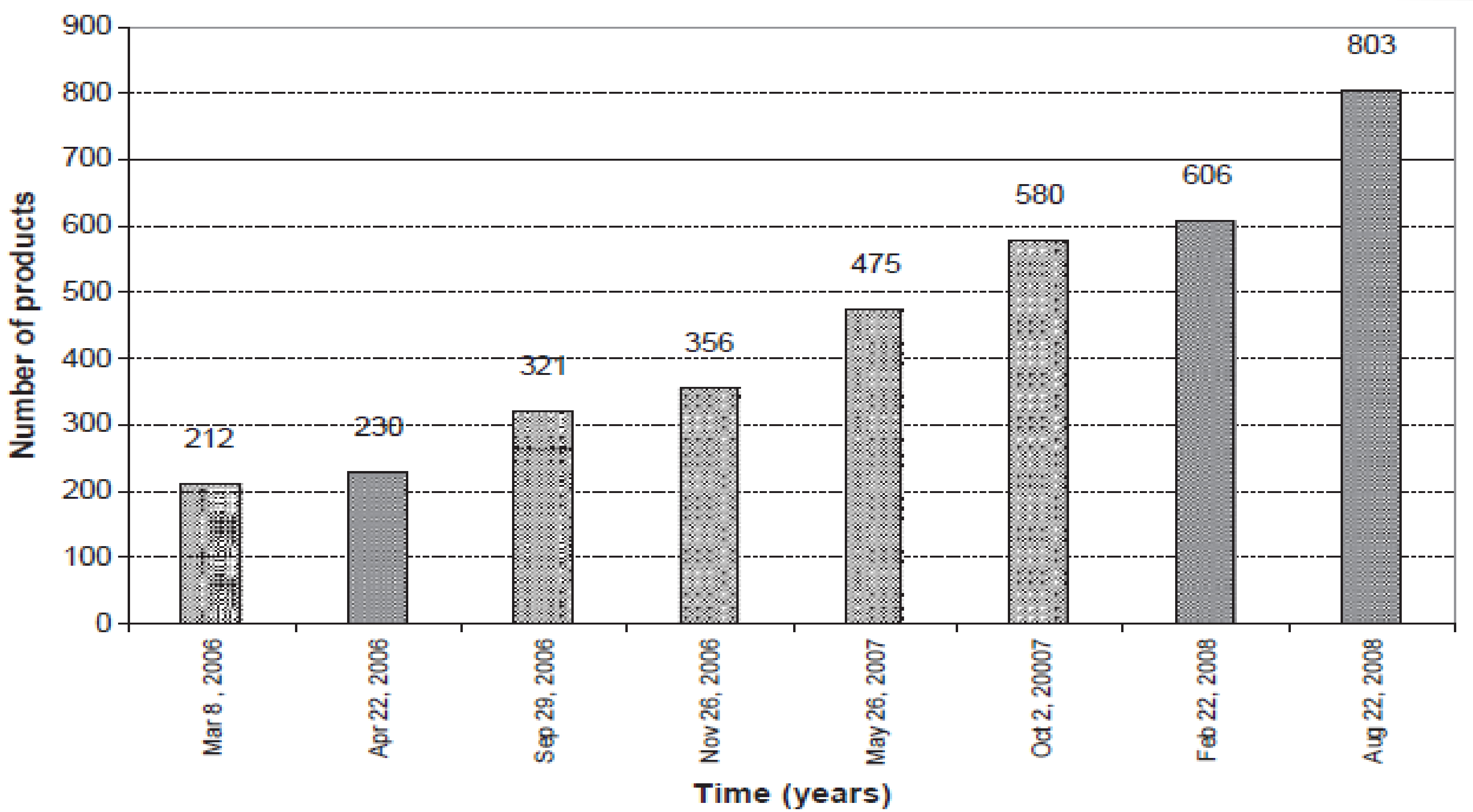
- large surface area
- uv rays blocking
- passes through skin
- attached to large molecular

NANO PARTICLE AS HAZARD

- Nano particles can be dangerous to human beings in following ways :

1. Nanoparticles may damage the lungs. 'ultra fine' particles from diesel machines, power plants and incinerators can cause considerable damage to human lungs. This is both because of their size (as they can get deep into the lungs) and also because they carry other chemicals including metals and hydrocarbons in with them.
2. Nanoparticles can get into the body through the skin, lungs and digestive system. This may help create 'free radicals' which can cause cell damage and damage to the DNA .
3. Inhaled carbon nanotubes can suppress the immune system by affecting the function of T cells, a type of white blood cell that organises the immune system to fight infections.

NANO PARTICLE PRODUCTION



ECF PROCESS

- Chemical mechanical polishing (CMP) process is used to fabricate microchips used in integrated circuits . The washing and cleaning step involve 40% of total water required for manufacturing . As a result it generates large quantity of waste water .
- The w/w comprises of nano sized SiO_2 particle, heavy metal ions etc.
- Electro-coagulation-flocculation (ECF) process is used for treatment of waste water.
- ECF process is better than conventional coagulation and flocculation process in following ways :
  1. The area and time requirement of ECF process is less as compare to conventional process .
  2. The sludge volume generated is less after using surfactants .

ECF PROCESS PRINCIPLE

- In this technique , aluminum ion and hydrogen gas are produced on passing electric current through aluminum electrodes .

$$Al_{(s)} \rightarrow Al_{(aq)}^{3+} + 3e^{-}$$

$$2H_2O_{(l)} + 2e^{-} \rightarrow 2OH_{(aq)}^{-} + H_{2(g)}$$

- Nano particles in waste water are then coagulated by al ions produced at anode . They are then removed by flotation with hydrogen gas produced at cathode .
- SURFACTANTS are added which serve the following purpose :
  1. They reduce bubble size and increase collective efficiency in dispersed and dissolved air flotation (DiAF and DAF) for long time .
  2. They reduce retention time , thereby enhancing the efficiency .
- Commonly used surfactants are
  1. Cetyltrimethylammonium bromide(CTAB)
  2. Sodium dodecylsulfate (SDS)

DEAD END MICROFILTRATION

- Until recently, the majority of the chip-making fabs rely on the conventional coagulation-flocculation process to treat the CMP wastewater.
- An alternative is to separate the particles from the wastewater by using microfiltration(MF).

- With a MF process the required coagulant dosage can he reduced substantially, which subsequently reduced sludge production.

MF PRINCIPLE:-

- In this method, a microfiltration (MF) process coupled with chemical pretreatment was investigated to separate the nano-scale panicles from the CMP wastewater to reclaim the water. Wastewater was filtered through a polytetrafluoroethylene membrane of pore size 0.5 gm at a low vacuum pressure (0.65 kg/cm2).

- The performance of the dead-end MF operation depended strongly on the turbidity of the influent.

- The performance of MF in water and wastewater treatments can be significantly enhanced by the addition of inorganic coagulants.

ELECTROFILTRATION:-

- a combination of mechanical and electrical filtration.
- Electrocoagulation (EC) and electrofiltration (EF) are effective in removing ultrafine particles from CMP wastewaters.
- Simultaneous electrocoagulation/electrofiltration process has been developed for evaluating its capability of treating various nanoparticles-containing wastewaters.

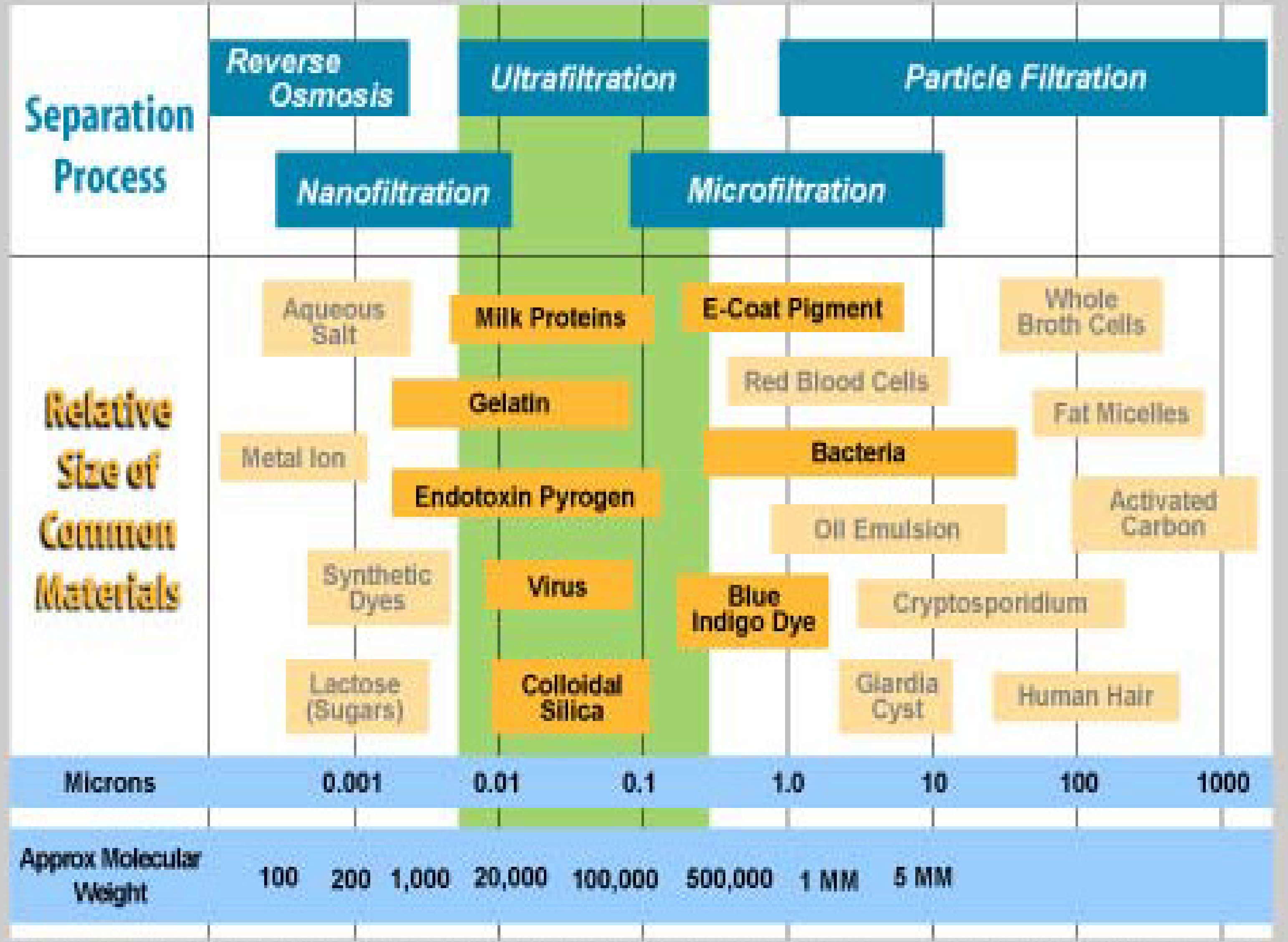
REMOVAL OF NANOPARTICLES BY FILTRATION

- Filtration is a process of removing particulate matter from water by forcing the water through a porous media.

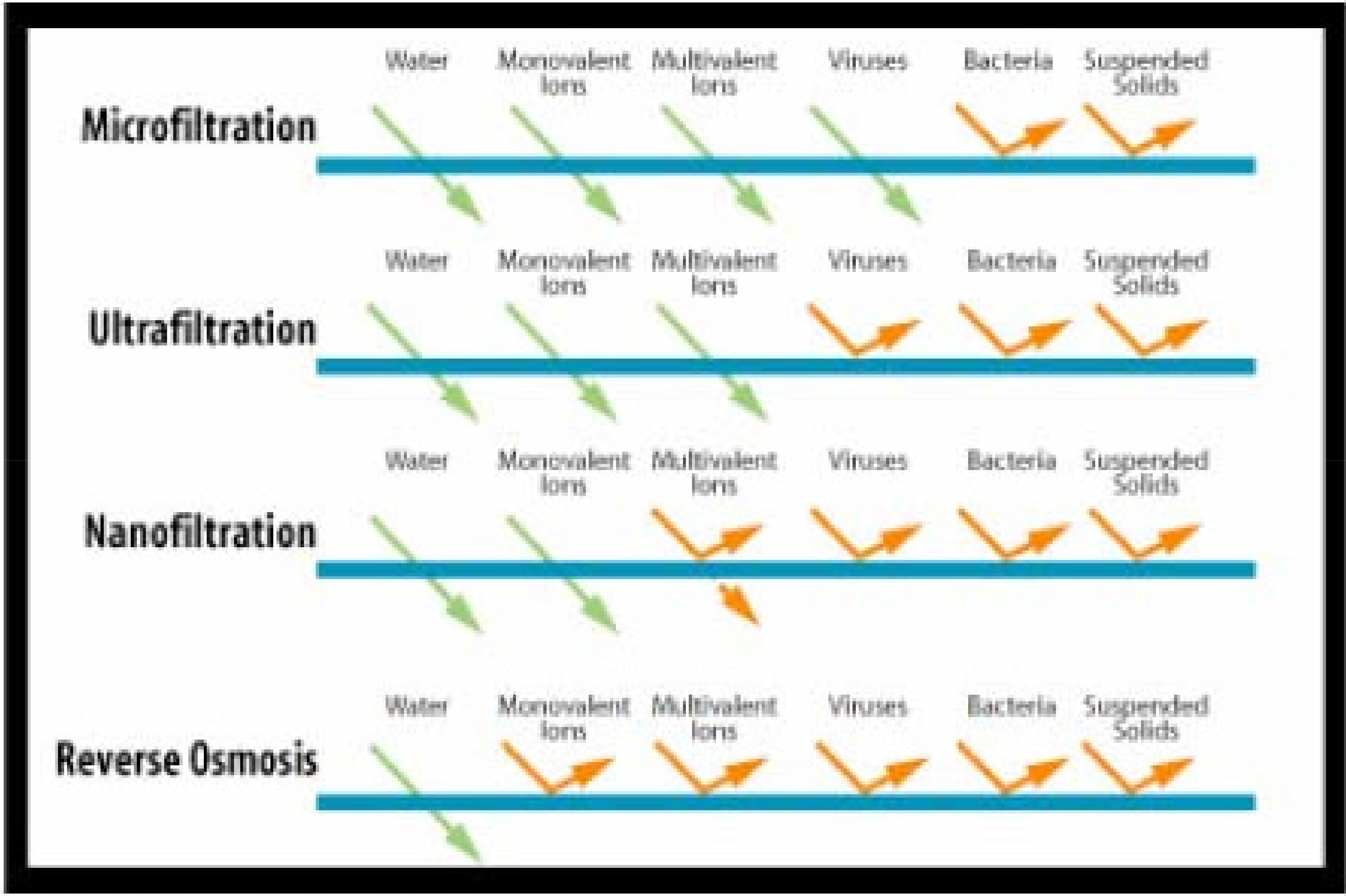
- The size of materials that can be removed during filtration depends upon the size of the pores of the filter.

SEPARATION PROCESS

- 1)Particle filtaration
- 2)Microfiltration
- 3)Ultrafiltration
- 4)Nanofiltration
- 5)Reverse osmosis



Note: 1 micron (micrometer) = 4 x 10-5 inches = 1 x 104 Angstrom units



Membrane Process Characteristics

CONCLUSION

- Nano particle removal from water is essential as they are harmful for human beings .they can enter human body through skin pores and water supply.
- It can be concluded that nano particles can't be removed by conventional methods , because they are designed as per size criteria . But in nano particles , surface area is deciding criteria .
- Additional methods involving principle of electrofilteration , electro coagulation , electro flotation has to be installed at water treatment plants in order to remove nanoparticles from water .

THANK YOU

Occurrence of Antibiotics in Drinking Water

Presented by :

Agnes Shiji Joy (2011CEV2845)
Sangeeta Pegu (2011CEV2865)
Nipun Verma (2010CET3042)
Rajeshwar Kushwaha (2010CEG3199)

General pathway of entry of antibiotics into Environment

- Excessive use of antibiotics in medicines.
- Excessive disposal of untreated hospital waste.
- Intensive animal husbandry and use of vetenary medicines.
- Intentional disposal/flushing of unused or /and expired drugs in water bodies.
- Aquaculture activities (fish pond).
- Runoff from agricultural applications.
- From human excreta as partially metabolized antibiotics.

Antibiotics present in drinking water

- Chlorotetracycline Sulfamethazine of class Tetracycline Sulfonamide was present in water in concentrations of 113 ppt and less.
- In the surface runoff from a livestock farm, amprolium was most frequently detected with the concentration range of 10–288 ng/L.
- Monensin was frequently detected with concentrations up to 37 ng/L.
- Tylosin was detected in two out of eleven samples, and carbadox was not detected in the surface runoff.

TETRACYCLINE

- Tetracycline is used extensively for human medicine and agriculture
- They are broad-spectrum Polyketide antibiotic produced by the *Streptomyces* genus of Actinobacteria
- They are indicated for use against many bacterial infections

Study conducted in Racoon River watershed

Site Code	Description	NITRATE NO_3^- N ppm	CHLORIDE ppm	PHOSPHATE PO_4-P ppm	TOTAL COLIFORMS	E.COLI EC/100mL	TETRACYCLINE Ppt TC/100mL
RR1	LAKE CREEK @HIGHWAY 20 EAST OF ROCKWELL CITY **RR-2**	7.24	101	0.22	14,390	2780	89.75
RR2	BIG CEDAR @ HIGHWAY 20 EAST OF SAC CITY	10.23	27.7	<0.1	517	17	65.69
RR3	RACCOON RIVER @ HIGHWAY 20 AT SAC CITY	14.2	34.1	0.41	411	36	113.3
RR4	RACCOON RIVER @ HIGHWAY 196 NORTH OF ULMER	11.48	31.5	0.28	579	33	<50.00
RR5	MIDDLE RACCOON RIVER AT CARROLL	9.42	18.6	<0.1	921	77	<50.00
RR6	STREAM ON N50 BY RACCOON RIVER AT DICKENSON TIMBER PRESERVE BY LIDDERDALE	11.2	52	<0.1	613	5	77.12
RR7	BEAVER CREEK @ 141	11.63	30.1	<0.1	1203	25	101.92
WW	DES MOINES WASTE WATER TREATMENT PLANT	NA	NA	NA	NA	NA	55.29

Result of Trial Study

- Tetracycline was detected in 5 of the 8 sites sampled.
- Tetracycline was introduced into the surface water by humans or livestock.
- Advanced searches confirmed the amount of tetracycline detected falls into expected concentration ranges for surface water influenced by animal waste or wastewater discharge.

Lake Creek Study

- Lake Creek(site 1) just east of Rockwell City was sampled during the trial study
- The goal of the study was to determine the lake is contaminated with Tetracycline and *E. coli* from Rockwell City's wastewater treatment plant or from agriculture confinement operations
- Analysis of the Lake Creek samples was done for both dissolved and total tetracycline.

Lake creek Sample locations

SITE Code	Site Location	Physical Site Observations
NR	Rainbow bridge ½ mile down stream from confluence of Lake Creek and North RR	Woodlands, park
LC2	Approx. 1 mile downstream from 100 head feed lot	Pasture, riparian, woodlands
LC8	Rockwell City wastewater effluent	Effluent into Lake Creek, grass
LC7 ALT	Across from feedlot east of Rockwell City on Hwy 20	Feedlot access to creek, pasture
LC7	Feedlot east of Rockwell City on Hwy 20	Downstream from wastewater treatment plant & before feedlot, pasture
LC11	Lake creek at 250	Some buffer, tree lined pothole to water cattle, evidence of cattle path, row crop
LC15	Wastewater effluent @ Pomeroy	Lagoon treatment plant discharging twice per year. Started discharging week before.

RESULTS OF LAKECREEK STUDY: APRIL 19, 2005

SITE #	CHLORIDE (ppm)	NO3-N(ppm)	PO4- P ppm	TOTAL COLIFORMS TC/100mL	E.COLI	Dissolved TETRACYLINE ppt	Total Dissolved TETRACYLINE ppt
NR	27.61	13.32	<0.2	6300	2000	<50	3090
LC2	46.63	14.98	0.44	686700	488400	<50	3176
LC8	>200	8.32	1.38	816400	72700	<50	1869
LC7 ALT	64.33	10.15	<0.2	1986300	1413600	314	2195
LC7	68.29	10.14	0.15	9208	1565	<50	3338
LC11	35.45	10.17	<0.2	2046	2382	<50	3000
LC15	<200	0.25	2.32	2046	262	<50	3500

Observation

- All samples were visually turbid
- The Pomeroy wastewater treatment plant sample was very green
- The color was determined to be due *Euglena*
- Dissolved tetracycline was detected only in the Rockwell City wastewater treatment plant effluent
- Sample analysis revealed *E.Coli* counts in the range of 2,000 to 730,000/100 mL
- Higher results for total tetracycline supports lends evidence to the hypothesis of tetracycline absorption onto soil particles

Study in India - Ujjain

- Information on antibiotic residue levels in effluent from Indian hospitals is not available
- Quantification of antibiotics prescribed in the inpatient wards of the hospital
- Seven antibiotics - amoxicillin, ceftriaxone, amikacin, ofloxacin, ciprofloxacin, norfloxacin and levofloxacin - were tested
- Ciprofloxacin-highest prescribed in the hospital and its residue levels were also the highest
- .

Observations

Levels of monitored antibiotics (µg/l) in waters associated with a hospital in Ujjain, India

Antibiotics	Site -	1	Site -	2	Site -	3
	Ground Water	Municipal Water	At 10:00	At 16:00	At 10:00	At 16:00
Amoxicillin	--	--	--	--	--	--
Ceftriaxone	--	--	--	--	--	--
Amikacin	--	--	--	--	--	--
Ofloxacin	--	--	--	4.5	5.6	7.5
Ciprofloxacin	--	--	2.2	218.3	67.3	236.6
Norfloxacin	--	--	--	6.4	29.6	22.8
Levofloxacin	--	--	--	5.0	6.8	8.8

2nd Study conducted in Ujjain

- Ujjain Charitable Trust Hospital & the 500 bedded CRGH hospital
- 1.incoming safe water ,2. Hospital effluent, 3.groundwater sources near hospital.
- The incoming safe water and groundwater were free of antibiotics
- However hospital effluents contains antibiotics such as ciprofloxacin in the range of 1.4–236.6 μg/L
- Contamination of aquatic environment by antibiotic usage in hospitals has serious implications on public health and environment.

Type of water	Sample source	MET	TIN	SMX	ERY	NOR	CIP	OFL	LEV	DXY	AMI	CEF	AMX	CEFT
Ujjain Charitable Trust Hospital (UCTH) (antibiotic amount (μg^{-1}))														
Incoming water	Municipal water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Borewell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hospital effluent	Drain 1	2.5	13.6	5.7	0.0	5.7	31.0	66.0	70.7	0.0	0.0	0.0	0.0	59.5
	Drain 2	0.0	0.0	2.7	0.0	0.0	8.0	2.7	3.3	0.0	0.0	0.0	0.0	58.3
	Drain 2 (repeat sample)	0.0	0.0	0.0	0.0	0.0	7.6	73.2	80.5	0.0	0.0	0.0	0.0	0.0
Groundwater proximate to hospital	Borewell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chandrikaben Rashmikant Gardi Hospital (CRGH) (antibiotic amount (μg^{-1}))														
Incoming water	Borewell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Municipal water	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hospital effluent	Drain 1	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Drain 2	3.8	50.4	0.0	0.0	0.0	64.8	1.5	1.6	0.0	0.0	0.0	0.0	0.0
	Drain 3	1.4	88.4	81.1	0.0	20.6	67.3	5.6	6.8	0.0	0.0	0.0	0.0	0.0
	Drain 3 (repeat sample)	0.0	30.4	36.7	0.0	22.8	236.6	7.5	0.0	0.0	0.0	0.0	0.0	0.0
Groundwater proximate to hospital	Borewell	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MET, Metronidazole; TIN, Tinidazole; SMX, Sulphamethoxazole; ERY, Erythromycin; NOR, Norfloxacin; CIP, Ciprofloxacin; OFL, Ofloxacin; LEV, Levofloxacin; DXY, Doxycycline; AMI, Amikacin; CEF, Cefoperazone; AMX, Amoxicillin, and CEFT, Ceftriaxone.

Conclusion

- Tetracycline is completely removed at both of DMWW.s treatment plants Apparently tetracycline is completely removed at both of DMWW.s treatment plants. tetracycline is completely removed at both of DMWW.s treatment plants.
- In 2 hospitals in Ujjain:No antibiotics were detected in coming safe water or groundwater sources.
- 8 of the 13 targeted antibiotics were detected : Cephalosporins, Fluoroquinolones, Sulphonamides and Imidazole derivatives.
- Ciprofloxacin is the most commonly detected antibiotic and was present in all effluent samples from both the hospitals.

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GROUP ACTIVITY

- AGNES-group leader, collection of material,sorting out, making report, communication between group members…..
- NIPUN-collecting materials,presentation making, report editing, scheduling time for discussion.
- RAJESHWAR-journal reading, report editing,presentation making,…
- SANGEETA-searching materials, report editing, presentation editing…
- EQUAL PARTICIPATION OF ALL MEMBERS THROUGHOUT THE TIME.
- Hours devoted -2hours per week before midreport submission and4 hours per week after that.


Thank You!

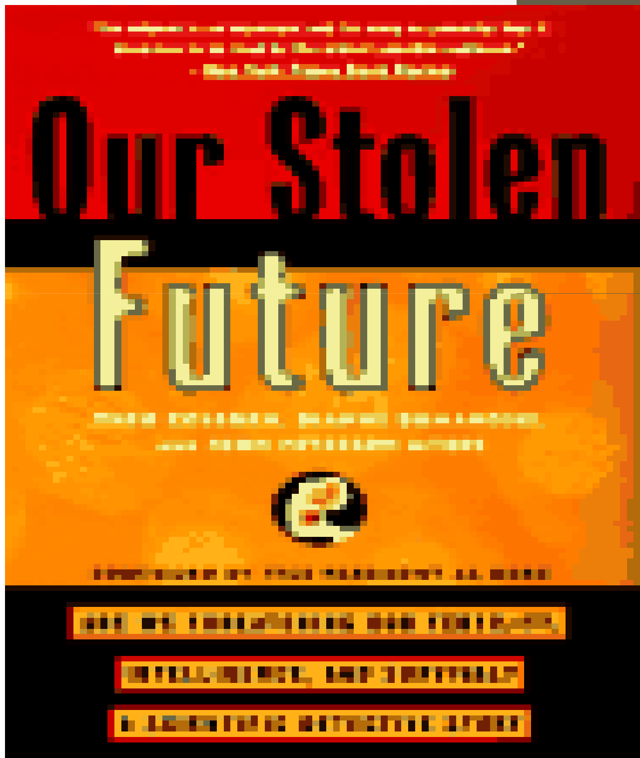
Effectiveness of adsorption, Coagulation and flocculation in removing endocrine-disrupting chemicals from water

Presented by...

Niharika Pandey

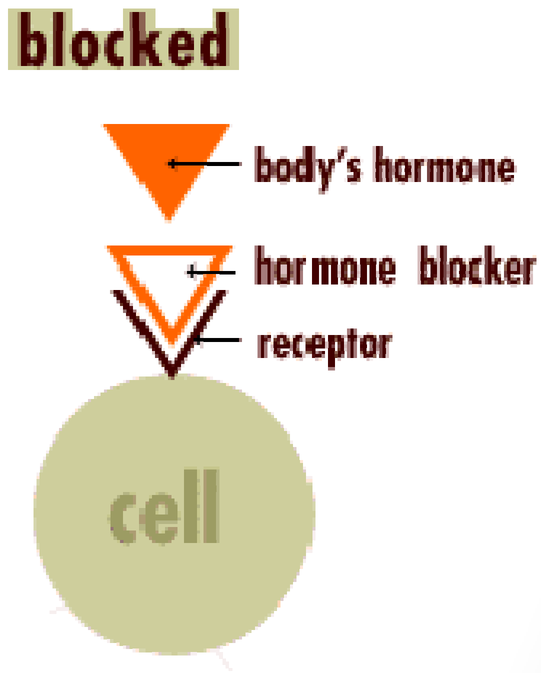
What are the EDCs

- An Endocrine disrupter is an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effect in an intact organism or its progeny or (sub)populations.



Objective and scope

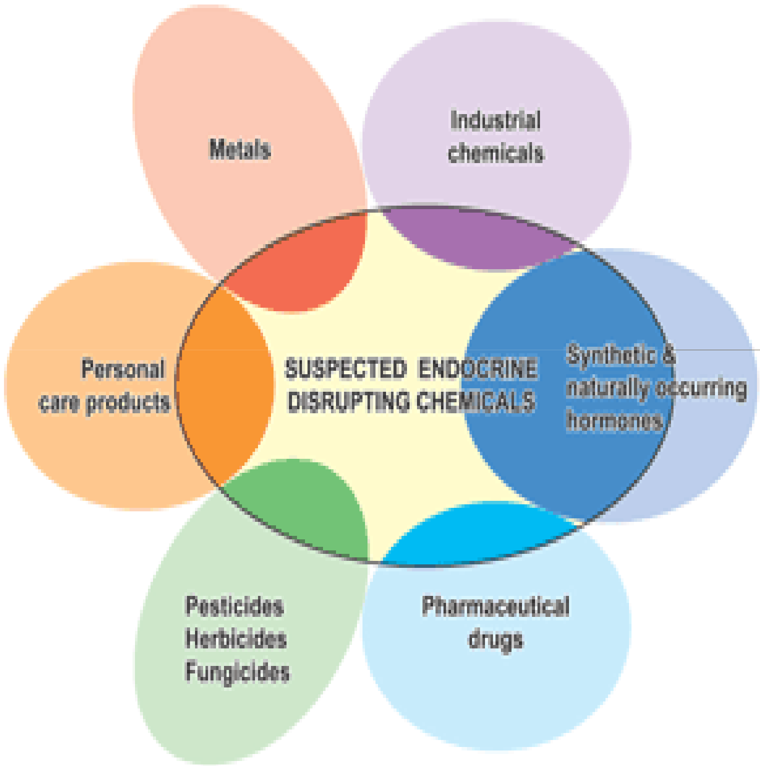
1) EDCs identification from water body
2) Removal process of endocrine disrupting chemical from water
3) Removal efficiency of water treatment process



EDCs includes

1) Natural compounds (plant estrogens, e.g., genistein and coumestrol),
2) Pharmaceuticals (diethylstilbestrol and ethynylestradiol
3) Environmental pollutants (polychlorinated biphenyls, DDT, dioxins, and polyaromatic hydrocarbons), and
4) Industrially relevant chemicals (alkyl phenols and bisphenol A).

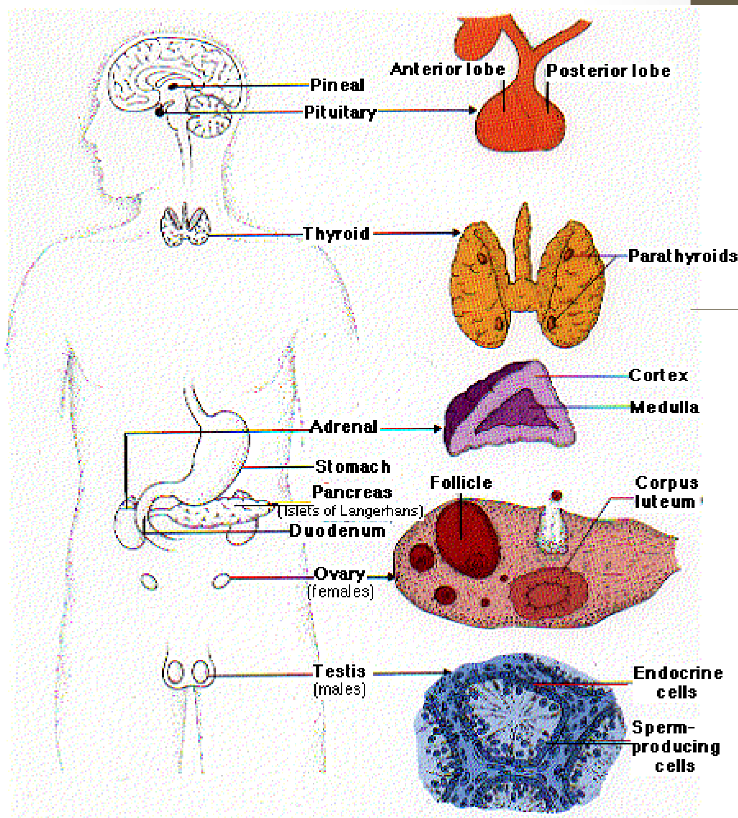
(Zacharewski, 1998)



Some chemicals from the "families" above are potentially endocrine disrupters

Effects of EDCs

- Mimic the sex hormones - estrogen and androgen
- characterized as estrogen modulators or androgen modulators
- may also block the activities of estrogen or androgen



Our Mission

- To remove endocrine disrupting chemicals from drinking water
- Provide safe and healthy life to people
- produce a scientific basis for innovative solutions to manage issues facing public health and the environment
- It is also our goal to examine the feasibility of existing and emerging technologies.

Removal Processes of EDCS

1) **Adsorption**
2) **Coagulation**
3) **Flocculation**

What is Adsorption

- Adsorption is the adhesion of atoms, ions, biomolecules or molecules of gas, liquid, or dissolved solids to a surface
- Chemicals used as adsorber

  a) Activated carbon(GAC or PAC)

  b) Zeolites

Adsorption

- Granular activated carbon (GAC) is a widely used and efficient method for removing organic contaminants from drinking water.
- PAC removal efficiencies ranged from 15% to 40% at 3 to 10 mg/L of PAC with a contact time of 15 minutes.

- Comparison between GAC and PAC for Removing some EDCs

carbon usage rate (mg/L)*	GAC	PAC
naproxen	23	16
carbamazepine	14	11
nonylphenol	8	16

Contd..

- More than 90 percent removal of many of the EDC
- >90% removal of; triclosan, fluoxetine, oxybenzone , mirex, DDT

- Other compounds had lower removals (40 to 60 percent) eg-ibuprofen, sulfamethoxazole, meprobamate, and iopromide.
- <50% Removal of; meprobamate, sulphemethoxazole, iopromide, trimethoprim, gemfibrozil

(*Environ. Sci. Technol.* ***2009,*** *43, 1474–1479*)

Coagulation

- The clumping together of solids so they can more easily be settled out or filtered out of water.
- The chemicals used as coagulants are

  1)Aluminum sulphate

  2)Ferric chloride

  Coagulation (alum or ferric) removed less than 20 percent of the compound concentration.
- EDCs associated with particulate matter (i.e., that were adsorbed) can effectively removed during coagulation

  Electron. J. Environ. Agric. Food Chem. ISSN 1579-4377

Flocculation

- Flocculation is a process wherein colloids come out of suspension in the form of floc or flakes by the addition of a clarifying agent
- Most flocculants are either multivalent cations such as calcium, magnesium and aluminum, or long-chain polymers
- >50% removal of benzo (a) pyrene, benzo (g,h,l) perylene, benzo (k) fluoranthene, mirex, benzo (b) fluoranthene, benzo (a) anthracene
- <10% removal of ; diazepam, diclofenac, meprobamate,sulfamethoxazole,trimethoprim

Conclusion

Coagulation has generally poor ability to remove EDC

1) effective for compound bound to particles

2) most compound with log Kow>5 limited removal

for e.g.- DDT(6), Galaxolide (5.9), Octylphenol (5.5), BAP(6.1)

Schafer et al. (2002).

Contd..

- Adsorption process has more than 90% removal efficiency for EDCs. The adsorption process is widely used for EDCs removal.
- Treatment strategies that combine process would be more effective like if we combinly used coagulation flcculation and floating then it will give better result than individual .
- No treatment process or processes will ever remove all the organic compound to below detection of sensitive analytical instruments!
- So it is better to control at source level and prevent.

Planning for the Future

- More emphasis on source control which will fall on Pretreatment’s shoulders
- Closer look at TTO list; incorporating into permits for non-categoricals
- From a holistic approach should we be working with drinking water plants?
- Theoretically water treatment plants are sources of problem

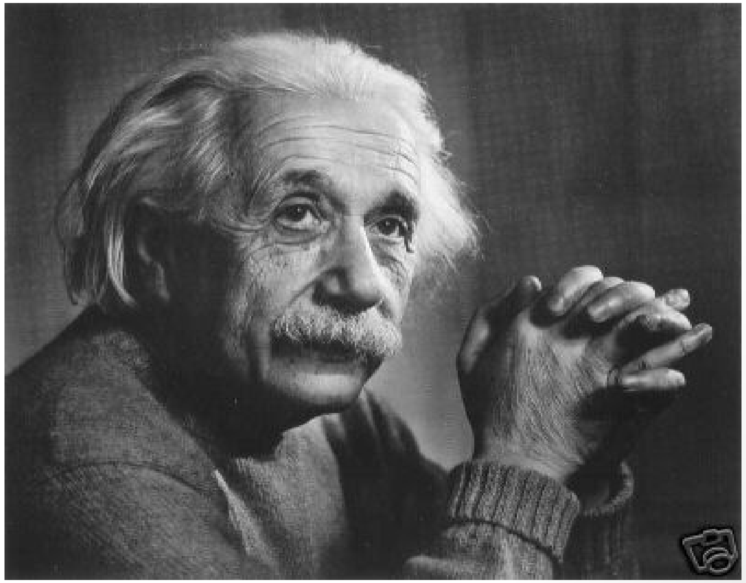
Final Thoughts

- What % removal is appropriated?
- Detection does not infer toxicity!
- We MUST understand the toxicological relevance at environmentally realistic conc !!!
- What is the cost / benefit ratio?

“Not everything that can be counted counts and not everything that counts can be counted’’

– attributed to

Albert Einstein



Thank you