THE RISKS OF NANOTECHNOLOGIES UTILIZATION IN PROCESS OF WATER USE

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NANOTECHNOLOGIES – POTENTIAL AND RISK

- Emerging technologies, including nanotechnologies, affect the social, economic, and environmental dimensions of our world, often in ways that are entirely unanticipated. [1]

PROCESS OF WATER USE

PROCESS OF WATER USE AND NANOTECHNOLOGIES UTILIZATION

WATER USE

- WATER SUPLY
- WATER CONSUMPTION
- WATER TREATMENT

NANOTECHNOLOGIES UTILIZATION IN PROCES OF WATER USE

- NANOTECHNOLOGIES IN WATER SUPLY
- NANOTECHNOLOGIES IN WATER CONSUMPTION
- NANOTECHNOLOGIES IN WATER TREATMENT

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PROCESS OF WATER USE

Water supply

- Risk of undesirable effects of nanotechnology in water supply

Water consumption

- Risk of undesirable effects of nanotechnology in water consumption

Water treatment

- Risk of undesirable effects of nanotechnology in water treatment

NANOTECHNOLOGIES IN PROCESS OF WATER SUPPLY

Water supply

- The extraordinary properties of nanomaterials, such as high surface area, photosensitivity, catalytic and antimicrobial activity, electrochemical, optical, and magnetic properties, and tunable pore size and surface chemistry, provide useful features for many applications.These applications include sensors for water quality monitoring, specialty adsorbents, solar disinfection/decontamination, and high performance membranes. More importantly, the modular, multifunctional and high-efficiency processes enabled by nanotechnology provide a promising route both to retrofit aging infrastructure and to develop high performance, low maintenance decentralized treatment systems including point-of-use devices.[2]

RISKS OF NANOTECHNOLOGIES IN PROCESS OF WATER SUPPLY

Water supply

- Although much attention has been focused on the potential benefits of water-treatment devices that incorporate nanotechnology, there is also a need for more research to assess the potential human health and environmental risks of nanotechnologies. Although only a few studies have been carried out, some of them indicate that the unique properties of nanomaterials (for example, size, shape, reactivity, conductivity) may cause them to be toxic. [3]

NANOTECHNOLOGIES IN PROCESS OF WATER CONSUMPTION

Water consumption

- Nanotechnology offers significant opportunities to revolutionize approaches towards drinking water treatment by enhancing the multifunctionality and versatility of treatment systems while reducing reliance on stoichiometric chemical addition (thus minimizing associated waste streams), shrinking large facilities with relatively long hydraulic contact times and minimizing energy intensive processes. [4]

RISKS OF NANOTECHNOLOGIES IN PROCESS OF WATER CONSUMPTION

Water consumption

- Natural nanoparticles (NNPs) in rivers, lakes, oceans and ground water predate humans, but engineered nanoparticles (ENPs) are emerging as potential pollutants due to increasing regulatory and public perception concerns. [5]

NANOTECHNOLOGIES IN PROCESS OF WATER TREATEMENT

Water treatment

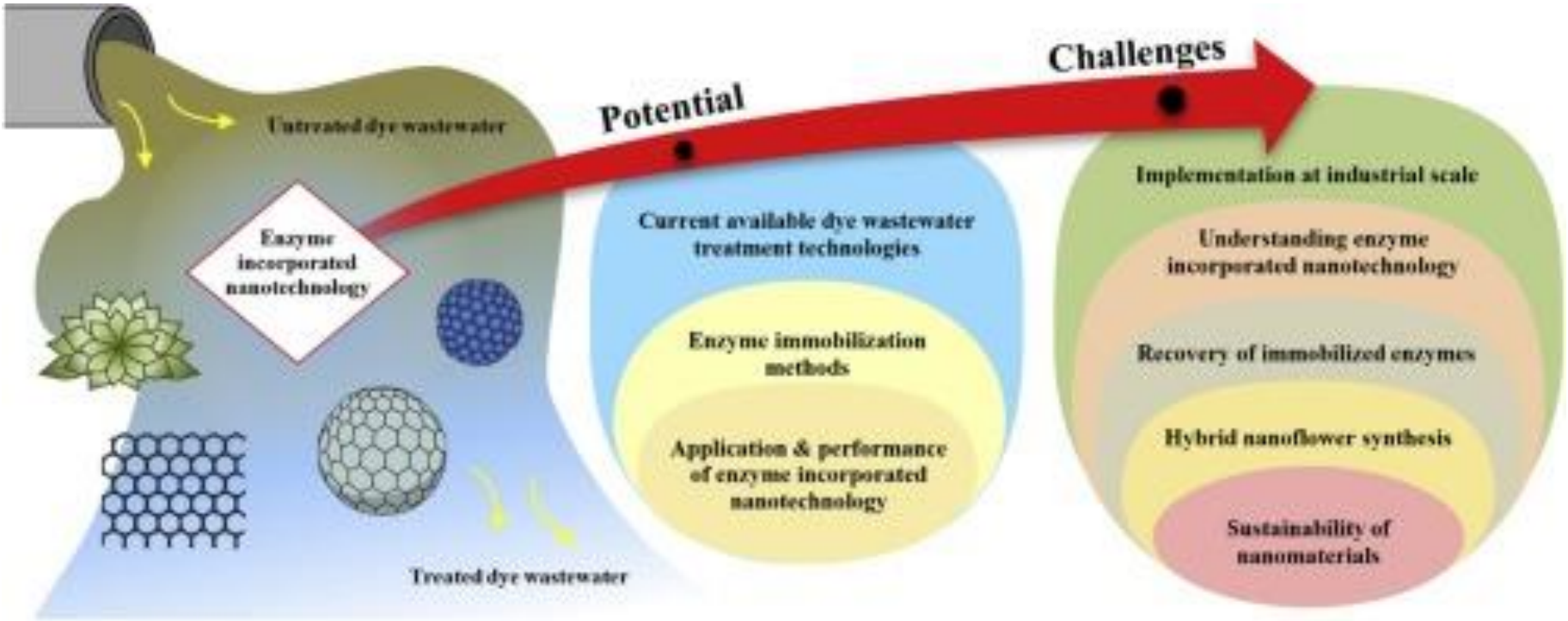
- Enzyme incorporated nanotechnology is a viable solution in dye wastewater treatment.
- Hybrid nanoflower as an alternative to conventional enzyme immobilization methods.
- The hybrid nanoflowers can enhance the enzymatic activity by up to 6.5 times.
- The hybrid nanocomposite exhibited 100% dye removal.[6]

RISKS OF NANOTECHNOLOGIES IN PROCESS OF WATER TREATEMENT

Water treatment

- key challenges faced by enzyme incorporated nanotechnology in dye wastewater treatment that includes: (i) realization of lab scale experiments to industrial applications; (ii) lack of understanding of enzymes incorporated nanotechnology; (iii) recovery of immobilized enzyme; (iv) synthesis of hybrid nanoflowers; and (v) sustainability of the nanomaterials used.[6]

POTENTIAL AND RISKS OF NANOTECHNOLOGIES IN PROCESS OF WATER TREATEMENT



RISK AND BENEFIT OF NANOTECHNOLOGY [7]

- Analysis of variance (ANOVA) illustrates that demographics indeed influences public benefit and risk perceptions of nanotechnology development. However, public knowledge about nanotechnology exerts no effect on public benefit and risk perceptions of nanotechnology development based on independent t-tests.
- Public attitude perceives nanotechnology to be more beneficial than risky, thus influencing benefit perception rather than risk perception. Public lifestyle, such as culture, religious beliefs and social group influence benefit perception but not risk perception.

PROBABILITY ELEMENTARY

$$P(A) \in [0,1]$$

$P(A)$ - probability of desirable event A

$$P(A^C) = 1 - P(A)$$

$P(A^C)$ - probability of undesirable event A^C

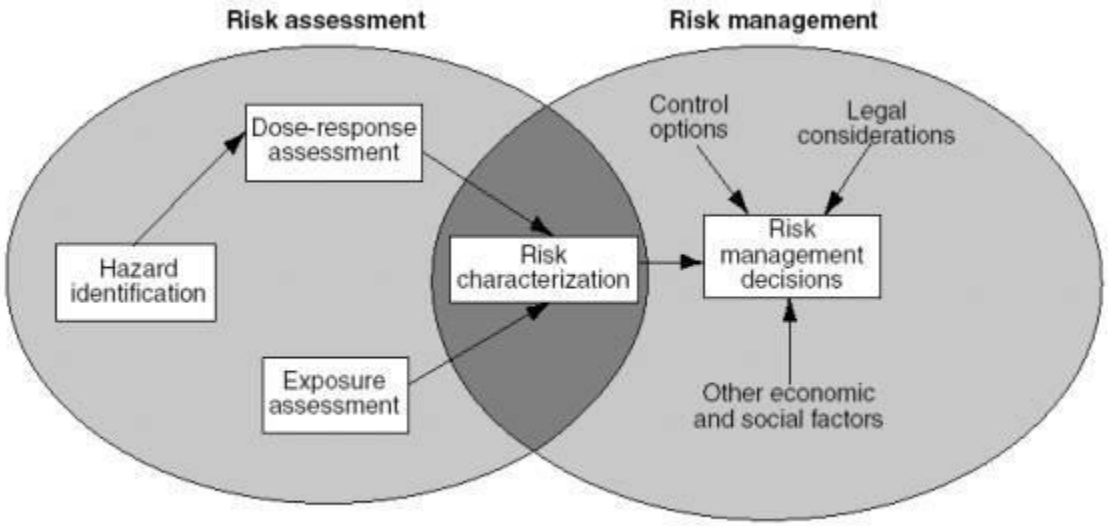
$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

$P(A|B)$ - probability of event A in case of given B

RISK ASSESSMENT

Nanotechnology may yield a plethora of beneficial applications, but it can also be expected to present risks. The challenge is to anticipate and reduce environmental and health risks or, at a minimum, identify and deal with such threats once they begin to become evident. Past experience, particularly with the fuel additive MTBE (methyl tertiary butyl ether), provides valuable guidance on how to assess the potential risks of nanotechnology using a comprehensive environmental assessment approach, which combines a product life-cycle perspective with the risk assessment paradigm. This systematic approach can serve not only to guide the development of a research strategy for assessing the risks of nanotechnology but possibly even help avert unintended consequences of nanotechnology. [8]

RISK ASSESSMENT/RISK MANAGEMENT PARADIGM [9]



Source: EPA Office of Research and Development.

PROBABILITY OF UNDESIRED EVENTS IN NANOTECHNOLOGY UTILIZATION IN PROCESS OF WATER USE

Water supply

- $P_{SW} = P(A^C{}_S)$

Water consumption

- $P_{CW} = P(A^C{}_S) + \frac{P(A^C{}_S|A^C{}_C)}{P(A^C{}_C)}$

Water treatment

- $P_{TW} = P(A^C{}_T) + \frac{P(A^C{}_T|A^C{}_S)}{P(A^C{}_T)} + \frac{P(A^C{}_T|A^C{}_c)}{P(A^C{}_T)}$

RISK ASSESSMENT/RISK MANAGEMENT AND PROBABILITY

- RA/RM – based on probability means that decisions are dependent of the probability of undesirable event

$$RA/RM = RA/RM[P(A^C)]$$

CONCLUSION

- Nanotechnology in contemporary conditions of water scarcity becomes the necessary for providing sustainable water use
- The risks and benefits are the issue of social and psychological perception but also the real phenomenon
- The utilization of risk assessment paradigm based on the probability could enable the proper decision making in nanotechnologies utilization in process of water use

Literature

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