The Feasibility Study of Water Disinfect & Quality-maintaining by a Controlled Release Technology

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Abstract

As a new safe and effective approach, controlled release technology (CRT) has attracted attentions more and more of related professionals, and a brand-new research domain is coming into being. But it only begins in water-quality science and its application & development needs associated effort. In this article, we introduced some common knowledge of CRT, analyzed the feasibility of utilizing various controlled release system (CRS) on disinfect & quality-maintaining (DQm) of water, pointed out the advantages, significance & prospect of utilizing CRT in DQm of water.

Keywords

Controlled release; Controlled release system; Disinfect; Quality-maintaining.

1. Introduction

Corrosion, scale formation, ease-propagation for bacteria and algae in water are some major problems about water quality, which have a significant effect on our life and production. The effect is harmful and wide. In order to solve these problems, nowadays one can use chemical agents with a certain concentration to delay the corrosion, prevent the scale formation, sterilize the bacteria and kill algae. However, it is difficult to manage because of much work of water-quality monitor, a large number of times to release chemical agents and difficult control of the amount of chemical agents. Therefore, the results are not satisfactory while various physical and electromagnetic techniques are difficult to maintain durability, some mechanism of these techniques are not clear, electricity has to be used in some of them. The application is limited.

In order to improve the current situation, we put forward some methods, such as micro-electrolysis DQm instruments, sustained release disinfectant by semipermeable membrance, slow release disinfectant instruments and water DQm by CRT. Based on analysing various methods on possibility, economy, application, safety and reliability, we were of the opinion that water DQm by CRT is a new way with high efficiency, safety, economy, and convenience. It is applcable to domestic water, industrial water (for instance circulating cooling water) and also part of the wastewater.

2. Brief Introduction of CRT.

CRT is to combine active agent (AA) and basis material (usually polymer materials) and release AA in a predetermined rate to the environment in a certain time by diffusing and otherwise. Therefore, the concentration of AA can be designed in advance in a given area and a period time. It started from 1950s. Its characteristic is that some AAs such as fertilizer, pesticide, medicines, biological active agents and catalysts are attached with polymer materials to generate a CRS of AAs [1].

3. Feasibility Analysis of CRS and ITS Application on Water Disinfect & Quality-Maintaining

3.1 Matrix physical methods of CRS.

The system is to disperse or dissolve AAs into polymers and release AAs by diffusing and otherwise. Simplicity of preparation and low cost can be realized by mixing of AAs and polymer powder followed by film-pressing, film-filling, squeezing-out, film-molding and so on, or by adding AAs and additives during the production. Because AAs are uniformly dispersed in polymer matrixes, it would be a fist order dynamics to only release AAs by diffusing. The release of AAs is related with the shape of system. If polymer can be degraded and the rate of degradation is much faster than the diffusion rate of AAs in polymers, indeed, the rate of degradation could be the rate of release of AAs. The process is surface-area controlled. For example, some matrixes with long cylindrical shape can keep the surface area constant during degradation, which can realize the uniform release of AAs. Generally, these kinds of polymers should have the following features: Toleration with environment and AAs, suitable rate of degradation, much resource and facile [2].

Analysis of feasibility. Matrix physical methods of CRS is one of major systems because of its simple preparation, low cost, reliable result and feasible period of release. Mostly, it is to use degradable polymers as the basis material. It will be a good method to introduce this technique to water DQm.

3.2 Solvent permeation (SP) CRS.

It is a novel and useful system. Its mechanism is to disperse soluble AAs uniformly in polymer matrix and release AAs due to the osmotic pressure difference between AAs solution and environmental media. Permeation control is realized by permeation from water to polymer materials or swollen effect of polymer matrix. The system can be design to constantly release AAs. Its release rate is only related with AAs solubility. In 1990s, Nelson-Rose SP. Pump, Higuchi-Theeuwes Pump and swollen system attracted much attention [3].

Analysis of feasibility. As described above, it is realized by permeation from water to polymer materials or swollen effect of polymer matrix. The rate of release is related with AAs solubility. The permeation controlled-release instrument based on this system already intrigues people's interest. It is feasible to develop this system in water DQm. But, the preparation is not easy and cost is high.

3.3 Chemical CRS.

It is to combine AAs and polymers by chemical binding. It is realized by breaking the chemical bonding between AAs and polymers and thus releasing AAs. The break of bonds includes hydrolysis and biological degradation processes. The factors of effect on rate of release include: the bond property between AAs and polymers, concentration of degradable agents, density of cross-linking, degree of polymerization and so on. Compared to physical methods, it needs less inertial polymers. However, a functional group must exist in both AAs and polymers, which limits its application. It has three types of combination: direct or indirect connection between AAs and polymers; the polymerization between AA monomers and derivatives; the polymerization between monomers or copolymerization with other monomers.

Analysis of feasibility. It is realized by bonding AAs and polymers. It doesn't introduce additives and thus is friendly to environments. The existence of functional groups in AAs for water DQm makes its application in water-purification possible. It is a new domain. However, the preparation is limited with some conditions. It also needs chemistry and chemical engineering knowledge and some instruments.

3.4 Novel CRS.

(1) Magnetically CRS [3]. It is disperse agents and magnetic powder in the polymers. Agents can release routinely when they release into the environmental media. However, a changed external magnetic field can speed up the rate of release. The mechanism is not clear. Ethylene-vinyl acetate is usually used as basis material. (2) Intelligent Release System [3]. It is based on smart polymers, which make agents CRS also smart. That is, agents release with need; agents don't release without

need. Its feature is whether agents need or not depends on agents themselves. It can combine sensor, processor and execution together. (3) Electrochemical CRS [4]. It is to attach molecules with functional agents' groups to polymer carriers and make the carrier fixed one the surface of electrode, which form a chemical-modified electrode. The molecules or ions of agents can be released to solution through redox process of controlled electrode.

Analysis of feasibility. All these methods have unique functions. They have good future. Due to preparation and technique reasons, it is not time to introduce them into water DQm. It might be applicable in some other domains in water industry.

4. Advantages, Significance and Prospect.

(1) Compared to traditional formulations, the controlled-release agents designing based on CRT have many advantages: (i) The concentration of agents can be maintained effective in a long time and thus make the interaction longer and improve the effectiveness. (ii) Increase the efficiency of agents and decrease the adding amount and thus the side reactions. Control agents at a safe concentration. (iii) Decrease the loss from evaporation, flowing and biological deformation. Increase the stability of physics and chemistry. Easy to preserve and transport. Convenient to apply controlled release agents. (iv) Relatively stable concentration of agents, no fluctuation. Mostly to use the agents. It is not necessary to add and monitor the agents, therefore decrease the amount of work and increase the economy [5,6].

(2) Water-quality science is attracting more and more attention in the world. Water DQm is tightly related with life and production. The controlled release agents designing from CRT have a lot of goodness such as expectable rate, precise design, long effectiveness, less amount. It open a new way with high efficiency, safety, economy and convenience for water DQm.

(3) Daily monitor and maintenance is more important than the agents themselves. The controlled release agents designing from CRT can minimize the amount of work. It has a good application.

(4) CRT already has some applications in medicine, pesticide and so on. At the present, slow-release, controlled release drugs, various novel CRS such as Magnetically CRS, intelligent release system appear in the market. With the progress of CRT and development of related science, it will be applied in more and more new domains. We believe that intelligent release DQm system based on one parameter with a combination of sensor, processor and execution will appear in the near future and generate new driving force for water-quality science.

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