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ABSTRACT: Radioactive waste water is in the process of nuclear power wastewater, with high variety and concentration of heavy metal element, radioactive, is of the characteristics of big harm to people and animals and the radioactive waste water treatment is of great significance. This paper expounds the source and harm of organic matter in radioactive wastewater treatment, including chemical precipitation, filtration, ion exchange method, evaporation concentration method, adsorption method, biological reduction/adsorption and membrane separation, light catalysis, etc.

1 INTRODUCTION

The development of nuclear power and other nuclear technology will surely give rise to a growing number of radioactive waste water. Radioactive waste water into the environmental cause water and soil pollution and may enter human body through various channels, cause harm to environment and human [1]. At present, China is implementing the "positive development of nuclear power" planning, according to the state council approved the energy development strategic action plan (2014-2020)" predicts 2020, nuclear power installed capacity of 58 million kilowatts, the spent fuel will produce up to 1000 tons per year, at the same time also will produce a large number of middle and lower liquid/solid waste water. Due to the presence of organic matter, not only conducive to the storage of radioactive waste liquid, the liquid waste processing and increase the difficulty of dealing with these radioactive waste liquid should not only consider its radioactive, consider the chemical toxicity [2]. The treatment/disposal of wastewater containing radioactive liquid waste organic matter/is still a big problem in the world. Especially since the fukushima nuclear accident, countries around the world attach great importance to the development and application of radioactive waste water treatment technology. Radioactive organic wastewater at home and abroad, the author introduces the source and harm and photo catalytic technology research and application in the treatment of such waste water.

1.1 The source of the radioactive wastewater organic

Radioactive organic wastewater from the nuclear industry production, nuclear research activities, and nuclear medicine application process such as [3-4]. Compared with the radioactive waste water, the output of radioactive organic wastewater is smaller. Most of the low level waste water after storage decay or proper handling, can be discharged into the environment. And the management of radioactive organic wastewater not only needs to consider it is radioactive and must also consider the chemical toxicity [5].

Radioactive organic waste liquid including oil, waste solvents, extracting agent, liquid scintillation and other mixed liquid [6]. Radioactive waste oil circuit system of mechanical components including nuclear power plants of lubricating oil, vacuum pump oil, the waste liquid generally contain a small amount of beta, gamma radioactive nuclide. Because the main pollution sources from the primary circuit coolant, such waste much contains some water. Is the most common organic solvent waste tributyl phosphate (the TBP) and thinner, such as dodecanoic or kerosene. Occurring in the process of spent fuel reprocessing the TBP and thinner, reducing its radiation breakdown products, after the extraction performance must be removed by washing, can make the TBP reuse. The TBP kerosene after reuse many times and ultimately become into the organic waste liquid. Scintillation liquid from the chemical analysis, main component for steroids, lipids and toluene, xylene and cyclohexane and other nonpolar solvent. Other mixed including various decontamination process of organic wastewater, such as toluene, carbon tetra chloride, alcohols, ethylenediamine tetra acetic acid, oxalic acid, such as tannic acid [7-8].
1.2 The hazards of the radioactive wastewater organic

Treatment and disposal of radioactive waste liquid in the organic matter in waste water hazards mainly embodied in the following four aspects:

(1) In the waste liquid, organic matter may be related to the state of the ion radioactive nuclide complex formation, made the radionuclide is difficult to separate, influence the effect of coagulation and precipitation [9].

(2) The presence of organic matter that coagulation and evaporation process of liquid bubble, nuclide and organic matter into the condensate, reduce the decontamination factor [10].

(3) In the final waste in the body, the adsorption effect of the presence of organic matter to reduce radioactive nuclide, accelerate the radionuclide migration in groundwater, soil and surface water rate, adverse effects on the liquid solidification treatment of.

(4) Chemical degradation of organic matter radiation, produces CO2, CO, H2, etc., make the waste body stability.

So before handling radioactive liquid waste on preprocessing of organic matter in waste liquid can be in accordance with the conventional method of wastewater for further processing.

2 THE ORGANIC MATTER IN THE RADIOACTIVE WASTE WATER TREATMENT METHOD

To the low level radioactive waste water, the average processing methods is that the most of the radioactive nuclide transfer to small bulk concentrate, concentrate processing, and then to further concentrate disposal, the rest of the radioactive nuclide in the large volume of wastewater to achieve discharge standard, its emissions in the environment will be diluted, diffusion. Radioactive waste water treatment effect evaluation index, therefore, there are mainly two: one is the concentration ratio; the second is decontamination factor. Enrichment ratio refers to the original volume of radioactive waste water and the volume ratio of concentrate treated, the greater the concentration multiple, the volume is smaller, after the enrichment is economic, security, storage. Decontamination factor refers to the radioactive concentration (activity) and raw water treatment after water (activity) of radioactive concentration ratio, the larger the decontamination, residual radioactive concentration in waste water is treated is lower, discharge, storage is more security.

For radioactive waste water treatment, according to the different kinds of radionuclide and exist in the solution of the form is different, need to adopt the different processing method [11-13]. At present, the commonly used processing methods can be divided into three categories. (1) Through the chemical reaction to remove radioactive nuclide ion in waste water, the specific methods are neutralization precipitation, sulfide precipitation, ferrite colloid precipitation method, chemical reduction, electrochemical reduction, etc. (2) By adsorption, concentration, separation and other means, make the radionuclide ion in waste water under the condition of not change its chemical form removal, specific methods have zeolite adsorption of bentonite, mineral adsorption, adsorption, solvent extraction, ion exchange, etc. (3) With the help of a microbial or plant absorption, accumulation and enrichment effect, removal of radioactive nuclide ion in waste water, specific methods have biological flocculation method, biological adsorption method, plant processing method, etc. At present, the commonly used method of radioactive wastewater treatment are mainly chemical precipitation, ion exchange and evaporation concentration method.

2.1 Chemical precipitation method

Chemical precipitation method is to put a certain amount of chemical flocculant in waste water, such as aluminum potassium sulfate, sodium aluminate, ferric sulfate, ferric chloride, etc., sometimes still need dosing coagulant aid, such as active silica, clay, such as polymer electrolyte, hydrolysis, flocculation occurred after classics agitate, lose colloidal substance in waste water stability and condenses into tiny can precipitate particles, radioactive nuclide in the wastewater to co crystallization, co precipitation, or after the floe, colloid absorption into the precipitation in the mud, to achieve the purpose of separation, decontamination, concentrated liquid waste.

2.2 Filtering method

Filtering method is mainly to remove suspended substance in waste water, the ionic state of radionuclide removal efficiency is very low, in actual radioactive waste water is mainly used as pretreatment. In the radioactive waste water treatment, there are three kinds of commonly used filter. Packing type filter is bottom filled with activated carbon, quartz sand and anthracite filter material, the runtime will waste water into the filter, the waste water to flow filter layer, packing type filter, often used as a pretreatment of suspended particulate matter in the removal of waste water and oil and other organic matter. Precoat filter is the powdered resin (or diatomite filter material) on the porous support layer, such as wastewater under the action of water pressure by coating and reach the purpose of filtering, waste paint and intercept pollutants from wastewater by dehydration, drying for further disposal.
Many radionuclides went into a state of ions in water, especially after dealing with the chemical precipitation of radioactive waste water. Due to the removal of suspended and colloidal radionuclides, the rest went into a state of ion species, most of which are cation. And radionuclide trace exist in the water, and therefore is very suitable for using ion exchange method to deal with.

3 THE INTRODUCTION OF TiO$_2$ PHOTOCATALYTIC AND ITS MECHANISM

3.1 TiO$_2$ photocatalysis

TiO$_2$ is widely used in coatings, cosmetics and food industries, etc., is the most important thing in daily life industrial and engineering materials. The TiO$_2$ photocatalysis phenomenon has been found as early as 60 years ago, such as coating under long-term outdoor exposure for TiO$_2$ in the coating will be one of the organic matter decomposition and lead to powder coating. But the practical application of TiO$_2$ catalytic originated in 1972, the Japanese scholar Fujishima found TiO$_2$ electrode of water splitting, marked the beginning of heterogeneous photocatalytic new era. Since then, from physics, chemistry, materials, and other scholars to explore in the field of TiO$_2$ photocatalysis, the basic process and improve the efficiency of photocatalysis has carried out detailed research. Photocatalytic studies with the purpose of energy to replace and storage are closely related, based on the deterioration of global environment problem increasingly prominent, people began to study apply this technology to purify the environment pollutants. In 1976, Cary found in the past under the irradiation of ultraviolet light, titanium dioxide can make PCBS dechlorination. In 1977, Frank and Bard found the cyanide in the water can be TiO$_2$ photocatalysis decomposition. In 1983, Pruden make halogenated organic compounds, such as using the technologies such as chemical (PVC, degradation of chlorinated methane, and even mineralization). These findings, for application of photocatalysis in the environmental protection field shows a broad prospect. Listing and numbering when listing facts use either the style tag List signs or the style tag List numbers.

Wastewater treatment at present, the use of semiconductor photocatalytic technology has taken in basic theory research and applied research. Have greater progress. In recent years, the most studied mainly include metal oxide semiconductor photocatalytic materials and sulfide, such as TiO$_2$, WO$_3$, Fe$_2$O$_3$, ZnO, and CdS, etc. Among them, the metal sulfides such as CdS and CsSe has the narrow forbidden band width and illumination is used light corrosion and not suitable for light catalyst; Iron oxides such as alpha Fe$_2$O$_3$, alpha FeOOH, beta FeOOH etc. With high band gap width, can make use of solar energy and the price is low, but easy to corrosion by the light and activity is low and not suitable for light catalyst. Metal oxide ZnO has a suitable band structure and showed a higher photocatalytic activity, but ZnO light is not stable, often in the catalyst surface zinc (OH)$_2$ and make the catalyst deactivation. Other semiconductor oxides such as WO$_3$ and SnO$_2$ have no photocatalytic activity in the photocatalytic reaction. High photochemical stability, non-toxic, cheap and have the high band gap width and the REDOX potential of TiO$_2$, is the ideal photocatalytic materials.

3.2 The basic principles of TiO$_2$ photocatalysis

Fujinshima and Honda since 1972 found TiO$_2$ electrode by light irradiation can split water after hydrogen production, since the TiO$_2$ photocatalytic performance more and more get the attention of the people. It can purify the air, the degradation of the organic and inorganic pollutants in wastewater, and can also be used for pharmaceutical and food packaging, coating, paint, etc of anti fouling sterilization. The TiO$_2$ of low cost, high photocatalytic activity, susceptible to erosion, light degradation of organic matter thoroughly, and not cause secondary pollution, has the practical value. In nature, there are three types of crystal structure, namely, rutile, anatase and plate titanium ore. As shown in figure 1.

Band gap of TiO$_2$ is full of electronic valence band (valence band, VB), and empty conduction band (conduction band, CB), band gap between the valence band and conduction band. Electronic when filling low priority from the energy of valence band to fill up. When energy is greater than the width of band gap (E$_g$) with light, price bring electronic (e$^-$) are transition to the conduction band, at the same time on the price with the corresponding holes (h$^+$), electrons and holes in the electric field under the action of separation and migrate to the surface. Band structure model is used to calculate the titanium oxide crystals of forbidden band width are 3.0eV (rutile phase), and 3.2eV (anatase phase). TiO$_2$ light absorption of fujian value related to its forbidden band width, its formula is:
\[ \lambda_g (\text{nm}) = \frac{1240}{E_g (\text{eV})} \]

In general, the TiO2 photocatalytic air and aqueous solution, this is because the molecular oxygen or water and raw electronic or light hole combination can produce chemical property is very active oxygen free radical (\(O_2^-\)) and hydroxyl radical (OH). Take advantage of these free radicals can be the organic substances in wastewater oxidation reduction for CO2, inorganic salt and water. At present TiO2 photocatalytic technology has been widely used in the study of the degradation of organic matter in wastewater.

3.3 The photocatalytic degradation of organic matter in radioactive waste water

At present, foreign institutions has been carried out using TiO2 photocatalytic technology research on catalytic degradation of organic matter in radioactive waste water, and achieved some results. Seshadri \[16] studied under ultraviolet light, such as use of Degussa P-25 TiO2 for detergent used in the nuclear industry ethylenediamine tetraacetic acid (EDTA) to carry on the photocatalytic degradation, and analyzes the solution pH, catalyst dosage and the effect of \(H_2O_2\). Results show that under the condition of acid degradation rate is highest, 1.5 h reaction the EDTA can be completely photocatalytic degradation. Detected in the degradation liquid amides, but degradation products will not affect the subsequent chemical precipitation, EDTA after degradation showed good decontamination factor. Alkaim etc detailed studied the influence of pH of TiO2 photocatalytic degradation of EDTA, it was found that when the pH value of 5, photocatalytic performance relative to neutral environment improved about 50%. Rekab and further studies the EDTA complexometric 60 co TiO2 photocatalytic degradation, the results showed that under uv light, TiO2 EDTA can be completely degradation and release the 60 co.

In addition, Kruthika etc \[16\] studied under uv light in the use of TiO2 nanoparticles of photocatalytic degradation of tannins, results show that under uv light, TiO2 after three hours of tannic acid degradation can be around 80%, degradation efficiency is higher than single ultraviolet or TiO2 exists under the condition of the degradation efficiency. Tao[17] to study the use of ilmenite, such as preparation of TiO2 rutile phase nanorods, and with the light catalytic degradation of radioactive waste water of oxalic acid, reaction obtained higher degradation rate of 25 minutes.

4 THE CONCLUSION AND PROSPECT

Photocatalytic technology in recent years, with its low cost, susceptible to erosion, light degradation of organic matter thoroughly and don't cause secondary pollution, photocatalysis has been applied widely in the field of environmental research. Especially in recent years in view of the radioactive waste water of organic matter, the researchers began to use on the degradation of photocatalytic technology, photocatalysis technology is expected to become an ideal organic pollution treatment technology. Composition is complicated, because of the radioactive waste water treatment is difficult, so the photocatalytic technology combined with traditional processing methods used in actual engineering application is undoubtedly the focus of the radioactive organic wastewater treatment in the future research direction.

REFERENCES

