P.G.SEMESTER-III

CC-XII

Environmental Chemistry and Green Chemistry

Unit-IV Green Chemistry : Def. & Obj.

Topic- Organic waste management in Green Chemistry

Dr. Jasmine Singh

Assistant Professor

Department of Chemistry

Maharaja College(VKSU), Ara

INTRODUCTION

There are more than nine million organic compounds known. Industries processing of organic compounds are numerous. Consequently, organic compounds as waste are ubiquitous in different matrices such as wastewater, air, or concentrated solid or liquid form. Historically, the importance of wastewater treatment was realized because of its disease-causing potential, foul smell, and color. Activated sludge process (ASP) is a breakthrough in cost-effective sewage treatment and has been considered a milestone in the history of wastewater treatment. As the complexity and diversity of the organic chemical industry have grown, the associated organic waste problem has also increased. Wastewaters containing non-biodegradable organic compounds such as phenols, pesticides, dyes, phthalates, pharmaceuticals have emerged. ASP alone could not degrade these refractory organic compounds as per regulations. Simultaneously, the emergence of hazardous organic liquids/solvents and solids such as petroleum sludge, ion exchange resins, organic solvents, PCBs, pesticides, POPs, etc.has become a severe issue. Air emissions containing volatile organic compounds (VOC) such as acetone, ethanol, and acetic acid have also become a problem. A distinct class of organic wastes arises from nuclear facilities. They are called organic radioactive wastes. Radioactive materials are present in this kind of organic wastes. The presence of radioactivity in the organic material changes treatment options many times.

ORGANIC WASTE MANAGEMENT BY 4R FORMULA

'Reduce, recover, recycle, and reuse' strategy is the 4R formula and a general strategy for waste management, including organic waste. Green chemistry, by judicious process modification, attempts to implement 4R formula, especially 'Reduce.' 4R formula has become quite useful and essential. Efforts, such as the following, are being made:

- Research efforts are in progress to recover nutrients and other valuable compounds from sewage water for reuse.
- Zero liquid discharge has become mandatory for 'red category industries' such as the hazardous waste processing industry in India.
- Recovery and reuse of solvents by vacuum or atmospheric distillation are routinely followed in many industries. Tributyl phosphate in n-dodecane solvent (TBP solvent) waste generated in the nuclear industry, for example, is vacuum-distilled for recovery and reuse over several cycles.
- Recovery and reuse of organic ion exchange resins in the demineralization plant by acid/alkali regeneration process are well known in nuclear and other industries.
- Recovery and reuse of VOCs from air streams by condensation are followed if the VOC concentration is high and the process is economically viable.

Despite the best efforts, waste generation cannot be stopped totally, and the need for its treatment exists. The focus of the review is organic waste treatment using green chemistry.

MINERALIZATION OF ORGANIC WASTE

Thermodynamically, all organic compounds, without exception, are mineralizable to CO_2 and water. It is, mostly, the basis for the treatment of organic wastes in different media and forms. Kinetics varies from compound to compound. Incineration has been the mainstay for the management of organic solid and liquid wastes for over a century. However, over the last few decades, it is losing its place in the scheme of things because of the evolution of stringent air pollution standards and the technical and economic issues associated with their compliance. Furan and dioxin, among others, are essential air pollutants from the incineration process. The presence of radioactivity in the organic waste complicates the matter further making incineration impractical for even wastes such as tissue papers, which are made of hydrogen, oxygen, and carbon atoms.

GREEN CHEMISTRY IN ORGANIC WASTE TREATMENT

Organic waste treatment by green chemistry is, in most cases, mineralization of organic compounds using benign oxidants, listed below, under moderate experimental conditions:

- Oxygen
- Hydrogen peroxide
- Ozone
- Electron (directly or indirectly)

The following discussion, mostly authors' work as case studies using these green oxidants, has been presented briefly:

TNT-bearing wastewater treatment by Photo-Fenton reaction

Because of the toxic effect which explosive, TNT has been widely reported to have on the human and ecological environment, this waste stream cannot be discharged unless the concentration of TNT and other dissolved explosives in the water is less than 1 mg/L. In the study, the wastewater contained 50-100 ppm of TNT arising from TNT handling facilities with a maximum generation rate of about 6-8 m3 /d. Following advanced oxidation processes (AOP), listed below, can be considered for the treatment of this water: Many review articles have appeared discussing the principles of AOP

- Fenton reaction
- Ozone/hydrogen peroxide or hydroxide
- Hydrogen peroxide/ultraviolet(U.V.)
- Photo-Fenton reaction
- Ozone/U.V.
- Photocatalytic oxidation using titanium dioxide

AOP is a process mediated by strongly oxidizing hydroxyl (OH) radicals with a standard potential of 2.8V(vs. SHE). These radicals are non-selective and kinetically fast, with rates controlled by diffusion (Leon and Gerald, 1973). OH, radicals initiate the oxidation process by hydrogen abstraction, double bond addition or electron transfer reactions.

H_2O_2/U.V. method

Among the AOP options, hydrogen peroxide/U.V. option is the cleanest. It involves U.V.(253.7 nm) irradiation of the mixture of wastewater and hydrogen peroxide. Hydrogen peroxide is converted into the water in the oxidation process. Low-pressure mercury lamps emitting this radiation monochromatically are available commercially. These lamps are used for disinfection purposes as well. Hydrogen peroxide decomposes to give OH radicals as follows:

$$H_2O_2 \xrightarrow{253.7\ nm} 2\ OH. \quad (1)$$

The molar extinction coefficient(ε) for this absorption is low (25 M^{-1} cm^{-1}). Besides, TNT also absorbs this U.V. light (inner filter effect) with ε more than 10,000 M^{-1} cm^{-1} wastefully . For these reasons, this method was not selected in this study. This method, however, shows promise if inner filter effects are absent and if the wastewater pH is9-10 as the conjugate base of H_2O_2, viz., H_2O_2 - absorbs 253.7 nm more strongly. ε of this base is 100-125 M^{-1} cm^{-1}. Higher pH, however, tends to accelerate the decomposition of H_2O_2 wastefully.

TO BE CONTINUED………

The students are requested to keep studying and stay tuned till further updates regarding the content .

THANK YOU !

You can mail your subject related queries on…

jasminechem1@gmail.com