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Gamma Radiolytic Decomposition of KNO_3 in Presence of Aluminium and Its Compounds

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The present work has been carried out to investigate the effect of aluminium and its different compounds on the radiolytic decomposition of potassium nitrate. The radiolytic decomposition of the admixtures has been studied over a range of gamma dose of 1–110 KGy. The amount of nitrite formed was estimated spectrophotometrically. In case of admixtures of aluminium powder and sodium aluminate with potassium nitrate the G values have been found to increase with increase in their mole fractions while in case of admixtures of aluminium oxide and potash alum with potassium nitrate a reverse trend is seen. The increase in G values has been attributed to the transfer of energy absorbed by the additives or *vice-versa.*

Key Words: Gamma radiolysis, Potassium nitrate, Al additives.

INTRODUCTION

The gamma rays being ionizing radiations bring about many visible changes such as fluorescence, colouration in glass, changes in crystallographic structures, destruction of existing species as well as formation of new species[1] etc. The radiolysis of inorganic nitrates has been studied widely[2–4]. Gamma radiations decompose the nitrates to nitrites along with the formation of other radiolytic products. ESR study of γ-irradiated single crystal of $K(UO_2)(NO_3)_3$ by Gundu Rao *et al.*[5] showed the presence of NO_3 radical at room temperature and NO_3^{2+} at 77K. γ-irradiated KNO_3 crystals[14] by EPR[6] showed the presence of NO_2, NO, NO_3^-. The effect of particle size of nitrate as heterophase impurity on radiolysis of pure and Ba^{2+} doped KNO_3 crystals has also been reported[7]. The decomposition mechanism of nitrate as given by Muhammad and Maddock[8] is as follows:

$$2NO_3^- \longrightarrow NO_3 + NO_3^{2-}$$

$$3NO_3^- \longrightarrow NO_3 + NO_2^{2+} + NO_2^- + O_2$$

$$2NO_3^- \longrightarrow 2NO_2^- + O_2$$

$$NO_3^- \longrightarrow NO_3 + e$$

These reactions occur at relatively low temperature but as the temperature approaches room temperature the reaction increasingly becomes

$$2NO_3^- \longrightarrow 2NO_2^- + O_2$$

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Protection of Gentian Violet on Gamma Irradiation in Presence of Certain Additives

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The present work has been carried out to investigate the effect of certain organic compounds on the radiolytic decomposition of gentian violet in aqueous medium. The γ-radiolytic decomposition of the dye solutions of various concentrations were studied at a dose range of 0.04–0.42 kGy in presence of oxygen and 0.06–0.59 kGy in an inert atmosphere. The amount of dye decomposed was estimated spectrophotometrically at λ_{max} of 583.0 nm. The protection of the dye was found to be better in absence of oxygen. In case of thiourea and glycerine as additives, the retention of the dye was 100% and as a result the G-value of dye decomposition was found to be zero. In case of glucose and EDTA, the protection of the dye was 90% whereas in case of urea only 70% retention was observed.

Key Words: Gamma radiolysis, Protection, Dye, Gentian violet.

INTRODUCTION

Methyl violet (C.I. 42535) and crystal violet (C.I. 42555) belong to a group of triaryl methane dyes[1]. Gentian violet is a mixture of methyl violet and crystal violet (for convenience it is considered as 1 : 1 mixture). Gentian violet is used as ink for stamp pads and as an antiseptic on wounds and mucous membranes[2].

In the present paper, the effect of gamma γ-radiation on the dye has been studied. It is well known that gamma radiations bring about decomposition of the dye by the breakage of the double bonds. Perkowski and Mayer[3] have reported decolorization of anthraquinone dye in aqueous solution by gamma radiation. They have also reported decolorization[4] of the dyehouse wastewater by irradiation. Certain oxidizing agents speed up the decolorization process when added to the wastewater prior to irradiation. Gupta[5] has reported decomposition of the xylenol orange dye. Certain compounds such as glucose, glycerine, etc. when added to the dye solution tend to protect the dye which is visible by the retention of colour even on exposure to that dose at which otherwise the dye by itself would decolorize almost completely.

EXPERIMENTAL

All chemicals used were of AR/GR grade and the solutions were prepared in doubly distilled water. The dye solutions were prepared fresh to avoid oxidation and used within 5 h. Gamma irradiation was carried out in stoppered corning glass tubes (14.0 cm height and 3.0 cm diameter) having B24 standard joints in cobalt-60 gamma chamber (GC 900) at a dose rate of 1.2 kGy h^{-1} (7.488×10^{18} eV g^{-1} h^{-1}).

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Preliminary feasibility study of congo red dye as a secondary dosimeter

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Abstract

The present work has been carried out to study the potential of congo red dye as secondary dosimetry. Congo red dye solution is found to be sensitive towards gamma radiations. The molar extinction coefficient of the dye solution was found to be $2.70 \times 10^5\,\mathrm{l\,mol^{-1}\,cm^{-1}}$ at λ_{max} 499.0 nm. Aqueous congo red dye solution of 0.02 mM concentration was irradiated for varying γ doses (0.05–0.15 kGy). The G-values were calculated by estimating the amount of dye consumed due to radiolytic decomposition. The average G-value was found to be 63.30 mol 100 eV at the above concentration. The estimation was done spectrophotometrically using ELICO SL-150/ Shimadzu UV 240 spectrophotometer. The dose determined using congo red dye solution was found to be in agreement with that of Fricke dosimetry.

Keywords: Secondary dosimetry; Congo red; G-value; Radiolytic decomposition

1. Introduction

A quantitative study in radiation chemistry requires knowledge of the amount of energy absorbed from the ionizing radiation. Determination of this absorbed energy is called radiation dosimetry and the system used for this purpose is called dosimeter. Various types of dosimeters are reported in a Handbook by Gupta and Bhat (1983). A system that measures the amount of energy absorbed from the ionizing radiation by the virtue of the chemical changes produced in the system on exposure to the radiations is a chemical dosimetry. However, such chemical dosimeters require calibration and so are used as secondary dosimeter. The use of many doped and undoped rare-earths, alkaline earth metal compounds that are conveniently used as dosimeter, is due to the change in their thermoluminescence and other optical properties. Such dosimeters are well-known and are widely studied by various researchers (Faria et al., 2004; Fernandes et al., 2004, Le Masson et al., 2004; Oliveira and Caldas, 2004; German et al., 2004). Many dye solutions are also used for this purpose. The high energy radiations bring about the radiolysis of the dyes which is used as a measure of the energy of the radiation incident on the system. The use of methylene blue dye as a secondary dosimetry was reported by Vereshchinski and Pikaev in the year 1964. el-Assy et al. (1991) have suggested the possible use of aqueous solution of chlorantine fast green BLL dye as a chemical dosimetry in the range of absorbed dose of 0.1–5.0 kGy. Collins et al. (1994) have investigated aqueous coumarine solutions as chemical dosimetry for radiation therapy.

Congo red (C. I. No. 22120) or the disodium salt of diphenyl diazobis-1-naphthylaminesulphonic acid is brownish red powder having absorbance maxima at 488.0 nm at pH 7.3. It is highly soluble in polar solvents like water and ethanol. The colour of the dye is pH sensitive (blue-violet at pH 3.0 and red at pH 5.0). Hence congo red is commonly used as an indicator for acid-base titrations. Apart from using it as an acid-base indicator, it is also used as addition to culture media, dye, biological stains, etc. The aqueous solutions of the dye also shows bleaching due to the ionizing radiations and this property can be used for dosimetry as the decomposition of the dye is linear with respect to the amount of dose absorbed. In the present paper we have investigated the potential of congo red dye as a secondary dosimetry. It is readily soluble in water and requires no special solvent.

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Plausible Applicability of Aqueous Congo Red Dye System as Secondary Gamma-ray Dosimeter

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Abstract: Aqueous congo red dye solutions in the concentration range of 0.01–0.03mM were irradiated for varying γ doses 0.050 kGy to 0.150 kGy. The molar extinction coefficient of the dye solution of congo red was found to be 2.70×10^5 at its absorption maxima 499.0 nm. No change in λ_{max} was observed on irradiation. As the dye solutions are sensitive towards γ–irradiation, decolouration occurs on irradiation. The G–values for the doses in between the range of 0.035 kGy to 0.125 kGy were found to be practically constant for pure aqueous systems. Hence this was used to determine the dose of the gamma source. With the addition of alcohols in the systems, degradation of the dyes due to radiations decreased considerably.

Keywords: Congo red, G–value, Radiolytic decomposition, Alcohols

Introduction

A system that measures the amount of energy absorbed from the ionizing radiation by virtue of the chemical changes produced in the system on exposure to the radiations is a chemical dosimeter[1]. The high energy radiations bring about the radiolysis of the dyes (decolouration or bleaching effect) which is used as a measure of the energy of the radiation incident on the system. The use of solutions of dyes such as methylene blue[2], chlorantine fast green BLL[3] and coumarine[4] for chemical dosimetry is reported. Congo red (C. I. No. 22120) or the di sodium salt of diphenyl diazo *bis*-1-naphthylaminesulphonic acid is brownish red powder having absorbance maxima at 499.0nm in aqueous medium. The aqueous solution has pH 7.3 and the systems were stable for several hours. The decolouration of the dye as a result of γ–irradiation may be delayed using certain additives. In the present paper we have investigated the effect of alcohols in delaying the degradation of the dye. An attempt is made to explore the possible use of the aqueous congo red systems as high energy dosimeter. Ajji[5] reported that alkaline methyl red dye solution could be used as chemical dosimeter for gamma rays in the range between 50 and 6000Gy.

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Effect of metal powders on γ-ray-induced decomposition of $2KNO_3 \cdot La(NO_3)_3 \cdot 2H_2O$

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It is a well-known fact that metals remain unaffected by electromagnetic radiation in general. However, they may be influenced to some extent by the formation of certain microstructural changes because of γ-radiation. The experimental data showed that γ-radiolysis of double nitrate was influenced by the presence of metal powders in the admixture. The decomposition of the double nitrate exhibits linear correlation with the first ionization potential of the metals ($r = 0.9787$) at 25 mol%. However, at higher concentrations of 50 and 75 mol% metal powders, poor correlation is observed, especially for Sn, Fe and W, which all show variable oxidation states, unlike Al and Zn, which exhibit stable oxidation states of +3 and +2, respectively.

Keywords: double nitrate; metal powders; γ-radiolytic decomposition

1. Introduction

The γ-radiolytic decomposition of several inorganic nitrates has been widely studied. The nitrates, on exposure to the ionizing radiation, are known to produce nitrites. Several workers have studied radiolytic decomposition of various nitrates (*1–4*).

The amount of nitrite formed is not only dose-dependent (*1*) but is also greatly affected by other parameters, like pressure, temperature, outer cation characteristics, water of crystallization, particle size and cation size of nitrates (*5–8*). The effect of various additives such as halides, borates, cyanides, oxides, thiocyanates and sulfates (*9–11*) have been studied intensively in the past. The mode of energy transfer during γ-radiolysis of nitrates dispersed in sulfate and carbonate media (*12*) is also broadly discussed. However, influence of pure metal powders on radiolysis of nitrates has not been reported in the literature.

The effect of high-energy radiation on metals is somewhat controversial. The damaging effect of γ-radiation on metallic bonds is not known to be a permanent one but preliminary treatment of metal powders with γ-or e-beam is reported to produce metals with better grain structure,

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Radiation sterilization of fluoroquinolones in solid state: Investigation of effect of gamma radiation and electron beam

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ABSTRACT

The effect of gamma radiation from ^{60}Co source and 2 MeV electron beam was studied on two fluoroquinolone antibiotics *viz* norfloxacin and gatifloxacin in the solid state. The changes in reflectance spectrum, yellowness index, vibrational characteristics, thermal behavior, UV spectrum, chemical potency (HPLC) and microbiological potency were investigated. ESR measurement gave the number of free radical species formed and their population. The nature of final radiolytic impurities was assessed by studying the HPLC impurity profile. Both norfloxacin and gatifloxacin were observed to be radiation resistant, and did not show significant changes in their physico-chemical properties. They could be radiation sterilized at a dose of 25 kGy.

1. Introduction

Radiation sterilization of the medical appliances by gamma radiation and electron beam is a well established technique. Many reports on radiation sterilization of drugs are available in the literature. The compounds on which radiation sterilization studies have been reported include vitamins (Basly et al., 1998), antiprotozoals (Basly et al., 1997a), antibiotics (Marciniec et al., 2008, 2002; Onori et al., 1996; Gibella and Tilquin, 1999; Crucq et al., 2000), steroids (Marciniec et al., 2005), bronchodilators (Basly et al., 1997b), anti-hypertensive (Engalytcheff et al., 2004) and anticancer agents (Varshney and Dodke, 2004). A study on fluoroquinolone antibiotic ciprofloxacin is also reported (Charoo et al., 2003). The compounds selected for this study are two fluoroquinolone antibiotics *viz* norfloxacin (NFX) and gatifloxacin (GFX).

The necessity of studying the effect of radiation on each drug molecule arises from the fact that radiation effect cannot be generalized for a class of compounds, as every drug molecule in a class differs in structure and therefore may show different radiation behavior (Varshney and Dodke, 2004).

The first-generation fluoroquinolones had limited gram-negative activity and were primarily used for the urinary tract infections. The discovery of new and more potent compounds resulted in increased prescriptions of fluoroquinolones. NFX is a second-generation fluoroquinolone with increased gram-negative activity, as well as some gram-positive and atypical pathogen coverage, whereas GFX is a third-generation fluoroquinolone with expanded activity against gram-positive organisms and atypical pathogens (Martin and Agents, 1999). Their structures are shown in Fig. 1. These compounds belong to the quinoline sub-class of fluoroquinolones with characteristic features, such as presence of a 3-carboxylic acid group, a piperazino functionality at position 7 and a 6-fluoro substituent. The only remarkable difference in the structure of NFX and GFX is the presence of a methoxy substituent at position 8 in case of GFX. Fluoroquinolones are both photolabile and thermolabile. Therefore, radiation sterilization technique seems to be a promising alternative method for their terminal sterilization. But the high energy ionizing radiation is known to cause discoloration, induce formation of free radicals and radiolytic products in the irradiated samples (Jacobs, 1995). The radiolytic products if unique and toxic render them unsafe for the human consumption. Therefore, suitability of radiation sterilization has to be established by a comprehensive study using several analytical techniques that furnishes both qualitative and quantitative information about radiolytic species (Marciniec et al., 2002).

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Study on gamma and electron beam sterilization of third generation cephalosporins cefdinir and cefixime in solid state

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ABSTRACT

The effect of gamma radiation from ^{60}Co source and 2 MeV e-beam was studied on two thermolabile cephalosporin antibiotics *viz* cefdinir and cefixime in solid state. The parameters studied to assess radiolytic degradation were loss of chemical and microbiological potency, change in optical rotation, electronic and vibrational absorption characteristics, thermal behavior and color modification. ESR spectroscopic study, HPLC related impurity profile, thermogram and Raman spectrum are applied in deducing the nature of radiolytic impurities and their formation hypotheses. Cefixime is radiation sensitive, whereas cefdinir has acceptable radiation resistance at 25 kGy dose. The nature of radiolytic related impurities and their concentrations indicates that the lactam ring is not highly susceptible to direct radiation attack, which otherwise is considered very sensitive to stress (thermal, chemical and photochemical).

1. Introduction

Cephalosporins are broad spectrum antibiotics of β-lactam group. The lactam ring of cephalosporins is sensitive to the influence of external factors that result in loss of potency, especially when in aqueous solutions. Therefore, their formulations are mainly in the form of tablets, capsules or dry injection powder dissolved *extempore* (United States Pharmacopoeia, 2008). The sterilization of cephalosporins by the classical method becomes impractical due to their thermal sensitivity. Microfiltration is frequently used for sterilizing such thermosensitive compounds, but the aseptic handling required thereafter until packaging is inconvenient. The only alternative is the radiosterilization method, which has been preferred over microfiltration in the *European Agency for Evaluation of Medicinal Products* decision tree (EMEA, 2000). It is known that ionizing radiation can effectively kill microorganisms, but in the process of sterilization it may also cause damage to the drug, which is undesirable. Therefore, safe application of radiation sterilization needs to be preceded by showing that ionizing radiation does not change the content and physicochemical properties of a drug, and thus does not change its activity (Marciniec and Dettlaff, 2008).

There are several studies reported in the literature on radiosterilization of β-lactam antibiotics of penicillin class and cephalosporins of lower hierarchy. In a study on ampicillin, the radiolytic degradation was proposed to be assessed by UV spectrometry. The suitability of UV spectrometric measurement was adjudged by comparison with HPLC diode array analysis (Gibella and Tilquin, 1999). It was shown in a study on the effect of β-radiation (e-beam) on penicillin that irradiation at 25 kGy dose with β-radiation did not cause any significant qualitative and quantitative change (Marciniec et al., 2002). Some of the parenteral veterinary cephalosporins irradiated with e-beam were also found to be sufficiently stable (Johns et al., 2003). In a feasibility study performed on cefazolin sodium (a first generation cephalosporin), the color modification was found to be a limitation to radiosterilization (Crucq et al., 2000).

In the present study, the effect of ionizing radiation on the third generation oral cephalosporins namely cefdinir and cefixime has been investigated. These drugs are structurally quite similar as shown in Fig. 1. The effect of radiation was investigated by observing changes in optical rotation, thermal behavior, color, chemical potency, microbiological potency and vibrational characteristics (IR and FT-Raman). The radiation induced free radical formation is also studied by ESR to get insight into the mechanism of radiolytic degradation. The irradiation was performed with gamma radiation and e-beam to study the effect of radiation type and dose rate.

2. Experimental

2.1. Materials

Cefdinir and cefixime working standards were gifted by Orchid Chemicals & Pharmaceuticals, India. The purity of working

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RADIOLYTIC TRANSFORMATION OF IODINE TO IODINE MONOCHLORIDE IN CHLORINATED ORGANIC SOLVENTS

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ABSTRACT: Gamma radiolysis of iodine in various air saturated chlorinated organic solvents has been studied for different concentrations and doses. Pre-irradiation I_2 shows electronic absorption maxima at ~515nm whereas post-irradiation ICl formation is evident from its characteristic electronic absorption maxima at 460nm. In electronic absorption spectra of irradiated I_2 solutions in all the chlorinated organic solvents studied, the spectra shows isobestic point indicating presence of two species viz, I_2 and ICl simultaneously. The formation of ICl and disappearance of I_2 from the system under study is found to have a linear correlation as a function of radiation dose. The ratio of the rate of disappearance of iodine and appearance of ICl can be calculated by using the molar absorptivities of the two species at the isobestic point. Concentration of ICl varies linearly with the dose absorbed in lower dose range. After a certain dose, a deviation is observed for every solvent and each concentration at particular dose. G(-I_2) and G(ICl) is found to be constant. It may perhaps be correlated with C–Cl bond dissociation energy.

Keywords:chlorinated compounds, G-value, iodine monochloride

1. INTRODUCTION

Effect of ionizing radiations on halogen substituted hydrocarbons has been a subject of detailed investigations[1-3]. Organic halides in general and aliphatic halides in particular are the most sensitive to ionizing radiation with exception of fluorides. Collinson and Swallow[4] extensively reviewed the radiation chemistry of organic compounds. Later on Swallow[5] wrote a monograph on the radiation chemistry of organic compounds. Holroyd[6] has given a detailed account of the radiation chemistry of organic compounds along with several other articles in the monograph on Fundamental Processes in Radiation Chemistry edited by Ausloos. The Principles and Application of Radiation Chemistry have been reviewed by Swallow[7].

In the present work we have investigated gamma radiolysis of air saturated solutions of iodine in various chlorinated organic solvents viz. 1,1,1-Trichloroethane CH_3CCl_3; 1,1,2,2-tetrachloroethane $Cl_2CHCHCl_2$; 1,4-dichlorobenzene in benzene $C_6H_4Cl_2$; dichloromethane CH_2Cl_2; chloroethane CH_3CH_2Cl; 2-chlorobenzyl chloride $ClC_6H_4CH_2Cl$; 4-chlorotoluene $ClC_6H_4CH_3$; 1-chlorobutane $CH_3CH_2CH_2CH_2Cl$; Allyl chloride $H_2C{=}CHCH_2Cl$; 2-chloro methyl propane $(CH_3)_3CCl$; hexachloroethane in toluene $Cl_3C\text{-}CCl_3$; hexachloroethane in n-hexane $Cl_3C–CCl_3$; chloromethane CH_3Cl; pentachloroethane $CHCl_2CCl_3$; ethyl chloroacetate $ClCH_2CO\text{-}OC_2H_5$; benzoyl chloride C_6H_5COCl; amyl chloride $CH_3(CH_2)_4Cl$ at different concentrations and gamma radiation doses. Radiation induced formation of ICl depends on the nature of organic solvents and its molecular structure, concentration of solute and radiation dose[8].

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GAMMA RADIOLYTIC DECOMPOSITION OF ACIDIC STANNOUS CHLORIDE SYSTEMS

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Abstract- The investigations involving the effect of ionization on the yields of radiation- chemical reaction in aqueous solutions suggest radical diffusion model for various radiation-induced chemical reactions in aqueous media. Gamma radiolysis of acidic stannous chloride solution at various absorbed doses and in presence of additives has been investigated. G(-Sn2+) is higher at the lower gamma dose. At the higher doses beyond 10 kGy the G values remain constant. The additives enhance the radiolytic transformation of stannous by energy transfer process. Presumably the additives exhibit sensitization effect. Efficiency of sensitization depends on the nature of the additives, concentration in the admixture and the absorbed dose. The additives were used in high concentration in contrast to the stannous chloride solutions. Thus, protection might be due to the shielding effect rather than scavenging.
Keywords- G-value, stannous chloride, additives, potassium aluminium sulphate, sodium aluminate, methacrylic acid

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Introduction

Ionizing radiations interact with matter and can cause formation as well as destruction of species. Radiolysis of aqueous systems has evoked much interest in radiolytic products of water which may then interact with solute causing complex reactions. Radiation chemical reaction taking place in water and in aqueous solutions have been the subject of numerous investigations [1-3].

The investigations involving the effect of ionization on the yields of radiation- chemical reaction in aqueous solutions suggest radical diffusion model for various radiation-induced chemical reactions in aqueous media. According to this model, radiation-induced chemical reactions in aqueous solution are initiated by radicals generated from water as a result of energy deposition [4-6].

In the present study, gamma radiolysis of stannous chloride in aqueous hydrochloric acid at various absorbed doses and in presence of additives has been investigated. Various additives used were methacrylic acid (MA), potassium aluminium sulphate (PAS) and sodium aluminate (SA).

Experimental

All the solutions were prepared in doubly distilled water with A.R./ G.R. grade chemicals. The stock solutions of the additives and stannous chloride were used to prepare the working standard of required concentrations. The stannous chloride solutions were freshly prepared to avoid atmospheric oxidation.

Stoppered corning glass tubes made of B24 joints were used as irradiation cells to minimize solvent evaporation. The solutions were irradiated in Gamma Chamber 900 (GC-900) housed in Nuclear Chemistry laboratory, Department of Chemistry, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur. The dose rate of the Co-60 source during the course of work was 80 krads/ hr.

About 10-15 mL of the solutions was irradiated for different time periods. Post irradiation chemical changes were determined spectrophotometrically using Shimadzu UV-240/Elico SL-150 UV–Visible spectrophotometer.

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SANTILLI'S NEW FUELS AS SOURCES OF CLEAN COMBUSTION

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Abstract

Molecular combustion or nuclear fission is the conventional source of energy, which are not clean as they generate large amount of green house gas or nuclear waste. Clean energy can be obtained by harnessing renewable energy sources like solar, wind, etc. However, each of these sources has their own limitations and is dependent on geographical locations. The modern day demand of clean, cheap and abundant energy gets fulfilled by the novel fuels that have been developed through hadronic mechanics/chemistry by Professor R. M. Santilli. In the present paper, a short review on such novel fuels like Hadronic energy of non-nuclear type (combustion of MagneGas) has been presented.

Keywords: Magnecules, alternative energy sources, hadronic chemistry, magnecular combustion.

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Separation of Zn(II) and Cd(II) ions from Synthetic Waste Water by Adsorption on Activated Carbon Derived from *Tridax procumbens*

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Abstract: The use of activated carbon derived from *Tridax procumbens* for the treatment of waste water containing heavy metals is an innovative method. It constitutes a simple, effective and economical means for waste water treatment. Adsorption of toxic heavy metals viz. Zn(II) and Cd(II) were studied from synthetic waste water on activated biocarbon derived from *Tridax procumbens*. Batch adsorption experiments were performed with activated biocarbon as a function of pH, contact time and amount of activated biocarbon. The most favourable pH required for maximum adsorption was found to be 3.6 and 3.8 for Zn(II) and Cd(II) respectively. The maximum contact time for the equilibrium condition was found to be 180 min. The maximum efficiencies of Zn(II) and Cd(II) removal by biocarbon were 97.74 % and 90.62 % respectively. When the amount of activated biocarbon was increased, percentage removal of metal ions also increased for the system containing upto 3.0 g of biocarbon. Beyond this no appreciable change was observed. The linear Langmuir and Freundlich models were applied to describe equilibrium isotherms and both models fitted well.

Key words: Adsorption, biocarbon, heavy metals, *Tridax procumbens*.

Introduction

The industrial revolution has resulted in an improving lifestyle, raising the standard of living of people, but it has also given rise to an indiscriminate exploitation of natural resources. Heavy metal pollution is one of the main problems. Almost all the industrial and commercial activities generate effluents containing one or more heavy metals. The discharge of metallic ions in industrial effluent is of great concern because their presence and accumulation have a toxic effect on living species [1]. Industrial waste water mostly contain metal ions such as nickel, lead, cadmium, copper, zinc and aluminium because these metals are used in a large number of industries such as electroplating, batteries manufacture, mining, metal finishing and brewery. Heavy metals are also toxic to aquatic organisms even at very low concentration [2]. Until recent centuries, when the orientation towards industrialization and production brought about many technological advances, most of these pollutants were present in environment only in minute quantities. But at present, these toxic metals have polluted our atmosphere, water, soil and have also entered into food chain. Therefore, the study of the existing effluent disposal methods, facilities and attitudes is essential in order to make a positive impact on the environmental hygiene [3].

Currently, water treatment technologies for the removal of heavy-metal ions include chemical precipitation, membrane filtration, ion exchange and electrochemical processes. However, these methods often incur high operational costs. Therefore, cost-effective alternative technologies

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A REVIEW OF HADRONIC CHEMISTRY AND ITS APPLICATION IN THE DEVELOPMENT OF NEW MAGNECULAR FUEL

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Abstract

The discipline, today known as Quantum Chemistry for atomic and subatomic level interactions has no doubt made a significant historical contributions to the society. Despite of its significant achievements, quantum chemistry is also known for its widespread denial of insufficiencies. An Italian-American Scientist *Professor Ruggero Maria Santilli* during his more than five decades of dedicated and sustained research has denounced the fact that quantum chemistry is mostly based on mere nomenclatures without any quantitative scientific contents. Professor R M Santilli first formulated the iso-, geno- and hyper- mathematics[1-4] that helped in understanding numerous diversified problems and removing inadequacies in most of the established and celebrated theories of 20th century physics and chemistry. This involves the isotopic, genotopic, etc. lifting of Lie algebra that generated Lie admissible mathematics to properly describe irreversible processes. The studies on Hadronic Mechanics in general and chemistry in particular based on Santilli's mathematics[3-5] for the first time have removed the very fundamental limitations of quantum chemistry [2, 6-8]. In the present discussion, we propose to present the review on the conceptual foundations of Hadronic Chemistry that imparts the completeness to the Quantum Mechanics and Chemistry via an addition of effects at distances of the order of 1 fm (only) and the industrial applications of Hadronic Chemistry in formulating the basically new chemical species of Magnecule[8, 12-14].

Keywords: *Hadronic Mechanics, Quantum Chemistry, Magnecules, Fuels.*

Introduction:

In the late seventeenth century, Issac Newton discovered classical mechanics, the laws of motion of macroscopic objects. In the early

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Hadronic Nuclear Energy: An Approach Towards Green Energy

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Abstract: Nuclear energy is undoubtedly the largest energy source capable of meeting the total energy requirements to a large extent in long terms. However the conventional nuclear energy involves production of high level radioactive wastes which possesses threat, both to the environment and mankind. The modern day demand of clean, cheap and abundant energy gets fulfilled by the novel fuels that have been developed through hadronic mechanics / chemistry. In the present paper, a review of Prof. R. M. Santilli's Hadronic nuclear energy by intermediate controlled nuclear synthesis and particle type like stimulated neutron decay and double beta decay has been presented.

Keywords: Intermediate Controlled Nuclear Synthesis, Stimulated Neutron Decay

1. Introduction

The ever increasing demand for good quality of livelihood has ultimately culminated in increasing global energy demands. The demand can be met conventionally by either molecular combustion or nuclear fission. The former is achieved by combustion of fossil fuel or hydrogen which produces large amount of green house gases as well as depletes breathable oxygen from the environment. The latter does not generate green house gases or depletes breathable oxygen but creates large amount of radioactive wastes. Moreover, the shielding from the high energy ionizing and non-ionizing radiations is cumbersome and expensive. The handling of the highly radioactive wastes posses environmental as well as security threat. Thus, handling of these wastes requires great deal of safety requirements. There are several ways that are used to curb the either menace such as using better furnace design, improvising fuels and additives for molecular combustion or improvising fuel geometry and reactor design for efficient nuclear fission. In either case the perilous waste products are not completely eliminated. Although there are energy sources that have zero emissions like the energy harnessed from renewable sources like solar, wind, tidal, geo-thermal, wave, ocean-thermal and so on but are mainly time and location dependent. Hence cannot be universally employed for harnessing energy or power generation.

On the other hand, the nucleus of an atom has always been considered to be the source of unlimited energy since its discovery in 1911 by Ernest Rutherford [1]. The basic nuclear processes are of two types viz., fission and fusion. Both these processes generate large amount of energy which can be conveniently harnessed for useful work. The fission reaction is exoergic and criticality can be attained easily but fusion is endoergic and achieving criticality is comparatively difficult. Hence fission has been extensively explored for destructive as well as constructive work.

The unlimited source of the atomic nucleus due to fission process was initially exclusively exploited for destructive purpose. However, post World War II the focus shifted more towards constructive work. Attention was turned to the peaceful and directly beneficial application of nuclear energy. In the course of developing nuclear weapons the Soviet Union and rest of the Western world had discovered range of new technologies. Scientists also realized that the tremendous heat produced in the process could be tapped either for direct use or for generating electricity. It was also clear that this new form of energy had tremendous potential for the development of compact long-lasting power sources which could have various applications.

The world's first artificial nuclear reactor was Chicago Pile-1. It was a research reactor. Its construction was a part of the Manhattan Project. It was carried out by the Metallurgical

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Gamma Radiolytic Remediation of Aqueous Solutions of Malachite Green Dye

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Abstract— *Synthetic dyes are used in diverse industries as coloring matter. These dyes being structurally complex are non degradable and hence effective degradation and decoloration of dye waste without causing any harm to the environment is desirable. The conventional technologies that are currently available are inefficient and fail to achieve this feat. Ionizing radiations like gamma radiation have been considered a promising tool for complete decoloration of dye effluents without leading to secondary pollution. In the present study, the possibility of using gamma radiations to degrade and decolorize aqueous solutions of Malachite Green dye was investigated. Different systems of Malachite Green in aqueous solutions were irradiated using ^{60}Co as gamma radiation source at doses in the range 0.1 to 0.5 kGy at a dose rate of 0.386 kGy/hr. The corresponding change in absorbance, pH, conductance and the degree of decoloration were examined. The role of initial dye concentration, gamma radiation dose, effect of H_2O_2 on the rate and extent of decolorization was also explored.*

Keywords— decoloration, radiolysis, GC-900, decolorization, water radiolysis

I. INTRODUCTION

Various synthetic dyes are used as coloring matter for diverse applications. Owing to the perilous consequences of water pollution and global government regulations, it has become mandatory for the industries, to treat the effluents efficiently with respect to concentration of dyes before releasing them to main stream. Even the traces of dye have potential to significantly color the effluent. Thus, it is objectionable from both aesthetic as well as aquatic life point of view. The effluent released by industries that employ dyes, is characterized by strong color, high COD and wide range of pH [1]. The synthetic dyes are often suspected to be carcinogens [2]. Also the color decreases the transmission of sunlight into the water stream and thus reduces the photosynthetic activity. Since dyes usually exhibit high photo-stability, resistance to microbial attack and temperature, the large majority of these compounds are not degradable using conventional wastewater treatment techniques that include physical, chemical and biological processes such as adsorption, coagulation, membrane process and oxidation-ozonation [4-6]. However, these processes are inefficient to purify dye wastewaters, as they simply transfer the compounds from aqueous to another phase, thus causing secondary pollution problems [7-8]. Thus it becomes customary to degrade them without hampering the environment before they enter into main stream water sources as mostly the wastewaters from dyeing industries is directly discharged to waterways or to municipal sewage treatment plants. [9-11].

Hence the search for a powerful tool to decolorize and degrade dyeing wastewaters to decrease their environmental impact has been matter of utmost concern and priority over the past few years.

Recent studies has revealed that, most colored material undergo bleaching or decoloration when exposed to high energy ionizing radiations. Gamma irradiation can be considered as an alternative method [12]. Moreover the radiolytic degradation technique helps to overcome the environmental problems very efficiently specially to waste waters effluents from dye as well as colorant industries [13].

The present communication explores the possibility of decolorization of aqueous solutions of Malachite Green dye using gamma source, ^{60}Co.The structure of Malachite Green is shown Fig. 1.

Malachite green is used extensively as a dye for leather, wool, cotton, jute, paper, certain fibers, etc. Malachite green and its metabolites and breakdown products may not be completely removed by wastewater treatment and may be present in sufficient amounts in effluents from industry or waste water treatment plants or other sources.

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Nuclear Power in India: Viability of Thorium fuel utilization

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Abstract— *The ever-growing demand for energy has led to investigate various possibilities of using renewable sources of energy and other lesser explored energy resources. Power generation through radioactive materials have always been lucrative. Nuclear power generation mostly uses controlled chain fission process. Reactors widely use ^{235}U fissile fuel, whose fission releases energy and neutrons that maintain the chain reaction. However due to fast depleting uranium resources some alternative nuclear fuels are being explored. Thorium occurring naturally is another fertile element that can be converted to ^{233}U isotope by slow neutrons. ^{233}U (considered as third fuel) is the only other known fissile material ($T_{1/2}=1.59\times10^5$ y). Using ^{232}Th as a nuclear fuel has many advantages over conventional nuclear power reactors using ^{235}U or ^{239}Pu as fuel. Over the last four decades there has been interest in utilizing Th as a nuclear fuel since all of the mined thorium is potentially useable in a reactor, compared with the 0.7% of natural uranium in today's reactors, so some 40 times the amount of energy per unit mass might theoretically be available. In India, several reactors use thorium based fuels.*

Keywords— Nuclear Reactors, Fissile Fuel, ^{233}U, ^{232}Th.

I. INTRODUCTION

The ever-growing demand for energy has led to investigate various possibilities of using renewable sources of energy and other lesser explored energy resources. However, harnessing renewable energy resources like solar, wind, tidal, geo-thermal energy has their own disadvantages. For instance solar panels are costly and not suitable for all climates; flow of wind is periodic; barrages for tidal energy are expensive to build and disrupt shipping and so on.

Hence power generation through non-renewable energy sources like coal or petroleum oil is largely preferred. With fast depletion of fossil fuels other alternative has to be searched. Power generation through radioactive materials have always been lucrative. However, due to several safety and operational constraints nuclear based power generation is not as widely used in India as coal based power generation.

II. NUCLEAR ENERGY

The pursuit of nuclear energy for electricity generation began soon after the discovery that radioactive elements like radium released immense amounts of energy according to the principle of mass–energy equivalence. Short half lives of the radioactive elements made harnessing nuclear energy impractical till the discovery of nuclear fission.

Electricity was generated for the first time by a nuclear reactor (using fission reaction) on December 20, 1951, at the Experimental Breeder Reactor – I, near Arco, Idaho which initially produced about 100 kW.

Post World War II, the prospects of using nuclear energy for constructive work rather than destructive were greatly advocated to avoid complete control of military organizations on all nuclear research. In 1953, US President Dwight Eisenhower gave his *Atoms for Peace* speech at the UN, emphasizing the need to develop peaceful uses of nuclear power. This was followed by the 1954 Amendments to the Atomic Energy Act which allowed rapid declassification of U.S. reactor technology and encouraged development by the private sector.

Nuclear energy can be harnessed from both fusion and fission reactions.

2.1 Fusion energy

Nuclear reactions between nuclei of low mass number like p, ^2H, ^3H, ^3He and ^4He are exoenergic reactions. Such reactions fuel sun and stars. Sun emits electromagnetic radiation at rate of 4×10^{23} ergs/s and can continue at same rate for another 10^{11} years.

These reactions are brought about by accelerating one of the nuclei to obtain kinetic energy that can overcome coulombic barrier between reacting nuclei.

EXPERIMENTAL INVESTIGATION OF RADIOSTABILITY OF POLYVINYL CHLORIDE FOR SUITABILITY IN HIGH ENERGY APPLICATIONS

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Abstract

Today's scenario is dominated by many smart materials. Of them all polymers play a major role. Polyvinyl chloride (PVC) is the third most widely used polymer for various applications. In the present study it is intended to explore stability of the polymeric powder against gamma-radiation. Various parameters like viscosity, density of the polymeric solutions as a function of concentration as well as absorbed dose are investigated. Some spectroscopic studies such as infra-red and UV-visible spectroscopy were also carried out to have an insight of the changes taking place at molecular levels.

Keywords: Polyvinyl chloride (PVC), gamma-radiation, infra-red spectroscopy, UV-visible spectroscopy

Introduction

Materials science, an interdisciplinary field involves study of the properties of matter and its applications to various areas of science and engineering. Materials have been pre-dominant in advent of civilization as well as technology. The material of choice of a given era is often its defining point such as Stone Age, Bronze Age and Steel Age. Modern materials science involves understanding of various advanced materials like metallic alloys, silica and carbon materials, development of revolutionary materials such as plastics, semiconductors, polymers, biomaterials etc. However, of them all polymers play a major role in today's scenario. It is omnipresent in today's scenario from engineering to medicine to various other applications.

Literature Review