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INTERNATIONAL MEETING ON RADIATION CHEMISTRY AND PROCESSING

Brdička Days 1986
20 th Czechoslovak Meeting

Spa Mariánské Lázně
APRIL 21 - 25, 1986

ABSTRACTS

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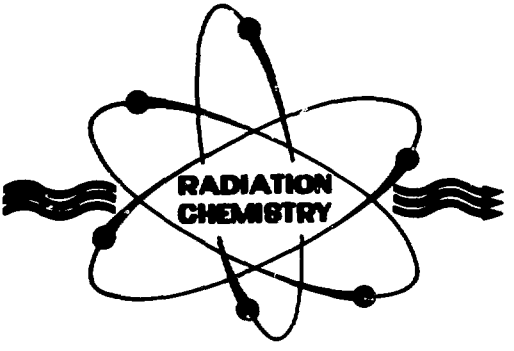

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UP-TO-DATE TRENDS IN DEVELOPMENT OF ELECTRON ACCELERATORS FOR RADIATION TECHNOLOGIES

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The development of various technologies and their wide applications in the industrial production advance new requirements for powerful electron accelerators intended to be used in industry.

On the one hand, there are the requirements to increase the energy and power of the accelerators and, on the other hand, to create special systems for beam extraction into the atmosphere which enables one to generate the irradiation field of necessary shape, thereby increasing the efficiency of the accelerators.

The report presents the data on the INP accelerators of 40 kW and higher power as well as the current works on the creation of accelerators at an energy of up to 3 MeV.

The systems of beam extraction into air, which have been designed at the Novosibirsk Institute of Nuclear Physics, permit one to perform both the three-side irradiation of long-size products such as tubes, hoses, cables, ect., and the two-side irradiation. Note that for the second case the system for conveying the irradiation products has been designed.

On the basis of the already created devices highly-efficient facilities are being built to irradiate cable and film products.

LINKING AND DISLINKING REACTIONS IN IRRADIATED POLYMERS

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The response of polymer material to high energy radiation is mainly determined by the reactions of crosslinking, end-linking and scission induced by radiation. A new approach is proposed for the explanation of the behavior of irradiated polymers, with an attempt of getting a better agreement with experimental data. The nature of each of the reactions and its influence on total changes is discussed separately for different absorbed doses, i.e. different degrees of radiation induced changes. Theoretical predictions are compared mainly with the experimental data obtained earlier and recently for different polyethylenes.

DOSIMETRY AND COMPUTER EXPERIMENTS IN GAMMA IRRADIATION UNITS

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Since 1976 a universal Co-60-irradiation unit of the PANORAMA type has been available at the Central Institute of Isotope and Radiation Research, Leipzig. The first radiation field evaluation was made by means of chemical dosimetry /Fricke, chlorobenzene/ and a simple calculation model.

Based on the comparison of the dosimetric results and the computer calculations the efficiency of the computer code was increased step by step. The resulting code DOSKMF2 offers many possibilities to evaluate real gamma irradiation facilities and to simulate new ones. In the case of the PANORAMA unit different configurations of the sources within the irradiation tubes were computed in order to determine the best way of carrying out the necessary charging and recharging procedures and a catalogue with grafic representations of typical irradiation configuration by means of the code ISORADL was prepared.

Based on this experience partial systems in gamma irradiation facilities of different types not only on a laboratory but also on an industrial scale were described and simulated. In real facilities the calculation results were combined in each case with experimental dosimetry.

STOCHASTIC SIMULATION OF PRIMARY PROCESSES IN RADIATION CHEMISTRY

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The stochastic simulation method for primary processes in radiation chemistry has been worked out. This method was applied to calculation of the ion recombination in nonpolar liquids. The ion recombination was simulated for the following systems : single isolated ion pairs, the ion clusters composed of two, three or four ion pairs, the short tracks of ionization composed of 20 to 50 ion pairs. The recombination kinetics and the escape probabilities at infinite time were computed for these systems.

The computer simulation method has also been applied to the problem of the trapped electron decay by tunnelling to scavenger molecules in low-temperature glassy systems. The influence of statistical dispersion of the potential barrier height on the tunnelling kinetics was examined. The possibility of the trap-to-trap tunnelling was investigated. The simulation method was also used to check the accuracy of some kinetic models of the electron tunnelling.

INVESTIGATIONS OF THE CHEMICAL EFFECTS OF IONIZING RADIATION IN THE SYSTEMS OF NUCLEAR POWER PLANTS

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Results of some experiments modelling radiation chemical processes in nuclear power plant systems are presented. A special attention is paid to the behaviour of various iodine compounds in the primary circuit coolant of the VVER reactor and formation of organic iodine forms in protecting barriers of nuclear power plants. The chemical transformations occuring in the case of a "loss-of-coolant accident" are discussed. The main radiation chemical problems connected with the operation of nuclear power plants are outlined.

THE MECHANISMS OF MACRORADICAL DECAY IN POLYOLEFINS

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In the course of last thirty years a number of the experimental results about structure and reactivity of macroradicals at post-radiation conditions in solid polymers were obtained, mainly by ESR technique. On the basis of these facts two hypotheses about the mechanisms of the macroradical decay have been formulated; first hypothesis preferring the migration of radical centre through chain motions and a second one preferring the chemical modes of migration /hydrogen transfers, β-scission .../. At present, however, detailed molecular mechanism of the migration stages of decay process is not known for most polymers.

Recently we have formulated the molecular aspects of macroradical reactivity from the point of view of physical processes, especially the chain dynamics and chemical reactions. In the framework of the model of diffusion - controlled reactions in condensed media at activation - energy level, acceptable mechanisms were suggested for transport stages of decay of alkyl macroradicals in polyethylene, isotactic polypropylene and polyisobutylene. It was found that a significant role is played by the conformational mobility without or with connection with intermolecular hydrogen transfer during approaching of macroradicals depending on temperature.

ELECTRONIC PERTURBATION INDUCED BY IONIZING RADIATION IN BIOLOGICAL MATTER

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In living matter, collective electronic excitations may appear as plasmons, excitons or solitons. Their physical nature is discussed briefly, and examples of their role in radiation chemistry and molecular radiobiology are suggested.

RADIATION-CHEMICAL REMOVAL OF NO_x BY ELECTRON-BEAM IRRADIATION OF EXHAUST GASES AND MODEL MIXTURES NO_x-N_2-O_2-H_2O IN GAS PHASE AT TEMPERATURES 298-523K.

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Experiments were carried out on radiation-chemical removal of NO_x /concentrations 100-500 ppm/ from exhaust gases by burning of propane and model mixtures NO_x-N_2-O_2-H_2O/concentrations of O_2 7-21 %, H_2O 2-10 %/ by electron-beam irradiation /energy 1,5 MeV, current 2-50 μA temperature 298-523 K/ in flow system /flow rate 0.02-5 Nm^3/hour/.

In the absence of irradiation the negative temperature dependence /temperature range 298-523 K/ of NO removal with effective energy of activation $E_a \approx -1.4$ kcal/mole was observed.

At low doses of irradiation /1-2 Mrad/ of exhaust gases and model mixtures an effective removal of NO and production of NO_2 were observed. The radiation-chemical yields G/-NO/ and $G/NO_2/$ are 5-6 molecules/100 eV at 80-100°C. When temperature increases to 523 K or reduces to 298 K G-values go down to half or a third of value.

At doses > 5 Mrad the radiolysis of N_2 and O_2 gives a noticeable contribution in production of NO and NO_2. At high doses /10-20 Mrad/ radiation-chemical method of NO_x removal from exhaust gases becomes noneffective.

INTRAMOLECULAR THREE-ELECTRON BONDS FORMATION IN METHIONYL HOMOPEPTIDES /di-L-Met/, /tri-L-Met/

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Three-electron-bonded sulphur-centred radical cations have recently gained prominence, as possible intermediates in electron transfer processes in biological systems e.g. peptides, expecially since these odd-electron species are unreactive toward molecular oxygen. In the present study we report the generation of three-electron-bonded species in methionyl homopeptides: methionyl-methionine /di-L-Met/ and methionyl-methionyl-methionine /tri-L-Met/.

Pulse radiolysis of 10^{-4}M di-L-Met and tri-L-Met, N_2O saturated aqueous solutions at pH $\sim$ 5 provided two transient absorption bands with maxima at 290 nm and 390 nm. A different spectrum is obtained for the corresponding solution at pH 1. The 390 nm band is now absent and instead a broad, rather intensive absorption is seen with maximum at ca. 480 nm. Similar absorption band was generated during Tl^{2+} - induced oxidation of di-L-Met and tri-L-Met at low concentration in both acid and slightly acid solutions. These results suggest the existence of two various three-electron-bonded radical cations: intramolecular sulphur-centred radical cation complex with absorption maximum at 480 nm, and intramolecularly formed S $\therefore$ N three-electron-bonded radical cation identified as transient intermediate with absorption maximum at 390 nm. All spectra include also a peak with λ_{max} = 290 nm attributable to α-/alkylthio/- alkyl radicals.

RADIATION-INDUCED TRANSIENT STYRENE SPECIES IN LIQUID AND GLASSY FREON-MIXTURES

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The optical absorption spectra of styrene transients generated by nanosecond electron pulses in a freon-mixture at room temperature and 77 K were observed and kinetically characterized.

For the pure freon-mixture a broad absorption spectrum between 320 and 650 nm with maxima at 320 and 330 nm formed during the 2 ns electron pulse was detected. From the decay kinetics the presence of different matrix species must be assumed.

In the presence of styrene in the glassy matrix the well known absorption peaks of the monomer radical cation $St^{\cdot +}$ at 350 and 630 nm appeared, while the absorption band of the dimer radical cation $^{\cdot}St\text{-}St^{+}$ could not be observed clearly.

In the liquid solution at room temperature the $St^{\cdot +}$ absorption immediately after the pulse almost completely disappeared, probably because of the very low viscosity of the liquid and the $^{\cdot}St\text{-}St^{+}$ peak at 460 nm appeared. Additionally, a very intense shoulder at 320 nm growing in after the electron pulse for styrene concentrations of $5 \cdot 10^{-3}$ and $1.5 \cdot 10^{-2}$ mol $\cdot$ dm^{-3} was observed.

From the kinetic analysis and the comparison with data on styrene transients in other irradiated solutions a reaction scheme was derived.

PRIMARY PROCESSES OF STABILIZER ACTION IN RADIATION-INDUCED ALKANE OXIDATION

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The paper deals with results of pulse radiolytic model experiments on the autoxidation of long-chain-n-alkanes and its retardation. In pure n-heptadecane and solutions of di-tert.-butyl-p-cresol or diphenylamine in it the reaction of alkyl radicals with oxygen and the corresponding competition reactions with the stabilizer prototypes are characterized by spectroscopic and kinetic data.

It was found that alkyl radicals formed form the $n\text{-}C_{17}H_{36}$ react selectively with the labile O-H and N-H bonds of the stabilizers. In contrast to that, H radicals react with these bonds as well as with the aromatic ring. In case of ϕ_2NH the radiation-generated triplet decays by H-abstraction form the solvent forming cyclohexadienyl type radicals only. Under our experimental conditions /40 ns, 100 Gy pulses of 1 MeV electrons, boosted analyzing light, time range up to 20 μs/ no reaction of alkylperoxy radicals could be observed.

A reaction mechanism describing the radiation-induced processes within the system long-chain-n-alkane /oxygen/ stabilizer is discussed. The reported results should serve as basis for the investigation of similar processes in polyolefin matrices.

NUCLEAR RADIATION SOURCES IN CHEMICAL TECHNOLOGY

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Chemical technology belongs to the most energy consuming branches of industry. The heat used to realize the endothermic processes is obtained mostly as a result of burning petroleum and natural gas. The resources of these nonrenewed energy sources being limited, in the USSR, USA, FRG and other countries the ways of using nuclear sources of energy /NSE/ instead of organic ones, are investigated. The principal adventages of NSE are not only the extremely high calorific value and breeding capability, but also the possibility of using simultaneously the heat and gamma-radiation of the radioactive wastes for radiation processing.

Research carried out in the USSR showed that the base of such combined use are uranium radiation contours, in which the nuclear fuel circulates between the core and the gamma--irradiator of commercial radiation unit. There have been developed the physical and numerical /Monte-Carlo/ methods to determine the parameters and the basis of designing of radiation chemical units, in which it is possible to use gamma-radiation of both long- and short-lived radionuclides-fission products. Gamma-power of such irradiators may amount to approx. 0. 3 % of the reactor thermal power and the economic effect of the radiation production is compared to the cost of heat generated by NSE. Due to this the NSE efficiency is greatly increased.

PRESERVATION OF STRAWBERRIES AND MUSHROOMS WITH 10MeV ELECTRON BEAM

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The influence of 10MeV electron beam and storage temperature after irradiation on the organoleptic properties of strawberries and mushrooms /champignons/ has been investigated. The content of sugars and ascorbic acid in strawberries has been also determined.

Strawberries were irradiated with the doses of 1.2 and 3 kGy while champignons with 1.5 and 2.5 kGy. No worsening of taste has been found in the samples, except of very little change in strawberries irradiated with 3 kGy.

All doses of radiation significantly retarded the growth of moulds and decomposition of sugars in strawberries stored at $+5^{\circ}C$ after irradiation.

The delay of ripening i.e. prevention of caps opening, and moulds growth have been observed in irradiated champignons, especially in those stored at $+10^{\circ}C$ after irradiation.

SOME PRESENT AND POTENTIAL DEVELOPMENTS IN RADIATION STUDIES

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The study of radiation effects has proceeded along several, often divergent lines. The first considers it as an important contribution to basic science, and as the subject of radiation chemists, leads to valuable new information on chemical reactions. Although new radiation processes may enlarge into technology, this is not the primary intention.

A different approach is found when there is a definite practical aim in view. Examples are the search for a radiation stable form of polypropylene, used in radiation sterilization, or the irradiation of rubber to improve its green strength and properties.

A third approach is to carry out research in fields where the aim is not clearly defined, but where past experience has shown as likely to yield products or properties of value.

One would hope to see these three approaches more together, but there remain considerable gaps. The researcher may not recognize a potential application of his work, the technologist may be unaware of the considerable advantages of radiation as an industrial process. International meetings are intended to bring them together informally, by presenting exemplex of applications being actively pursued, and by providing opportunities for informal discussions.

Recent examples of such applications are the modification of polymers by additives, orientation, pressure, fillers, senzitizers; the elaboration of new methods of crosslinking e.g. P.V.C; the search for new applications for grafted polymer; improvements of the environment /sewage, sludge, exhaust gases/; lithography; textiles; curing of surface coatings and especially food preservation. Associated with these are the availability of radiation sources for exploration, and the economics of radiation processing.

We must also attempt to familiarize, to the public at large, the potential large-scale benefits of high-energy radiation as an important industrial tool.

ALKYLATION AND FIMERISATION OF 2,6-SUBSTITUTED PHENOLS INDUCED BY 60 Co GAMMA RADIATION IN HYDROCARBONS

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The aim of this work was to find out whether a fixation of antioxidant of phenolic type on carbon skeleton of polyolefinic polymers is possible by ionizing radiation.

For this purpose we arranged following model experiments. We irradiated with gamma radiation/3,9 kGy/hr/ up to 100 hrs 0,1 M deaerated solution of 2-methyl-6-tert.butylphenol /I./ in isooctane. Using chromatographic analysis of irradiated solution, we found among products 2-methyl-4-/2,2',4,4'-tetramethylbutyl/-6-tert.butylphenol /II./ in relatively high conversion /30 %/. The latter compound was prepared by chemical synthesis for identification. Among products of above reaction we found also small yield of 3,3'-dimethyl-5,5'-ditert.butyl-4,4'-dihydroxydiphenyl /III./

Occurence of this dimeric product encouraged us to do these experiments in more suitable conditions-in nonreactive solvent-benzene. We irradiated under above conditions solutions of /I./ in concentrations 5,10,20 % in benzene and found by chromatographic analysis in different proportions depending on concentration of /I./ yields of diphenyl and /III./. Similar experiments were performed with 2,6-dimethylphenol /IV./ and 2,6-ditert.butylphenol /V./ in which we received dimeric products.

We propose the mechanism of alkylation and dimerisation reactions and measured the radiation yields of products.

In conclusion we can say that phenolic antioxidant in polymer matrix is not depleted by gamma radiation. Finally we confirmed the possibility of fixation of phenolic antioxidant on hydrocarbon linkage by gamma radiation.

THE PARTIAL YIELDS OF Cl^- IONS IN TWO-PHASE SYSTEMS WITH TRICHLOROMETHANE AND TETRACHLOROMETHANE

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The partial G-values of HCl at the radiolysis of CCl_4 - water and $CHCl_3$ - water systems indicate approximately double reactivity of organic phases in both unmixed systems at the high doses. The results from a short irradiation time are the same as the ones in mixed systems. The influence of thickness of reactive phase layer and its critical value are discussed. The results confirm the idea of diffusion as having a potential limiting role at the radiolysis of systems with two-liquid partitioning of substrates and being an important factor of radiation yield decrease in unmixed systems at higher doses and low solubility of substrates.

THE PARTIAL YIELDS OF RADIOLYTICAL PRODUCTS IN TWO-PHASE SYSTEMS WITH NITROBENZENE

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The importance of two-phase additivity rule for radiation yields on two-phase radiolysis of nitrobenzene-water /HNO_3, H_2SO_4 resp./ has been demonstrated. Total radiation yields of p-nitrophenol, m-nitrophenol, p-nitrosophenol, 2,4-dinitrophenol, 2,5-dinitrophenol, o-nitroaniline and o-, m-, p-aminophenols was determined.The data of partial radiation yields of these products indicated nitrobenzene phase to be several times more reactive than a water phase in respect of phenols and aniline formation. The probable mechanism of products formation is discussed.

THE EFFECT OF SOME ANTIOXIDANTS ON RADIATION CROSSLINKING OF POLYETHYLENE-VINYLACETATE

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The electron beam induced crosslinking of polyethylene-vinylacetate in the presence of two selected antioxidants - polymeric 2,2,4-trimethyl-1,2-dihydroquinoline /Flectol H D/S/ and N,N´-bis/3-/3´,5´-di-t.butyl-4´-hydroxyphenyl/ propionyl/ hydrazine /Irganox 1024/ was studied and compared with investigations of the equivalent polyethylene compounds. The effect of vinylacetate groups on crosslinking efficiency of mentioned copolymer was studied too. The method of swelling in hot xylene to estimate the crosslink density was perfomed to describe crosslinking process in irradiated samples. It is shown that both antioxidants used decreased crosslinking efficiency of irradiated polyethylene-vinylacetate compounds. The dependence of crosslinking rate decrease on concentration of vinylacetate groups was found only for compounds containing Irganox 1024. Higher thermo-oxidative stability of radiation-crosslinked polyethylene-vinylacetate was determined in the mixtures with the addition of Flectol H D/S.

RADIOLYSIS OF OXYGENATED AQUEOUS SOLUTIONS OF TYROSINE

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The aromatic amino acid tyrosine represents an essential part of many proteins and enzymes. With regard to the oxygen toxicity in biological systems the elucidation of the reaction mechanism of tyrosine with oxy-species is of special importance for radiobiology and radiation chemistry. Some of oxy-species, i.e. hydroxyl radical, OH, and superoxide anion, $O_2^{\cdot -}$, as well as hydrogen peroxide, H_2O_2, are formed under irradiation in oxygenated aqueous solutions. Therefore the study on the effect of oxygen on the radiolysis of tyrosine has been undertaken. In the gamma radiolysis the decomposition yield of tyrosine and yields of 3,4-dihydroxyphenylalanine /DOPA/ and hydrogen peroxide were determoned in the pH range 1 - 10. By using the pulse radiolysis technique the reaction of tyrosyl radical, TyrO; with O_2 and/or $O_2^{\cdot -}$ radical was investigated. It was found that TyrO$^{\cdot}$ radical is relatively unreactive with oxygen, $k \leq 2 \times 10^5$ mol^{-1} dm^3 s^{-1}, whereas the reaction TyrO$^{\cdot}$ + $O_2^{\cdot -}$ is almost diffusion controlled. On the basis of results obtained and taking into account the previous findings on this subject the mechanism of tyrosine radiolysis in the presence of oxygen has been discussed.

RADIATION-CHEMICAL ASPECTS OF CHEMISTRY ON PRECAMBRIAN EARTH AND IN COMETARY NUCLEI

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Ionizing radiation was one of energy sources for chemistry in the hydrosphere of our early planet. Some geological arrangements of uranium and water, known as natural nuclear reactors, could have been particularly important sites of free radical-promoted chemical processes. Cosmic rays and radiations of radionuclides embedded in icy cometary material are suitable sources of energy for cometary chemistry.

We examine the types of radiations involved, possible irradiation conditions and inventories of absorbed doses.

We present some experimental results on aqueous systems /liquid and frozen, kilorad - multimegarad doses/ and review some findings of interest to chemistry on the primitive earth and chemical alterations of pristine cometary material, which we have given in more detail elsewhere /Precambrian Research /1983/, 20,283-298; Icarus /1984/ 60,464-475; Adv.Space Res. /1984/, 4,115-119; J.Mol.Evol., /1985/, 22 /.

A better understanding of Precambrian earth and cometary nuclei stimulates the examination of the role of ionizing radiation, particularly in promoting the chemistry in multicomponent aqueous systems in a large range of temperatures, LET, absorbed doses and dose rates. We believe that such studies merit more attention than presently given.

STATISTICAL THEORY OF CROSSLINKING AND DEGRADATION OF POLYMER CHAINS IN THE PRE-GEL AND POST-GEL STATES

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The crosslinking and degradation processes in a collection of polymer chains caused, e.g., by radiation are usually described by integro-differential equations /Saito-Inokuti/ which are based on the assumptions of constant rates of scission and crosslinking and proportionality of the scission probability to the degree of polymerization of chains. Therefore, the validity ot this approach is limited to low degrees of scission and crosslinking and to high degrees of polymerization of primary chains. In this contribution, the theory of branching processes based on the tree-like model of Flory and Stockmayer and employing cascade substitution and the formalism of probability generating functions has been adapted to cover both degradation and crosslinking. The random degradation and crosslinking of discrete and continuous degree of polymerization distributions has treated and extended to include more complicated mechanisms such as bond scission in systems obtained by endlinking of telechelic polymers and crosslinking induced by degradation. The effect of deviations caused by the approximations used in the Saito-Inokuti approach have been analyzed. The theory of branching processes has been extended to cover the structural changes beyond the gel point such as sol fraction, and parameters determining the equilibrium elasticity of the networks - the concentration of elastically active network chains and the cycle rank. All postgel parameters can be derived from the extinction probability, easily obtained from the weight-fraction distribution function of primary chains.

ESR STUDIES ON THE GAMMA IRRADIATION OF MODIFIED POLYPROPYLENE

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Gamma irradiation of polypropylene /PP/ modified by radiation chemical grafting was investigated by electron spin resonance. PP films with about 100 % grafting yield of vinyl acetate, 4-vinyl pyridine, N-vinyl pyrrolidone and acrylamide were irradiated in air at room temperature and investigated by ESR. The concentration of free radicals trapped at room temperature in each of these graft copolymers was much less than that found in the PP homopolymer irradiated to the same dose. The rate od decay of the residual free radicals was almost the same as in PP except in the PP-acrylamide graft copolymer in which the radicals decayed much faster. The results are discussed in view of free radical mechanism of the oxidative degradation of irradiated PP and the possibility of its stabilization by radiation chemical grafting of a suitable monomer.

RADIATION DESTRUCTION OF CELLULOSE. EFFECT OF THERMAL AND MECHANICAL ACTION

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The effect of irradiation, thermal and mechanical action on the destruction of cellulose has been studied. It was shown that preliminary thermal treatment does not affect the radiation destruction. At the same time preliminary irradiation intensifies the process of thermal destruction. The following equation connecting the number of the breaked bonds S with the absorbed dose D has been obtained:

$$S = S_o + \alpha G.D$$

where S_o and $\alpha (>1)$ are coefficients and G yield of destruction equal to 7.0 ± 0.3. Acceleration of thermal destruction of cellulose after irradiation is connected with formation of new active chemical groups in cellulose, reducing thermal stability of polymers.

Mechanical milling of cellulose leads to amorphisation. Increasing of amorphous phase reduces yield of destruction. Quantitative regularity of mutual influence of milling and radiation at physico-chemical state of cellulose was determined.

Influence of combined methods of treatment on hydrolysis in aqueous solutions was also studied.

RADIATION PRODUCED HYDROPHYLIC GELS AS CARRIERS FOR IMMOBILIZED CELLS AND ENZYMES

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Hydrophylic gels were obtained by irradiation polymerisation, crosslinking and grafting in aqueous solution of acrylamide and other hydrophylic monomers.

The dependence between structure of the carrier microcells or enzymes and substrate was investigated and correlated with the stability and efficiency of immobilized product.

Results concerning immobilisation of enzymes like catalase, amiloglucozidase and cells like saccharomyces cerevisiae and Streptomyces sp. are briefly presented.

MULTIPURPOSE TECHNOLOGICAL GAMMA IRRADIATOR

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A description of the design, construction and operation of the 10 000 Ci - gamma irradiator is given.

Various possibilities to use the facility for research and/or semi-industrial production purposes are analysed.

The main features declared and explained are:

1. Variation of dose and dose-rate within a large range - 2 and 3 orders of magnitude.
2. Irradiation geometry adaptable for materials thick up to 200 mm.
3. Continuous transportation of processed materials.

EXCITON-QUANTUM STATES OF SMALL SEMICONDUCTOR CLUSTERS PART II - RADIATION CHEMISTRY OF "Q-STATES" PARTICLES

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By reducing the size of the semiconductor charge carrier, the existence of "excitons" at room temperature has been demonstrated. Extremely small particles of colloidal semiconductors were prepared in aqueous and alcoholic solution. These particles exhibit unusual optical properties /Q-state material/. The absorption spectrum contains a maximum which is attributed to the transition of an electron from the valence band to the exciton state. While this optical transition can be observed for the macrocrystalline materials only at liquid helium temperature, it is seen for the small particles already at ambient temperature! With decreasing size, the absorption band shifts towards shorter wavelengths, i.e. particles of different size can be recognized by their optical absorption. Under certain conditions of precipitation, where Ostwald ripening is suppressed, colloids with an absorption spectrum containing several maxima are obtained. The maxima are attributed to the exciton transitions in particles of different size. The sizes producing the maxima correspond to "magic aglomeration numbers" in the size distribution of the colloid. The fluorescence ot the exciton and of trapped charge carriers was also observed. The fluorescence bands shift towards shorter wavelengths with decreasing particle size.

Pulse radiolysis was used to determine the size of the particles making use of the diffusion controlled reaction of OH radicals with particles that contain S^{2-} or P^{3-} as anions. Further, the absorption spectrum of the product of oxidation by OH was observed. Is has a broad band in the visible or near infrared. The product is thought to be a positive hole trapped at the surface. The anodic corrosion of semiconductors is a great problem in electrochemistry. Pulse radiolysis may help to elucidate the mechanism of corrosion. The absorption of

the trapped hole is thought to be brought about by the transfer of an electron from S^- or P^{2-} into an unoccupied electronic level of the semiconductor particle. With decreasing particle size, the absorption band of the hole is blue-shifted as the electronic levels in the particle are shifted to higher energies. Oxygen was found to react with the trapped positive holes in sulfide and phosphide semiconductor particles.

THE INFLUENCE OF IONIZING RADIATION ON SOME PHYSICO-CHEMICAL PROPERTIES OF VARIOUS SORTS OF RUBBER

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The influence of nuclear radiations / γ ^{137}Cs/ in a range of doses of 0-27 Mrad and at a dose rate of 6.10^4 rad/h, upon elongation, resistance to tearing, mode of elasticity, as well as upon the following electrical units- ε , tg δ , and breakdown resistance is studied: for three kinds of synthetic rubbers made up of binary and ternary polymers: KSM /ethylene and propylene/, LDS /acrylonitrile-butadiene/; GP_4 /butadiene-acrylonitrile and PVC/ and a sort of natural rubber FBE. The structural changes ellicites were pointed out by means of infrared assays.

By discussing the experimental results, some conclusions upon the possibilities of utilisation of these polymers as materials in the nuclear power plants are drawn.

A mechanism of radiochemical transformation of the polymers studied is also suggested.

RADIOLYSIS AND PULSE RADIOLYSIS OF CHLORINATED PHENOLS IN AQUEOUS SOLUTIONS

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As a consequence of the fast industrial development and the enhanced application of various chemicals /e.g. chlorinated pesticides etc./ in the modern agriculture, the purification of drinking water and wastewater becomes of increasing importance. The radiation technology is receiving widespread attention for the solution of such environmental problems. Chlorinated phenols were used as model compounds. The decomposition of 2-, 3- and 4-Cl-phenols under steady state conditions was studied in aqueous solutions saturated with argon or with air as a function of the employed dose. The spectroscopic and kinetic characteristics of the transients formed in deoxygenated aqueous 2-Cl-phenols at various pH were obtained by pulse radiolysis technique. Probable reaction mechanisms were presented.

THE PULSE RADIOLYSIS OF THE LEUCOCYANIDE OF MALACHITE GREEN DYE IN SOME POLAR SOLVENTS

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The transient absorption spectra observed in pulse radiolysis of the leucocyanide of malachite green dye MGCN in some polar solvents are ascribed to $MGCN^{\cdot}$ radicals, $MGCN^{+}$ radical cations and MG^{+} carbonium ions. $MGCN^{+}$ is relatively unstable in most of the solvents and could be seen only in nanosecond time region.

In the presence of low concentration of oxygen the oxidation of $MGCN^{\cdot}$ radical to MG^{+} carbonium ion occurs. The mechanism of this process has been investigated in methanol, n-propanol and 2-propanol solutions. There is an experimental evidence that reactions of peroxyl radicals derived from alcohols play a crucial role in the mechanism of an additional MG^{+} formation.

RADIOLYSIS OF AQUEOUS SOLUTIONS REMOVING I_2 and CH_3I IN NUCLEAR POWER PLANTS

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Two kinds of aqueous solutions, containing either H_3BO_3 + $Na_2S_2O_3$ + NaOH or H_3BO_3 + N_2H_4, designed for the removal of I_2 and CH_3I in nuclear power plants, were irradiated under both static and dynamic conditions. The dependence of the concentration decrease of the efficient components of these solutions, i.e. $Na_2S_2O_3$ and N_2H_4, on the absorbed dose, dose rate and temperature was investigated. The yields of some radiolytic products of these compounds were determined. The solution containing $Na_2S_2O_3$ has a higher temperature and radiolytic stability and reacts more quickly with CH_3I than the solution with N_2H_4.

DETECTION OF LOW - AND HIGH-LET RADIATION WITH ALANINE

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Our research and postal calibration- and intercomparison services have shown that alanine is very useful as a dose meter as it is cheap, robust and stable in response. The response to irradiation is monitored by means of a non-destructive ESR-technique enabling the dose meter to be kept for documentation purposes and further used as a secondary standard and as an integrating dose meter. Alanine is suitable for use in high-LET dosimetry as it closely fits the theory of track structure, which predicts relative effectiveness for high-LET radiations. The number of radicals formed is found to be proportional to the radiation dose over more than four orders of magnitude independent of the radiation quality. The useful dose range for low-LET radiation is from 0.5 to 10^5 Gy with a standard deviation as low as 0.5 % with optimal read-out. Experimental and theoretical work on the use alanine for monitoring low- and high-LET radiation will be presented.

TECHNOLOGICAL ASPECTS OF RADIATION CROSS-LINKING OF CABLES AND TUBES WITH ELECTRONS

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At the cross-linking of cables and tubes with high energy electrons technologies of multiple irradiations have to be applied in order to guarantee sufficient dose values in the absorbers. The main criterions for such technologies are the homogeneity of dose within the absorbers as well as the attainable productivities. Under those points of view the irradiation technological aspects are discussed on the example of cables and tubes. A special process for the simultaneous cross-linking of cables and tubes is presented which improves the homogeneity of the dose distribution within the absorbers as well as the total productivity of the process.

ELECTROCURTAIN® TECHNICAL CENTER IN GENEVA

B. Hugelin

Energy Sciences International, 109, rue de Lyon, CH-1211 Geneva, Switzerland

When the first low energy electron accelerator with linear cathode came on the market, 15 years ago, only few people were able to predict its impact on the paper, film, plastic converting industry. The possibility offered to potential customers to evaluate the process and develop new products with unigue properties with the help of the ELECTROCURTAIN® TECHNICAL CENTRES operational in Woburn, Mass. /USA/, Geneva /Switzerland/ and Tokyo /Japan/, was certainly a major reason for this success. These facilities allow the selection of the correct EB formulation, the adjustment of the curing parameters and the choice of the best suited application method.

A selection of possible applications in relation to the description of the facilities in Geneva consisting of a versatile coating and laminating machine equipped with a 90 cm wide Electrocurtain-Processor shall be presented in the paper.

SYNERGETIC EFFECTS IN THERMO-IRRADIATED POLYETHYLENE

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The experimental studies have put into evidence a powerful synergism in the thermo-radiation degradation of low density polyethylene. For the thermal degration an oven with appropiate form and parameters has been built up.

The irradiations have been carried out with a γ-^{137}Cs equipment, M-38-2, produced by Radiation Machinery Corporation, New Jersey, of 1600 Curie at a dose rate of 4.6×10^{4} Rad/h. The evaluation of the changes produced in aged polyethylene has been made by the following methodes: elongation, I.R. spectroscopy, radiothermoluminescence and crystallinity degree. The analysis of the experimental data indicates that the elongation and the concentration of carbonyl groups can be used as equivalent parameters in apprecation of thermal, radiation and thermo-radiation aging of polyethylene, which is largely used as an important material in nuclear power plants.

A FILM-DOSIMETER-SYSTEM FOR HIGH DOSE DOSIMETRY OF IONIZING RADIATION

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K.Knabe[+]

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The development of a film-dosimeter-system for the measurement of ionizing radiation for science and processing was initiated from international trends of high efficient high-energy irradiation.

The paper in hand shows the possibility to utilize a special PETP-film /DT 2500, producer: ORWO Wolfen/ for dosimetrical purposes up to 2,500 Gy by prescribing a measurement technique using an especially developed evaluating device ORWO-Raytape-Reader /RTR-3/.

As dose-equivalent measure serves the light absorption measured at 330 nm.
After irradiation the film is thermally aged at 120 ^{o}C for five minutes or for 24 hours at ambient temperature. Fading well-known for PETP, is after that process compensated in such a way, that the films show a value of transmission, which remains constant during storage.

EFFECT OF RADIATION ON CHEMICAL FORMS OF IODINE SPECIES IN RELATION TO NUCLEAR REACTOR ACCIDENTS

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Behaviour of radioactive iodine is one of the largest concerns in the recent estimation of the "source term" at nuclear reactor accidents. In this study the effect of radiation on chemical iodine forms was examined by the product analysis and pulse radiolysis techniques. The 10^{-4}, 10^{-5} and 10^{-6}M solutions of CsI were irradiated at ambient temperature with gamma rays from a cobalt-60 source, and analysed for iodine species, H_2O_2, O_2 and H_2 as radiolysis products. It was found that I^- is more or less oxidized to I_2/HOI/ and IO_3^- by radiation, but the reactions strongly depend on the initial concentration of CsI. In all cases the yields of I_2 /HOI/ and IO_3^- levelled off after small doses of radiation, and this is considered to be due to a subtle balance between oxidation and reduction of iodine species. Hydrogen peroxide produced by radiolysis was found to play an important role, being involved in the oxidation-reduction reactions.

Pulse radiolysis experiments were carried out to measure the rate constants of the relevant important reactions including the reduction of I_2 with O_2^-. It has been reported in the literature that the oxidation reaction of I^- with OH is better explained by postulating an intermediate of IOH^-. The present study showed that is does not seem necessary to assume the intermediate species IOH^- in the oxidation reaction at least in neutral solutions.

PHASE TRANSFORMATION OF IONIC SALTS IN NUCLEAR REACTOR RADIATION FIELD

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The development of the reactor grade temperature standards exploiting the steep electrical conductivity jump at the phase transformation /melting/ has emphasized the importance of a thorough investigation of the reactor irradiation impact on the ionic compounds behaviour. For the irradiation studies, the miniature glass sensors charged by HgI_2 were developed. The temperature dependence of the electrical conductivy was studied with two sets of thermocouples. The conductivity jump at melting was investigated in detail, in order to ascertain any deviation from the usual process in absence ot the irradiation.

In course of the long term in-pile measurements several hundreds curves were obtained and evaluated. On the whole, 24 ionic temperature detectors, armed with 30 thermocouples were irradiated in light water reactor /10 MWs/. The maximum fluence level was $2.6.10^{20}$ n/cm^2 of the thermal and $4.8.10^{20}$ n/cm^2 of the fast neutrons at the melting temperature 256.0 ± 0.3 ^{o}C. The slope of the conductivity jump was not changed at all, while the exact position of the jump inflection point versus temperature axis is influenced by the overall irradiation flux /or immediate reactor power/ in a regular fashion. The correction for this phenomenon is suggested in a form of simple equation. The effect is caused by the heat production on the structural sensor materials and in the mass of HgI_2 itself. Besides that, no indication of the other irradiation influence on melting was observed. A comparison with calculated heat balance is briefly discussed.

ELECTRON BEAM IRRADIATION OF POLYETHYLENE IN MULTILAYER FORM

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The changes of the dose-depth profiles of multilayer polyethylene films irradiated with pulsed 1.8 MeV electron beam at current density of the order of mA/cm^2 were studied.

The samples were in the form of film stacks with and/or without air between polymer layers. The dose-depth profiles determination was performed for different film thickness. The absorbed dose was estimated by crosslinking efficiency.

Range shortening effect was disscussed in terms of "oxygen effect" and charge deposition model.

RADIOLYTIC STUDY OF THE ANTIOXIDANT ACTIVITY OF VITAMIN E

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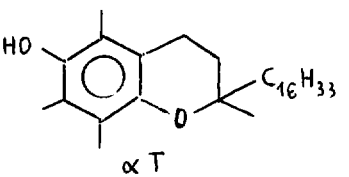
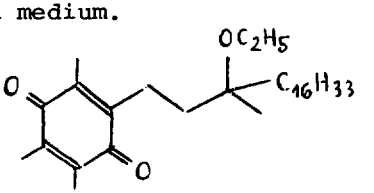
α tocopherol / α TH/, the most important component of vitamin E, plays biologically an antioxidant role by preventing the membranes from peroxidation.

γ radiolysis of aerated α tocopherol ethanolic solutions was performed for different concentrations of the solute. The results analysis leads to admit that α tocopherol with H_3C - - CH (OH) - OO$^\bullet$ ($RO_2^\bullet$) radicals giving $\alpha T^\bullet$ radical ($k_{\alpha TH + RO_2^\bullet} = 9.1 \times 10^4 mol.^{-1} 1.s^{-1}$). $\alpha T^\bullet$ disappears in our conditions, rather by disproportionation ($k_{\alpha T^\bullet + \alpha T^\bullet} = 1 \times 10^4$ mol.$^{-1}$1.s^{-1}) than by reaction with $RO_2^\bullet$ ($k_{\alpha T^\bullet + RO_2^\bullet} = 2.5 \times 10^6$ mol.$^{-1}$ 1.s^{-1}). The obtained intermediate αT^+ reacts with ethanol and leads to a single stable product αTOC_2H_5 (λ_{max} = 242 nm, ε = 8600 1.mol^{-1}. cm^{-1}) which can be converted into α tocopheryl quinone by nucleophilic substitution in aqueous acid medium.

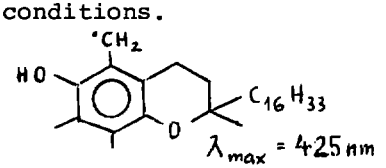


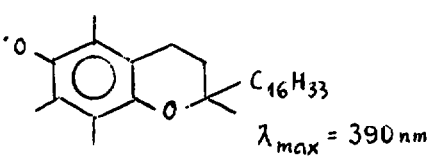
αT



αTOC_2H_5

Pulse radiolysis of O_2 and N_2 saturated ethanolic solutions of tocopherol was performed with high doses /230 Gy/ and low doses /5 Gy/. Two different radicals were observed according to the conditions.





TH seems to be therefore an efficient $RO_2^\bullet$ radical scavenger.

THE EFFECT OF OXYGEN ON THE RADIOLYSIS OF TRYPTOPHAN IN ACID MEDIA

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The effect of oxygen on radiation induced decomposition of tryptophan in aqueous solution at pH 2 was investigated. In the gamma radiolysis the decomposition yield of tryptophan and the yield of hydrogen peroxide were determined. The reactions of tryptophan radical cation, $Trp^{+}_{\cdot}$, with O_2 and/or HO_2 racicals, and with H-adducts, .TrpH, and corresponding peroxy radicals, $TrpHO^{\cdot}_2$, were studied by pulse radiolysis technique. By varying the initial concentration of tryptophan in irradiated solutions HO_2 and .TrpH radicals were produced in different yields. At low initial tryptophan concentration the only reactive species produced were $Trp^{+}_{\cdot}$ and HO_2 radicals. At higher concentrations, due to the competition of tryptophan and oxygen for H atoms, .TrpH radicals are formed at the expense of HO_2 formation. It was found that $Trp^{+}_{\cdot}$ radical is relatively unreactive with oxygen, $k \leqslant 5 \times 10^4$ mol^{-1} dm^3 s^{-1}, whereas the reaction Trp^{+} + HO_2 is very fast, $k = 1 \times 10^9$ mol^{-1} dm^3 s^{-1}. One the basis of results obtained the reaction mechanism of the radiolysis of tryptophan in the presence of oxygen is discussed.

RADIATION REDUCTION OF NITRATE IONS IN CONCENTRATED AQUEOUS SOLUTIONS AND IN NITRATE GLASSES

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The yields of radiation reduction of nitrate ions in concentrated aqueous, liquid and frozen solutions as well as in nitrate glasses of MeI - MeII type have been determined.

In concentrated solutions two effects: direct and indirect one have been distinguished. It has been shown that the yield of both direct and indirect effects have been affected by the phase type: liquid - glassy - polycrystalline and by the form of the ions occurring in the examined systems. The type of dependence $G/H_2O_2/$ vs. the nitrate concentration implies the direct connection between the hydrogen peroxide formation and the free, unbonded water molecules.

The absorption spectra of ion-radicals formed in gamma irradiated nitrate glasses and in frozen aqueous glassy solutions have been studied and the mechanism of radiation - chemical processes has been elaborated.

DESTRUCTION OF PHENOL AT LOW PHENOL CONCENTRATION BY ULTRAVIOLET LIGHT AND GAMMA RADIATION

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This investigation is about the destruction of phenol in 2×10^{-5} and 10^{-4}M aerated aqueous solutions of phenol by UV light and gamma radiation. The destruction is followed by the optical spectrum of the total final products absorption. Neutral and acid /10^{-3}N - 5×10^{-2}N - H_2SO_4/ solutions are investigated. It is found that sulphuric acid accelerates more then two times the destruction. The acceleration dependes on the sulphuric acid concentration.

NATURE OF THE ELECTRON - AND GAMMA-INDUCED RADIATION EFFECTS IN POWER SILICON SEMICONDUCTOR DEVICES

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The nature and kinetics of various radiation defects formation and disappearance in power silicion devices is studied with respect to the different effects of high-energy electrons and γ radiation. The mechanism of the predominant defects formation is briefly described and the role of various defects /namely A-centres, E-centres, and divacancies/ on the carrier lifetime reduction is discussed. The advantages and shortcomings of electron /4 MeV/ and ^{60}Co γ irradiations, as demonstrated by the experimental results, are shown and their probable physical explanation is proposed.

THE EFFECT OF ANTIOXIDANTS ON THE MELTING BEHAVIOR OF GAMMA IRRADIATED POLYPROPYLENE

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Differential scanning calorimetry /DSC/ and optical spectroscopy have been used for studying the effect of gamma radiation on the melting and crystallization behavior of isotactic polypropylene /Himont PP Flake/ containing various amounts of antioxidants. Two types of antioxidant were chosen: the primary Irganox 1Ø1Ø, Ciba Geigy, /A5/ and the secondary LDTP, American Cyanamid, /A3/. Samples of pure polymer /without additive/ and with 1 and 3w% A5 or A3 were irradiated in air, at room temperature, in a Co-6Ø source at 14 kGy/h up to 1ØØ kGy absorbed dose. The systems and the condition of irradiation have been chosen having in mind the need and problems of radiation sterilization of medical devices.

The calorimetric measurements were performed within three days after irradiation. Two main characteristics of melting behavior of samples have been measured: the melting temperatures and the heat of fusion. In all systems studied both decrease with the increasing absorbed dose. However, the presence of antioxidant diminishes the effect. This finding is in agreement with our measurements of spherulite size by optical microscopy. The influence of the antioxidants on the melting behavior and morphology of the irradiated iPP is discussed on the basis of optical microscopy measurements.

PENETRATION OF AN ELECTRON BEAM INTO THE POLYMER AND DISSIPATION OF ENERGY

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The communication concerns a theoretical calculation of energy dissipation of a focussed electron beam of fast electrons /primary energy 5-25 keV/ into the polymer. The calculation is founded on a combination of Bethe´s energy loss theory and of the space distribution of electrons penetrating into the solid material using the multiple scattering theory as formulated by Molière and others. This theoretical approach was numerically applied /DOSE programme in the FORTRAN IV lanquage/ to the calculation of energy losses along the electron paths during passage through poly/methyl methacrylate/ and for determination of the dependence of dissipated energy on the penetration depth, for a primary beam having the energy 5.15 and 25 keV. Using an analysis of these dependences, it was possible to evaluate the dependence of the position of the nucleus of interaction volume in the polymer on the energy of the primary beam. Correctness of the results obtained, which hold for the forward scattering is confirmed by a comparison of the electron range as an energy function determined by the procedure just mentioned and by means of Grün´s empirical relation. The effect of back scattering has been considered approximatively when determining the neck width of the interaction volume on the sample surface. The theoretical results reported here are used in an interpretation of experimental findings concerning the interaction between the electron beam and polymers in a scanning electron microscope and in the electron lithography process.

MECHANISM AND KINETICS OF PRIMARY PROCESSES INDUCED BY IRRADIATION OF NONCRYSTALLINE SOLIDS

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Fundamental radiation induced processes are described according to their time scale: electron localisation and solvation, electron tunneling, reactions of H, OH and other radicals.

The mechanisms responsible for the above processes are discussed. They include : relaxation of trapped species by multiphonon emission, tunneling, CTRW model as developed in this Institute.

The validity of these mechanisms is illustrated by examples for aqueous and alcohol glasses as well as polymeric matrices.

The latest developments and perspectives of future basic research in radiation chemistry are discussed.

TRANSMISSION LOSSES IN γ-IRRADIATED PCS OPTICAL FIBERS

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[+]Institute for Research, Production and Application of Radioisotopes, Prague, Czechoslovakia

PCS /polymer-coated-silica/ optical fibers produced in Czechoslovakia were irradiated with ^{60}Co γ rays at various γ dose rates. In source of irradiation the tranmission losses at first increase very rapidly, pass trough a maximum, and then slowly decrease and finally reach a constant value, close to the original value of tranmission. Fibers treated in this way exhibit an improved radiation stability towards further irradiation. The mechanism of these effects is discussed in terms of the refractive index changes and space-charge formation in the irradiated fibers. The possibility of the use of these effects in the high-dose γ dosimetry is discussed.

THE RADIATION AND QUANTUM YIELDS OF Cl^- IN CHLOROBENZENE, CARBON TETRACHLORIDE AND WATER TWO-PHASE SYSTEMS

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In this study the radiation-chemical and quantum yields of Cl^- ions in the chlorobenzene-water and carbon tetrachloride-water systems have been investigated.

At the γ-radiolysis of unstirred two-phase systems the dependence of total radiation-chemical yields of Cl^- ions on the partial volume of phase II /organic phase/ has been examined. From this dependence partial yields $G/Cl^-/$ and $G/Cl^-/$ for water and organic phase respectively have been calculated.[1,2]

In the water-carbon tetrachloride system radiolysis ${}_{I}G/Cl^-/ = 10.5 \pm 0.5$ and for organic phase ${}_{II}G/Cl^{-1}/ = 7.0 \pm 0.6$.

In the case of water-chlorobenzene system radiolysis both phases were equally reactive: ${}_{I}G/Cl^-/ = 1.02 \pm 0.02$ and ${}_{II}G/Cl^-/ = 1.28 \pm 0.05$.

The linearity of both dependences enables us to assume that radiolytic processes in investigated two-phase systems under given irradiation conditions follow a kinetic regime.

Likewise the dependence of total radiation-chemical yield of Cl^- on the composition of phase II has been examined in the radiolysis of two-phase water-nitrobenzene-carbon tetrachloride, or water-chlorobenzene-carbon tetrachloride systems under both air saturated and N_2-bubbled conditions. The influence of HNO_3 on the total radiation-chemical yields of Cl^- ions has been investigated.

In the photolysis / λ = 254 nm/ of two-phase water-carbon tetrachloride system at irradiation of organic phase only the average quantum yield of formation Cl^- ions was $\phi_{Cl^-} = 0,89 \pm 0,04$, at the photolysis of saturated solution CCl_4 in water $\phi_{Cl^-} = 18.9 \pm 5.6$.

In the photolysis of water-chlorobenzene system the quantum yield on irradiation of organic phase was $\phi_{Cl^-} = 0.14 \pm 0.01$ and for the saturated water chlorobenzene solution $\phi_{Cl^-} = 0.56 \pm 0.03$.

/1/ F.Macášek, R.Čech, Radiat. Phys. Chem., 23, 473 /1984/
/2/ F.Macášek, Radiat. Phys. Chem., 23, 481 /1984/

FOOD IRRADIATION IN BELGIUM
THE PLANTS OF THE "INSTITUT NATIONAL DES RADIOELEMENTS"

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Institut National des Radioéléments - 6220 Fleurus Belgium

Food irradiation on a commercial scale has certainly got off on a strong footing in Belgium.

As in most countries food irradiation legislation in Belgium is very clear: it authorizes radiation treatment for research purposes but the industrial use of the process and the sale of irradiated food is subject to a prior authorization by the Belgian Ministry of Public Health on the basis of a complete scientific dossier.

With the aim of promoting ionizing radiations, the Institute of Radioelements /I.R.E./ and in particular its MEDIRIS department, with the help of Belgian experts, have prepared a serial of food files conforming to the International Project in the Field of Food Irradiation recommendations.

The activities led to ministerial approvals authorising the irradiation of foodstuffs.

Following the clearances and for 1985, Mediris has irradiated with its two cobalt 60 gamma plants /source strength: 2.10^6 curies/ 4000 tons of feed.

RADIATION INDUCED CLEANING OF EXHAUST GASES - CURRENT STATUS, PROSPECTS AND TASKS TO BASIC RESEARCH

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Results about radiation induced oxidation of SO_2 and NO_x in stack gases and of toxic or bad smelling compounds like captans were studied in various laboratories. Pilot plants treat exhaust gases in steel industry in Japan and in coal-fired power stations in USA by means of electron accelerators. At doses of some Mrad´s SO_2 and NO_x could be decreased simultaneously by a factor of 10^{δ} . The advantage of that technology might be lower costs in comparison with other ones. However the application to large coal-fired power stations is limited by the needed accelerators capacity because due to a G-value of 15 about 3 - 5 % of the produced electrical power has to be converted into beam power.

Therefore the improvement of the energetical yields of the radiation induced ocidation or degradation reactions is the point for future development. There are needs in more detailed knowledge about the radiation chemistry in gas systems related. A promising way might be the use of electromagnetic fields to increase G-values remarkably. Versions of combined radiation technologies are introduced and discussed.

INDUCED GYNOGENESIS BY RETENTION OF THE SECOND POLAR BODY IN COMMON TENCH, TINCA TINCA L.

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The carp /Cyprinus carpio/ irradiated sperm /^{60}Co, absorbed dose 1,000 Gy in high homogeneous field/ was used to activate the development of tench /Tinca tinca/ eggs. The cold shock and cytochalasin B treatment /=CB/ were both used to restitute the diploid constitution. The highest level of diploid fry /16.7%/ was observed using 25 min cold shock /0 - 4°C/ 5 min after the activation. The amount of diploid fry decreased to 0.5% without cold shock or CB. A heterozygosity rate of 48.8% was detected for transferrin locus in the offspring of 10 females.

INDUCED GYNOGENESIS BY RETENTION OF THE SECOND POLAR BODY IN THE COMMON CARP, CYPRINUS CARPIO L., AND HETEROZYGOSITY OF GYNOGENETIC PROGENY IN TRANSFERRIN AND Ldh-B^1 LOCI

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For two years /1983 and 1984/, experiments with induced gynogenesis by the retention and fusion of the second polar body were carried out in the common carp. Gamma rays /^{60}Co, absorbed dose 1,000 Gy/ were used to inactivate the spermatozoan DNA. To restore the diploid constitution, eggs were cold-shocked /at 0 - 4°C for 60 min/ 5 and 15 minutes after activation of spermatozoa and eggs by the fertilization solution. The gynogenetic nature of the progeny /i.e., the absence of the paternal genome/ was tested various loci by checking on scaliness, transferrin and Ldh - B^1 phenotypes. In the mirror genotype, great variability was observed in the amount and localization of scales. The progeny heterozygosities in the transferrin locus were 0,95% /of 1 female/ and 5.56% /of 4 females/ in 1983 and 1984, respectively. The progeny heterozygosities in Ldh - B^1 locus were 38.84% /of 2 females/ and 42.42% /of 2 females/ in 1983 and 1984, respectively.

ENHANCED FREE RADICAL FORMATION IN IRRADIATED POLYETHYLENE CONTAINING ZnO

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The concentration of free radicals formed under gamma irradiation in low-density polyethylene /PE/ containing zero, 0.01; 0.02; 0.05; 0.1; 0.2 and 0.4w% ZnO was measured by using the technique of ESR spectroscopy. When samples are irradiated in air an increase of the total amount of free radicals compared to that of pure polymer without ZnO was observed. This increase appeared over the whole range of ZnO content, with a maximum at about 0.02w% ZnO.

The results obtained by ESR are consistent with the data on gel formation reported in a previous paper [Ref]. A comparison of ESR data obtained on samples in air and in vacuo suggests that the phenomenon is due to the presence of oxygen during irradiation and that it is probably the result of two dominant processes taking part at the interface of ZnO and PE chains: the first one is the formation of free radicals one the chains perturbation sites, whereas the second process is relevant to the interaction between formed radicals and oxygen diffused into the system. Other possible causes of the increased generation of free radicals are also considered.

Ref.: G.R. Ghassemi Mahidasht et al., Radiat.Phys.Chem. 25, 349 /1985/

EXCITED STATES FORMATION IN LOW TEMPERATURE MATRICES - PULSE RADIOLYSIS INVESTIGATION

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The excited states formation in hydrocarbon matrices at low temperature was investigated using nanosecond pulse radiolysis method.
Naphthalene, 9,10-diphenylanthracene and biphenyl were applied as scavengers. The influence of scavenger concentration and temperature down to 90 K on the yield and lifetime of solute fluorescence were found.

The contribution of photophysical and radiation induced processes to a mechanism of excited state formation is discussed.

ATOMIC STATES AND EXCIMERS OBSERVED IN ELECTRON PULSE IRRADIATED ARGON

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In electron-pulse irradiated argon /pressure range 0.03 - 0.4 MPa/ argon excited atomic states Ar /1s,2p/ and excimers $Ar_2/^3\sum_u^+$ / were studied by optical absorption spectroscopy. From the effect of additives S such as O_2, N_2, CO_2, H_2O, CCl_4 and N_2O on the time profiles of the atomic and molecular species rate constants of the reactions

$$Ar/1s/ + S \longrightarrow \text{products}$$
$$Ar_2/^3\Sigma_u^+/ + S \longrightarrow \text{products}$$

were determined.

A mechanism of the excimer formation is discussed as well.

DOSIMETRY FOR RADIATION PROCESSING

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During the past few years significat advances have taken place in the different areas of dosimetry for radiation processing, mainly stimulated by the increased interest in radiation for food preservation, plastic processing and sterilization of medical products. Reference services both by international organizations /IAEA/ and by national laboratories have helped to improve the reliability of dose measurements. Several dosimeter systems like perspex, ethanol-chlorobenzene, ceric-cerous, and radiochromic dye films have been improved and new systems have emerged, e.g. spectrophotometry of dichromate solution for reference and sterilization dosimetry, optichromic dosimeters in the shape of small tubes for food processing, and ESR spectroscopy of alanine for reference dosimetry.

In this paper the special features of radiation processing dosimetry are discussed, and several commonly used dosimeters are reviewed, as are factors leading to errors or increased uncertainty in dose measurement.

RADIATION INDUCED PROCESSES ON THE SOLID SURFACES - GENERAL APPROACH AND OUTLOOK

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At present time there are many important and convincing reasons for focusing the attention on the nature, kinetics and yield of radiation induced /or radiation promoted/ heterogeneous reactions, some of which are the following:

- undoubtedly, heterogeneity is practically one of the most common properties for almost all conceivable systems in nature and technology;
- up to 80% of the modern chemical industry and almost all biochemical technologies are based on the heterogeneous /or microheterogeneous - fermentative/ catalysis;
- share of technological process, under irradiation, is constantly increasing due to successful development of the world nuclear power;
- it is known that thermodynamic parameters of heterogeneous reactions and their selectivity, as a rule, are sufficiently altered under irradiation;
- it is proved that the chemical effectiveness of the radiation induced processes on the boundary of interphase surface can be considerably bigger /in some cases - one order or more/ than is homogeneous media.

In this study the analysis of the present situation in the field of radiation chemisty of heterogeneous processes /with emphasis on the systems "solid-gas" and "solid-liquid"/ are presented. Perspectivity of investigations, both for practical purposes and with a view of further development of scientific ideas, is well founded and some systematic and methodological problems, the solution of which can promote accelerated evolution of this important branch of radiation chemistry, are considered.

RADIATION PROMOTED DISSOLUTION OF METAL OXIDES IN MINERAL ACIDS

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In this study the influence of γ-radiation on kinetics of ferric oxides dissolution in a number of mineral acids was investigated. It was proved that dissolution process is promoted by γ photons only when the acid concentration is less than C_o. This parameter C_o - threshold of radiation sensitivity - for the same oxide depends on the chemical nature of acid and increases regularly in array $C_o^{HCl} < C_o^{HNO_3} < C_o^{HClO_4}$; the rate of the radiation-induced process does not depend on the temperature and, under constant pH, does not depend on acid ions concentration /table/. Effectiveness of dissolution under irradiation is strongly inhibited by acceptors of oxidable particles. For example, the difference between dissolution rates of hematite in HCl under and without irradiation / ΔW/ could be expressed as a function of iodide concentration /C_i/ by the equation

$$\Delta W_i = \Delta W_o - kC_1^{1/3}$$

where k is an empirical constant; $C_i \ll [Cl^-]$.

Table. Parameters of kinetic equation $W = k [H^+]^n [A]^m$
E - activation energy /kJ.mol^{-1}/

System	C_o mol.dm^3	without irradiation			under irradiation		
		n	m	E	n	m	E
Fe_2O_3/HCl	0.52	0.75 ± 0.09	$0,76 \pm 0.01$	49 ± 6	$0.77 \pm 0,06$	0	0
Fe_2O_3/HNO_3	8.1	0.37 ± 0.05	0.23 ± 0.05	37 ± 4	0.38 ± 0.09	0	0
$Fe_2O_3/HClO_4$	$7.2.10^3$	0.25 ± 0.04	0.08 ± 0.04	33 ± 6	0.26 ± 0.04	0	0

The mechanism of metal oxides dissolution under irradiation in being discussed.

DOSIMETRIC DESIGN AND MEASUREMENTS FOR A 10 kCi IRRADIATION FACILITY

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The dimensions, shape and construction materials for the container have been established by calculations based on Monte Carlo method accounting for the cource intensities and their emplacement; although the dose rate outside the container wall is kept under allowed limits.

- The radiometric design for the biological shielding has been done considering the effects of the direct, scatterad and backscattered gamma radiations.
- The isodose maps have been obtained for different irradiation geometries.

The agreement between the calculated and measured values is presented.

HIGH-DOSE DOSIMETRY IN MASSIVE RADIATION PROCESSING WITH 10-13 MeV ELECTRON BEAM

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Electron beam dosimetry methods related mainly to routine sterilization of medical supplies, radiation cross-linking of organic polymers and radiation modification of solid state silicon devices will be presented.

The typical interval of irradiation doses used for different processing purpose lies between 10 and 150 kGy /1 to 15 Mrads/. As an absolute system /for calibration of routine dosimeters/ water and graphite quasi-adiabatic calometers have been applied.

For chemical routine systems thin-layer dosimeters such as PVC and CTA films, and recently developed polyethylene "shrink" dosimeter were used /solid state aminoacidic dosimeter is actually tested as well, using ESR/.

Efforts were made for fitting the dosimetric materials to properties of irradiated materials.

Special attention has been paid to radiation dosimetry reliability from industrial scale point of view, particularly for alternating thickness supplies and materials treated with electron beam.

USE OF SILICON DIODES FOR GAMMA DOSE MEASUREMENTS

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Long-base silicon diodes prepared by ion implantation of boron and phosphorus into the silicon sigle crystals can be used for the measurement of high gamma doses in the range from kGy to hundreds of kGy. The PN junction formed by implantation injects carriers into the diode base, the lifetime of which is changed by irradiation. This parameter is strongly dependent on the silicon crystal lattice damage caused by gamma irradiation and this damage is reflected in the change of the diode current-voltage characteristics. The forward bias change $\Delta U = U - U$ increases with the increasing gamma dose /U_o and U^o are the forward bias values of the unirradiated and irradiated diodes, respectively/. The measurement is carried out on a special apparatus at a constant value of the forward current.

The gamma dose cannot be measured in the presence of neutron radiation as the diodes are about 10^3 times more sensitive to fast neutrons. The measured dependence of ΔU vs. gamma dose is not linear in the whole range of doses. At higher doses the effect tends to saturation and the diode response is less sensitive to the dose.

The conditions for the use of silicon diodes for gamma dose measurements in radiation sources as well as the conditions for the diode measurements are described and discussed. Both the long-base silicon diodes used for these dosimetric applications and the corresponding measuring device are produced by the Institute for Research, Production and Application of Radioisotopes, Prague.

IRRADIATION OPTIMIZATION ON RADIONUCLIDE SOURCES

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Procedures for the evaluation of exposure- and dose rates in radionuclide gamma sources using simple computers are presented. The computational programmes are based on summing up the exposure rate contributions from individual point sources.

For the computations of the exposure- and dose rates for a set of linear sources the programme EXPES is used. It yields the exposure - or dose rates either in air or in the irradiated material. The programme MAPEX is used for the evaluation of the exposure rate distribution throughout the whole irradiation chamber for arbitrary arrangements of sources in the chamber. The programme PERUN is used also for the graphical output in these computations. In this case the exposure rates are calculated, e.g., in given straight lines, perpendicular to the irradiation chamber floor. The exposure - and dose rates in various planes /e.g., parallel to the chamber floor/ can be calculated and graphically illustrated using the computational programme GRAPEX. This procedure makes possible to obtain a complete image about the spatial distribution of exposure rates in the irradiated volume for different arrangements of radiation sources, to decide the most suitable geometrical arrangement of sources in the chamber, to choose the best position for additional sources and to find optimum irradiation condition for various materials.

EFFECT OF CHAIN TRANSFER AGENT ON THE CHEMICAL STRUCTURE OF CHROMIUM /III/ CROSSLINKED COLLAGEN - POLY /METHYL METHACRYLATE/ COPOLYMERS

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Our previous works on radiation induced graft copolymerisation have shown that leather modified with vinyl monomers exhibits improved physical and functional properties. These properties depend among others on the type and content of grafted synthetic polymer but also on the chemical structure of the formed grafted copolymer.

In this work the influence of thioglycolic acid on grafting yield, length and density of poly/methyl methacrylate/ /PMMA/ chains grafted onto collagen has been investigated. Aqueous emulsions of methyl methacrylate /MMA/ containing thioglycolic acid at concentrations from 0.01 to 0.1 mol per mol of monomer have been used in grafting experiments. Values of grafting degree, average molecular weight /$\bar{M}_n$/ of PMMA and $\bar{M}_n$ collagen found in these studies enabled us to work out the conditions for the most efficient grafting. It was found for example that for emulsion containing 25 % w/w of MMA and thioglycolic acidadded in molar ratio relatively to MMA equal to 0.075, the value of $\bar{M}_n$ of grafted chains is close to 200 000. In similar experiment but without thioglycolic acid $\bar{M}_n$ was by about 30 % higher. In the presence of thioglycolic acid both radiation yield and grafting density increase by about 45 %.

Mechanism of termination process for growing PMMA chains in the presence of thioglycolic acid has been discussed.

MOLECULAR ORIGINS OF TIME-DEPENDENT REACTIVITY OF SPECIES TRAPPED IN SOLIDS

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The adequate description of the time-dependent reactivity of species trapped in solids, from electrons and hydrogen atoms in low-temperature glasses to macroradicals in polymer matrices, was recently achieved with the use of the time-dependent rate constant

$$k\,t = Bt^{\alpha - 1}, \quad 0 < \alpha \leq 1$$

where B and α are constants.

It is common to interpret thus obtained kinetic patterns in terms of reactivity distribution reflecting the distribution of trapped species environments. This picture, however, seems to have more formal than physical significance in some systems and there is considered an alternative picture in which the distribution of reactivity originates from complex cooperative processes of matrix molecule movements needed to make the trapped species reactive or mobile.

RADIATION-INDUCED DILATATION EFFECTS IN SOLIDS FROM THE POINT OF VIEW OF CONTEMPORARY EXPERIMENTAL METHODS

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The commonly accepted idea of the radiation-induced changes of the specific volumes, density, and porosity of irradiated solids is critically reconsidered from the point of view of various modern and more precise experimental methods, namely gaseous pycnometry, measurements of pore distributions, etc. It is shown that many previously reported dilatation effects can be ascribed to the shortcomings of the experimental methods used.

MODIFICATION OF POLYPROPYLENE FIBRES BY PREIRRADIATION TECHNIQUE

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This work is dealing with modification of polypropylene fibres /POP/ and POP fleece prepared by the preirradiation technique. A grafting measure, a hydrophility change and dyeing ability in the radiation-modified samples were studied. The preirradiation as well as simultaneous irradiation were performed in a chamber type RCH - gamma - 30 radiation equipment, charged with ^{60}Co. For radiation-induced grafting the concentration of acrylic acid from 5 % to 30 % was used.

It was proved that the percentage of radiation-induced grafting of both POP fibres and POP fleece increased with the radiation dose and the concentration of acrylic acid. The samples modified by this technique were shown to have a good dyeing ability and their dyeing intensity increased with regard to the percentage of grafting.

RADICAL DECOMPOSITION OF ACETIC ACID IN AQUEOUS SOLUTIONS

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In the industrial process of production of terephthalic acid from p-xylene by oxidation with molecular oxygen, acetic acid is used as solvent. Reactions of acetic acid with catalysts and radicals lead to a significant loss of the solvent.

Action of $H^{\cdot}$ /$R^{\cdot}$/, $OH^{\cdot}$ and $HO_2^{\cdot}/RO_2^{\cdot}$/ radicals on AcOH was investigated in the temperature range of 298-263 K. Based on the analysis of end-products taking into account the physico-chemical state of the solutions and the results of reactions with 1-^{14}C and 2-^{14}C acetic acid, a tentative decarboxylation and decarbonylation mechanism of acetic acid was proposed.

INP ACCELERATORS OF UP TO 90 kW POWER

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On the basis of the ELV-series accelerators the accelerator ELV-6 has been built whose power achieves 90 kW at an energy of up to 1.4 MeV. The report deals with the circuit diagram of the accelerator, the parameters of the beam extracted into the atmosphere as well as the possibilities of automatic control of the accelerator.

METHODS OF CHARACTERIZATION OF PRODUCTION CAPACITY OF INDUSTRIAL ELECTRON ACCELERATORS FOR RADIATION TECHNOLOGY

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The paper discusses the various methods for assessment and characterization of production capacity used on the world market of electron accelerators for industrial radiation-technological processes. Possible causes of discrepancies between data presented by individual manufacturers and suppliers are outlined and recommendations for a consistent and unified approach given, with the aim to increase the reliability of preliminary technico-economical analyses performed by potential customers and users.

ELECTRON BEAM CURING OF COATINGS

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Modern low-energy electron beam processors offer the possibility for high-speed curing of coatings on paper, plastics, wood and metal. Today the electron beam curing gets more importance due to the increasing environmental problems and the rising cost of energy. For an effective curing process low-energy electron beam processors as well as very reactive binders are necessary. Generally such binders consist of acrylic-modified unsaturated polyester resins, polyacrylates, urethane acrylates or epoxy acrylates and vinyl monomers, mostly multifunctional acrylates.

First results on the production of EBC binders on the basis of polyester resins and vinyl monomers will be presented. The aim of our investigations is to obtain binders with curing doses $\leq$ 50 kGy. In order to reduce the curing dose we studied mixtures of resins and acrylates.

SOME EXPERIENCE WITH THE IRRADIATION OF WHEAT FLOUR

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Flour and other cereal products are infested with insects and mites during processing and storage. Flour, leaving the mill, very often contains eggs of Ephestia kuehniella or other pests. By ionizing radiation it is possible to kill insects and mites or to cause their sexual sterilization. Simultaneously the doses up to 0,5 kGy improve the baking quality of flour.

Baked products were prepared from both, irradiated and non-irradiated flour. Sensoric tests showed no difference between the two categories, when a dose of 0,5 kGy or less was used.

The results of economic calculations confirmed the dependence of the costs of radiation disinfestation on the capacity of the flour mill, irradiation dose required and several other factors.

U.S. DEVELOPMENT IN FOOD IRRADIATION AND THE USE OF CESIUM IRRADIATORS

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Food irradiation was formally initiated in the United States under President Eisenhower's "Atomsfor Peace" program in 1953. Although interest has varied during this time, significant achievements were made and these will be discussed. Recently, the activities have been catalized by the U.S. Department of Energy programs investigating use of byproduct isotopes such as cesium-137. Support from the Congress in funding significant research and technology transfer programs has led to completion of programs such as irradiation as an alternative to fumigants such as ethylene dibromide /EDB/, as a means of parasite control such as trichinosis in pork and for treating agricultural products for disinfestation, shelf-like extension, and other desirable technical effects. The U.S. Food and Drug Administration and other agencies are approving food irradiation regulations. Six irradiation systems are being built to accelerate transfer of food irradiation technology to the private sector.

ELECTRON BEAM CURABLE COATINGS

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Electron beam curable coating materials consisting of unsaturated oligomers and multifunctional acrylic monomers have been investigated. Samples were prepared and cured by 1.8 MeV electrons on glass plates. The effect of irradiation dose on the mechanical properties /e.g. hardness, tensile properties/ of cured films has been studied.

The dose requirement of the compositions and the mechanical properties of the cured films as function of the monomer/ oligomer ratio, the type of the oligomer and monomer are discussed.

MOBILE IRRADIATOR AND ITS APPLICATION IN PRESERVATION OF THE OBJECTS OF ART

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[illegible]

[+] [illegible]

[++] [illegible]

The ionizing radiation is used as an efficient agent for preservation of wooden objects of cultural or historical value attacked by wood-destroying insect or fungi. This radiation preservation is carried out in many specialized laboratories, for instance in ČSSR in The Central Bohemia Museum in Roztoky.

However, many objects are not in state to be easily transported to the radiation laboratory and an idea appears to arrange the irradiation in situ.

In this communication a project of a transportable mobile irradiation robot is described. The irradiator with cca 6000 Ci ^{137}Cs moves automatically according to a precalculated programme on a stand situated in front of the object to irradiate it with optimum homogenity and to achieve to lowest desirable dose. The dimensions of the object may be up to 6 x 2 m. The conditions of the radiation safety during the irradiation are discussed. An example of an irradiation programme is shown.

Few preliminary results of the radiation efficiency on wood destroying fungi are presented.

RADIATION PROCESSING APPLICATIONS IN THE CZECHOSLOVAK WATER TREATMENT TECHNOLOGIES

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The regeneration of biologically clogged water wells by radiation proved to be a successful and economically beneficial process among other promising applications of ionizing radiation in the water supply technology. The application conditions and experience are mentioned.

Some toxic substances in the underground water can be efficiently degradated by gamma radiation directly in the wells drilled as a hydraulic barrier surrounding the contaminated land area. Substantial decrease of CN^- concentration and C.O.D. value was observed in water pumped from such well equipped with cobalt sources and charcoal.

The potential pathogenic Mycobacteria occuring in the warm washing and bathing water are resistant against chlorine and ozone. The radiation sensitivity of Mycobacteria allowed to suggest a device for their destroying by radiation.

The removing of pathogenic contamination remains to be the main goal of radiation processing in the water purification technologies. The decrease of liquid sludge specific filter resistance and sedimentation acceleration by irradiation have a minor technological importance. The hygienization of sludge cake from the mechanical belt filter press by electron beam appears to be the optimum application in the Czechoslovak conditions. The potatoes and barley crop yields from experimental plots treated with sludge were higher in comparison with using the manure.

Biological sludge from the municipal and food industry water purification plants contains nutritive components. The proper hygienization is a necessary condition for using them

as a livestock feed supplement. Feeding experiments with broilers and pigs confirmed the possibility of partial /e.g. 50 %/ replacement of soya-, bone- or fish flour in feed mixtures by dried sludge hygienized either by heat or by the irradiation.

DETERMINATION OF THE CONCENTRATION OF ELASTICALLY EFFECTIVE CHAINS IN RADIATION CROSSLINKED LOW-DENSITY POLYETHYLENE

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Well-known practical applications of ionizing radiation to polyethylene products resulting in the improvement of especially their thermo-mechanical properties called forth interest in the elucidation of formation and structure of the polymeric network produced in this way of treatment. Properties of the polymer network above melting point of polyethylene are determined by the concentration of elastically active network chains. The concentration of crosslinks can be estimated either by means of sol-gel analysis or by stress-strain measurements above melting point. The former method allows to estime only the number of chemical crosslinks which is not sufficient to predict the deformation behaviour of polymers, as there are various network defects and physical entanglements in addition. On the other hand it is very difficult to estimate the actual number of chemical crosslinks using the latter mathod. This investigation has been carried out to compare the concentration of elastically active chains determined by above mentioned methods in view of current theories regarding the formation of networks and the determination of the concentration of elastically active chains.

XENON HEAVY ATOM EFFECT ON EXCITED STATE QUENCHING OF HYDROCARBONS

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The decay of S_1 excited states of organic molecules usually occurs in competition of singlet--singlet /radiative or non-radiative $S_1 \rightarrow S_o$ and $S_1 \rightarrow P$, where P is photochemical product/ and singlet--triplet /$S_1 \rightarrow T_n$/ transitions. The ratio of the two processes can be influenced by adding so-called heavy atom perturbers to the solution which by a spin-orbit coupling mechanism may enhance the $S_1 \rightarrow T_n$ intersystem crossing rate. In practice mainly brominated and iodinated compounds /e.g. ethyl iodide/ are used as heavy atom quenchers. However, these compounds readily react with electrons and their use in radiolysis is not recommended. In our study the applicability of xenon was tested which is well soluble in most organic solvents. The excited state quenching of several aromatic hydrocarbons /pyrene, naphthalenes/was investigated in alkane solvents by measuring the fluorescence induced by 80 ns pulses of 4 MeV electrons delivered by a LINAC LPR-4 accelerator. Upon adding Xe to the solutions the fluorescence intensity and lifetime were found to decrease which indicates the reaction with S_1 excited molecules. The xenon was found to be an ideal quencher in these systems since it did not react with precursors of excited states. The quenching rate parameters were found to be 10^7-10^8 mol^{-1} dm^3 s^{-1}, i.e. by 1-3 orders of magnitude smaller than the so-called diffusion controlled rate parameter.

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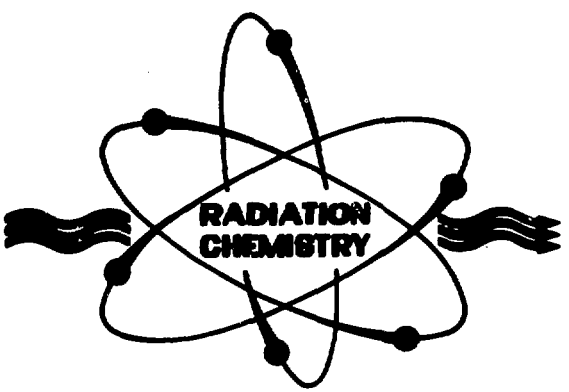

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Dr. BEDŘICH FRIDRICH	Director of the Institute of Research, Production and Application of Radioisotopes, Prague
Prof. JIŘÍ MOSTECKÝ	Chancellor of the Prague Institute of Chemical Technology, Prague
Prof. FEDOR MACÁŠEK	Dean of the Faculty of Sciences, Comenius University, Bratislava
Prof. JOSEF CABICAR	Head of the Nuclear Chemistry Department, Faculty of Nuclear and Physical Engineering, Czech Technical University, Prague
Ing. RUDOLF KOPEK	Chairman of the National Committee of Mariánské Lázně

O R G A N I Z I N G C O M M I T T E E

Chairman: J. Teplý

Members:

B. Bartoníček

R. Čech

V. Ducháček

A. Habersbergerová /scientific programme/

J. Hruška /secretary/

A. Fojtík

I. Janovský /scientific programme/

P. Kouřím

Z. Kovář

M. Pešek

Z. Prášil /scientific programme/

Z. Schweiner

F. Šmirous /treasurer/

K. Vacek /scientific programme/

A. Vokál

T I M E S C H E D U L E

Registration	Sunday, April 20	12.00 - 22.00
Registration	Monday, April 21	8.00 - 14.00
Opening of the Meeting	- " - - " -	14.00 - 14.30
Section 1: Fundamental Radiation Chemistry	- " - - " -	14.30 - 18.00
Opening of the Poster Session	Tuesday, April 22	8.30 - 9.00
Section 2: Polymers and Radiation	- " - - " -	9.00 - 12.00
- " - - " - contd.	- " - - " -	14.00 - 16.30
Poster Session	- " - - " -	16.30 - 17.30
Section 3: Sources and Dosimetry	Wednesday, April 23	8.30 - 11.30
Excursion to Karlovy Vary - - China-Ware Factory	- " - - " -	13.00 - 18.00
Social Dinner		19.30
Section 4: Food Irradiation	Thursday, April 24	8.30 - 11.30
Environment and Radiation	- " - - " -	14.00 - 17,00
Poster Session	- " - - " -	17.00 - 18.00
Concert	- " - - " -	19.30
Section 5: Radiation Chemistry Related to Nuclear Technology	Friday, April 25	8.30 - 10.30
Closing of the Meeting	- " - - " -	11.30 - 12.00

LECTURES

MONDAY - AFTERNOON

SECTION 1

Fundamental Radiation Chemistry

J. KROH	Mechanism and Kinetics of Primary Processes Induced by Irradiation of Non-crystalline Solids	40 min
A. PLONKA	Molecular Origins of Time-Dependent Reactivity of Species Trapped in Solids	15 min
A. NECHAEV	Radiation Induced Processes on the Solid Surfaces - General Approach and Outlook	15 min
J. BEDNÁŘ	Electronic Perturbation Induced by Ionizing Radiation	15 min
W. BARTCZAK	Stochastic Simulation of Primary Processes in Radiation Chemistry	15 min
Break		30 min
N. GETOFF, S. SOLAR	Radiolysis and Pulse Radiolysis of Chlorinated Phenols in Aqueous Solutions	30 min
A. FOJTÍK	Exciton - Quantum States of Small Semiconductor Clusters - Radiation Chemistry of "Q-States" Particles	15 min
I.G. DRAGANIĆ, Z.D. DRAGANIĆ	Radiation-Chemical Aspects of Chemistry on Precambrian Earth and in Cometary Nuclei	15 min

TUESDAY - MORNING

SECTION 2

Polymers and Radiation

A. CHARLESBY	Some Present and Potential Developments in Radiation Studies	40 min
K. DUŠEK, M. DEMJANENKO	Statistical Theory of Crosslinking and Degradation of Polymer Chains in the Pre-Gel and Post-Gel States	30 min
Break		30 min
D. BABIC	Linking and Dislinking Reactions in Irradiated Polymers	30 min
A. VOKÁL	Determination of the Concentration of Elastically Effective Chains in Radiation Crosslinked Low-Density Polyethylene	30 min

TUESDAY - AFTERNOON

SECTION 2 - CONTD.

Polymers and Radiation

J. SILVERMAN	Radiation Processing - Introductory Lecture	40 min
O. BREDE, R. HERMANN, R. MEHNERT	Primary Porcesses of Stabilizer Action in Radiation-Induced Alkane Oxidation	15 min
A. IFRIM, V. FIRETEANU, J. PAUN, I. MIHALCEA, S. JIPA	Synergistic Effects in Thermo-Irradiated Polyethylene	15 min
Break		30 min
E. JAWORSKA	Electron Beam Irradiation of Polyethylene in Multilayer Form	15 min
V. KRÁL, Z. PELZBAUER	Penetration of an Electron Beam into Polymer and Dissipation of Energy	15 min

WEDNESDAY - MORNING

SECTION 3

Sources and Dosimetry

V.L. AUSLENDER	Up-to-date Trends in Development of Electron Accelerators for Radiation Technologies	25 min
B. HUGELIN	ELECTROCURTAIN Technical Center in Geneva	15 min
R.A. SALIMOV	Institute of Nuclear Physics Accelerators of Up to 90 kW Power	15 min
I. SANTAR, I. ČADERSKÝ	Methods for Characterization of Production Capacity in Industrial Electron Accelerators for Radiation Technology	15 min
Break		25 min
A.CH. BREGER	Nuclear Radiation Sources in Chemical Technology	25 min
A. MILLER	Dosimetry for Radiation Processing	25 min
P. PANTA	High-Dose Dosimetry in Massive Radiation Processing with 10-13 MeV Electron Beam	15 min

THURSDAY - MORNING

SECTION 4

Food Irradiation

J.S. SIVINSKI	U.S. Development in Food Irradiation and the Use of Cesium Irradiators	30 min
A. WOLF	Food Irradiation from the Hygienic Point of View	30 min
Break		30 min
J.P. LACROIX	Food Irradiation in Belgium	15 min
E. KOVACS, I. KISS, A. BOROS, N. HORVATH, J. TOTH	Disinfestation of Different Cereal Products by Irradiation	15 min
J. SEDLÁČKOVÁ, J. ZUSKA, M. PERNICOVÁ, J. KOSAŘOVÁ	Some Experience with the Irradiation of Wheat Flour	15 min
K. BOBROWSKI, J. HOLCMAN	Intramolecular Three-Electron Bonds Formation in Methionyl Homopeptides /di-L-Met/, /tri-L-Met/	15 min
M. FITI, M. DRĂGUSIN, R. MORARU, C. PONTA	Radiation Produced Hydrophylic Gels as Carriers for Immobilized Cells and Enzymes	15 min

THURSDAY - AFTERNOON

SECTION 4 - CONTD.

Environment and Radiation

J.W. LEONHARDT Radiation Induced Cleaning of Exhaust Gases - Corrent Status, Prospects and Tasks to Basis Research 40 min

E.V. BELOUSOVA, B.G. DZANTIEV, I.K. LARIN, S.V. PAVLOVA, D.N. SAPOZHNIKOV, O.O. SIROTYUK, A.P. SHVEDCHIKOV Radiation-Chemical Removal of NO_x by Electron Beam Irradiation of Exhaust Gases and Model Mixtures NO_x-N_2-O_2-H_2O in Gas Phase at Temperatures 298-523 K 15 min

Break

K. VACEK, M. SEDLÁČEK, F. PASTUSZEK Radiation Processing Applications in the Czechoslovak Water Treatment Technologies 40 min

N.A. VYSOTSKAYA Physico-Chemical Aspects of Sewage Sludge Ionizing Radiation Treatment 15 min

J. TEPLÝ, Č. FRANĚK, R. KRAUS, V. ČERVENKA Mobile Irradiator and Its Application in Preservation of the Objects of Art 15 min

FRIDAY - MORNING

SECTION 5

Radiation Chemistry Related to Nuclear Technology

B. BARTONÍČEK — Investigations of the Chemical Effects of Ionizing Radiation in the Systems of Nuclear Power Plants — 40 min

H. ISHIGURE, H. SHIRASHI, H. OKUDA, N. FUJITA — Effect of Radiation on Chemical Forms of Iodine Species in Relation to Nuclear Reactor Accidents — 40 min

A. HABERSBERGEROVÁ, I. JANOVSKÝ, R. PEJŠA — Radiolysis of Aqueous Solutions Removing I_2 and CH_3I in Nuclear Power Plants — 15 min

D. JAKEŠ — Phase Transformation of Ionic Salts in Nuclear Reactor Radiation Field — 15 min

Break

CLOSING SESSION

P O S T E R S

Fundamental Radiation Chemistry

1 J. MAYER, M. SZADKOWSKA-NICZE, J. KROH

Excited States Formation in Low-Temperature Matrices - Pulse Radiolysis Investigation

2 B. CHUTNÝ, J. BRODILOVÁ, J. POSPÍŠIL

Alkylation and Dimerization of 2,6-Substituted Phenols Induced by Cobalt-60 Gamma Radiation in Hydrocarbons

3 R. ČECH, P. RAČAY, F. MACÁŠEK

The Partial Yields of Cl^- Ions in Two-Phase Systems with Trichloromethane and Tetrachloromethane

4 S. ČEFOVÁ, R. ČECH, F. MACÁŠEK

The Partial Yields of Radiolytical Products in Two-Phase Systems with Nitrobenzene

5 G.V. PUTIRSKAYA, I. MATUS, N.G. ARIKO, N.P. KENIGSBERG

Radical Decomposition of Acetic Acid in Aqueous Solutions

6 J. GRODKOWSKI, Z. STUGLIK, G. WIECZOREK

The Pulse Radiolysis of the Leucocyanide of Malachite Green Dye in Some Polar Solvents

7 J. KALECINSKI

Radiation Reduction of Nitrate Ions in Concentrated Aqueous Solutions and in Nitrate Glasses

8 I. KARAIVANOV, I. PUMPALOV

Destruction of Phenol at Low Phenol Concentration by Ultraviolet Light and Gamma Radiation

9 J. KURUC, A. HLATKÁ, R. ČECH

The Radiation and Quantum Yields of Cl^- in Chlorobenzene, Carbon Tetrachloride and Water Two-Phase Systems

10 R. MEHNERT, O. BREDE, R. HERMAN

Atomic States and Excimers Observed in Electron Pulse Irradiated Argon

11 A. NECHAEV, N. KAL´AZIN

Radiation Promoted Dissolution of Metal Oxides in Mineral Acids

12 L. WOJNAROVITS, V. SILBERER, G. FÖLDIAK

Xenon Heavy Atom Effect on Excited State Quenching of Hydrocarbons

13 G.A. KURANOVA, G.M. POPOVICH, L.T. BUGAENKO

Paramagnetic Silver Particles in Gamma Irradiated Synthetic Zeolites

14 M.A. NOVOSELOVA, G.M. POPOVICH, L.I. NEKRASOV

Regularities of Silver Atoms Formation in Gamma Irradiated Aluminium Silicates Modified by Lanthanum /III/ Oxide

15 G.M. POPOVICH

Formation and Physico-Chemical Transformations of Silver Atoms on the Surface of Gamma Irradiated Solids

16 G.M. POPOVICH, L.T. BUGAENKO, O.G. KUPENKO

Kinetic Transformations of Silver Atoms in Gamma Irradiated Solutions of Silver Salts

17 J. BÖS, M. WASHIO, S. TAGAWA, Y. TABATA

Radiation-Induced Transient Styrene Species in Liquid and Glassy Freon-Mixtures

Polymers and Radiation

26 D. KOSTOSKI, Z. STOJANOVIC, O. GAL, W. STANNETT

The Effect of Antioxidants on the Melting Behaviour of Gamma Irradiated Polypropylene

27 G.R. GHASSEMI MAHIDASHT, O. GAL, M. STOJIĆ

Enhanced Free Radical FOrmation in Irradiated Polyethylene Containing ZnO

28 K. PIETRUCHA

Effect of Chain Transfer Agent on the Chemical Structure of Chromium/III/ Crosslinked Collagen - Polymethylmethacrylate Copolymers

29 J. PRUŽINEC, A. MANOVÁ, J. SEVERA, J. KNAJFL

Modification of Polypropylene Fibers by Pre-irradiation Technique

30 J. SCHMIDT, M. MAI

Electron Beam Curing of Coatings

31 E. TAKÁCS, I. CZAILIK, T. CZVIKOVSZKY

Electron Beam Curable Coatings

32 E.R. KLINSHPONT, V.K. MILINCHUK, G.S. ZHDANOV, I.D. SHELUKHOV

. Photoradiation Processes in Polymers - Reactions of Charged Particles

S o u r c e s a n d D o s i m e t r y

33 M. BÄR, M. REMER

Dosimetry and Computer Experiments in Gamma Irradiation Units

34 C. FLORU, C. PONTA, D. NICOLESCU

Multipurpose Technological Gamma Irradiator

35 B. IHME, H. DORSCHNER, A. HEGER, D. PLASCHNICK, G. KNABE

A Film Dosimeter System for High Dose Dosimetry of Ionizing Radiation

36 M. ONCESCU, G. OCHEANĂ, C. PONTA

Dosimetric Design and Measurements for a 10 kCi Irradiation Facility

37 M. PEŠEK, J. KITS, O. OBRAZ, B. SOPKO, A. ŠKUBAL

Use of Silicon Diodes for Gamma Dose Measurements

38 M. PEŠEK, M. HOŠPES

Irradiation Optimization on Radionuclide Sources

39 J.W. HANSEN

Detection of Low- and High-LET Radiation with Alanine

40 H. WAGNER

A Polyethylene Film Dosimeter for High Energy Radiation

Food Irradiation
Environment and Radiation

41 T. BRYL-SANDELEWSKA, M. ROCHALSKA, Z. ZIMEK, E. MILNER, P. PANTA, W. STACHOWICZ

Preservation of Strawberries and Mushrooms with 10 MeV Electron Beam

42 I. ČUDINA, Lj. JOSIMOVIĆ

Radiolysis of Oxygenated Aqueous Solutions of Tyrosine

43 B.G. ERSHOV

Radiation Destruction of Cellulose. Effect of Thermal and Mechanical Action

44 D. JORE, C. FERRADINI

Radiolytic Study of the Antioxidant Activity of Vitamin E

45 Lj. JOSIMOVIĆ, I. ČUDINA, B.H. MILOSAVLEVIĆ

The Effect of Oxygen on the Radiolysis of Tryptophan in Acid Media

46 R. MIRCHI

Degradation Products as Extraction Agents

47 O. LINHART, P. KVASNIČKA, J. KAŇKA, J. PIPOTA

Induced Gynogenesis by Retention of the Second Polar Body in Common Tench Tinca Tinca L.

48 O. LINHART, P. KVASNIČKA, J. POKORNÝ, V. ŠLECHTOVÁ

Induced Gynogenesis by Retention of the Second Polar Body in the Common Carp Cyprinus Carpio L., and Heterozygosity of Gynogenetic Progeny in Transferrin and Ldh-B^1 Loci

49 N.A. VYSOTSKAYA

The Radiolysis of an Anthraquinone Dye Aqueous Solution