RADIATION PROTECTION - SELECTED TOPICS
Paper presented at Int. Symposium
Dubrovnik, 2-6 October 1989

RADIOACTIVE WASTE TREATMENT AT THE BORIS KIDRIČ INSTITUTE OF NUCLEAR SCIENCES

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ABSTRACT

The results of many years work on the problems of treatment and interim storage of radioactive waste at the Boris Kidrič Institute of Nuclear Sciences are presented. The main R/D work based on chemical treatment, solidification and pressing is described.

Keywords: radioactive waste, chemical treatment, solidification, pressing, interim storage.

INTRODUCTION

Fourty years have passed since the Boris Kidrič Institute was founded and more than thirty years since the Institute of radiation and environmental protection was established,at first as laboratory, now as the Institute. In the frame of this Institute there exists the Department of radioactive waste management. Problems connected with radioactive waste appeared immediately, together with the beginning of work, because of the application of radium and other radioactive sources which required immediate safety conditions for storage of both sources and radioactive waste. At first,the storage was provided in concrete containers,then,till 1968 an open depository was established for solid radioactive waste contained in metal barrels of 200 litars. From the present point of view such way of storage is quite unacceptable.

The features of typical nuclear center the Institute gained in 60-ties with building nuclear research reactor RA,5 MW. Only then we began with radioisotope production and with establishment of new laboratories for materials,fuel reprocessing,radiation chemistry and application of radio isotopes in research, medicine and other fields.

At the same time,as urgent,appeared the need for building four underground reservoirs of stainless still,volume 300 m³ each for interim storage of liquid radioactive waste.

1. The origin and composition of radioactive waste

Through the years passed,radioactive waste arised from different sources in liquid and solid form of various chemical and radio chemical content and composition.

Liquid waste

There are three main sources of liquid waste:

1. Reactor building which is connected t. underground basins through a special net work system. Certain amount of waste arises from remont and decontamination works. The principle isotopes are ^{60}Co, ^{137}Cs and ^{3}H,with the approximate activity of waste of 4×10^{10} Bq/m³.
2. Radioisotope production laboratory where the people from the waste management section supply liquid waste in concentrated form. Liquid wastes of quite different composition and activities is separated in two groups-short lived and long lived liquid waste.
3. Liquid waste comming from application of isotopes in research, medicine, industry and etc.

Different laboratories at the Boris Kidrič Institute and other institutions in Serbia produce liquid waste which is safely provided and stored at the Boris Kidrič Institute.

Solid waste

Practicaly solid waste comes from the same origin as the liquid one. They appear as compressible and uncompressible and consist of spent radioactive sources,pieces of equipment and vessels which do not decontaminate, etc. For thirty years of Department work on waste management,it was gethered about 25m³ of liquid and 70 m³ solid waste,per year,having in mind that fluctuationsin amounts characterizes periodical changes in intensity of work on nuclear program, as well as remont work.

2. R/D work on the treatment of radioactive waste

The conception of radioactive waste management for the last decade was based on chemical treatment of liquid radioactive waste, by phase separation, solidification of concentrate by cementing procedure, as well as by reduction of solid waste by pressing.

R/D work in this period concerned mainly development of methods for chemical treatment, solidification of concentrate as well as the analysis of safety aspects of disposal. Chemical precipitation is a relatively simple process and mainly suitable for treatment of liquid waste with low activity, high degree of polution and high salt content. Chemical precipitation has been successfully applied in many plants for many years. (1)

Development of methods and the optimization of the process of chemical treatment was performed at various levels of characterization. For example, at microkinetic level of characterization, the balance conditions of the mass carrier and radionuclides were analysed during moving to the system and from liquid to solid phase. At microkinetic level changes of local concentration of carrier and radionuclide were analysed (2).

The technological scheme for purification by the coprecipitation of microimpurities with slighty soluble collectors is shown in Fig.1. According to the scheme, concentrated reagent solutions are introduced into the water flow by means of a set of injectors, thus forming the collector phase. By mixing in the vicinity of the injector, the reagents form a high local supersaturation of the solution which leads to the appearance of a highly dispersed collector which is capable of increased sorption.

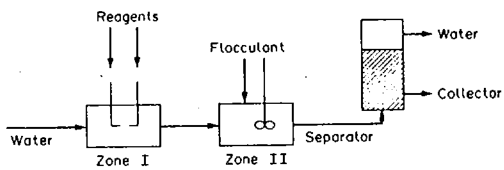

Fig.1. Scheme of water purification by flocculation

Furthermore, the suspension moves into a solid particle aggregation zone where, if necessary, flocculators are introduced. Here the collector particles are enlarged after which they move to the separator. The optimization of Scheme 1 requires knowledge of the characteristics of chemical crystallization of slightly soluble substances. It was assumed that such crystallization occurs isothermally in each of the zones. Consequently the state of the suspension in these zones is determined by the solution concentration, and the distribution functions of unit crystals φ_0 and aggregates φ_1 by states. It was assumed that the unit crystals derive from active aggregation centres (crystalline associates). The binding of molecules(ions)into individual crystals(molecular growth)and of crystals to aggregates(coagular growth),in the whole interval of particle size that is of practical interest may be considered a continuous process.

By solving the get of equation for given boundary conditions it is possible to determine unknown functions. Data concerning the determination of these functions will be given by using the example of barium carbonate crystallization,which is used in the purification of waste waters from radioactive strontium (3,4).

Analysing the procedure of solidification by cementing, the concentration ratio of a basic components of concrete and concentrate by addition of additives which improve some properties studied were mechanical stability,permeability and leaching test. It was shown that it is possible to obtain solidified products with satisfactory characteristics.

Some aspects of this study are given in more details in the Paper for the Conference (5,6).

Pilot plant under construction is based on the research and parameters studied and is planned to be of 0,5 m^3/day capacity, but it has not been finished yet.

3. Removal of the open depository

An open depository, 80x35 m, for about 600 m^3 of solid radioactive waste,stored in metal barrels which were greatly damaged by corrosion, were very dangerous for environment. This depository had to be reclaimed by pressing barrels using 50 t press. Pressed products were stored in new metal barrels of 200 liters and placed in a new hangar. The achieved reduction factor was 3 and contaminated soil layer in some critical points of the debth of 5-10 cm was removed, so that the site where the depository was, is now decontaminated green loan.

4. Problems connected with final disposal of radioactive waste

Special problems of radioactive waste treatment at the Institute occur out of the fact that in Yugoslavia does not exist permanent depository for radioactive waste. Therefore, in 1984 a document as "Social Agreement concerning conditions and the way of solving the problem of deposition of irradiated nuclear fuel and final disposal of radioactive waste in SFRJ" was adopted. The realization of the Program began in 1985/86 but because of public opinion and the lack of financial means it broke off. In the mean time, the new Regulation on temporary prohibition of nuclear plant building was adopted. Exception of this Regulation were the objects for deposition of radioactive waste. In such circumstances, these new items greatly burden the Institute strategy concerning the safe radioactive waste disposal.

Having this in mind, the future plans of the Institute will be directed towards the search of the conditions which would provide, in all phases of radioactive waste management, the decrease of the volume of radiactive waste and provide the safe and economize storage of the radioactive waste.

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