



SUMMARY OF AN INTERNATIONAL SYMPOSIUM AT MUNICH, FRG, 17-21 MARCH

The meeting on "Use of High-Level Radiation in Waste Treatment – Status and Prospects" was attended by 160 participants from 26 Member States and by representatives of 2 international organizations.

Waste Treatment by Radiation

Since 1969 several meetings have been convened to study the possibility of using high-level radiation in waste treatment. It was agreed that ionizing radiation offered some promise as a feasible technology for a certain unique purpose, but economic considerations mitigated any overwhelming enthusiasm for early industrial realization.

Recently a significant change has taken place in the world energy supply picture, and the expanded projection of nuclear power generation affects the analysis of comparative economic feasibility of ionizing radiation treatment of wastes. In addition, increased consideration of environmental quality not only calls for the re-evaluation of conventional waste treatment technologies, but also the development of more effective means where conventional methods might be unsatisfactory.

As a result of several allied considerations, it was thought necessary and timely to review the status of research and development in the application of ionizing radiation to waste treatment and to consider the environmental implication of the proposed technology. Accordingly, the Symposium on the Use of High-Level Radiation in Waste Treatment – Status and Prospects was convened by the IAEA, in co-operation with the Government of the Federal Republic of Germany and the Bayerische Landesanstalt für Bodenkultur und Pflanzenbau. Forty-eight papers were presented in eight sessions covering the current technology of waste-water treatment and re-use, radiosensitivity of micro-organisms, disinfection and microbiological control, physical and chemical modification of aqueous pollutants, technological and economic considerations, pilot-plant design and operating experiences, and radiation treatment of gaseous and solid wastes. The following report is summarized from papers presented at the different sessions:

Current technology: In the first review session it became apparent that no waste-water treatment employed at present can guarantee an effluent without human and/or animal pathogens and that in some cases treated sludges contain pathogens in higher concentration than in the untreated raw sludge, resulting in a threat to human and/or animal health through dietary practice. The relative importance of treated but still polluted water and sludges, to say nothing of untreated ones, has to be established in comparison to other pathways of infection before any drastic measures should be taken to improve the hygienic quality of current practice. However, there is a need for improved treatment and radiation might provide an effective means to achieve it. Unfortunately, essential information is still lacking on radiation effect on pathogens, especially on parasites under practical conditions.

Radiosensitivity of micro-organisms: A survey of radiosensitivity of viruses in respect to waste-water treatment showed that radiosensitivity is affected by temperature and suspending medium. It was stressed that assessment of the quantity of micro-organisms present in the water is essential for effective radiation treatment. In the case of viruses,

most of the work has been done with bacteriophages which may not be a reasonable indicator of animal viruses. Only two types of viruses, which are directly relevant to waste water have so far been examined, i.e., polio virus and adenovirus, the latter being more resistant than the former, and considered to be the better indicator. The existence of radioresistant asporogenic bacteria in natural high radioactivity was reported. This indicates an occurrence of natural selection (or adaptation) of micro-organisms as a result of long, continuous exposure to ionizing radiation, and is a warning signal that bacteria may occur which cannot be destroyed by irradiation.

Disinfection and microbiological control: One paper strongly emphasized, from the hygienic point of view, the need to interrupt the transmission cycle of pathogenic micro-organisms starting from sewage sludge, through plants and animals to man, and proposed effective sanitation of sludge or sewage water as most essential. If radiation is to be used as a practical method of microbiological control, the cost-effectiveness must be improved. Several approaches in increasing the effectiveness were reported in this session.

Physical and chemical modification of aqueous pollutants: Papers were presented on various aqueous pollutants of environmental importance such as organic solvents, phenols, linear alkylsulfonate surfactants, pesticides, anthraquinonic dyes, and polychlorinated biphenils either from a laboratory mechanistic approach or under simulated practical conditions. While some of the data indicated the advantage of ionizing radiation in decomposing these pollutants, the yield is mostly too low to be competitive with other methods such as ozone treatment.

Technological and economic aspects: Economy and effectiveness of radiation treatment of waste depend primarily on the choice of radiation source. Sources available today are the electron accelerator (low and high voltage), gamma-ray source of radioactive cobalt or cesium, possibly spent fuel elements and fission products obtainable from power reactor operation. The factors to be taken into account in making a choice were discussed and the importance of having a clear definition of process objectives and a critical comparison of available radiation energy options was stressed. Public acceptance of municipal sewage sludge irradiation systems, including social benefit, public information and safeguards were outlined and it was pointed out that there was a high potential social benefit of sludge irradiation in view of the fact that many sewage plants do not consistently remove pathogens from sludge and that sludge irradiation can result in reducing major public risk.

Pilot-plant design and operating experience: It was reported that in spite of problems left unsolved at the experimental stage, several pilot plants have already been operating to accumulate considerable data in the Fed. Rep. of Germany, the USA and the USSR. Some others are at the planning stage in Hungary and other countries. Although it is noted that we are at the stage where necessary work of an experimental nature is being done by national agencies, but not at the expense of national authorities in charge of water treatment, it is felt that it may not be long before the first truly commercial plant will be built by such authorities, based on the operating experiences obtained by this pilot plant study. A comprehensive report was made on the pilot plant of the Abwasserverband Ampergruppe at Geiselbullach, FRG, for the irradiation of sewage sludge; this plant has accumulated operating experience for about one year. Starting with the cost calculation, all the aspects involved were analyzed and evaluated, covering dosimetry, bacteriology, virology, dewatering properties of irradiated sludge, effect of treated sludge on plant and soil,

and chemical analysis of irradiated sludge. It was quite apparent that this kind of comprehensive study is essential in promoting the introduction of radiation treatment to be accepted both by the scientific community and by the public in general, and that it could be a model for other pilot plants, operating or in the planning stage, to follow, so that data could be compared for proper assessment.

Radiation treatment of non-liquid waste: In an extensive review on the recent advances in the treatment of solid waste, one author described currently available methods of disposal of municipal solid waste such as sanitary landfill, incineration, pyrolysis, composting, anaerobic digestion, and ocean disposal, followed by processing (comminution, separation) and resource recovery, with emphasis on the latter. Another speaker reported on the utilization of radiation sterilized raw material obtained after separation of garbage into components, as animal feeds. Along the same line of thought, the possibility of using the materials contained in the sludge as fodder or fodder supplement was reported. Although certain toxicological problems exist, especially regarding heavy metals, nutritionally and economically speaking this application seems to warrant further exploration. Use of radiation in recycling polytetrafluorethylene scrap is already an industrialized process with proven economic merit, a Japanese delegate reported. The radiation polymerization of vinyl chloride, highly toxic gas used once as aerosol propellant, now prohibited and stored waiting for disposal in huge amounts in Japan, was also proposed. Although this method might not be economically very attractive because of the high dose requirement, the process is so simple and safe for workers that it is expected to be introduced. Regarding air pollution, papers were presented on the use of electrons (5.5 MeV) for removal of nitrogen oxides (NO_x) and sulfur dioxide (SO₂) from the combustion gas.

Conclusion: There exists no one perfect process, conventional or otherwise, which can solve every problem in all situations. It became clear during the meeting that ionizing radiation alone, or in combination with other methods, has the potential utility of contributing towards the solution of certain problems of waste treatment and re-use of spent resources. ^{for} Take sewage sludge ^{for example} radiation treatment showed better sedimentation and dewatering, and provided improved sludges as fertilizer or as possible animal feed additives. Cost-benefit considerations are still obscure. The choice of radiation source to be employed is still controversial. It was shown, however, that given a clearly-cut requirement in terms of type and nature of effluent, through-put rate and dose to be applied, technological solutions exist and cost estimates can be made for the specific technology. For the evaluation of performance, especially in comparison to other options, co-operative efforts from scientists, engineers and administrative authorities of all relevant disciplines are essential.

At the end of the conference, selected experts met to elaborate recommendations regarding the activities necessary to promote this particular application of ionizing radiation. Excerpts of the recommendations are as follows:

- (a) An attempt should be made to understand surface properties of suspended sewage particles and their reaction with radiolytic species.
- (b) End products, as well as their polluttional effects, should be identified when pollutants of public health and environmental concern are reported as being destroyed by radiation.

- (c) Present gaps in knowledge on the radiation resistance of bacteria, viruses and parasites in their natural environment should be filled, especially with regard to dose rate effects. The character of radiation resistance in naturally occurring highly resistant microbes should be investigated.
 - (d) Experimental protocol for chemists and microbiologists working in radiation treatment of sludge and waste water should be developed.
 - (e) Synergistic effects of radiation with chemicals (chlorine, ozone, air, etc.) and physical properties (heat, vibration, etc.) should be pursued.
 - (f) Exchange of information and experiences should be facilitated between pilot plants presently in operation or to be commissioned in the near future.
 - (g) Public health problems involved in the use of sludge (and solid waste) as fertilizer, soil conditioner or fodder should be evaluated by joint co-operative efforts of FAO, WHO and IAEA.
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INTERNATIONAL SYMPOSIUM, STOCKHOLM, 2–5 JUNE

The meeting on "Combined Effects on the Environment of Radioactive, Chemical and Thermal Releases from the Nuclear Industry" was attended by 133 participants from 24 countries and representatives from 9 international organizations.

Environmental Effects from the Nuclear Industry

For many years extensive studies have been carried out on the effects on the environment of releases of radioactivity from the nuclear industry, particularly in regard to the impact on man. More recently, with the forecast rapid development of nuclear power, the environmental impacts of thermal releases from nuclear power stations and of chemical releases from the nuclear industry have also been examined individually. However, the possibility of synergistic and combination effects from interactions of these releases and their significance to man and his environment have received relatively little attention.

During the past few years a number of countries have taken a more active interest in studies of combined effects, not only in regard to releases to aquatic environments, particularly rivers and lakes, but also in respect to releases to the atmosphere. In order to provide a forum for exchange of information in this field, the IAEA in co-operation with the Nuclear Energy Agency of O.E.C.D. organized a symposium, held in Stockholm from 2–5 June, on the combined effects on the environment of radioactive, chemical and thermal releases from the nuclear industry.

Among the topics discussed at the symposium were:

- *Effects of temperature on radionuclide uptake by aquatic species;*
- *Synergistic and combination effects in aquatic systems;*
- *Effects of chemical releases on radionuclide uptake;*
- *Synergistic and combination effects from releases to the atmosphere.*