CONDITIONS OF THE IRRADIATION EXPERIMENTS PERFORMED AT THE CESAR IRRADIATOR

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1. INTRODUCTION

The investigation of the impact of gamma radiation emitted by radioactive wastes on rock salt, studied in the framework of the HAW project, has been performed in laboratory experiments. The irradiation experiments were mainly carried out in the Gamma Irradiation Facilities at Petten (The Netherlands) and Saclay (France). Nevertheless, additional experimental work was performed in a Spanish facility in order to gain further knowledge on the effect of gamma irradiation on rock salt, which leads to the radiolytical decomposition of the rock salt and volatile components contained in the pore space of the rock.

Two irradiation facilities were available in order to fulfil the objectives of the Spanish irradiation programme. The first, located at Barcelona, is the low dose irradiation facility owned by the INTE (Institut de Técniques Energètiques, UPC). It has 8 sources: one of Co^{60}, six of Cs^{137} and one of Am^{241}. The facility allows dose rates between 0.2 μGy/h and 0.2 Gy/h to be reached. The temperature during the irradiation can be controlled between 25 and 200 ^{o}C.

The second facility is the industrial irradiator CESAR, owned by AragoGamma and located at Granollers. This facility is currently being used as sterilizer of several products from the medical, pharmaceutic and cosmetics industries. It consists of an assemblage of several Co^{60} sources. This facility was selected due to the higher activity of the sources. However it was adapted to the programme needs, in order to speed up the absorbed doses by an increase in the dose rate level, thus avoiding very long experimental times. .

2. EXPERIMENTAL CONDITIONS

The irradiation cell of an area of about 8 m^2 is shielded with concrete walls. The assemblage of Co^{60} sources are placed in the center of the cell. Figure 1 shows a plan view of the irradiation cell. The products to be sterilized are placed in boxes which are transported by a conveyor. During irradiation products receive a dose of about 25 kGy. The assemblage of Co60 sources (Amersham International PLC model CKC-1800 LSA-Co60 IN*180 Capsule) consists of 19 cylinders forming a panel. Each cylinder has a starting activity of $1.11 * 10^{15}$ Bq. The gamma energy spectrum emitted is 1174 and 1332 keV. When the irradiation cell is not in operation, the assemblage of sources is driven by remote control into a small chamber located below the ground of the irradiation cell. The small chamber is shielded and water cooled to evacuate the heat released from the sources. From time to time, due to their radioactive decay, several cylinders are replaced in order to obtain higher doses.

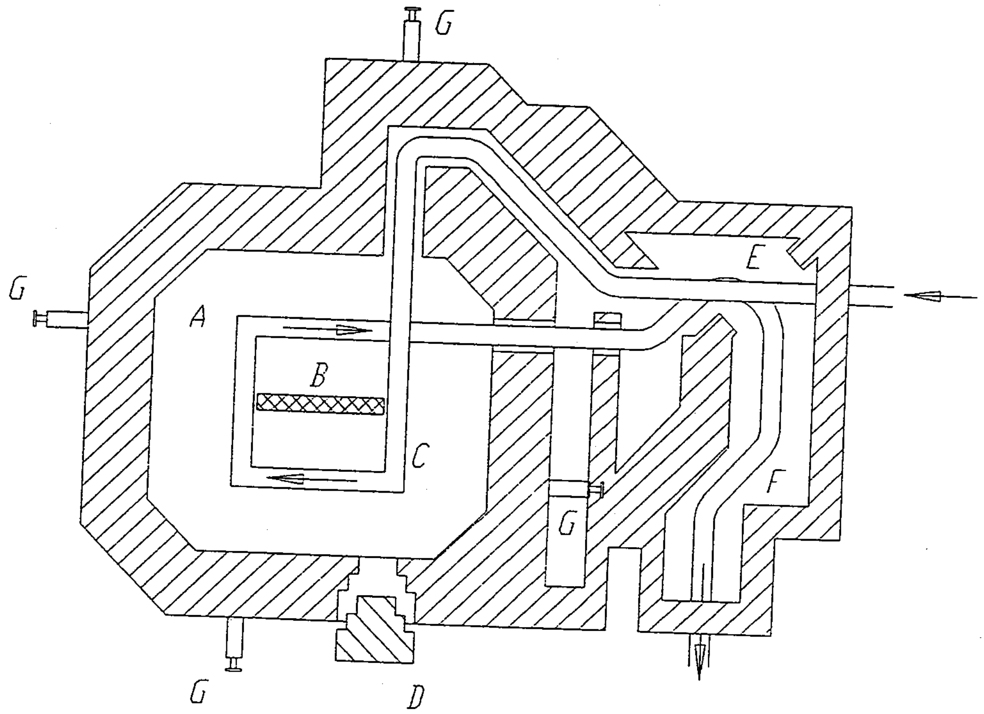

Figure 1: Plan view of the CESAR industrial irradiator. A: Irradiation cell. B: Co-60 source. C: Conveyor. D: Access door. E: Material Entrance. F: Material Exit. G: Push Rod

In order to ensure that the samples would receive the theoretically estimated doses, dosimetric mapping was performed inside the cell before starting the irradiation experiments. Alanine and red-methylpolymetacrylate (red perspex) dosemeters were used for dose calibration at a temperature of 25°C. The doses achieved inside the cell varied between 20 Gy/h and 35 kGy/h depending on the distance to the source. The temperature in the cell rose from room temperature before irradiation to between 40 and 55 °C (depending on the position in the cell) immediately after irradiation. The specific conditions at the point where the samples were placed were dose rate about 30 kGy/h and maximum temperature of 50°C. In the experiments reported in article 10 of this volume, 11 encapsulated glass ampoules containing rock salt were irradiated to doses up to 1 MGy.

3. FURTHER INSTRUMENTAL DEVELOPMENTS

Althought the irradiation experiments refered in article 10 of this volume were performed without temperature control during irradiation (samples were heated by the energy released by the Co^{60} sources), several improvements have been achieved in the framework of another on-going irradiation programme. The aim of that programme was the study the effect of temperature on the radiolytical effects on rock salt.

To fulfil those objectives, a special heating unit was designed to control and homogeneize the temperature (between 5° and 200°C) irrespective of the dose absorbed. This heating unit, which is being monitored outside the irradiation cell, is shown schematically in Figure 2. It consists of a heating device a pipe system and a cylindrical 316-L stainless-steel container. Heat conduction between the heating device and the container is provided by fluid circulation through two stainless-steel pipes (I.D. 10 mm). The pipes are filled with water (in irradiation experiments at temperatures lower than 50 °C) or oil (for the range of temperatures between 50 and 200 °C). The pipes are insulated by glass fibre to keep the temperature of the fluid constant.

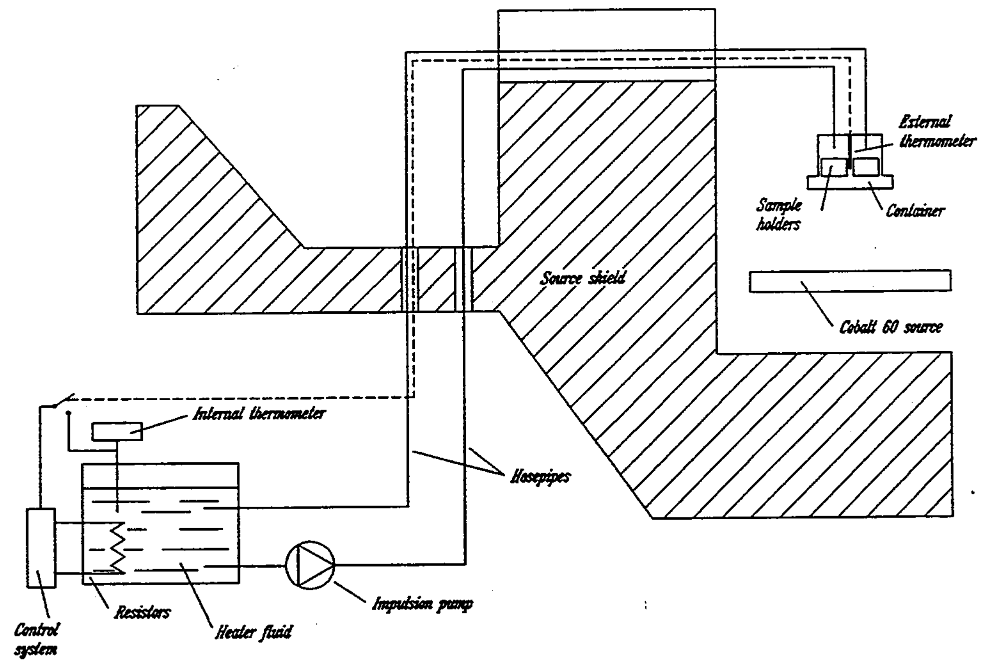

Figure 2: General view of the heating system.

The cylindrical container (150 mm O.D. and 57 mm height) allows simultaneous irradiation of 4 cylindrical sample holders (50 mm O.D and 19 mm height), also made of stainless steel. A Pt100 thermocouple which goes from the container to the heating device controls the temperature inside the container. The cylindrical container is shown schematically on Figure 3. The time needed to reach a temperature of 200 ^{o}C is about 90 minutes. Further improvements, which will result in a new cylindrical container, will permit simultaneous irradiation of 8 cylindrical sample holders and 6 encapsulated glass ampoules (50 mm O.D and 250 mm height).

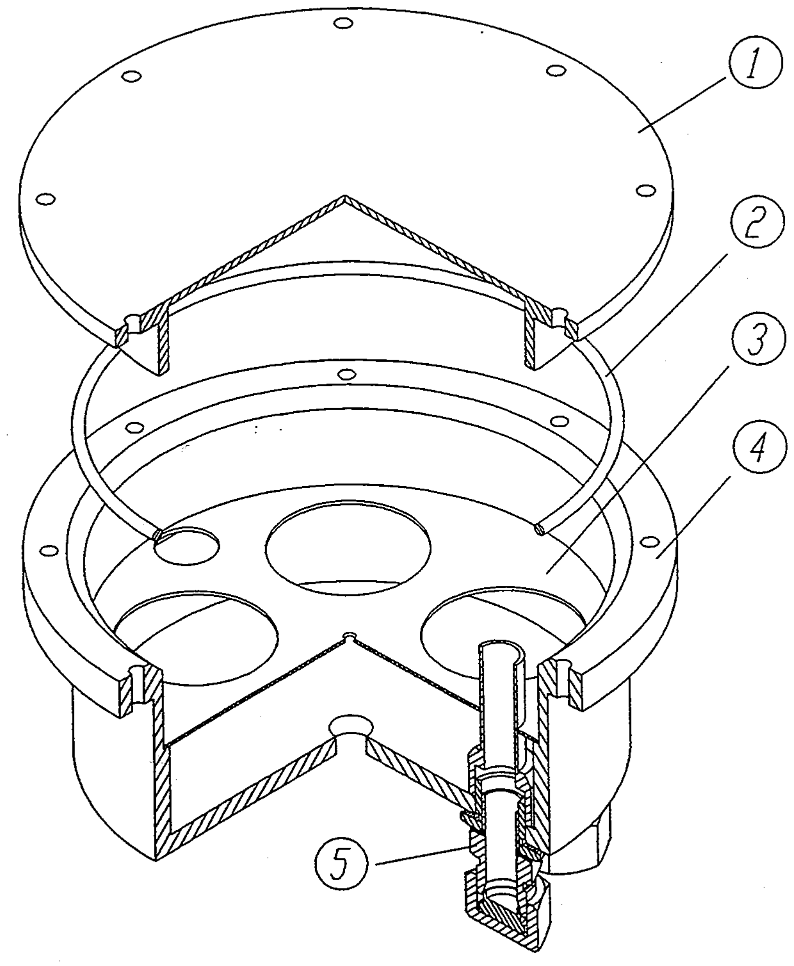

Figure 3: General view of the container: 1.- Lid. 2.- O-Ring. 3.- Intermediate plate. 4.- Frame. 5.- Hosepipe connector.

PART III

PRE-IRRADIATION CHARACTERISTICS OF TWO SALT FORMATIONS