OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

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RADIOACTIVE SOURCE DEVELOPMENT

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ISOTOPES DEVELOPMENT CENTER

PROGRESS REPORT

RADIOACTIVE SOURCE DEVELOPMENT

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1. CESIUM SOURCE DEVELOPMENT

Several cesium glass compositions were investigated with emphasis on melting points and solubilities. In addition to cesium-lead glasses, the following cesium glasses (empirical formulas) were investigated:

$$0.55Cs_2O \cdot 0.15Li_2O \cdot 0.3CdO \cdot 2.65SiO_2$$
$$0.55Cs_2O \cdot 0.15Li_2O \cdot 0.3ZnO \cdot 2.80SiO_2$$
$$0.55Cs_2O \cdot 0.15Li_2O \cdot 0.3SrO \cdot 2.80SiO_2$$
$$0.55Cs_2O \cdot 0.15Li_2O \cdot 0.3BaO \cdot 2.80SiO_2$$

The melting point of the above glasses ranged from 1050 to 1200°C, and the solubility is ≤ 5 mg cm^{-2} day^{-1}. The cesium-cadmium glass was chosen for future development because of high cesium content, reasonable melting range, and low solubility.

The cesium-cadmium glass compound $0.15Li_2O \cdot 0.55Cs_2O \cdot 0.3CdO \cdot 2.7SiO_2$ contains 43% cesium, which represents ~15 curies of Cs^{137} per gram of glass. This glass is prepared from cesium acid oxalate, lithium carbonate, cadmium oxide, and silica. The cesium in the glass has a solubility of 0.8 mg cm^{-2} day^{-1}, and the leach rate is linear with time as shown by a 30-day leach rate test. The glass melts at 1200 to 1250°C, can be annealed at 495 ± 10°C, and can be molded in graphite with a resultant density of 3 g/cm^3. The problem of volatility loss at fusion temperature (~5 mg of Cs_2O cm^{-2} hr^{-1} and ~10 mg of Cs_2O cm^{-2} hr^{-1} at 1250°C) is being investigated.

Engineering work is underway to translate the laboratory results and techniques into equipment to be used at the Fission Products Development Laboratory in the fabrication of the sources. The major problem areas are techniques of molding to produce flat slabs, furnace development to produce proper temperatures and control, and an adequate scrubber system to retain the volatilized material at melting temperatures.

2. BREMSSTRAHLUNG AND X-RAY SOURCE DEVELOPMENT

Promethium-147

Promethium-147 oxide pressed into pellets was encapsulated in aluminum capsules to form sources of low energy x-ray. Beta emission from the decay of Pm^{147} will produce its characteristic 38 Kev K_α x-ray as secondary radiation.

In the same manner the characteristic K_α of antimony can be produced by pressing a mixture of antimony metal and Pm_2O_3 into a pellet. This second type of source in which target material is added to $Pm_2^{147}O_3$ reduces the efficiency of production of x-ray because of the added self-absorption of photons after production.

Three Pm^{147} sources were fabricated. Source 1 consisted of 180 curies of promethium metal pressed into a pellet 7.0 mm diam by 2.0 mm long. The radiation reading from this source was 100 mr/hr at 16 in. Promethium oxide (250 curies) was pressed with a 7.0 mm die (30,000 lb psi) into a pellet which was sintered at 1500°C to form Source 2. The radiation reading from this 5.5 by 2.8 mm source was 180 mr at 16 in. The third source which was composed of 300 curies of Pm_2O_3 pressed in a 7.0 mm die at 100,000 lb psi measured 7.0 mm diam by 2.6 mm long. The radiation reading at 16 in. was 280 mr/hr and at 1-1/2 in. from the face of the source was 25 to 30 r/hr. The sources were encapsulated in small aluminum capsules and sealed by fusion welding.

Radiographs were made using the 300-curie Pm^{147} source and Polaroid 3000X film with an exposure time of ~4 min at a distance of 22 to 24 in.

Iodine-125 Source

Two curies of I^{125} as AgI was encapsulated, and the capsule having a 2-mil stainless steel window was sealed by welding. The diameter across the face of the source was 3.0 mm. For ease of handling, the radioactivity was confined to the end of a stainless steel rod ~3 in. long by 1/8 in. diam. The radiation reading from the source at 16 in. was 450 mr/hr and at 1-1/2 in. from the face of the source was 50 to 55 r/hr.

Radiographs were made using 1/2- to 1-in.-thick flesh and bone (pork ribs) at exposures of 1 to 1-1/2 hr. No intensifiers were used with the Kodak Royal Blue x-ray film. These radiographs show very good contrast between flesh and bone and also difference in thickness of overlapping flesh and bone. The use of intensifying screens should reduce the time of exposure necessary to produce suitable radiographs.

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