

IODINE-125 SEEDS FOR CANCER TREATMENT

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ABSTRACT

In Brazil, cancer has become one of the major public health problems. An estimate by the Health Ministry showed that 466,430 people had the disease in the country in 2008. The prostate cancer is the second largest death cause among men. The National Institute of Cancer estimated the occurrence of 50,000 new cases for 2009. Some of these patients are treated with Brachytherapy, using Iodine-125 seeds. By this technique, small seeds with Iodine-125, a radioactive material, are implanted in the prostate. The advantages of radioactive seed implants are the preservation of healthy tissues and organs near the prostate, besides the low rate of impotence and urinary incontinence. The Energy and Nuclear Research Institute – IPEN, which belongs to the Nuclear Energy National Commission – CNEN, established a program for the development of the technique and production of Iodine-125 seeds in Brazil. The estimate for the 125-Iodine seeds demand is of 8,000 seeds/month and the laboratory to be implanted will need this production capacity. The purpose of this paper is to explain the project status and show some data about the seeds used in the country. The project will be divided in two phases: technological development of a prototype and a laboratory implementation for the seeds production.

1. INTRODUCTION

Considered a public health problem in Brazil, cancer is the second death cause of disease. An estimate by the National Institute of Cancer – INCA showed that 466,430 people had the disease in the country, in 2008 [1].

The prostate cancer is the second largest death cause among men. Studies by the National Institute of Cancer – INCA estimated that, for the year 2009, the occurrence of new cases of prostate cancer would affect more than 50,000 patients [1].

Brachytherapy, irradiation at a very close distance, is a form of lesions treatment which is based on the insertion of sources, in this case iodine-125 seeds inside tumors. During this process, the ionizing radiation destroys the malignant cells very efficiently.[2] Some of the major Brachytherapy advantages over the external radiation, the capacity to give form to the isodose distribution in irregular lesions, the considerable diminishing of dose outside the implant area (saving normal tissues) and the treatment quickness can be highlighted [3].

One of the options for prostate cancer treatment is the brachytherapy. By this technique, small seeds with Iodine-125, a radioactive material, are implanted in the prostate. The advantages of radioactive seed implants are the preservation of healthy tissues and organs near the prostate, besides the low rate of sexual impotence and urinary incontinence, compared to conventional treatments, such as the radical prostatectomy and the external radiation beam [4, 5].

These radioactive sources are imported at a high cost, what restricts this application. The local production of these radioactive sources became a priority in order to reduce the cancer management impact in end users.

Taking into account the seeds price and the difficulties to import, the Energy and Nuclear Research Institute – IPEN, which belongs to the Nuclear Energy National Commission – CNEN, established a program for the development of the technique and production of 125-Iodine seeds. The estimate for the 125-Iodine seeds demand is of 8,000 seeds/month and the laboratory to be implanted will need this production capacity. Nowadays, IPEN distributes the Iodine seeds in Brazil. There are eighteen clinics and hospitals using these seeds in the country, most of them in the southeastern region.

2. METHODOLOGY

2.1 Iodine seeds

The seed consists of a titanium capsule of 0.8 mm external diameter, 0.05mm wall thickness and 4.5mm long. The inner capsule houses a silver thread, 3mm long and 0.5mm diameter, containing the adsorbed Iodine-125. Typical seed apparent activity is of 14.8MBq, with a recommended variation of about 5% at most, in a same batch of seeds [6].

During the project execution, the following methods were developed:

- the seed core (silver) cutting,
- the titanium tube cutting,
- the iodine immobilization through its deposition in silver substrate,
- the sealing of the seeds through the microplasma welding process, and
- the leakage tests can be done according to the “International Standard Organization- radiation protection – sealed radioactive sources - ISO 9978”. [7].

2.2 Seeds distribution

Regarding their presentation form, the seeds can be loose or in strands.

In relation to their application, the seeds are used in prostate, ophthalmic and cerebral cancers.

For prostate cancer use, the seeds may be loose or in strands. For the other types of cancer, loose seeds are used.

3. RESULTS

3.1 Iodine seeds

A model of the ¹²⁵-iodine seed was developed, as shown in Fig. 1.

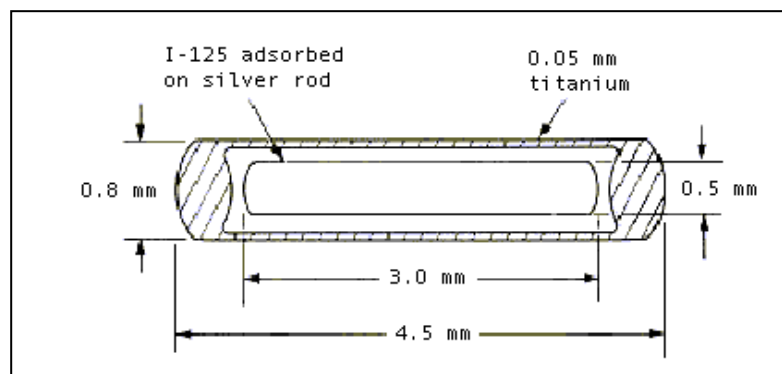


FIGURE 1: Schematic diagram of the ¹²⁵ – iodine seed.

The seed core and titanium tube cuttings were carried out with a “cut-off” device Buehler LTD, model Isomet 11-1180, made of an aluminum oxide disc and, then, the debris was sandpapered. The visual inspection was done by an optical microscope. The result was a perpendicular cutting, without debris (fig.2).

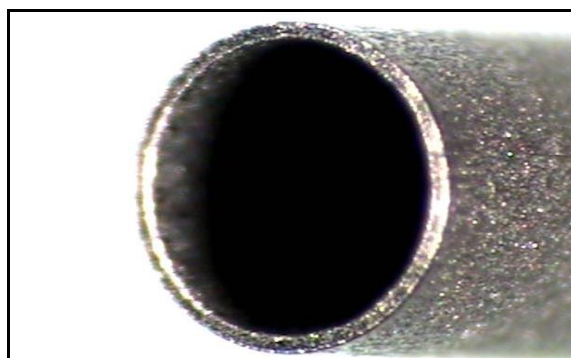


FIGURE 2: Titanium tube cutting.

In the ¹²⁵-iodine-immobilization through its adsorption on the silver substrate, a reaction yield up to 90% was obtained with an average value of 80% over 500 experiments. The deposition was done for batches of 30 seeds.

The sealing of the seeds was done through the microplasma welding process in a Secheron Soudure welding machine model plasmafix 50E.

The seed sealing was performed in the following conditions:

- pilot arc current – 2,5A (fixed);
- transferred arc current – 2,5A (welding);
- opening welding arc delay – 2seconds;
- argon pilot plasma gas flow – 0,2 l/min;
- argon shielding gas flow – 10 l/min.

The process result was a homogeneous weld without inclusions, cracks or fissures (fig. 3).

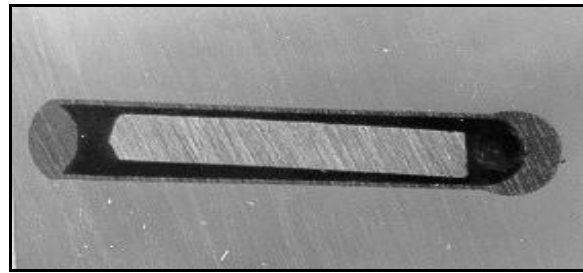


FIGURE 3: Longitudinal cut to view the microplasma welding process.

After sealing, the weld integrity was evaluated with the use of an optical microscopy and leakage test, according to the ISO 9978 standard.

The purpose of this paper is to explain the project status and show some data about the seeds used in the country.

3.2 Seeds distribution

In 2008, 33,413 ¹²⁵-iodine seeds were distributed by IPEN. From this total, 5,835 were loose seeds, 27,380 in strands, 192 ophthalmic and 6, brain seeds.

Figure 4 shows the number of ¹²⁵-iodine seeds, distributed by region in the country, in 2008.

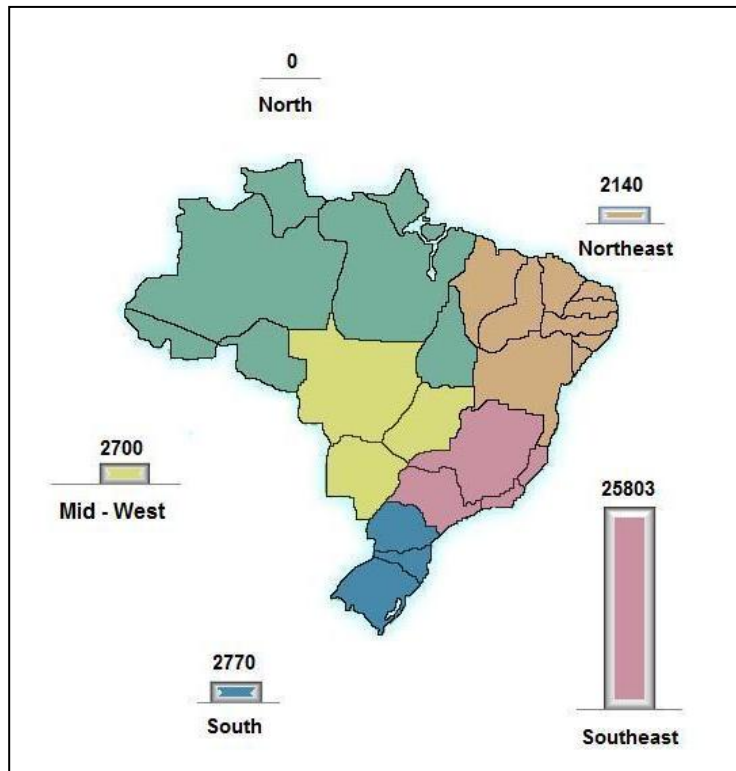


FIGURE 4: Number of seeds by region

Figure 5, below, shows the number and type of seed, distributed by hospital in 2008.

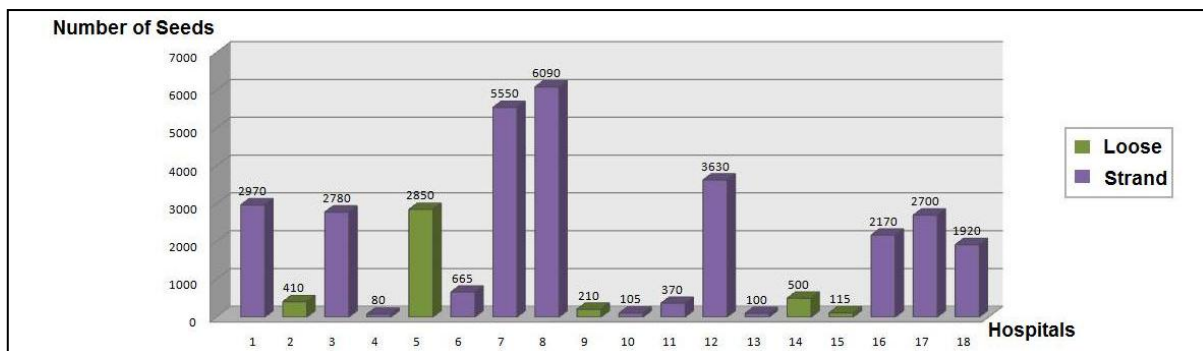


FIGURE 5: Number and type of seeds by hospital.

4. CONCLUSIONS

As targeted, a 125-iodine seed prototype was developed in Brazil. The seeds showed to be satisfactory as to the 125-iodine deposition, welding method and leakage tests carried out,

according to the norm ISO-9978 [6]. Nowadays, the laboratory for routine production is being set up.

IPEN is responsible for the distribution of all the ¹²⁵I-iodine seeds used in the country.

The project goal is to enable the country for the ¹²⁵I-iodine seeds production, at a cost meeting the Brazilian reality and, thus, allowing a larger number of patients to access this type of therapy.

ACKNOWLEDGMENTS

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