# THE POSSIBILITY OF GAMMA RAY STERILIZATION BY USING ITU TRIGA MARK II REACTOR

A.N. BILGE, B. TUĞRUL, H. YAVUZ
Istanbul Technical University
Institute for Nuclear Energy

## ABSTRACT

Gamma rays are one of the effective method for sterilization which is preferred for a long time. Generally Co-60 radioisotope sources betatrons or accelerators are used for the sterilization.

In this work, it was aimed to find the possibilities of the sterilization by gamma rays obtained in ITU TRIGA Mark-II radial tube. Radiation dosages are measured in the radial tube and several medical products are irradiated. Irradiation is arranged according to the desired dosages. Irradiated sterilized goods (mainly medical products) tested and checked at the Governmental Medical Health Center and results compared with literature.

It can be seen that this kind of irradiation is a good tool for sterilization. Unfortunately, because of the stability of the radial tube and unpractibility of the system it is rather difficult to compete with industrial system using Co-60 and accelerators. Nevertheless, this type of irradiation is also applicable for the purpose of the sterilization by using ITU TRIGA Mark II.

## INTRODUCTION

Sterilization with the radioactivity is improved for medical products and on some foods (1,2). Gamma rays are one of the effective method for sterilization which is preferred for a long time. Generally, Co-60 radioisitope sources or accelerators are used for the sterilization process.

It was aimed to evaluate possibilities of the sterilization by using gamma rays obtain in TRIGA Mark-II Research and Training Reactor. Therefore, the study is to search whether or not the gamma rays sterilization could be realized in TRIGA Reactor.

ITU TRIGA Mark-II Research and Training Reactor has a power of 250 KW. It has three beam tubes and thermal column for the related research activities. Fig.1 shows general view of the ITU TRIGA Reactor.

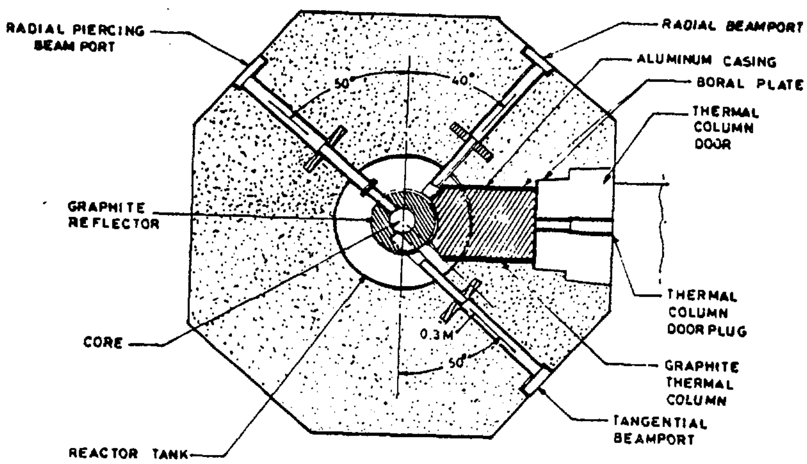



Fig.-1- Shows General View Of The ITU TRIGA Reactor

Naturally, in the beam tubes and thermal column the radioactivity is heteregenous and mixed. However, the ratio of them are different according to geometrical positions.

It is desired to find strong gamma rays with neutrons in the piercing and radial tubes. The neutron beam must be more strong in the piercing tube than the radial tube since the piercing tube is going through the reactor core. The radial beam tube has graphite block before the core.

In the thermal column, the gamma rays must be lower than the piercing and radial tubes due to have large block of the graphite, and therefore thermal neutron population is naturally high.

In TRIGA Reactor, tangential beam tube has a collimator system for neutron radiography (3,4). The gamma rays has being eliminated in a large amount in this tube. Therefore,the tangential beam tube couldn't used for gamma rays sterilization.

## EXPERIMENTAL WORK

At the begining of the study, the important thing is determine the radiation dosages in the tubes. The different methods were tried to find the real dosages and some problems due to the high level of radioactivity have to be solved.

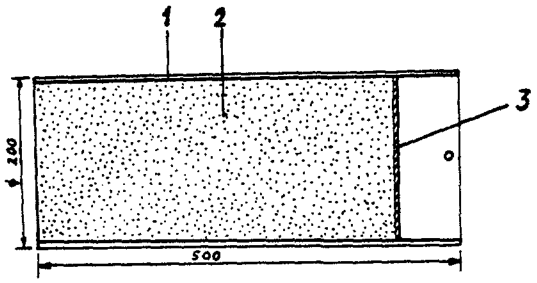
The photographic emulsions method were tried at the beginning (5). The, radiation dosages of the beam tubes were out of the sensitivity limits of this method. Therefore this method could not be satisfactory.

Afterthat, Thermoluminescent Dosimeters (TLD) were used (5). The measured dosages for thermal column and tangential beam tube were within the limits but the dosages levels of the radial and piercing tubes were still being high for TLD. Therefore TLD dosimeters were saturated.

Finally, the Fricke dosimeters were used for the measurements of the gamma doses (6,7). As it is known the Fricke dosimeters are the type of a chemical dosimeter and they don't have the sensitivity under the neutron doses. Therefore, the neutron avalibility was a problem, and the neutrons were effected on the solution.

The elimination of the neutrons, a neutron plug was constructed for each beam tubes. It was made from paraphine and acid-boric in a PVC container.

There is a cadmium plate at the end of the paraphine blocks. These plug thermalizes the neutrons by the paraphine and absorbed them by the acid-boric and cadmium. The ratio of the acid boric is approximately 5 % in the neutron plugs Fig.2 shows the plug schematically.




| No | Part Name | Material |
|---|---|---|
| 3 | Plate | Cadmium |
| 2 | Plug | Paraphine 8% Acid-Boric |
| 1 | Pipe | Poly vinel chlorur(PVC) |

NEUTRON PLUG

Fig. 2- Neutron Plug

Using this neutron plugs, the gamma doses could also measured in piercing and radial tubes by the fricke dosimeters. Table : 1 shows the gamma doses for different beam tubes in ITU TRIGA Reactor.

Table 1

Gamma Doses For Different Beam Tubes in ITU TRIGA Reactor

| Place of The Measurement | Gamma Doses (R/h) |
|---|---|
| Radial Beam Tube | 2200 |
| Piercing Beam Tube | 3463 |
| Tangential Beam Tube | 640 |
| Thermal Column | 3850 (including the neutron dose) |

For the sterilization, the dose rate is necessary between the 0,05 KGray to 50 KGray according to the materials(2).

Under this circumstances, it can be evaluated that the radial and the piercing beam tubes may be used for the aim of the sterilization.

STERILIZATION PROCESS

Neutron availability is also problem for the sterilization process due to destroy the structure of the matter. In this study, polyetylen medical products were selected as the sterilization goods.

The chemical conjuctions of the organic matter can be broken under the radioactivity, especially by neutron doses.

The neutron plugs which is made of paraphine and mixed with acid-boric were used for the elimination of the neutron effects. The plugs were tested with the irradiation the golden foils with the cadmium covered and alone and decided that the neutron plugs has effected against the neutrons.

After the placing of the neutron plugs in the beam tubes, the medical goods (e.g. enjectors and their needles are irradiated), Fig.3 shows the sterilization system for the radial and piercing beam tubes.

Irradiation were realized for difeerent periods in the beam tubes. These are between approximately 6.5 to 16.75 hours. The irradiation levels of them are between 142 Gray to 580 Grays.

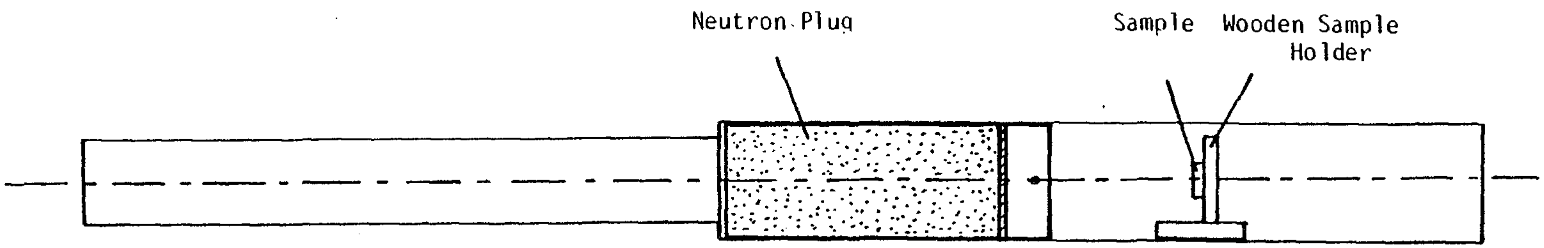



Fig. 3- Sterilization System

CONCLUSION

After the irradiatiation process, irradiated goods were send to the Governmental Medical Health Center for testing and checking their sterilization The Results of the Sterilization Experiments are summarized in Table: 2.

Table 2

The Results Of Sterilization Experiment

| Irradiation | Material | Irradiation | Mean Irradiation Dose | | Results |
|---|---|---|---|---|---|
| | | | (Rad) | (Gray) | |
| Radial Beam Tube | Polyuretan | 6 h. 27 min. | 14203 | 142 | Sterilized |
| | Metal | 6 h. 27 min. | 14203 | 142 | Sterilized |
| Piercing Beam Tube | Polyuretan | 6 h. 27 min. | 22336 | 223 | Sterilized |
| | Metal | 6 h. 27 min. | 22336 | 223 | Sterilized |
| Radial Beam Tube | Polyuretan | 12 h. 27 min. | 27415 | 274 | Sterilized |
| | Metal | 12 h. 27 min. | 27415 | 274 | Sterilized |
| Piercing Beam Tube | Polyuretan | 12 h. 27 min. | 43114 | 431 | Sterilized |
| | Metal | 12 h. 27 min. | 43114 | 431 | Sterilized |
| Radial Beam Tube | Polyuretan | 16 h. 45 min. | 36884 | 368 | Sterilized |
| | Metal | 16 h. 45 min. | 36884 | 368 | Sterilized |
| Piercing Beam Tube | Polyuretan | 16 h. 45 min. | 58005 | 580 | Sterilized |
| | Metal | 16 h. 45 min. | 58005 | 580 | Sterilized |

As it is seen from Table : 2 these doses are useful for the sterilization and for that reason one can conclude that radial and pearcing beam tubes are useful for the radiation sterilization not on the commercial scale.

## ACKNOWLEDGEMENT

We are grateful to the Turkish Atomic Energy Authority for supporting this project and Çekmece Research and Training Center for supply the Fricke and TLD dosimeters for the studies. We are thankful to M.Sc. Eng. Mehmet A. YAVUZ for helping us during the our studies in the ITU TRIGA Mark-II Research and Training Reactor.

## REFERENCES

1- Etherington, H., "Nuclear Engineering Handbook", McGraw-Hill Book Company.

2- Mutluer, B., "History For Sterilization On Foods", (in turkish), The Course On Food Sterilization, Turkish Atomic Energy Authority, Lalahan, ANKARA 13-17 June 1988.

3- Bilge, A.N., Tuğrul, B., "Nuclear Applications With ITU TRIGA Reactor", International Symposium On The Utilization Of Multi-Purpose Research Reactors And Related International Co-Operation, Grenoble-France, IAEA-SM-300/024, 19-23 Oct. 1987.

4- Tuğrul, B., Bilge, A.N., "Modernization Design Of Neutron Radiography Of ITU TRIGA Mark-II Reactor", 10 th European TRIGA Users Conference, Wien-Austria, 14-16 Sep. 1988.

5- Tsoufanidis, N., "Measurement And Detection Of Radiation", McGraw-Hill Book Company, Hemispher Publishing Corporation, Washington, 1972.

6- Spinks, J.W.T., Woods, R.S., "An Introduction To Radiation Chemistry", 2 nd Edition, 1976.

7- Jayson, G.G., Parsons, B.J., Swallow, A.S., "The Mechanism Of The Fricke Dosimeter", Int. Journal Radiat. Phys. Chem. Pergamon Press. Vol. 7. pp.363-370, 1975.