P-6a-323

Air Monitoring Program for Thorium Sulfate Processing Plant

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Poster No.323 Poster Session No.06a

INTRODUCTION

This work describes the method employed to evaluate the dispersion of the airborne particles at workplace in the thorium pilot plant at IPEN/CNEN/SP.

At this place the workers handle drums of thorium sulfate in a weighting fume hood. The material is weighted in batches and transferred manually to the dissolution reactor, where it is homogenized. After this step, the material is discharged in plastic drums for decantation. Following, it is filtered under vacuum and during this process is washed several times. At this stage, the obtained material is in the chemical form of thorium oxide carbonate ($ThOCO_3$). Finally, the material is sent to the purification process in another building.

According to the ICRP recommendations, the monitoring program for this processing plant has taken into account the workplace monitoring as well as of the workers. So, this workplace is monitored giving emphasis to the air monitoring. The air is monitored during the steps of weighting the thorium sulfate and its transfer to the dissolution reactor, where the probability of inhalation is higher.

MATERIALS AND METHODS

In order to evaluate the concentration of thorium airborne in the facility and obtaining the AMAD (activity median aerodynamic diameter) for the thorium particulate two monitoring systems were used and the evaluated parameter was the DAC (derived air concentration).

The first monitoring system consists of a vacuum pump, Eberline , model RAS-1 with flow rate of 50 l/min and cellulose filter, Millipore, with AMAD of 0.3 μm . Since the concentration of aerosols during the execution of the tasks has to be determined, the air was sampled at the individual breathing zones. This concentration is different from that at the workplace.

The second measurement system consists of an impactor in cascade with flow rate of 1 l/min and 7 stages, Pixe International Corporation, operating in a particle size range between 16 and 0.01 μm, a flowmeter and a vacuum pump, Eberline, model (RAP-1).

The obtained samples, in these two monitoring systems, were irradiated at the researcher reactor of IPEN and analyzed by epithermal neutron activation method, whose sensibility is 1μg, by the Environmental Monitoring Department of IPEN.

After the determination of the concentrations of airborne particles and the particle size distribution, these results were compared with the Derived Air Concentration (DAC) of the element ^{232}Th and then the final results are reported.

RESULTS

The results obtained by the first monitoring system are presented in table 1.

Table 1 Results obtained from vacuum pump measurements

Filter	Air volume m^3	^{232}Th μg
1	$2.5x10^{-1}$	848 ± 22
2	$2.5x10^{-1}$	799 ± 13
3	$2.5x10^{-1}$	787 ± 25

It is necessary to do some considerations:

1- The effective dose committed by the unit of incorporation/inhalation for AMAD of 5μm of ^{232}Th is

12μSv (1) .
2- The reference annual limit for the worker should be $15x10^3$μSv, so the activity in Bq for one year of work should not surpass 1250 Bq/y or approximately $6.3x10^{-1}$ Bq/h.
3- The volume of air breathed by the worker in normal conditions is $1.2m^3$/h. Therefore the calculated DAC for 5μm is $5.3x10^{-1}$ Bq/m^3, based in 2,000 hours. But, in thorium pilot plant the real time of the thorium sulfate handling powder is 150h/y, and the DAC is 7.06Bq/m^3 and the investigation level N.I is 2,35Bq/m^3 h.
4- 1 Bq of ^{232}Th is equal to 250 μg .

In this case, de concentration of our first sample is 848 / 2.510^{-1} x 250, equal to 13.56Bq/m^3.This value correspond to an annual dose of 28,810μSv.

In the case where it was used the impactor in cascade the obtained results are showed in table 2.

Table 2- Results obtained from impactor in cascade measurements.

Aerodynamic cut-off Diam. μm	**Stage number**	**^{232}Th μg**
16	7	134 ± 6
8	6	180 ± 9
4	5	57 ± 3
2	4	6.1 ± 0.3
1	3	4.5 ± 0.2
0.5	2	1.4 ± 0.1
0.25	1	< 1
< 0.06	After filter	< 1

According to the obtained results the particle size ≤ 5μm contributes with 18% of the equivalent dose committed in the worker, in case of inhalation.

It has to be highlighted that the worker in those phases of handling the powder of thorium sulfate, has to be using equipment for individual protection.

CONCLUSION

The results show that we can continue performing the optimization of the radiation protection using quantitative decision aiding techniques with the aim to decrease the dose to $15x10^3$μSv/y in the first step and to $5x10^3$μSv/y in the second step.

ACKNOWLEDGEMENTS

The authors are grateful to FAPESP and CNPq by the financial support.

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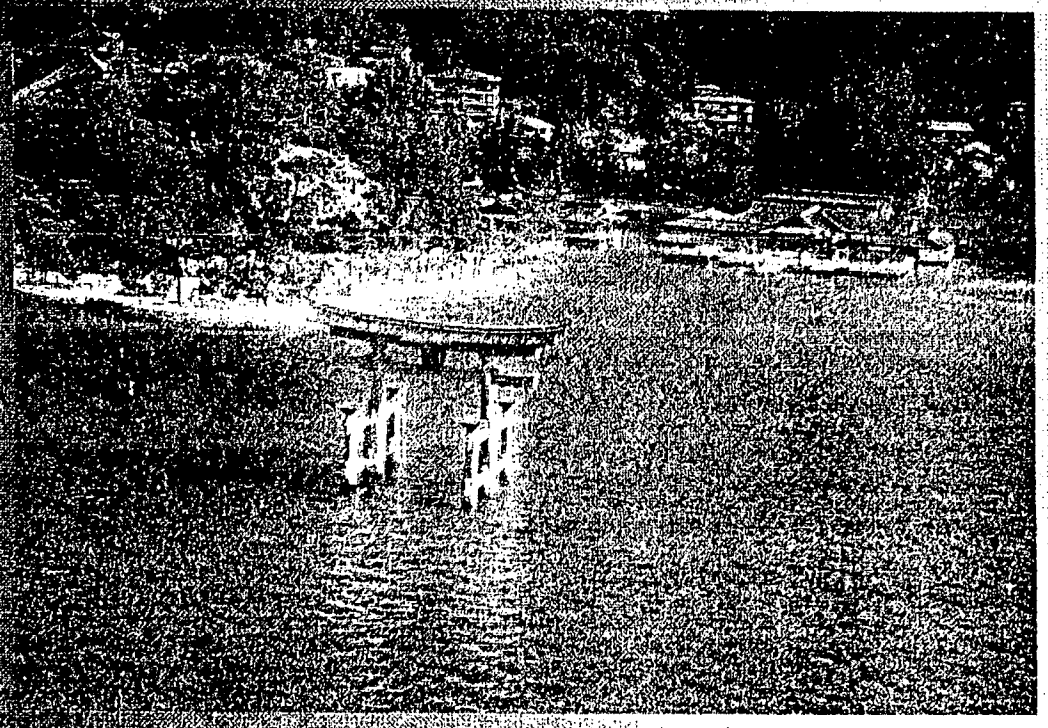

Proceedings

International Conference
Center Hiroshima
May 14-19, 2000
Hiroshima, Japan