NOTES

A SYSTEM FOR THE REMOVAL OF TRITIUM FROM EXHAUST AIR

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INTRODUCTION

To prevent unpermissible amounts of radioactivity in the exhaust of a radio isotope laboratory high efficiency filters can be used. However, tritium gas is not retained by these filters. Therefore other methods must be applied.

A system has been developed in which hydrogen gas from glove boxes is oxidized by a Deoxo unit and most of the activity of the water is removed by spray scrubbers. Finally the air is injected into the central exhaust shaft of the laboratory.

METHOD

In the Deoxo unit (ex Engelhard Industries, Ltd., type D 200/100) hydrogen is converted into water over a palladium catalyst. The concentration of hydrogen in the gas stream is reduced by the Deoxo purifier to 1 ppm or less. To avoid the escape of very small amounts of tritium gas, hydrogen gas is added to the air stream from the glove boxes (content 0.5 m^3; flow 4.5 m^3/h) in a concentration of 1%. The gas is added from a cylinder with a flow controller. For good performance the flow in the unit should not exceed 5 m^3/h. The temperature of the Deoxo unit during operation is well above 100°C.

The reactivity of the Deoxo unit is checked by means of a katharometer, which has a lower limit of detection of 100 ppm H_2.

The air stream from the Deoxo unit, containing water vapour is introduced into a system of two spray scrubbers in line (Fig. 1).

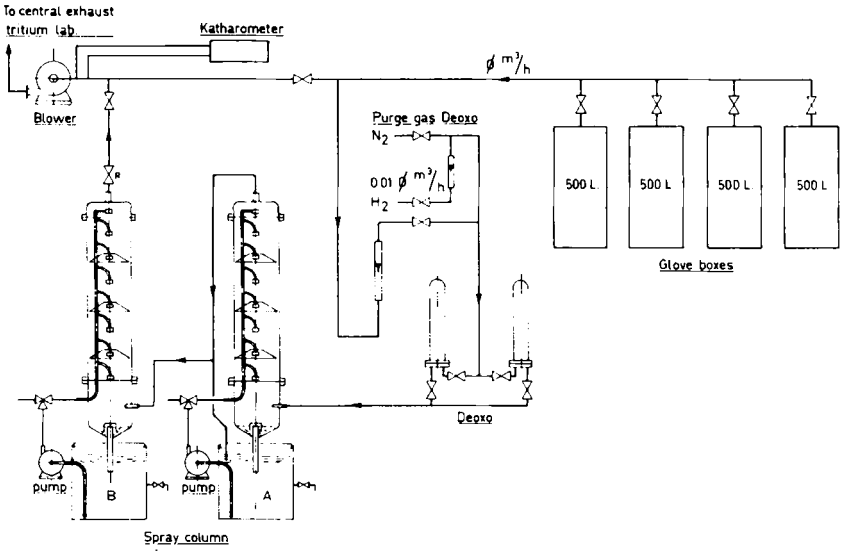

Fig. 1. Flow sheet of the system for removal of tritium gas from exhaust air.

In the towers, water from a reservoir of about 100 l is continuously circulated by means of a centrifugal pump, and atomized by means of seven nozzles at a total rate of 12 l/min. The air stream enters the lower part of the column and flows in countercurrent with the atomized water. In case of a sudden release of tritium gas, the radioactive water produced by the Deoxo unit exchanges in the tower and is collected in the reservoir of the first tower. The air stream, saturated with water, enters the second tower and the exchange process is repeated.

PERFORMANCE OF THE SYSTEM

The system is checked by introducing 18 mCi of tritium gas into the glove box. The radioactivity in the tanks is determined as a function of time (Fig. 2). Within the experimental error all radioactivity is collected in 2 h in the water reservoir A. The second water reservoir B has a radioactivity which is lower by a factor of about 10^3.

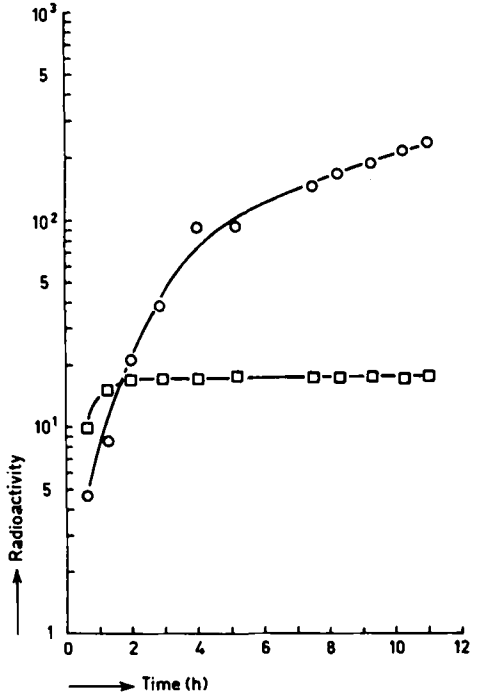

Fig. 2. Radioactivity in tank A (□ in mCi) and in tank B (○ in mCi x 10^{-3}) as a function of time.

The radioactivity in tank B increases with time, due to the transfer of water vapour with the air stream from the first to the second scrubber, this being enhanced by an increase in the water temperature to 40°C reached when the system has been operating for 10 h. The activity of the water in tank B determines

the radioactivity of the water vapour exhausted to the atmosphere. With the system a reduction in the released water radioactivity by more than a factor 10^6 is attained.

When 10 Ci tritium gas is released instantaneously, a maximum level of 10 Ci/0.5 m^3 may be reached at the outlet of the glove box. This level is reduced by a factor of 10^4 to 2 x 10^3 $\mu Ci/m^3$ by the Deoxo unit and by another factor of 500 to 4 $\mu Ci/m^3$ by dilution in the central exhaust shaft. This means that the level of maximum radioactivity then equals the continuously permissible tritium concentration in air of 4 $\mu Ci/m^3$ (Ref. 1).

In the same way it can be calculated, by assuming a saturation concentration of water after passing the scrubbers of 29 g H_2O/m^3 ($T = 28^oC$), that the maximum level of water activity in the exhaust air will be 0.006 $\mu Ci/m^3$ after 2 h. This also compares favourably with respect to the maximum permissible concentration of 0.02 $\mu Ci/m^3$ for tritiated water (Ref. 1).

Safe handling of large amounts of tritium in glove boxes can be achieved by running the system during experiments and for 2 h after an accident. The water in the reservoirs should be removed as normal liquid radioactive waste.

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1. Safe handling of radio isotopes, Vienna 1962, no. 1 p. 85.