RETENTION OF RADIOACTIVE SUBSTANCES, AEROSOLS AND POISON GAS BY SANDFILTER

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INTRODUCTION

In the last wars sheltering rooms have proved their effectiveness if they are properly equipped.
One of the most important components is the filtering system. It consists generally of a non-burnable prefilter filled with gravel, sand or other loose material which acts as heat and shock protector followed by an activated charcoal filter to absorb volatile poisons.
We tried to develop a filter system with only one non-inflamable medium with sufficient capability for the retention of harmful gases and aerosols.

EXPERIMENT

Testing of filtering materials

Various kinds of inorganic materials as gravel, sand, dolomite, slags etc. were tested. For the use in filters, sands of basalt or dunite proofed to be the best, but others can be taken if they fulfill the following conditions:
-large inner surface (>3 m²/σ)
-airflow resistance (3,5 mbar)
-particle diameter 0,2 - 0,025 cm.

Influence of humidity on sandfilters

It is a well known fact that in the presence of humidity the capacity decreases very quickly.
In a series of experiments air, saturated with water, was sucked through a sandfilter. The humidity in the bed was measured by hygrometers which had been posted in different dephths.
No significant change during 60 hours could be observed on the hygrometer in the sheltering room, because - as could be noticed from the other hygrometers - an equilibrium between the humidity of the air and the water content of the sand was formed.

Behaviour of sandfilters against hot air

In case of accidents higher temperatures may occur in the surroundings of the shelter. To simulate this conditions an airstream was heated to 120°C and conducted through the sandfilter, in which several thermometers had been inserted. After six hours no remarkable temperature rise was observed till 75 cm distance from the surface of the filter. Later the temperature increased in the following 18 hours to 60°C and remained after 48 hours at 70°C.

Behaviour of filtersands against aerosols

For checking on laboratory scale a definite volume of air was led over an emanating sample of ^{228}Th. After a decay time of 10 min for Thoron, the air stream was devided. The first part was directly sucked through a micropore filter while the second had to pass a sandfilter before reaching also a micropore filter. The activity gathered on the two micropore filters showed that the aerosols were absorbed completely by the sand.
In a similar experiment paraffin aerosols with a medium diameter of 0,3 µm were produced with a special generator, mixed with air and a steady stream of 1,5 l/min was sent through the sand.
The measuring apparatus consisted of a plastic tube of 6 cm diameter, which was filled to 1 m height with the sand. On one side of the tube, in distances of 10 cm, holes were drilled and connected with an exhausting pipe and a case holding a micropore filter. By the two way valve the airstream loaded with the aerosols was sucked through the sand or the aerosol could be extracted from different height out of the sandfilter.
While in 28 cm dephth 1,4 mg aerosol could be sucked off in 10 min, a layer of 28 cm was sufficient to with hold the aerosols. Totally, the filter column was loaded with 9 g paraffin during 100 hours.
For comparison, a similar column was filled with activated charcoal of 1,5 mm particle diameter till a height of 38 cm. The break through was observed after 25 hours, in which 2,25 g paraffin had been precipitated. The sand showed therefore under the mentioned conditions a four times greater capacity.

Behaviour of filtersands against methyliodide

After reactor incidents ^{131}I is one of the most volatile fission products. The iodine can be present in form of element, acids or organic compounds. Form the latter methyliodide can only be retained by charcoal filter impregnated with alcali iodides or amines and at higher temperatures, only molecular sieves containing Ag or Cu are successful.
We tested the sandfilters with ^{131}I labelled methyliodide and could only register a very poor retention about 0,1 % of the starting activity.
Better results about 1 % were obtained when the loaded airstream was mixed with ozon coming from an electrical generator.

Retention of tear and poison gases

Since chemical warfare is not prohibited the presence of poison gas and aerosols must be taken into account.
In the first series of tests we used bromoacetone, which effects the eyes even in a concentration of 1 mg/m³ very

severely.
To simulate conditions in the sheltering room an airstream of 1,5 l/min was charged with the teargas and the carried amount determined by adsorption on charcoal. In the following test the stream was conducted through the sandfilter and the break through registered by coloration of filterpaper impregnated with 2,4 dinitrophenylhydrazine. An ordinary sandfilter with a volume of 1 m^3 can therefore retain 1,67 g of bromoacetone.
From the poison gases phosgen was chosen, because it is one of the most toxic. The experiments were conducted in similar way in gloveboxes. The dried airstream was mixed with phosgen coming from a steel bottle. On the normal sandfilter 166 g phosgen were retained. For comparison, specification for charcoal filters ask for a retention of 155 g.

SUMMARY

Selected filtersand showed a climatizing effect for humidity and hot air. By their greater outer surface and moisture content they display a very good retention of aerosols and are in this case even effectiver than activated charcoal filters.
Methyliodide passes through sand and untreated charcoal filters and can only be withheld by sands to a small extent after ozonisation.
Our sandfilters showed because of their moisture content very good retentions of bromoacetone and were even superior to charcoal in the presence of phosgen.