

PRODUCTION OF ACTIVATED CHARCOAL SAMPLER TUBES FOR SAMPLING AIR CONTAMINANTS

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ABSTRACT

The importance of the use of activated charcoal tubes for sampling gases and vapours is very well-known. For producing these tubes in the country, their production started in the laboratory of the department of occupational health using activated charcoal, polyurethane foam and glaswool and consequently two types of foamed and foamless tubes were produced.

To investigate the quality of the raw materials used, 186 tubes were exposed to various proportions of solutions of different volumes of known percentages of four compoun-

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ds of benzene, toluene, O-xylene and P-xylene. The desorption of various parts of sampler tubes was done by a chemical method using CS_2 and the final analysis was done by gas chromatography.

The results obtained show that the amount of the above-named compounds adsorbed by glasswool and foam in comparison to the activated charcoal isn't significant (respectively $P < 0.001$ & $P < 0.05$). Also the experiments don't show any significant differences between the total amount of adsorbed chemicals by charcoal in the back-up layer and the sample layer of the foamed tube and the amount adsorbed in the foamless tube, when treated with various compounds ($P < 0.001$). Considering the equal adsorption of both types of tubes and the advantage of foamed tubes in controlling the time duration and the flow rate of sampling, the foamed type was recommended for production and use.

INTRODUCTION

The use of activated charcoal for adsorbing the hazardous compounds from the atmosphere, started before the world war I, and continued during and after it for the elimination of poisonous chemical vapours from the air inhaled. It has been used in canister masks for protection of the respiratory tract. The use of activated charcoal in the shape of activated charcoal sampler tubes has been recommended by international occupational health organizations for sampling gases and vapours and is one of the

most reliable and current methods. The ability of activated charcoal tubes in adsorbing gases and vapours and the possibility of its microanalysis by chromatographical methods are the reasons in favour of its increasing acceptance and a wide spread use as a sampler.

MATERIALS AND METHODS

For producing activated charcoal tubes, the necessary materials including activated charcoal, glasswool, and polyurethane foam were obtained from various sources and then the sampling tubes were made according to the standard specifications.(4)

Two types of foamed (Fig. 1) and foamless (Fig.2) were filled in our laboratory. The tubes were put in boxes containing 10 tubes each. Since the production of these tubes, on the first stage is to use them in a programme of research, 93 foamless and 93 foamed tubes were selected randomly according to statistical calculations and were artificially exposed to certain different volume percentages of benzene, toluene, O-Xylene and P-Xylene (Fig. 3). After a certain period of time (on the basis of temperature and pressure fluctuations) the desorption process was done by a chemical method using carbon disulphide (5).

The final analysis was done by gas chromatography method in following conditions:

Detector: FID

Glass column (2.06mm x 2m)., Column temperature:90-150 C^o

(Temperature programming).

Packing: Silicone OV- 17 with chromosorbe (AW-DMCS) as support. Volume injected 2 μ l.

RESULTS AND DISCUSSION

The mean and standard deviations of benzene, toluen, O-Xylene and P-Xylene desorption for various volume percentages and various section of foamed and foamless tubes are given in diagrams 1-2 and tables 1-4.

Analysis of variance were carried out on the quantities adsorbed by glasswool and foam for various volume percentages separately. The results show that it is not significant compared to the adsorption percentages of the activated charcoal ($P < 0.001$, $P < 0.05$). The results show that the foam and glasswool used had the required good quality for our experiments.

Then a T- test was conducted to compare the total adsorption percentage of back-up layers and sample layers of activated charcoal of the foamed tubes, in one hand and the charcoal part of the foamless tubes on the other hand. The results showed that the total adsorption percentages in foamed tubes don't differ significantly from that of the foamless tubes ($P < 0.001$). So, it could be concluded that, foamed activated charcoal tubes can be made locally and recommended for measurements of work-environmental pollutants.

In addition to the peaks related to the compounds

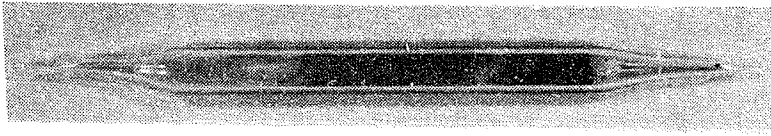


Fig. 1: Foamed activated charcoal tube

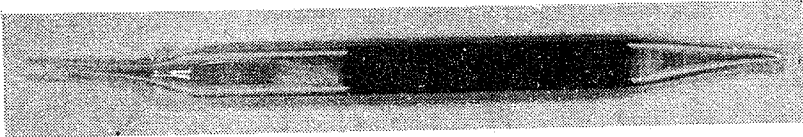


Fig. 2: Foamless activated charcoal tube

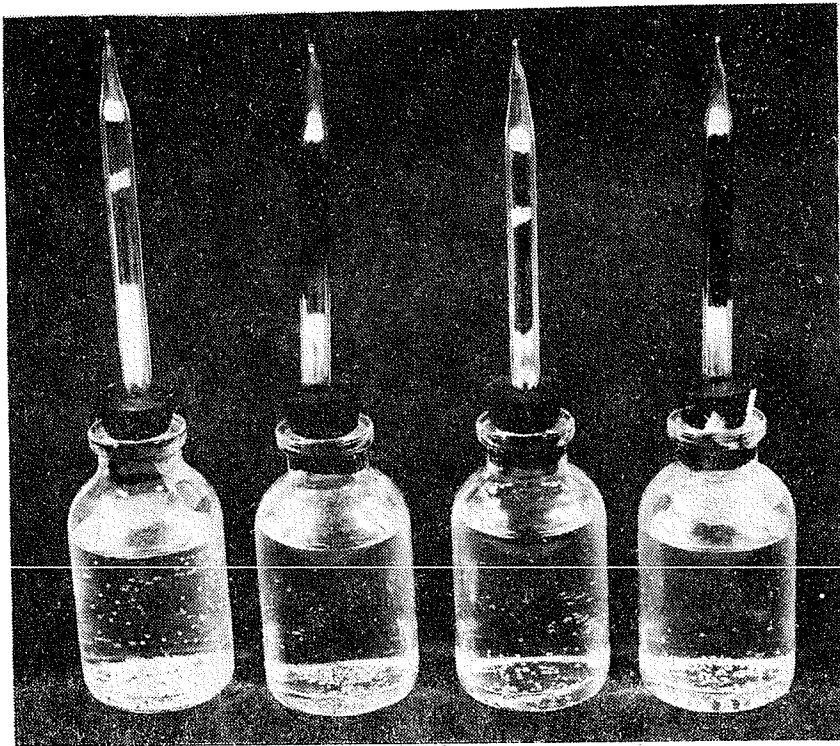
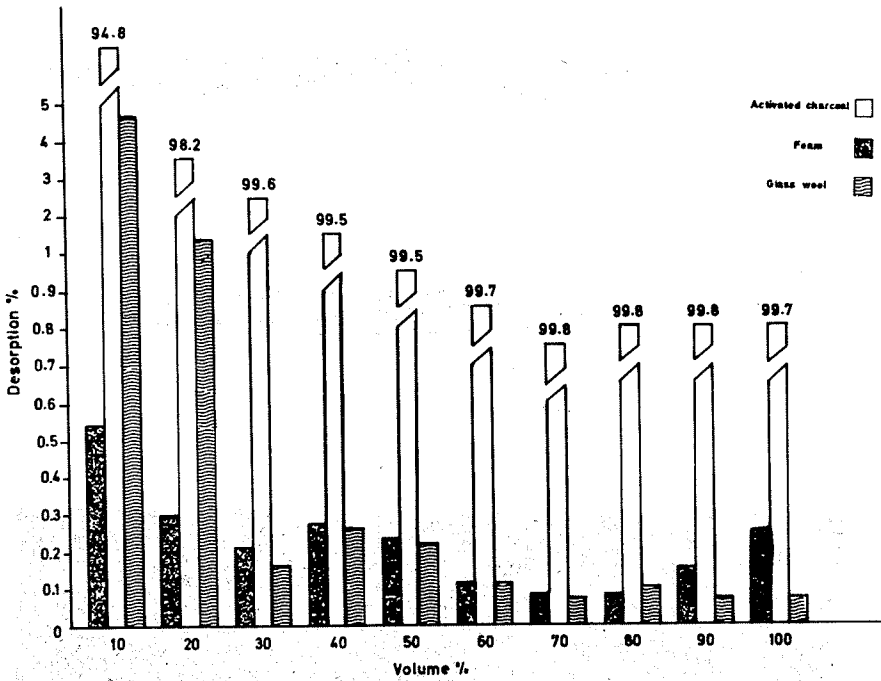
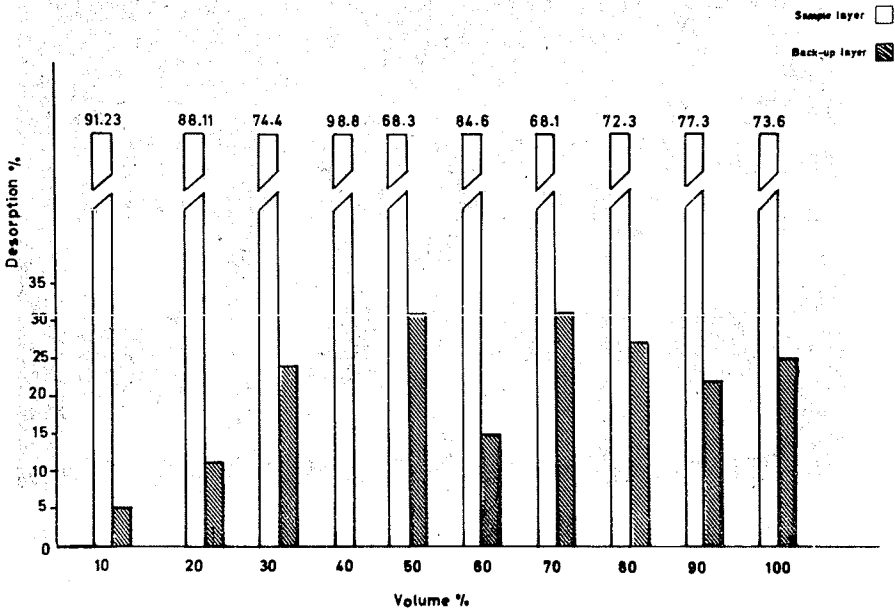


Fig. 3: Artificial exposure of the activated charcoal sampler tubes to different volume percentages of benzen, toluene and Xylene.



Diag. 1. Desorption percentages of benzene by different parts of the foamless activated charcoal tubes.



Diag. 2. Desorption percentages of benzene by sample and back-up layers of the foamed activated charcoal tubes.

Table 1. Desorption percentages of Toluene by different parts of foamless activated charcoal tubes.

Volume % of Toluene	Desorption Percentage		
	Activated Charcoal	Foam	Glasswool
10	97.45(2.37)*	0.00	0.00
20	98.70(0.47)	0.11(0.23)	0.17(0.33)
30	98.12(0.13)	0.06(0.00)	0.81(0.03)
40	99.76(0.18)	0.06(0.01)	0.18(0.03)
50	99.9(0.10)	0.05(0.00)	0.006(0.00)
60	97.65(0.08)	0.025(0.00)	2.24(0.00)
70	99.92(0.08)	0.06(0.00)	0.01(0.00)
80	99.91(0.09)	0.06(0.03)	0.03(0.00)
90	98.92(0.04)	1.01(0.00)	0.07(0.00)
100	98.9(0.10)	1(0.00)	0.00

Table 2. Desorption percentages of O-Xylene by different parts of foamless activated charcoal tubes.

Volume % of O-Xylene	Desorption Percentage		
	Activated Charcoal	Foam	Glasswool
10	98.67(1.25)*	0.71(1.81)	0.49(1.30)
20	100 (0.00)	0.00	0.00
30	100 (0.00)	0.00	0.00
40	100 (0.00)	0.00	0.00
50	100 (0.00)	0.00	0.00
60	96.39(0.25)	0.00	3.6(0.00)
70	100 (0.00)	0.00	0.00
80	100 (0.00)	0.00	0.00
90	100 (0.00)	0.00	0.00
100	100 (0.00)	0.00	0.00

* () = Standard deviation

Table 3. Desorption percentages of Toluene by different Parts of foamed activated charcoal tubes

Volume % of Toluene	Desorption Percentages				
	Sample Layer	Back-up layer	middle foam	end foam	glasswool
10	99.86(0.21)*	0.00	0.028(0.00)	0.026(0)	0.052(0.00)
20	98.85(1.35)	0.00	0.00	0.00	0.9(0.00)
30	99.55(0.27)	0.41(0.12)	0.015(0.00)	0.012(0)	0.0007(0.00)
40	99.79(0.18)	0.00	0.078(0.00)	0.122(0)	0.00
50	99.58(0.23)	0.4(0.07)	0.01(0.00)	0.00	0.01(0.00)
60	99.45(0.36)	0.03(0.03)	0.002(0.00)	0.04(0)	0.47(0.01)
70	99.94(0.06)	0.00	0.00	0.00	0.00
80	99.8(0.18)	0.09(0.08)	0.09(0.00)	0.00	0.007(0.00)
90	98.24(0.9)	0.89(0.88)	0.05(0.00)	0.07(0)	0.003(0.00)
100	99.67(0.09)	0.01(0.01)	0.27(0.00)	0.00	0.05(0.00)

Table 4. Desorption percentage of P-Xylene by different parts of foamed activated charcoal tubes

Volume% of P-Xylene	Desorption Percentages				
	Sample layer	back-up layer	middle foam	end foam	glasswool
10	98.16(1.31)*	1.04(1.70)	0.09(0.18)	0.43(1.53)	0.27(1.7)
20	99.75(0.25)	0.00	0.00	0.00	0.07(0.180)
30	98.54(1.46)	0.16(0.28)	0.00	0.00	0.00
40	99.31(0.7)	0.03(0.05)	0.00	0.00	0.00
50	91.53(0.8)	4.70(3.0)	0.00	0.00	0.13(0.00)
60	99.16(0.8)	0.59(0.51)	0.22(0.00)	0.00	0.00
70	98.4(1.6)	0.07(0.12)	0.00	0.00	0.00
80	98.26(1.6)	0.07(0.12)	0.00	0.00	0.00
90	95.7(3.62)	3.6(2.72)	0.00	0.00	0.00
100	99.26(0.27)	0.15(0.25)	0.00	0.00	0.00

* () = Standard deviation

used, the occurrence of unknown peaks were observed, which may concern the presence of polyurethane foam decomposition. So unexposed polyurethane foam and glasswool were also extracted separately by carbon disulphide and then injected into the G.C., but the unknown peaks obtained weren't identified. Next stage was the injection of the extraction of the materials used in the manufacture of polyurethane foam dissolved in CS_2 into the G.C. The peaks observed had the same retention times as for the above unknown peaks which probably are due to the decomposition of the foam while exposure, desorption and analysis was performed.

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