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FIELD COMPARISON OF TWO KINDS OF CHARCOAL TUBES FOR SAMPLING AROMATIC HYDROCARBONS (TOLUENE & XYLENE) IN A PAINT FACTORY

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Abstract

In order to evaluate the effectiveness of the Iranian made charcoal tubes in the field , 60 local made and 60 imported ones (SKC type) were randomly selected and placed side by side for sampling aromatic hydrocarbons (including Benzene , Toluene , Xylene) in workers breathing zone in a paint factory. The results indicated that there were no statistically significant differences between the mean concentration of aromatic hydrocarbons measured in studied groups. The ratios of pressure drop to flow rate of Iranian made tubes were statistically higher than the SKC ones ($P<0.01$).

Introduction

The activated charcoal sampler tubes were produced for the first time in occupational health laboratory in 1988 (1). It was also evaluated (2).This study has been carried out in order to evaluate the effectiveness of the local made sampler tubes in the field in comparison with foreign made (SKC) activated charocal sampler tubes.

Materials and methods

Among the several important activated charcoal sampler tubes , the ones made by SKC were more available in our country , so they were used as a comparison tubes. 60 local made and 60 SKC made charcoal tubes were randomly selected and placed side by side for air sampling in workers breathing zone,

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by using SKC pump type 222-3 in association with two adjustable limiting used orifice , to control low flow rate (100 ml/min). The charcoal tubes holders were placed vertically to prevent air channel and also the distance between the tubes were 7 centimeters. The desorption of the pair samples were performed by chemical method (1) and analyzed by gas chromatography method (GC).

GC column packing substance: 3% silicon methyl (OV-1)

(OV-1) chromosorb WHP , mesh 80/100

Glass column , 2 m & 4 mm ID , 5 mm OD

Detector : FID

Carrier gas , N_2 , 5ml/min

Temp. 80°C

Detector temp. 150 , Injector temp. 130°C

In order to measure the pressure drop of the sampling tubes and make a comparison with the imported ones , 5 local made tubes and imported tubes were randomly selected and their pressure drop were measured at flow rates equal tp 100 , 200 , 900 ml/min (Fig. 1).

The desorption efficiency were caluculated on the basis of NIOSH recommendation (3). Known amounts of the solvents injected directly by a microsyringe to the sample layer of the tubes. Then after passing 24 hours , they were analyzed by GC instrument. In this stage 18 charcoal tubes were randomly selected from the two goups and the experiments were carried out for six levels of toluene & Xylene concentration. In each level 3 local made and 3 imported tubes were exposed to the above mentioned solvents and the results compared with control tubes. The desorption efficiency (DE) were computed from the following formula (3).

$$DE = \frac{\text{ug Sample - blank in ug}}{\text{Weight added in ug}}$$

Results

Table 1 shows the measured concentration of aromatic solvents : toluene , meta , para and orto Xylene by both activated charcoal sampling tubes. As the results show , there were no statistically significant differences between the mean concentration of above-mentioned solvents in studied groups.

The comparison between pressure drops in different flow rates of local made and imported sampling tubes are summarized in Tabel 2. For having comparable conditions , the ratio of pressure drop to flow rate was used. The results of paired t-test showed that the above-mentioned ratio of Iranian made sampling tubes were statisticaly higher than the SKC one ($P<0.01$). The pressure drop of SKC sampling charcoal tubes was more than the limits recommended by NIOSH. It means that the Iranian made activited charocal sampling tubes are more resistant to air flow in equal flow rates. Desorption efficiency of tested tubes are shown in Table 3. The paired t-test data in this part of the study indicated that the mean desorption efficiency of the imported tubes are statistically higher than the local made one $P<0.01$, except for 0-Xylene which didnot show any differences.

Discussion

Sampling efficiency of Iranian made charcoal tubes were assessed for toluene , meta , para and orto-xylene in comparison with SKC ones.

The results indicated no difference , so that the correlation coefficients (r) for toluene , m. p. and o. xylene were higher than 0.99 (Table 4) which showed the Iranian charcoal tubes reflect the true concentration. Of course , there are some sources of errors due to unknown chemicals which occupied the granular bed and may interfere with analysis. Totally , the results indicated that the local made charcoal tubes are suitable for measuring aromatic solvent vapours in the fields.

Pressure drops of local made charcoal sampling tubes were more than the SKC tubes. However , the SKC tubes had higher pressure drop than the values recommended by NIOSH. It may be due to filling manner of charcoal granules inside the tubes which were produced manually. So the arrangement of granules may cause these differences. The other source of error may be due to the mesh of the granules , because there is a relationship between the particle size distribution and the pressure drop.

The results of recovery efficiency indicated that there was not any significant difference between tubes for sampling 0-xylene , but some differences were observed in the case of m.xylene and toluene. It may be

expressed as below:

There was no possibility for analyzing the samples immediately after sampling and it was usually done after a delay. This delay may have resulted in loss of collected vapours. Another reason may be due to variations of internal diameter which produce significant variations in cross-sectional area that results in calibration errors.

It is the judgment of the authors that the potential errors did not significantly affect the results , then it can be concluded that these tubes could be used in the field with high confidence.

Table 1- Mean concentration of measured aromatic solvents by two kinds of charocal sampler tubes

Statistical Indices / N / Solvents		Iranian tubes	SKC Tubes	Differences
Toluene	60	7.8 (8.3)	7.9 (8)	-6.17 (0.95)
M. & P. xylene	60	29.29 (48.3)	29.44 (47.3)	-0.14 (2.75)
0.Xylene	60	5.36 (5.9)	5.5 (5.5)	-0.16 (0.862)

( ) = Standard deviation

Table 2- Pressure drops of charcoal sampler tubes in different flow rates , Cm. WG.

Tubes / parameters / N / Flow rate ranges		Iranian made Q Lit/min	Iranian made P CmWG	Iranian made P/Q	SKC Q Lit/min	SKC P CmWG	SKC P/Q
0.1 ml/min	1	0.095	5.7	60.0	0.098	4.2	42.9
	2	0.095	5.7	60.0	0.097	4.35	44.8
	3	0.096	5.2	54.2	0.097	4.15	42.8
	4	0.095	5.9	61.5	0.096	5.0	51.5
	5	0.096	5.2	54.2	0.096	4.15	43.2
Mean (S.D)		0.095 (0.0005)	5.94 (1.03)	57.98 3.5	0.096 (0.0008)	4.37 (0.36)	45 (3.7)
0.2 ml/min	1	0.191	12.3	64.4	0.193	8.7	45.1
	2	0.188	15.9	84.6	0.203	9.4	46.3
	3	0.196	10.5	53.6	0.200	8.5	42.5
	4	0.196	10.3	53.6	0.200	10.5	52.5
	5	0.198	10.2	51.5	0.199	8.4	42.2
Mean (S.D)		0.194 (0.0044)	12.2 (2.27)	63.24 (13.13)	0.199 0.0036	9.1 (0.87)	45,7 (4.16)
0.9 ml	1	0.909	85.6	94.2	0.938	54.4	58.0
	2	0.879	108.0	122.9	0.930	55.7	59.9
	3	0.923	67.9	73.6	0.927	54.4	58.7
	4	0.909	81.5	89.6	0.923	63.9	69.2
	5	0.913	68.0	74.5	0.930	51.6	55.6
Mean (S.D)		0.906 0.016	82.2 16.5	91.0 (20)	0.929 (0.0055)	56.0 (4.7)	66.3 5.25

Table 3 - Desorption efficiency of iranian and imported charcoal sampling tubes in different concentrations for tuluene , m.xylene and o.xylene

Solvents	toluene				m.xylene				o.xylene			
Sampler tubes	Iranian		SKC		Iranian		SKC		Iranian		SKC	
Statistical indices	X	S.D	X	S.D	X	S.D	X	S.D	X	S.D	X	S.D
N / Volumes of solvents												
0.05	91.0	2.7	93.7	1.3	90.6	4.0	91.2	1.3	96.1	2.8	95.1	1.25
0.1	94.8	0.76	96.6	1.3	94.2	1.2	95.7	1.8	98.6	1.3	97.5	1.25
0.5	99.3	1.6	99.7	1.5	98.7	1.2	98.7	1.8	97.7	1.7	98.1	1.6
1.0	95.8	2.5	99.6	1.7	95.6	4.0	>99.7	3.5	96.3	3.2	97.9	3.2
5.0	99.0	0.28	100.0	1.4	98.2	0.49	99.9	1.5	99.8	0.52	98.9	1.48
10.0	97.4	2.4	99.9	0.64	98.3	2.9	99.1	0.62	98.0	0.7	97.9	0.7
N	3	3	3	3	3	3	3	3	3	3	3	3
total efficiency	96.23	3.1	98.24	2.58	95.95	3.16	97.38	3.3	97.75	1.39	97.57	1.31

Table 4- Comparison between Iranian and imported activated charcoal tubes

Statistical Indices / N / Solvents	T-Test	Correlation coefficient
toulene	-1.42*	0.994**
m & p. Xylene	-0.4 *	0.999**
o.xylene	-1.45*	0.99**

* Not significan t

** P<0.001

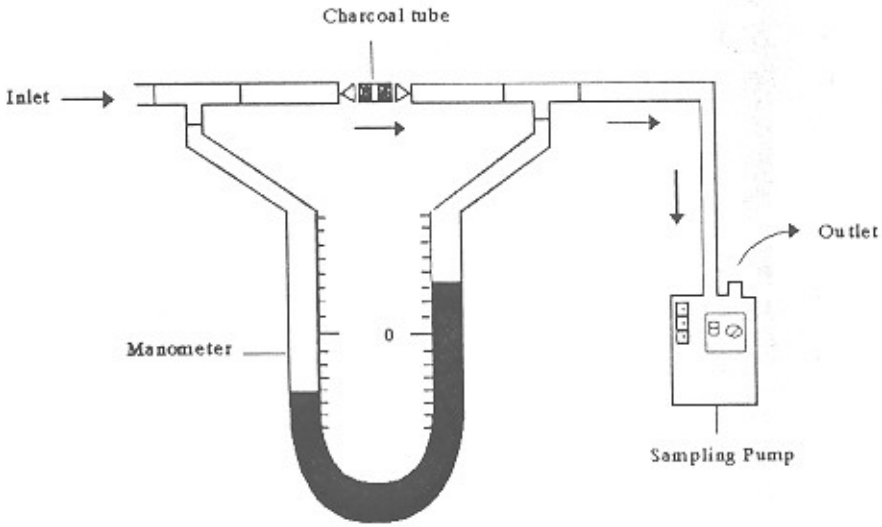

Fig. 1- Pressure Drop Calibration line

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