Environment Protection Engineering

Vol. 12 1986 No. 4

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USABILITY OF DIRECTIONAL DUST SAMPLER FOR ESTIMATING THE AIR POLLUTION

For the purpose of estimating the air pollution the authors compared the efficiencies of collecting the falling dust by Weck's jar, fixed dust sampler, and directional dust sampler. Dust collection efficiency was analysed with respect to varying meteorological conditions such as: the amount of rainfall and wind speed, as well as their frequencies.

The product of the frequency of wind of a given speed and the respective speed (% V), and correlation coefficient defining the co-occurrence of Zn, Cr, Ni, Fe, Mn, Pb, and Cd in collected dust were assumed as criteria of usability of instruments. The research results speak in favour of the directional dust sampler.

1. INTRODUCTION

An important issue of investigating the air pollution background is representative sampling. The requirements for such a sampling seem to be met by directional dust sampler (Patent number 36662).

The aim of the research was to examine and then to compare the effectiveness of collecting the falling dust by means of directional dust sampler, fixed dust sampler, and Weck's jar, under varying meteorological conditions.

2. METHODS

Directional dust sampler, fixed dust sampler, and Weck's jar (figure) were installed in the airfield in Katowice. The open area covered with grass ensured a relatively steady rate of probable secondary dust emission from the ground. Topographical conditions around the measuring stand and a relatively distant wood

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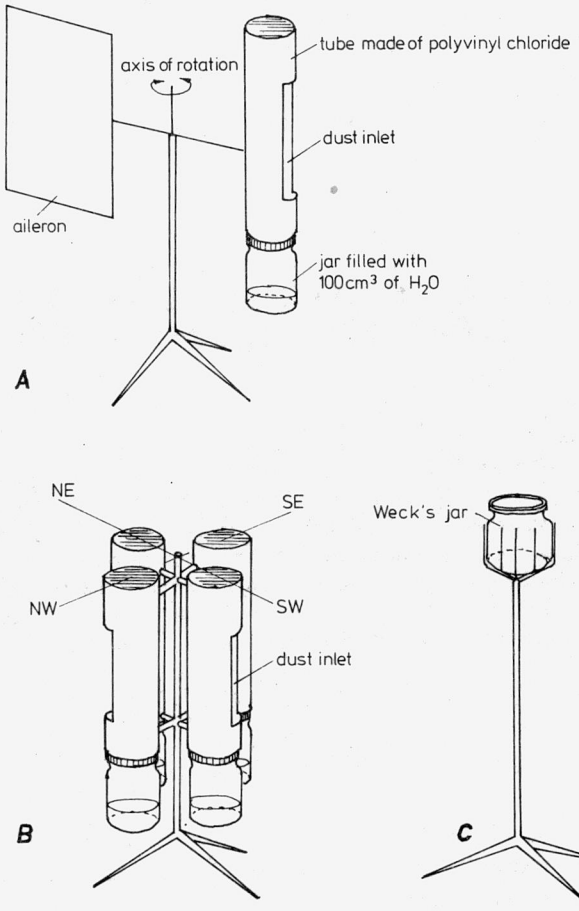

Directional dust sampler (A), fixed dust sampler (B), Weck's jar (C)

line (about 2 km), perpendicular to the measuring stand, should not cause nearby disturbances to dustiness of air. The choice of such a place is representative for comparative dust measurements.

The measurements, on the basis of which efficiencies of the three instruments were to be compared, were carried out from May 15, 1985 till October 27, 1985, within subsequent ten-day intervals.

After a ten-day exposition, and after the water had been taken by evaporating, the collected dust was weighed and then, in order to determine the presence of selected metals, it was subjected to atomic absorption spectrophotometric analysis, using an instrument of the Instrumentation Laboratory Inc., Modell I1-257 (USA).

Continuous recording of meteorological conditions was made simultaneously to dust collection. The amount and frequency of rainfall, as well as speed, direction and frequency of wind were registered.

Table 1

Quantitative comparison of dust collected by Weck's jar, directional dust sampler and fixed dust sampler (in g)

Date of sampling	Amount of rain fall*	Weck's jar	Directional dust sampler	Fixed dust sampler				
				SW direction	NW direction	NE direction	SE direction	$\bar{c}$ mean values
15.05–24.05	41.5	0.0225	0.0323	0.0182	0.0135	0.0130	0.0147	0.0148
25.05– 4.06	51.5	0.0150	0.0526	0.0155	0.0101	0.0247	0.0198	0.0175
5.06–14.06	31.4	0.0167	0.0371	0.0384	0.0331	0.0096	0.0087	0.0224
15.06–24.06	19.2	0.0246	0.0139	0.0242	0.0310	0.0104	0.0100	0.0189
28.06– 7.07	14.8	0.0200	0.0023	0.0250	0.0130	0.0100	0.0073	0.0138
8.07–17.07	49.6	0.0021	0.0317	0.0022	0.0014	0.0012	0.0285	0.0083
18.07–27.07	39.7	0.0090	0.0180	0.0170	0.0220	0.0090	0.0090	0.0142
28.07– 7.08	101.9	0.0290	0.0372	0.0228	0.0226	0.0270	0.0151	0.0219
8.08–17.08	71.5	0.0061	0.0177	0.0067	0.0011	0.0046	0.0030	0.0038
18.08–27.08	25.9	0.0272	0.0224	0.0075	0.0122	0.0106	0.0067	0.0092
28.08– 7.09	11.6	0.0166	0.0357	0.0159	0.0293	0.0368	0.0131	0.0238
8.09–17.09	8.3	0.0847	0.0269	0.0466	0.1406	0.3561	0.0168	0.1400
18.09–27.09	0.3	0.0076	—	0.0087	0.0100	0.0172	0.0036	0.0098
28.09– 7.10	0.2	0.0040	0.0190	0.0125	0.0068	0.0039	0.0012	0.0061
8.10–17.10	19.8	0.0133	0.0267	0.0148	0.0321	0.0064	0.0056	0.0147
18.10–27.10	4.1	0.0245	0.0363	0.0151	0.0194	0.0160	0.0174	0.0169

* mm $H_2O/200\ cm^2$

Table 2

Influence of wind upon efficiency of directional dust sampler

Date of sampling	$\sum \%\cdot V[\%\cdot m\cdot s^{-1}]$	Mass of dust [g]
15.05–24.05	311.03	0.0323
25.05– 4.06	246.62	0.0526
5.06–14.06	405.78	0.0371
15.06–24.06	284.15	0.0139
28.06– 7.07	286.66	0.0023
8.07–17.07	212.29	0.0317
18.07–27.07	324.30	0.0180
28.07– 7.08	299.82	0.0372
8.08–17.08	261.22	0.0177
18.08–27.08	270.77	0.0224
28.08– 7.09	254.07	0.0357
8.09–17.09	379.62	0.0269
18.09–27.09	265.57	—
28.09– 7.10	227.05	0.0190
8.10–17.10	320.9	0.0267
18.10–27.10	204.12	0.0363

Table 3

Metal content in dust collected by directional dust sampler for decades when total amount of rainfall was below 15 mm H_2O/200 cm^2

Date of sampling	Metal content [g]							Mass of dust [g]
	Ni	Cu	Fe	Mn	Zn	Pb	Cd	
28.06– 7.07	0.026	0.012	—	0.063	0.151	0.042	0.006	0.0023
28.08– 7.09	0.033	0.013	0.256	0.108	0.175	0.063	0.010	0.0357
8.09–17.09	0.029	0.006	0.237	0.022	0.062	0.001	0.010	0.0269
28.09– 7.10	0.060	0.016	0.714	0.070	0.128	0.002	0.002	0.0190
8.10–17.10	0.020	0.016	0.870	0.152	0.254	0.090	0.002	0.0267
18.10–28.10	0.004	0.005	0.36	0.038	0.080	0.032	0.003	0.0363

3. RESULTS AND DISCUSSION

Table 1 presents the data on the basis of which the dust collection efficiency can be determined with respect to particular dust samplers. The masses of the collected dust are put into separate table columns for Weck's jar, directional dust sampler, and fixed dust sampler.

The obtained results reveal the complexity of selective dust collection according to prevailing meteorological conditions, mainly to precipitations and average wind rose in a given decade. When there is the fall of rain, overrated values of mass of the dust collected by Weck's jar are obtained. Diverse wind speeds in a dry period favour instruments of the type of directional dust sampler.

Relative least dust collection efficiency of fixed dust sampler during rainfall can be explained by the lack of sufficient active exposition to the rain of the four stationary dust samplers, hence in this case the results may be inadequate to the dustiness of air.

The dependence between the amount of the collected dust and the wind speed is shown in tab. 2. In general, it can be observed that the mass of the dust collected by directional dust sampler increases with the increase of the product of the frequency of winds of a given direction and their average speed ($\% \cdot V$). This gives evidence of correct reaction of the instrument to varying anemological conditions.

Tables 3 and 4 present the results of chemical analyses determining the presence of metals. Dust samples collected by directional dust sampler were tested in conditions when the amount of rainfall was below 15 mm H_2O per 200 cm^2 (tab. 3) and when it exceeded 15 mm H_2O per 200 cm^2 (tab. 4). It is easily seen that, regardless of the amount of rainfall, the obtained results are similar.

The assumed criteria of efficiency of the examined devices are as follows:

masses of dusts collected simultaneously by the particular devices,

Table 4

Metal content in dust collected by directional dust sampler for the decades when total amount of rainfall was above 15 mm $H_2O/200\ cm^2$

Date of sampling	Metal content [g]							Mass of dust [g]
	Ni	Cu	Fe	Mn	Zn	Pb	Cd	
15.05–24.05	0.015	0.007	0.080	0.028	0.404	0.092	0.007	0.0323
23.05– 4.06	0.019	0.012	0.133	0.015	0.061	0.121	0.007	0.0526
5.06–14.06	0.026	0.011	0.121	0.117	0.013	0.145	0.096	0.0371
15.06–24.06	0.028	0.016	—	0.102	0.097	0.115	0.017	0.0139
8.07–17.07	0.045	0.021	0.335	0.173	0.395	0.116	0.015	0.0317
18.07–27.07	0.037	0.009	0.177	0.053	0.220	0.045	0.014	0.0180
28.07– 7.08	0.014	0.012	0.100	0.148	0.240	0.122	0.006	0.0372
8.08–17.08	0.010	0.006	0.380	0.040	0.087	0.041	0.006	0.0177
18.08–27.08	0.010	0.007	0.129	0.039	0.093	0.041	0.006	0.0224

correlation coefficient between the metals present in dust — tabs. 5 and 6, product of the frequency of wind of a given speed and the respective speed. The values of correlation coefficient between particular metals present in dust are

Table 5

Co-occurrence of metals in dust collected by directional dust sampler for the decades when total amount of rainfall was below 15 mm $H_2O/200\ cm^2$

Determination coefficient / Multiple corrrelation coefficient	Elements						
	Ni	Cu	Fe	Mn	Zn	Pb	Cd
Ni		0.095 / 0.308	0.990 / 0.995	0.080 / 0.283	0.138 / 0.372	0.409 / 0.640	0.086 / 0.290
Cu			0.631 / 0.794	0.409 / 0.640	0.574 / 0.757	0.231 / 0.481	0.630 / 0.790
Fe				0.367 / 0.606	0.419 / 0.648	0.122 / 0.349	0.960 / 0.980
Mn					0.952 / 0.976	0.809 / 0.899	0.221 / 0.470
Zn						0.800 / 0.927	0.269 / 0.518
Pb							0.032 / 0.179
Cd							

Table 6

Co-occurrence of metals in dust collected by directional dust sampler for the decades when total amount of rainfall was below 15 mm $H_2O/200$ cm^2

Determination coefficient / Multiple corrrelation coefficient	Elements						
	Ni	Cu	Fe	Mn	Zn	Pb	Cd
Ni		0.462 / 0.680	0.005 / 0.071	0.224 / 0.474	0.104 / 0.324	0.075 / 0.274	0.036 / 0.191
Cu			0.196 / 0.443	0.611 / 0.782	0.104 / 0.323	0.075 / 0.274	0.036 / 0.189
Fe				0.196 / 0.443	0.026 / 0.163	0.018 / 0.136	0.061 / 0.248
Mn					0.104 / 0.323	0.244 / 0.494	0.165 / 0.406
Zn						0 / 0.003	0.095 / 0.308
Pb							0.216 / 0.464
Cd							

diverse. They indicate, however, the same efficiency of trapping particular metals by directional dust sampler, this especially referring to Ni and Fe.

On the basis of the obtained results and the analysis of the principles of operation of the dust samplers (1) we can state that the directional dust sampler ensures the most representative results which testify to the pollution of air, resulting from the secondary dusting or angular transport of polluted masses of air.

PRZYDATNOŚĆ PYŁOMIERZA KIERUNKOWEGO W OCENIE INTOKSYKACJI POWIETRZA

Aby ocenić intoksykację powietrza, porównano skuteczność zbierania opadających pyłów przez słój Wecka, pyłomierz stały i pyłomierz kierunkowy. Efektywność zbierania pyłów analizowano w kontekście zmiennych warunków meteorologicznych, takich jak: ilość opadów deszczu, prędkość wiatrów i częstość ich występowania.

Za kryterium miarodajności ilości pyłu zebranego przez dane urządzenie przyjęto wartość iloczynu występowania wiatru o danej prędkości i prędkości wiatru ($\% \cdot V$) oraz współczynnik korelacji określający współwystępowanie Zn, Cu, Ni, Fe, Mn, Pb i Cd w zebranym pyle. Przeprowadzone badania przemawiają za użyciem pyłomierza kierunkowego.

ПРИГОДНОСТЬ НАПРАВЛЕННОГО ПЫЛЕМЕРА ДЛЯ ОЦЕНКИ ИНТОКСИКАЦИИ ВОЗДУХА

Для оценки интоксикации воздуха, сравнена эффективность сбора оседающихся пылей с помощью стеклянной банки Века, стационарного и направленного пылемеров. Эффективность сбора пылей анализировано в контексте переменных метеорологических условий таких как: количество дождевых осадков, скорость ветра и частоточность их присуствования.

Критерием достоверности количества пыли собранной данными оборудованиями принято считать величину произведения присутствования ветра с данной скоростью ветра ($\%\cdot V$), а также коэффициент корреляции определяющий совместное присутствование Zn, Cu, Ni, Fe, Mn, Pb, Cd в собранной пыли. Проведены исследования заступаются за употребление направленного пылемера.