DUSTFALL AT JODHPUR—PART IV

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(*Received* 12 *January* 1970 ; *revised* 8 *April* 1970)

Atmospheric dustfall collections were determined during the year 1966 and 1967 in a newly designed dustfall collector and in large aluminium pans. The water solubles and insolubles were determined. The ionic constituents CO_3^{--}, HCO_3^{-} Cl^{-}, NO_2^{-}, NO_3^{-}, SO_4^{--}, Ca^{++}, Mg^{++}, Na^{+} and K^{+} were determined in the water soluble portion of the dust. CO_3^{--} was found absent in all the samples.

This investigation forms a part of the long term programme of studies undertaken to evaluate the quantum and quality of dustfall at Jodhpur initiated in June 1961[1—3]. This data will help in understanding the annual transport of water soluble ions along with the dustfall in Jodhpur regions which in turn be of use in evaluating the serviceability of service equipments under desert conditions from the point of view of their performance, corrosion behaviour and life of surface paints. This dustfall data is for the years 1966 and 1967.

EXPERIMENTAL PROCEDURE

Apparatus

The dustfall was collected and analysed with the following types of dust collectors installed at a height of one metre (height was measured from the ground to the top rim of the dust collecting vessel) and employed as mentioned against each :

(*i*) *Aluminium Pan, Circular* (dia 122 cm, depth 25·4 cm)—It was fabricated from INDAL 3S, 3 mm thick. It was employed as follows :

(*a*) dry

(*b*) wet, i.e. filled with distilled water to two-third height of the pan.

(*ii*) *Dustfall Collector*[2] (top dia 30 cm)—It was employed in two ways :

(*a*) wet

(*b*) wet, but kept in a partly-sheltered shed.

(*iii*) *Dust Collecting Cylinder*[4] (dia 15 cm)—As per ASTM standard. Distilled water was filled to two-third height of the Cylinder.

Site

Open exposure yard in the laboratory campus.

Sampling Procedure

It was ensured that the water kept in the dust collectors was replenished whenever the water level went down to half the original level. The dust along with water solubles was collected once in 30 ± 2 days and brought to the laboratory for detailed examination.

TABLE 1

WATER SOLUBLE CONSTITUENTS OF YEARLY DUSTFALL SAMPLES. (METRIC TONS/KM²)
(First set of values are for the year 1966 and the second for 1967)

Type of collector	Na^+	K^+	Ca^{++}	Mg^{++}	HCO_3^-	Cl^-	SO_4^{--}	NO_3^-	NO_2^-
Aluminium Pan*(wet)	1·198	0·792	6·013	0·277	22·78	1·02	0·623	0·174	0·006
	1·256	1·005	11·598	0·865	39·88	0·99	1·023	2·495	Nil
Dustfall Collector (open)	1·054	0·865	6·681	0·639	25·41	1·11	1·088	0·871	0·002
	1·001	0·715	8·462	1·065	30·96	0·91	1·990	1·174	Nil
Dustfall Collector (shed)	0·705	0·560	1·152	0·362	21·31	0·66	0·381	1·431	0·006
	0·771	0·598	6·125	0·536	21·14	0·75	1·163	2·423	Nil
Dust Collecting Cylinder	2·071	1·452	13·450	0·750	48·75	1·98	1·710	2·663	0·009
	1·527	1·138	11·967	0·980	54·95	1·16	3·510	1·285	Nil

*Contents in Aluminium Pan (dry) were not examined.

Method of Examination

The water insoluble portion was separated by filtration, dried at 105° C and weighed. Particle size of selected samples was determined by using aerojet test sieve.

The water soluble portion was always made up to 5 litres with distilled water and analysed for total dust solubles, cations and anions. The *p*H and conductivity of the solution were also determined by using a cambridge *p*H meter Bench-pattern and a mains operated conductivity bridge WTW type, LBB/B respectively.

The cations determined were Ca^{++}, Mg^{++}, Na^+ and K^+ and anions CO_3^{--}, HCO_3^-, Cl^-, SO_4^{--}, NO_3^- and NO_2^-. Of these Ca^{++} and Mg^{++} were estimated by EDTA method, Na^+ and K^+ by flame photometry, and the rest by standard methods. Cl^- and SO_4^{--} were determined after concentrating the test filtrate.

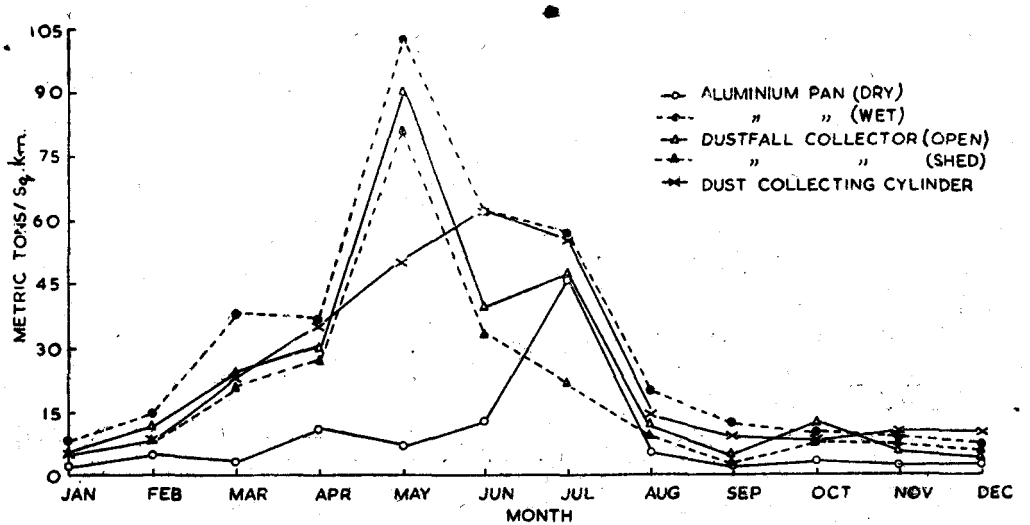

Fig. 1—Monthly dustfall at Jodhpur by different collectors in 1966.

TABLE 2

ANALYSIS OF RAIN-WATER AT JODHPUR IN 1967

Period of collection	Rainfall (mm)	Bicarbonate content (mg/lit)	Fall of bicarbonate due to rainfall (metric tons/km²)
4 August	6·6	11·7	0·071
8 August	8·3	18·6	0·158
14 August	67·1	23·5	1·572
21 August	17·5	62·8	1·100
24 August	22·9	11·7	0·085
28 August	4·6	30·6	0·139
TOTAL	127·0	158·9	3·125

RESULTS AND DISCUSSION

The data on the monthly dustfall collected with various types of collectors kept in different environments at one metre height in the years 1966 and 1967 at Jodhpur are graphically represented in Fig. 1 and Fig. 2. In general, the dustfall in 1966 is found to be higher than the dustfall in 1967; also the dustfall is higher in the summer months (March–July) when dust storms are severe. The dustfall is low in the months of November, December and January.

The water soluble constituents in dust samples collected by various types of collectors are given in Table 1. The water soluble contents of dustfall in Aluminium Pan, Circular (dry), were not examined.

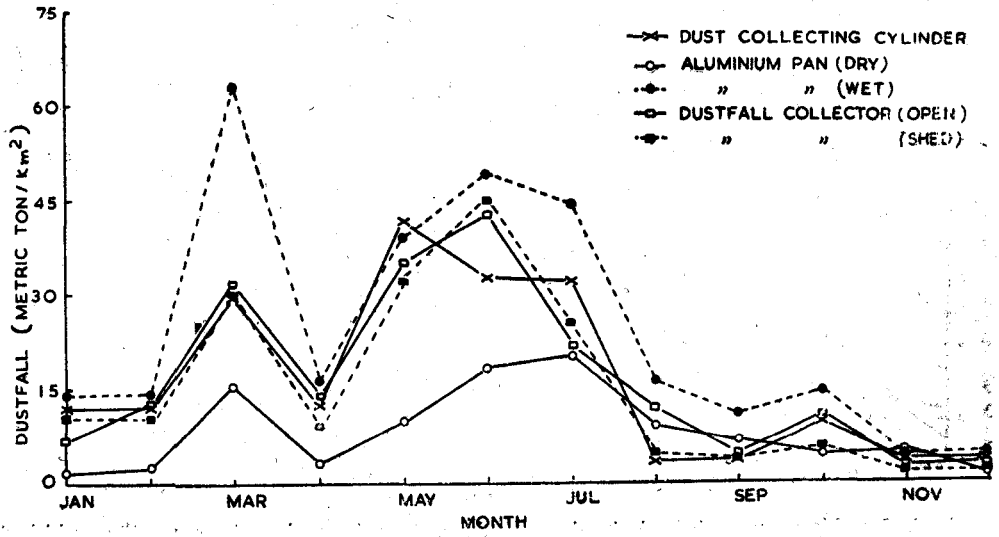

Fig. 2—Monthly dustfall at Jodhpur by different collectors in 1967.

It is seen that the dust samples contain large quantities of bicarbonate which is attributable to the dissolved CO_2 from the atmosphere. This is evident from data on rain-water presented in Table 2. Carbonate is absent. Nitrite is found in traces at times. Significant amount of chloride and sulphate are found always. Sulphate, even though could not be detected in our earlier study[3], was found present when the soluble portion in water was concentrated.

Dustfall During Summer

An idea of the extent of heavy dustfall during summer can be had from the fact that the following percentages of annual dustfall were collected during the four summer months (March-July) in 1966 and 1967 by the various methods :

Method	Dustfall (%)	
	1966	1967
Aluminium Pan (dry)	77	68
Aluminium Pan (wet)	78	72
Dustfall Collector (open)	78	73
Dustfall Collector (shed)	79	78
Dust Collecting Cylinder	77	76

*p*H *Value*

The *p*H of water solubles varied from 6·60 to 8·22 in 1966 and 6·68 to 8·22 in 1967.

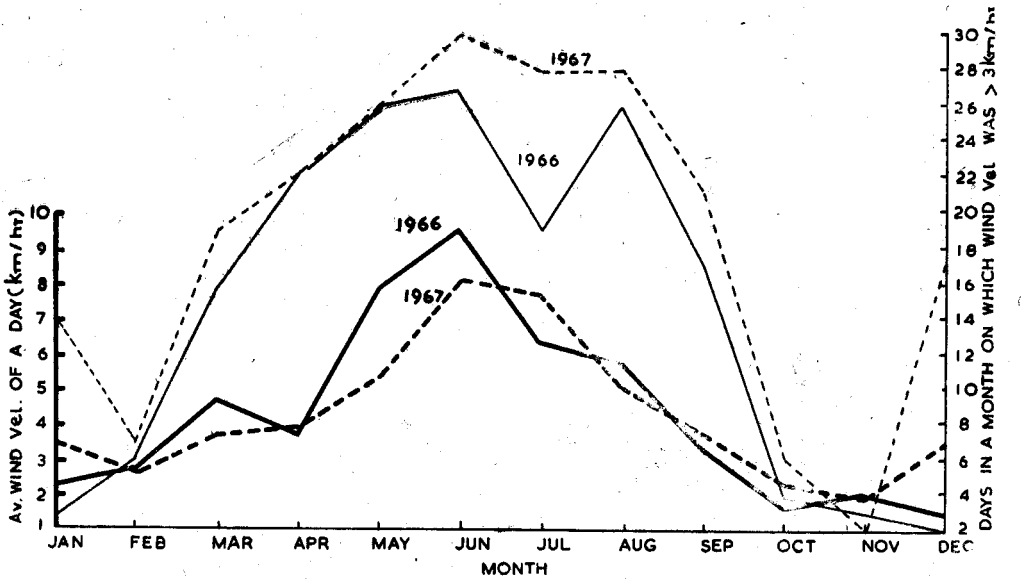

Fig. 3—Monthly average wind velocity data of a day and number of days in a month on which the wind velocity was > 3 km/hr.

Particle Size

Data on the sieve analysis of a few dust samples collected by Aluminium Pan, Circular (wet and dry) and Dustfall Collector during January, May, June and December of 1966 and 1967 are presented in Table 3 (since the quantity of dust collected by the Dustfall Collector was very small in the months of January and December, particle sizes could not be determined). From the data it is seen that, generally, particles bigger than 210 microns are found less. Particles collected by different collectors in the same period do not show uniformity in their sizes.

Rainfall

Rainfall in 1966 was about 343 mm as compared to 640 mm in 1967. This probably resulted in more settlement of dust and low dustfall collection in 1967.

Wind Velocity

A comparison of "wind velocity data and the number of days in which the wind velocity was greater than 3 km/hr" (Fig. 3) with "monthly dustfall (Fig. 1 and 2) shows that, in general, the dustfall is more during the period in which the wind velocity is high and of long duration".

TABLE 3

SIEVE ANALYSIS OF DUST COLLECTED AT JODHPUR BY VARIOUS COLLECTORS
(First set of values are for the year 1966 and the second for 1967)

Sieve size	Dust passing through various sieves (%)									
	Aluminium Pan (dry)				Aluminium Pan (wet)				Dustfall Collector (open)	
(microns)	Jan	May	June	Dec	Jan	May	June	Dec	May	June
20	18·2	4·1	24·5	14·0	15·2	4·3	18·7	19·7	12·6	20·6
	12·1	25·7	30·0	12·0	20·2	22·4	25·6	12·0	24·6	28·8
30	14·3	7·4	20·4	17·5	15·0	13·4	22·0	35·8	24·0	32·0
	13·0	23·8	27·2	20·9	22·8	27·5	22·0	11·0	16·6	29·8
32	6·5	9·5	9·0	9·0	7·7	27·8	17·4	2·0	26·0	16·6
	8·8	8·4	12·0	14·0	4·0	4·0	11·3	8·8	28·2	20·7
40	5·3	30·7	7·6	8·1	6·2	19·8	12·4	19·0	25·1	7·3
	8·4	6·0	5·7	9·0	18·2	16·7	9·2	8·0	6·8	8·1
44		3·5	2·4	Nil	Nil	5·6	3·7	Nil	0·8	1·9
	—	—	—	Nil	Nil	Nil	Nil	Nil	2·0	2·6
53	7·6	2·8	5·5	13·4	7·8	6·8	6·3	6·3	1·9	3·0
	10·2	5·7	4·4	9·0	7·9	7·8	6·1	6·8	3·4	2·8
63	—	1·0	1·8	Nil	Nil	3·8	2·9	Nil	0·1	1·3
	—	—	—	Nil	Nil	Nil	Nil	Nil	2·9	1·2
76	10·8	3·3	3·4	9·1	7·7	4·3	3·0	4·8	1·5	3·3
	10·0	5·4	5·0	6·2	6·3	9·8	6·6	5·5	2·6	2·8
104	24·4	18·9	20·9	19·5	19·2	7·8	10·1	7·8	2·5	7·1
	24·8	10·9	9·8	14·1	10·4	4·9	8·5	8·3	6·8	1·8
152	10·3	16·4	3·0	8·7	15·0	4·9	2·4	3·1	1·0	5·0
	9·9	11·0	5·0	7·9	7·5	5·9	5·9	10·3	3·4	1·4
210	1·0	0·5	1·1	0·4	4·1	0·8	1·1	0·6	0·4	1·9
	1·7	1·3	0·7	3·3	1·2	0·5	2·1	7·4	1·1	0·3
>210	1·5	2·3	Nil	0·5	2·3	0·3	Nil	0·4	4·1	Nil
	1·6	2·0	Nil	3·6	1·1	0·9	2·4	21·8	1·3	Nil

TABLE 4

CHLORIDE CONTENT OF RAIN-WATER

(First set of values are for the year 1966 and the second for 1967)

Month	Rainfall (mm)	Chloride content (mg/lit)	Fall of chloride (metric tons/km²)
March	Nil	Nil	Nil
	89	1·06	0·089
June	20	1·83	0·034
	82	1·91	0·072
July	105	6·26	0·162
	183	2·22	0·060
August	151	3·96	0·150
	116	3·81	0·051
September	67	1·74	0·056
	147	4·63	0·054
October	Nil	Nil	Nil
	20	1·89	0·038
December	Nil	Nil	Nil
	3	0·88	0·002
TOTAL	343	—	0·402
	640	—	0·366

Total Dustfall by Different Collectors

(*i*) *Aluminium Pan (dry)*—The total annual dustfalls have been of the order of 104 and 98 metric tons/km²/year in 1966 and 1967 respectively.

The dry pan gave 72 per cent and 63 per cent less dustfall collection in 1966 and 1967 respectively than the wet pan method.

(*ii*) *Aluminium Pan (wet)*—The total annual dustfall was 379 and 290 metric tons/km²/year in 1966 and 1967 respectively. The water soluble portion however, was found to be 14 and 45 metric tons/km²/year which represents 3·6 per cent and 15·5 per cent of the total dustfall in 1966 and 1967 respectively. A comparison of dustfalls in 1966 and 1967 shows that 23 per cent less dustfall had occurred in 1967.

(*iii*) *Dustfall Collector (open)*—It was seen that the dustfall in the peak summer months of April–July during the year 1966 were higher than the value for the corresponding months in 1967 except in the month of June. The total annual dustfall had been of the order of 297 and 205 metric ton/km²/year in 1966 and 1967 respectively; the water soluble portions, however, were 28 and 31 metric tons/km²/year. The lower water solubles met within 1966 may be due to the presence of larger silica particles in the dust. This is borne out by the data presented in Table 3, from which it is seen that particles larger than 210 microns were present to the tune of about 4·1 per cent in May 1966 as against 1·3 per cent in May 1967. Also in June 1967, no particle bigger than 210 microns was present.

(*iv*) *Dustfall Collector (shed)*—238 and 183 metric tons/sq km of dustfall occurred during 1966 and 1967 respectively when determined by Dustfall Collector kept in shed. The water soluble content was found to be 25 and 22 metric tons/km^2/year which represents 10·5 per cent and 12 per cent of the total dustfall in 1966 and 1967 respectively.

(*v*) *Dust Collecting Cylinder*—Dustfall to the extent of 293 and 198 metric tons/km^2 occurred during the year 1966 and 1967 respectively. The water soluble content was found to be 46 and 57 metric tons/km^2/year which represents 16 per cent and 29 per cent of the total dustfall in 1966 and 1967 respectively.

Water-solubles and Insolubles

As regards water-soluble contents of dustfall, bicarbonate and calcium contents were generally high; chloride, sulphate, nitrate, potassium, and sodium contents were in significant quantities and nitrite was found in traces (see Table 1). Chloride content of rain-water collected in 1966 and 1967 is given in Table 4.

The data indicate that large quantities of chloride are washed down from the atmosphere during rains.

CONCLUSIONS

The results show that dustfall varies from year to year and so also the percentage of water solubles. The quantity of dustfall collected depends on the design of the collector. It points to the need and desirability of collecting dustfall by means of one standard collector always so that all results can be compared. At best the values are indicative of the quantum of dustfall only and the data cannot be taken as precise.

Minimum dust is found to be collected in the Aluminium Pan kept dry. This is understandable because of the possibilities of dust being blown away after deposition from the large pan. Dust Collecting Cylinder (ASTM) shows a lower value than Aluminium Pan (wet) or Dustfall Collector. This could be attributed to the narrow size of the cylinder. The lower value in the partly-sheltered shed is probably due to the exclusion of part of the dust by wire netting provided on all sides of the shed.

ACKNOWLEDGEMENTS

Thanks are due to Dr. B. N. Singh, Director and Shri A. N. Nandy, Principal Scientific Officer, Defence Laboratory, Jodhpur for their keen interest and encouragement and to Dr. R. Natarajan for help in conducting the work.

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