551. 577. 35: 546. 11

Hydrogen ion concentration of monsoon rain water at Calcutta

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(*Received 29 September 1956*)

1. Introduction

Hydrogen ion concentration of some samples of monsoon rain water at Calcutta were measured. Calcutta being an industrial city may not be considered as an ideal place for determining *pH* of rain water, since there is always some possibility of contamination due to atmospheric pollution in the city air. However, in this experiment samples were collected and measurements of *pH* values were done at Jadavpur (University premises), southern-most area of Calcutta where there is much less chance of getting polluted air because of less concentration of industries. The site of collection was selected in such a way that there was no factory to the south or southwest of the place. Prevailing wind at Calcutta is southerly. So it may be expected that the effect of contamination due to atmospheric pollution from the city air is likely to be small.

2. Measurement of *pH*

Water was collected in a Jena bottle with 10 cm Pyrex funnel on 6 and 18 August 1955 and on 19 August 1955 and afterwards in a Royal Berlin porcelain basin placed on a tripod stand. Measurements of *pH* values were done immediately after the collection of rain water with the help of glass electrode *pH*-meter. During 6 to 19 August 1955 measurements were done with Phillips A.C. operated *pH*-meter. On other days measurements were taken with Beckman *pH*-meter model-G. Cleaning and washing of apparatus and glass wares used were done by double distilled water prepared by standard methods. The temperature of rain water samples was between 28·0° and 29·5°C. The observational data are given in Table 1.

3. Discussion

A glance at the data given in Table 1 reveals that rain water samples examined in the present experiment were more or less neutral. This is, however, normally expected since rain water is usually very pure. But recent observations in Sweden by Barrett and Brodin (1955) show that this idea may not be correct. They infer that natural water should not be neutral but will be slightly acidic because atmospheric carbon dioxide will remain dissolved in it. Thus a neutral water will show a *pH* value of 5·7 at laboratory temperatures (at 25°C), the value expected by taking atmospheric carbon dioxide in equilibrium with dissolved gas in water. According to them, therefore, rain water with *pH* 5·7 is neutral, *pH* greater than 5·7 is alkaline and *pH* less than 5·7 is acidic. They classified their observed data in that order. They have presented the data of a network of observation centres and discussed the variation of acidity and alkalinity with time and place.

In the case of our present determination at one station we cannot, however, discuss our result in that manner. The main point of our observation was how *pH* of rain water varies with time and amount of precipitation. There is a fundamental difference between the methods of collection and measurement followed here and by

TABLE 1

Date	Collected during (IST)	Interval (min)	Amount collected (cc)	pH	Remarks
6-8-55	1100—1115	15	30	7·10	No thunder
	1115—1130	15	32	6·98	
	1130—1200	30	35	6·80	
	1200—1230	30	30	7·10	
	1230—1400	90	29	7·10	
18-8-55	1135—1145	10	25	7·06	No thunder
	1145—1200	15	25	6·98	
	1200—1220	20	27	6·90	
19-8-55	1020—1030	10	50	6·90	Thundershower
	1030—1040	10	52	6·98	
	1040—1050	10	50	7·12	
	1050—1100	10	55	7·12	
	1100—1110	10	45	6·92	
	1110—1130	20	37	6·88	
9-7-56	1200—1215	15	55	6·60	Thundershower
	1215—1230	15	47	7·02	
11-7-56	1000—1010	10	40	5·54	No thunder
	1010—1020	10	48	6·02	
	1020—1030	10	42	6·20	
	1030—1040	10	32	6·45	
	1040—1100	20	30	6·83	

Swedish workers. In case of Swedish rain water, the water was collected for a certain number of days, brought to a central place and then its pH was measured. Thus a considerable time elapsed between the formation of rain and the measurement of pH of that rain water. In our case, collection of the sample was immediately followed by the measurement of pH. Moreover, we measured pH of fractions of rain.

Apparently, the reason for high value seems to be due to the presence of ammonia, the only alkaline gas present in air. Barrett and Brodin (*loc. cit.*) explains the alkalinity of some of their samples as due to the presence of ammonia which came from the extensive dairy farms of Denmark. In the present investigation also we have to check up whether similar explanation can be advanced for the above pH values. Winds at 1000, 2000 and 3000 feet above sea level are given in Table 2. These have been collected from the *Indian Daily Weather Reports.*

From the wind data given in Table 2, it is clear that in most of the cases wind was from south to southwest direction. On some occasions even small southeasterly components were present. On those occasions,

TABLE 2

Date	Time of observation (IST)	Winds at 1000 ft	Winds at 2000 ft	Winds at 3000 ft
6-8-55	0800	220°/20 kts	230°/16 kts	230°/19 kts
	1400	..	..	..
18-8-55	0800	230°/06 kts	250°/08 kts	250°/08 kts
	1400	180°/05 kts	140°/06 kts	170°/06 kts
19-8-55	0800	240°/04 kts	030°/03 kts	250°/08 kts
	1400	160°/07 kts	150°/05 kts	130°/04 kts
9-7-56	0700	150°/07 kts	150°/08 kts	150°/11 kts
	1400	180°/07 kts	160°/09 kts	150°/10 kts
11-7-56	0700	080°/09 kts	090°/23 kts	090°/23 kts
	1400	080°/15 kts	080°/20 kts	080°/15 kts

therefore, wind came over the station from the countryside. Apparently alkaline *pH* values may, therefore, be due to ammonia carried from the areas from where the wind came. This large amount of ammonia may again be due to the high cattle population in the villages. However, this argument does not seem to be applicable. Ammonia is known to be highly soluble in water. Hence if ammonia was responsible for increasing *pH* values of rain water, we should expect less and less dissolved ammonia as the rain continues. Thus if we measure *pH* of fractions of rain water, as we have done in the present study, we should get decreasing *pH* values with progress of rain. If we assume with Barrett and Brodin (*loc. cit.*) that water with *pH* greater than 5·7 is alkaline we should get *pH* of successive fractions of rain water to have lower and lower values and gradually approaching the theoretical value of 5·7. But this is not the case as can be very well observed from Table 1. Thus it appears that the idea of rain water having dissolved carbon dioxide in equilibrium with atmospheric carbon dioxide may not be correct. Probably it is due to the fact that carbon dioxide dissolves in rain water only slowly and that it takes a long time to establish equilibrium (Eriksson 1955).

The conclusion just arrived at in an indirect way can be verified by a somewhat direct manner. On 11 July 1956 rain fell in the morning when the upper wind was easterly. This air was naturally polluted as it had to travel over the industrial areas of Calcutta to reach the place where rain water was collected. Thus we should get acidic rain water as is indicated by the *pH* values given in Table 1. Moreover as the rain progresses, air becomes washed out of materials responsible for pollution and as these materials (specially oxides of sulphur) impart acidity we should get decreasing acidity with progress of rain. If 5·7 represents neutral *pH* value we should get a set of *pH* values gradually approaching to 5·7. Instead of that we find the *pH* approaching 7·0. Thus 7·0, the normal *pH* value of neutral water is the *pH* for neutral rain water and not 5·7 as suggested by Barrett and Brodin.

4. Conclusion

From the present study of pH of monsoon rain water we can conclude—

(*a*) Monsoon rain water is neutral under Calcutta conditions.

(*b*) Rain water dissolves little carbon dioxide and the dissolved gas is not in equilibrium with atmospheric carbon dioxide.

5. Acknowledgement

My thanks are due to Dr. S.N. Mukherjee, Professor of Physical Chemistry, Jadavpur University, Calcutta, for taking some of the pH measurements and to the authorities of Jadavpur University for providing laboratory facilities.

REFERENCES

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