

Acidity of Monsoon Rain Water

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ABSTRACT. *pH* of rain water from continuous rains at Calcutta and Bombay were studied. It is found that the *pH* values lie within 6 and 7. *pH* of neutral rain water in monsoon is close to but less than 7.0. Thus it dissolves little carbon dioxide whereas studies in Europe show that dissolved carbon dioxide in rain water is probably in equilibrium with the atmospheric carbon dioxide. This difference may be due to difference in mechanism of precipitation in two places.

1. Introduction

pH of monsoon rain water at Calcutta was studied by the author in 1955 and 1956 and was reported in a previous paper (Mukherjee 1957). It was inferred that *pH* of monsoon rain water is 7.0 at 25°C, the accepted value of neutral water. Barret and Brodin (1955) from a study for a number of stations in Scandinavia came to the conclusion that the *pH* of neutral rain water should be 5.7 at 25°C, a value arrived at by considering atmospheric carbon dioxide in equilibrium with the dissolved carbon dioxide in rain water. It was also pointed out that low values of *pH* obtained by the Scandinavian workers were probably due to the dissolution of carbon dioxide from the atmosphere after the water was collected and stored for measurements.

The data presented in the previous paper relates mostly to showery type of rainfall; rainfalls, from which the samples were collected, were not preceded by considerable amount of precipitation. It may, therefore, be argued that the *pH* values obtained in those samples may not truly be representative of monsoon rainfalls; or, in other words, the water samples might have contained some dissolved alkaline materials, the possibility of which was also pointed out. It was, therefore, considered worthwhile to study the *pH* of monsoon rain water samples from falls in which whatever

alkaline material was present in the atmosphere would have been washed out by the preceding rain and the sample would reveal the true character of monsoon rain water. For this reason some particular occasions were selected to get suitable samples. The measurements were made at Calcutta towards the end of monsoon in 1956. Similar measurements were made at Bombay in August 1959 under above conditions. The results of all these measurements are presented in this work.

2. Data

Experimental details for measurements at Calcutta (Jadavpur University area) are the same as given in the earlier paper. In the present case a 10-inch diameter porcelain basin was used for collection of rain water. The measurement of *pH* was, as usual, done immediately after the collection of water samples. Temperature of the collected rain water was between 27° and 28°C. The values of *pH* are presented in Table 1.

Measurements of *pH* at Bombay (at Colaba Observatory) were done during August 1959 with *pH* papers. It gives *pH* values in integers only found by comparison of colours from which *pH* upto first decimal place was estimated. The paper strips were held directly in rain in case of moderate to heavy rain and were moistened with rain water collected on porcelain plate

TABLE 1
pH of rain water (Calcutta)

Date	Period of collection of rain water (IST)	Intervals at which samples collected (min)	Volume of water sample (cc)	<i>pH</i>
24-9-56	0950-1047	5	40	6.82
		5	48	6.60
		7	55	6.42
		10	90	6.96
		30	36	6.84
26-9-56	0750-1010	15	50	6.75
		13	58	6.60
		10	20	6.78
		25	46	6.62
		27	34	6.73
		20	32	7.21
		15	37	6.78
		20	27	6.84

TABLE 2
pH of rain water (Bombay)

Date	Time (IST)	Nature of rainfall	<i>pH</i>	Date	Time (IST)	Nature of rainfall	<i>pH</i>
20-8-59	1800	Light	6.5	24-8-59	0630	Moderate	6.8
					1100	Moderate	6.8
22-8-59	0630	Heavy	6.8	25-8-59	1500	Light	6.2
	0830	Light	6.5		0945	Moderate	6.8
	1100	Moderate	6.8		1150	Moderate	6.5
	1400	Light	6.5		1300	Light	6.2
23-8-59	0700	Drizzle	6.5	27-8-59	1730	Light	6.5
	1045	Heavy	6.8		0900	Moderate	6.8
	1400	Light	6.5		1130	Light	6.5
	1700	Drizzle	6.2				

in case of light rain or drizzle. The results are given in Table 2. In spite of some subjective factors remaining in these measurements, the conclusions were not affected as can be seen in Table 2. Temperatures of rain water were not measured. However, the air temperature remained between 25°C and 28°C.

On 26 September 1956 the precipitation, from which samples were collected, was from cumuliform clouds. On all other dates rain water samples were from stratiform clouds, mainly altostratus and sometimes in combination with nimbostratus clouds.

Jadavpur University, where measurements were taken in 1956, is at the southern end of the city of Calcutta. The prevailing wind on the days of measurements were from south to southwest from which side there was no possibility of local pollution. Colaba Observatory, where the measurements were taken in 1959 is on the southern end of the city of Bombay. The prevailing winds in the lower levels were mainly from west and here also there was no possibility of pollution from the city or from local sources.

3. Discussion

The data, as presented above, show that the pH of rain water samples were less than but quite close to 7.0 except for an isolated value of 7.21 on 26 September 1956. The data for Bombay show a lower value. As mentioned earlier, the pH were read correctly upto the integral values and estimated upto the first decimal place. In spite of the approximate method used here it can be said that on all occasions the pH value of rain water remained between 6.0 and 7.0.

Barret and Brodin (*loc. cit.*) found from a study of pH of rain water in Scandinavia that pH values were low and the neutral value should be 5.7. According to Junge (1958), the pH values of rain water vary within the range of 3 and 7 with an average of 5. The reason for the above pH values, as given by the authors, is the dissolution of carbon dioxide in rain water. But the present

set of data differs considerably from their conclusion. It has already been stated that the probable value for lower pH in Scandinavian rain water was due to the dissolution of carbon dioxide during the storage time before the measurements. It was, therefore, possible that if they measured immediately after the collection of the samples, they could have obtained pH values close to 7.0. But in the light of Landsberg's (1954) measurements over Boston, it appears that geographical position of the place and also the industrialisation around should be considered. He measured pH of rain drops, snow-flakes etc in Boston with pH papers. He found the values between 3.0 and 5.5. Mean for the rain water was 3.93 and for snow-flakes it was 4.43. Thus we find that rain drops collected by him were definitely acidic. This high acidity of rain drops found by Landsberg may be due to the fact that the air over Boston was highly polluted from local sources as pointed out by Junge (*loc. cit.*). Other measurements in the extra tropical regions, however, show divergent results. Thus Harrassowitz (1956) finds that pH of rain water at Germany lies between 3.1 and 3.5. Barba (1951) has also measured pH of frontal precipitation and is of the opinion that in most of the cases the pH of rain water samples are higher than 6.0. His values range from 5.5 to 8.0. He opines that pH of neutral rain water should be about 7.0 which agrees well with author's results.

Landsberg did not find any variation of pH of rain water with the progress of rain. Barba on the other hand finds that the curve for pH variation during precipitation is of exponential type. In the present work pH values of experimental samples are more or less uniform throughout the period of study.

4. Conclusion

From the present study we conclude—
(i) pH values of monsoon rain water are fairly uniform and remain within 6 and 7, (ii) pH of neutral rain water in monsoon is

close to but less than 7.0, the neutral value of laboratory water, (iii) Monsoon rain water dissolves little carbon dioxide from atmosphere indicating that the processes of cloud formation and precipitation is much more rapid than those in the extra tropical regions.

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