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pH OF PRECIPITATION IN THE AREA OF THE TOWN OF BIJELJINA

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ABSTRACT

Presence of certain polluting substances in the atmosphere causes disturbance of natural pH values that leads to acidic precipitation occurrence.

Measurement of pH of precipitation in the area of the town of Bijeljina has been done since 2008 and the sampling has been performed at three points. This paper presents measurement results of surveys for a period of one year in graphs and tables. During the winter months low pH of precipitation were recorded due to increased emission of sulfur dioxide, nitrogen oxide and carbon dioxide into the air.

Key words: *precipitation, polluting substances (pollutants), acid rains, pH*

INTRODUCTION

Precipitations have a changeable pH and it is mostly lower than normal, namely they have increased acidity. In many areas throughout the world, there are precipitations that have reduced pH. The cause of acid rains is the presence of certain polluting substances in the air (SO_2, CO_2, NO_x). They react with water and form inorganic acids that dissociate into hydrogen ions and acid residue, resulting in an increase of the concentration of hydrogen ions and thereby decrease of the pH [1].

In the atmosphere, sulfur dioxide becomes sulfuric and sulfurous acid and sulfate. Carbon dioxide partially dissolves in water to form carbonic acid that increases the acidity of precipitations. Nitrogen oxygen in the air turns into nitrous and nitric acid, nitrite and nitrate [2, 3]. Resulting acids fall together with precipitations in the atmosphere or are deposited by a free fall under the influence of gravitation forces. The proportion of acids in precipitations changes depending on the emission of pollutants. It was confirmed in certain areas that the major content of precipitations is sulfuric acid, followed by nitric and hydrochloric in the least. Composition of acidic precipitations is also influenced by local conditions and the distance from the source of polluting substance [4, 5, 6].

As defined, the pH is a negative logarithm of concentration of hydrogen ions: [7]

$$pH = - \log [H^+]$$

pH is the concentration of hydrogen ions in aqueous solution and presents the measure of acidity or alkalinity of environment. If the concentration of hydrogen ions in the water is greater than 10^{-7} mol/l the water is alkaline (pH > 7), and otherwise it is acidic (pH < 7). If the concentracion of OH^- and H^+ ions in the solution is eaqualy represented, the solution reacts neutral (pH = 7) [2]. The main feature of pH is that each degree being below or above the neutrality of 7 is ten times higher or lower than the previouse one. For example, if the acidity of solution increases by 1 pH unit, the concentration of hydrogen ions increases by ten times [8].

The Figure 1 presents pH scale with examples of pH values of some well-known compounds as well as their impact on the environment. Water with a pH of 4.2 units can cause mortality of fish if it gets into aquatic ecosystems. Acid rain has a pH of 4.2 to 4.4 units while the pH of "clean" rain is 5.6. Sea water has a pH value of 8. The products for cleaning of drainage pipes are alkaline solutions with a pH of 14 units [9].

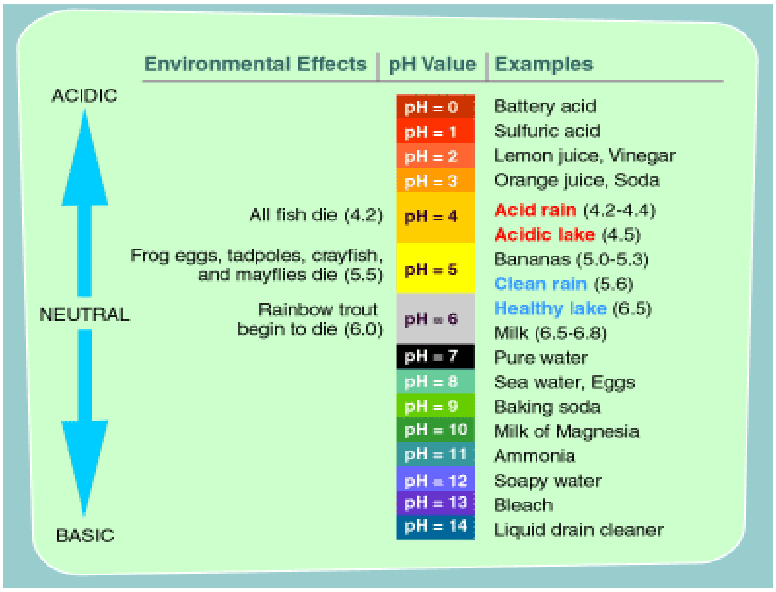

Figure 1 pH scale and values of some well-known compounds

Chemically clean water has a pH of 7 (neutral environment) at 25 ^{0}C. The range of pH values are from 0 (highly acidic environment) up to 14 (highly alkaline environment). Water in nature have a pH of 4,5 to 8.3 and those values are determined by a balance between carbon dioxide and bicarbonate ions in water. Drinking water is characterized by neutral to purely basic reaction (pH = 7,0 – 7,4). Extremely acidic water contains hydrolyzing salts or strong acids. Extremely alkaline water contains waste, alkaline substances [10, 11, 12].

Depending on the quantity of carbon dioxide and aerated water in the atmosphere, pH of clean precipitation is 5,6 units so that precipitations with a pH lower than 5,6 are considered acidic.

LOCATIONS OF MEASUREMENT POINTS

Sampling was carried out at three measurement points:

- Metering point 1 (MM1): Plato by the building of the Town of Bijeljina, centre
- Metering point 2 (MM2): Dimitrija Tucovica Street, the garden od Zitopromet company
- Metering point 3 (MM3): Sremska Street, the garden of Panaflex company
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Locations were chosen to represent the most polluted parts of the town.

MEASURING INSTRUMENT

Measuring of the pH of precipitation was performed by meter Hach Lange HQ40D that aside from pH measures the amount of oxygen dissolved in water, conductivity and temperature. It is equipped with automatic temperature compensation for precise measurements at different temperatures. It is desirable to place the device into the suitable room of moderate relative humidity, free of corrosive gases and significant temperature fluctuations. Once the measuring parameter is defined, a particular electrode for this parameter measurement is mounted. The device is turned on at least 10 minutes prior to measurement. Thereafter it is calibrated using standard solutions (pH 4,00, pH 7,00 and pH 10). Calibration is performed by immersing the electrode in standard solutions starting from the lowest to the greatest value.

After the calibration of device was performed as specified by manufacturer pH, measurements were carried out. During the measurement, the electrode is immersed in the sample, and it is pulled out after reading results from a display. After each measuring, the electrodes are washed down with distilled water to neutralize the influence of the previous sample in order to prevent errors in measurement. The device is presented in Figure 2.

Figure 2 pH meter Hach Lange HQ40D

Characteristics of the measuring instrument are as follows:
High Quality Multiinstrument

Dual Chanel, USB interface, Sensor status, Sampl ID, Datalogger
Parameter: ph/ORP or Us or DO or ISE
Measuring range : ph 0-14
ORP: + - 1500 mV
Conductivity: 0,01-µS - 200µS
TDS: 0- 50000 mg/l
Salinity: 0-42 ppt
Disolved oxigen: 0,1 – 20 mg/l

- PHC1010 (pH probe)

Intellical ph probe, standard, gel filled, 1-m cable with intergrated T- sensor
Measuring range 0-14 ph; 0 ... 80°C

MEASUREMENT RESULTS

Results of pH measuring during the year, since March 2012 until February 2013, are presented in Table 1.

Table 1 pH of precipitation

	pH of precipitation		
	MM1	MM2	MM3
MARCH 2012	5.92	6.42	5.87
APRIL 2012	7.40	7.58	7.36
MAY 2012	7.02	7.01	7.26
JUNE 2012	7.03	7.20	7.20
JULY 2012	7.38	7.18	7.48
AUGUST 2012	-	-	-
SEPTEMBER 2012	-	-	-
OCTOBER 2012	6.57	6.89	6.86
NOVEMBER 2012	5.05	6.41	6.37
DECEMBER 2012	4.94	5.27	5.47
JANUARY 2013	4.75	4.82	5.04
FEBRUARY 2013	4.82	5.48	5.33

Out of thirty samples 10 had a pH lower than 5.6. For the period August – September 2012 the measurement was omitted due to lack of precipitation. The majority of the processed samples had acid reaction. Figure 3 presents a chart of pH of precipitation sampled at the Metering point 1.

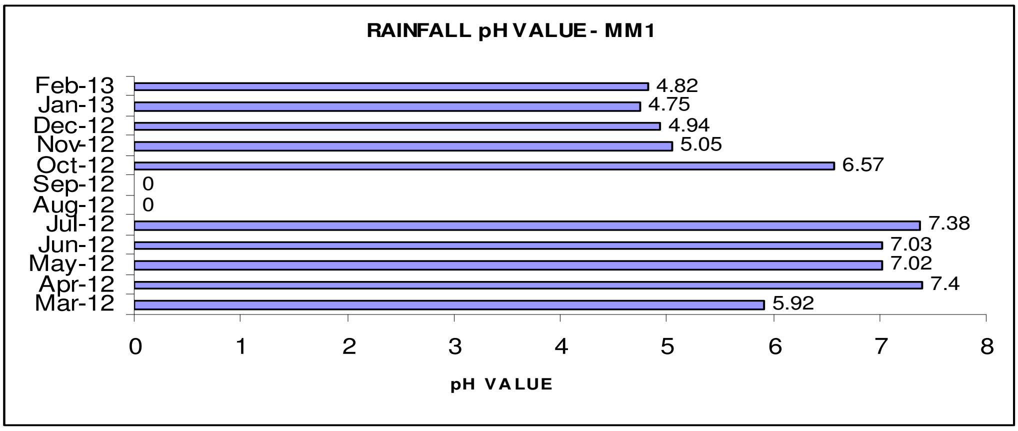

Figure 3 Chart of pH values of precipitation at the Metering point 1

On the location in the center of the town, four samples had a value lower than 5.6 pH units; two samples had values between 5.6 and 7, while four samples had alkaline reaction. Figure 4 presents the results obtained from samples collected at the Metering point 2.

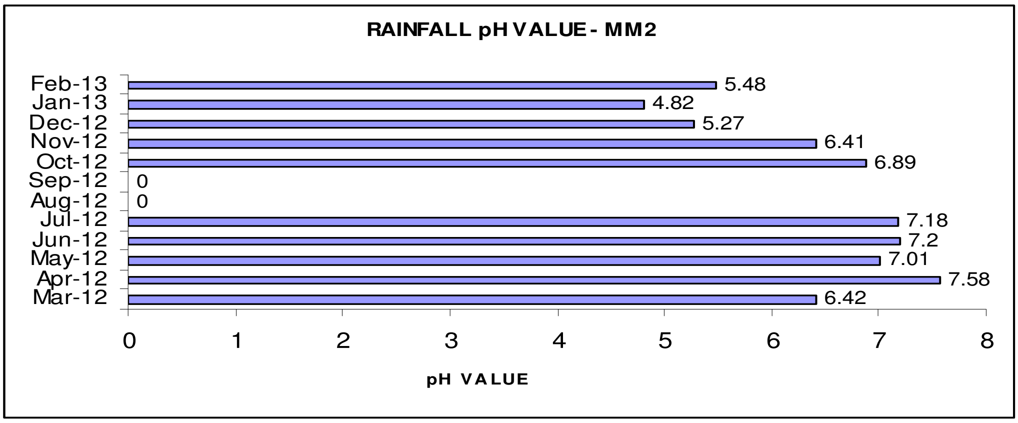

Figure 4 Chart of pH values of precipitation at the Metering point 2

Results of pH measurements from the Metering point 2 shows that three samples had a value lower than 5.6 pH units, values of three samples were between 6 and 7, and four samples had a value higher than 7 pH units.

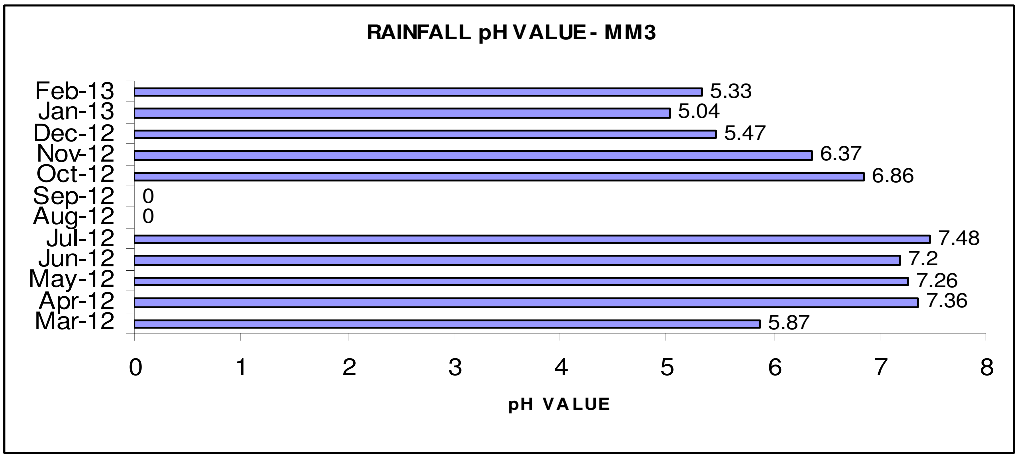

Figure 5 Chart of pH values of precipitation at the Metering point 3

The Figure 5 presents results obtained by processing of samples from the Metering point 3, which show that three samples had a value below 5.6, three samples between 5.6 and 7 pH units, while four samples had alkaline reaction.

Low pH values were recorded during the autumn and winter months (November 2012 – February 2013) at all three metering points. The lowest value was measured in January 2013 in the center of the town and it was 4.75. The highest pH during the measurement period was measured in April at the Metering point 2 and it was 7,58 pH units.

CONCLUSION

pH provides information regarding the acidity of precipitation. Acidity is higher if there are more hydrogen ions in the solution. They enter precipitation by dissociation of strong acids primarily sulfur and nitrogen formed by merging sulfur and nitrogen oxides with aerated water in the atmosphere. On the basis of the performed measurement it can be concluded that during the winter months precipitations had a pH lower than 5,6 placing them in acidic precipitation.

The occurrence of acid precipitation in winter may be explained by the enhanced emission of pollutants originating from heating plants. During winter months the concentration of sulfur dioxide increases highly compared to the rest of the year, and the concentration of nitrogen oxides slightly increases. The presence of these pollutants in the atmosphere leads to the reaction with aerated water thus forming the acids that disrupt natural pH balance. Aside from that, cross-border pollution is typical for the occurrence of acid precipitations and therefore the impact from the region cannot be neglected.

Precipitation with a low pH value can cause significant damages to wildlife, building materials and cultural monuments. Their negative impact is vast and it is therefore necessary to undertake certain measures to reduce the emission of pollutants and thus prevent the occurrence of acid precipitation.

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LITERATURE

[1] Gacesa, S., Klasnja, M.(1994). Water and Wastewater Technology. Belgrade.
[2] Djuric, N., Djukovic, J., Bozic, N., Babic, R., Stojanovic, B. (2009) The content of sulfur dioxide in the air of the town of Bijeljina. Bijeljina. Archives of Technical Sciences, year I – no. 1, pp 110-118.
[3] Djuric, N., Bocic, N., Babic, R., Stojanovic, B. Vidakovic, M. (2010) Monitoring of total nitrogen oxides in the air of the town of Bijeljina. Bijeljina. Archives of Technical Sciences, year II – no. 3, pp 141-148.

[4] Djuric, N., Babic, R., Djuran, P., Vidakovic, M. (2011). SO_2, NO_x and CO as the most important indicators of air quality in the town of Bijeljina. Bijeljina. Archives of Technical Sciences, year II – no. 3, pp 141-148.

[5] Djukovic, J. (2001). Chemistry of the Atmosphere. Belgrade. Mining Institute.

[6] Djukovic, J., Djukic, B., Lazic D., Marsenic, M. (2000). Water Technology. Zvornik. Faculty of Technology.

[7] Vekalic, V., Vitorovic, O. Analytical Testing in Technological Production – Principles and Procedures. Belgrade: University of Belgrade. Faculty of Technology and Metallurgy.

[8] Jaksic, B. (1995). Protection of Water Streams. Banja Luka. University of Banja Luka. Faculty of Technology.

[9] Vojinovic-Miloradov, M., Fisl, J., Prica, M. (2002). Internal script for chemistry for students of the Faculty of Technical Sciences. Novi Sad. Faculty of Technical Sciences.

[10] Hodolic, J., Stevic, M., Budak, I., Vukelic, Dj. (2007). Measurement and Control of Pollution. Novi Sad. Faculty of Technical Sciences.

[11] Sokolovic, M., Sokolovic, S., (1994). Protection of the environment from contamination caused by chemical industry, Part I, Methods of wastwater treatment. Novi Sad: Faculty of Technology.

[12] Kuburovic, M., Petrov, A. (1994). Environment Protection Issues. Belgrade. SMEITS and Faculty of Mechanical Engineering

[13] Petrovic, O. (2004). Microbiological and Biochemical Principles. Novi Sad. Faculty of Technical Sciences.