Aguilar, Rafael Hipólito
Composition of drainage water of
Hinkson and Grindstone creeks.

AGUILAR COMPOSITION OF DRAINAGE WATER


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COMPOSITION of DRAINAGE WATER of HINKSON and GRINDSTONE CREEKS.

THESIS

for

the DEGREE of

CHEMICAL ENGINEER.

1911.

RAFAEL HIPÓLITO AGUILAR. 1887—

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of HINKSON and GRINDSTONE CREEKS.
COLUMBIA, MISSOURI.

INTRODUCTION.

A chemical analysis of water is carried on by very different methods, depending on the use to which the water is to be put. These methods may be conveniently clasified as, (a) those in which the potability of water is determined, and (b) those by which the suitability of water for industrial purposes is determined. The potability of water is determined by its freedom from pathogenic organisms illsmelling and bad tasting substances, while its suitability for industrial purposes is generally determined by the amount of mineral matter that is dissolved or suspended in it. This is especially true in case of steam making, paper manufacture, etc. In some industries, however, such as starch making, brewing, distilling, ice making, the potability, physical and chemical characteristics of water must also be considered. But the problem of industrial water is primarily a consideration of the mineral substances contained in the supplies. Water as it perculates throughthe soil, dissolves more or less of everything with which it comes in contact, and the chemical analysis of these various substances determine its adaptability to different industrial processes.

Another problem of great importance is the determination of the mineral constituents removed from the soil

of definite area as suspended or dissolved matter.

The study of this problem in a scientific way is now being conducted by the engineering experimental station of the University of Missouri. The work is under the general supervision of Professor T.J. Rodhouse, and its general plan was as follows: (1) A small drainage area was chosen for stude, and this consists of drainage area of Hinkson and Grindstone creeks, Columbia, Missouri. (2) Continuous measurements are to be made on the amounts of drainage water from the chosen area, at the same time the rainfall on this area is to be noted. (3) A survey of the chosen area was made. (4) The chemical analysis of the water from this drainage area are to be determined.

The last part of the general plan is the object of this work, that is, the analytical determination of the constituents of water which flows percolates from through the drainage area of Hinkson and Grindstone creeks.

The methods of analysis employed were essentially the same as those described in the paper No. 236(1909) of the United States Geological Survey, on "The Quality of Surface Water in U.S.", except in the determination of iron for which a different method has been followed. Another important part of this work is the determination of the conductivity of water. This was suggested by Dr. Herman Schlundt, of the University of Missouri, for the purpose of studying the influence of dissolved mineral constituents in the water upon

its electrical conductivity.

ACKNOWLEDGMENTS.

Much voluntary assistance was accorded this work by Mr. Proctor Thomson, student in Chemical Engineering, and Prof. T.J. Rodhouse. With the cooperation of these gentlemen, my experimental data have been completed. Mr. Thomson being himself interested in this work, determined the suspended matters and nitrates radicals of the various samples. Professor Rodhouse furnished the mean gage heights and rates of stream flow.

SCOPE of WORK.

The scope of this work includes the following:

(a) Location of convenient places for collecting samples,
(b) Arrangements for obtaining a composite sample and division of samples.
(c) Determination of total suspended and dissolved solids.
(d) Preparation of standard solutions.
(e) Determination of mineral constituents.
(f) Determination of electrical conductivity.

PLACES for COLLECTING SAMPLES.

The places were carefully chosen, from which, water as nearly representative of the average stream flow as possible may be collected. The place just under the bridge on the Ashland gravel road in the Grindstone Creek, was chosen

for this purpose. In the case of Hinkson Creek, the bridge oh the same road did not offer the same convenience. The place under the bridge was shallow, and the stream flow carries with it sand and other impurities which do not represent the average water composition. A place about 150 feet up stream from the bridge was chosen for this purpose.

The COLLECTION of COMPOSITE SAMPLE and its DIVISION.

The general plan is the same as that followed by the U.S. Geological Surveying on similar determination, and is as follows: Empty bottles about 1500 c.c. were carefully cleaned. About 4 ounce bottles were used for the collection of daily samples. The bottles were filled in the places previously chosen by lowering them with suitable holders. The daily samples thus collected were poured into the large bottle, and a composite of seven consecutive samples was obtained, representing the average condition of one week. After the composite sample had been thoroughly mixed by shaking, portions were generally withdrawn as follows: For determination of suspended solids and filteration, 500 c.c; for determination of nitrates, 50 c.c; for determination of carbonates and hicarbonates, 50 c.c; for determination of electrical conductivity, 100 c.c: This left about 700 c.c. for reserve in case of accident.

ANALYTICAL PART.

The determination of suspended and dissolved solids, preparation of standard solutions and determination of the different mineral constituents are fully discussed in the paper No. 236 of the U.S. Geological Survey. In case of the determination of iron, however, the following process was followed.

The iron in the filtrate from the determination of silica was oxidized by boiling the solution with a few drops of nitric acid (sp. gr. 1.42). After a slight excess of ammonium hydrate had been added, the liquid was heated to precipitate the oxides of iron and aluminum, which were removed by filteration, washed with a little ammonium chloride. The precipitate thus obtained is ignited and weighed as $Al_2 O_3$ - $Fe_2 O_3$, one of the metals was determined, the other being obtained by difference. For this purpose it is simplest to determine the iron volumetrically. The precipitate was fused with acid potassium sulphate until dissolved, the fused mass dissolved in water. The solution of iron and aluminum is treated with zinc to reduce the iron, which is titrated with standard potassium permanganate solution. If the bulk of the precipitate shows that the amount of iron and aluminum is less than 8 parts per million, the aluminum was not determined. In this case the precipitate of aluminum and iron hydroxide is dissolved in hydrochloric acid in Erlanmeyer flask, the air in the flask is expelled by adding a little

sodium carbonate, and covered with small watch glass. Zinc is then added and the solution warmed nearly to boiling. The complete reduction of iron is indicated by the change in color from yellow of the ferric chloride into light green of ferrous chloride. Sulphuric acid is then added and the solution heated until all the zinc is dissolved. Distilled water was added, the solution cooled, and then it was titrated with standard potassium permanganate solution.

DETERMINATION of ELECTRIC CONDUCTIVITY.

This was determined by means of Kohlrausch method. The electrical conductivity of the several samples were measured at 25° C. These were compared with the conductivity of n/100 solution of potassium chloride of known specific conductivity.

Results.

The results presented in the following tables cover four samples, one for each week; and the data caver~~s~~ a period of one month.

MINERAL ANALYSIS of WATER

from GRINDSTONE CREEK, COLUMBIA, Mo.

From February 25, to Mar 25, 1911.

(Parts per million, unless otherwise stated)

ANALYTICAL RESULTS.	From Feb,25 to Mar,24.	From Mar,4 toMar11.	From Mar11 toMar18	From Mar18 toMar25	Mean	Per.ct. of Anhydrous Residue.
Suspended **Mat.**	89.	135.	34.5	13.9	68.1	
Silica	14.8	22.4	10	7.8	17.75	7.0
Iron	.89	1.39	trace	.00	.57	.6(a)
Calcium,	19.55	13.64	24.47	31.32	22.24	8.8
Magnesium,	1.36	.56	1.00	1.24	1.04	.4
Sodium & Pot.	15.86	15.43	12.28	17.95	61.52	24.3
Co_3 Radical,	4.80	.00	7.20	.72	3.18	1.2
HCo_3 Radical,	68.32	46.36	90.28	138.83	85.94	
So_4 Radical,	80.70	83.39	130.02	125.90	105.	41.5
No_3 Radical,	5.2	2.00	1.26	1.0	2.36	.9
Chlorine,	8.0	10.83	7.71	4.27	7.70	3.0
Total Dissolved Solids,	218.4	200.2	279.6	316.	253.55	
Mean Gage height, (feet)	1.71	1.36	1.03	.86		
Rate of Flow (Cu. Ft. Sec)	27.	12.5	2.5	.2		
Meeasured Resistance,	-	313.	359.	220.		
Electrical Conductivity,	-	.000345	.000301	.000492		

(a) Computed as Fe_2O_3

MINERAL ANALYSIS of WATER from HINKSON CREEK, COLUMBIA, Mo.

From February 25 to March 25, 1911.

(Parts per million, unless otherwise stated)

ANALYTICAL RESULTS.	From Feb,25 to Mar4	From Mar,4 to Mar11	Rrom Mar,11 to Mar18	From Mar,18 to Mar25	Mean	Per.ct Anhydrous Residue.
Suspended Mat.	115.	387.	135.	16.3	163.3	-----
Silica.	22.4	23.4	27.	7.6	20.1	8.1
Iron.	?	7.86	2.12	.00	3.32	3.8(a)
Calcium,	15.36	14.04	17.61	29.36	19.09	7.7
Magnesium,	1.20	.80	.92	1.08	1.00	.4
Sodium & Pot.	18.08	11.65	22.21	14.49	16.60	6.7
Co_3 Radical,	11.52	trace	18.72	.00	7.56	3.0
HCo_3 Radical,	31.72	51.24	32.69	131.76	61.85	-----
So_4 Radical,	77.90	75.47	103.16	134.14	97.67	392
No_3 Radical,	?	.8	1.2	2.5	1.5	.6
Chlorine,	12.	15.52	6.77	5.93	10.05	4.0
Total Dissolved Solids,	194.8	204.4	259.8	336.	248.75	
Mean Gage Height, (Feet)	1.48	1.09	.75	.36		
Rate of Flow (Cu. Ft. Sec.)	236.	82.	34.	7.		
Measured Resistance(Ohms)	----	376.	400.	258.		
Electrical conductivity,	----	.000287	.000270	.000419		

(a) Computed as Fe_2O_3

DISCUSSION.

A detailed discussion of the results of this work would be almost impossible for lack of sufficient data. From the experimental results however, it can be shown that the drainage waters are different from one another in their mineralization, and that their concentration varies from time to time. This was undoubtedly known before the commencement of the investigation. In case of mineral waters that are sold as beverages, time ~~and expenses~~ are expenses are of secondary importance. But in case of drainage waters that may change 100 per cent, very accurate and costly procedures are prohibitive, because a large number of samples are involved. Hence the simple, fairly accurate and inexpensive methods followed in this work are justified.

CONCLUSION.

This work is only the beginning of a series of investigations on the Hinkson and Grindstone creeks. It was our plan that a whole year determination of this kind should be done, to get an idea of the constituents which the water leaches from the chosen area at different periods of the year, and determine the electrical conductivity of the different samples, to study the relation existing between the water constituents and its conductivity. If such relation can be ascertained, the conductivity method would be a handy way of getting an idea of the quality of any surface water. At the suggestion of Dr. Herman Schlundt, this work was undertaken and its accomplishment was due to his kindly interest and assistance, for which I here wish to express my sincere thanks.

(Signed) Rafeal H. Aguilar,

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University of Missouri,
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June 3,1911.

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