

TABLE XI.—RATE OF DETERIORATION OF C-1 UNDER THE CONDITIONS OF THE STUDY

Date of Chlorine Determination	Per Cent of Available Chlorine for Various Colors of Storage Bottles			
	Clear	Green	Blue	Amber
May 24, 1940 (Initial)	0.96	1.01	1.01	1.06
June 15, 1940	0.00	0.00	0.00	0.98
July 1, 1940	0.94
July 15, 1940	0.89
Aug. 15, 1940	0.85
Sept. 18, 1940
Oct. 17, 1940	0.82
Nov. 15, 1940	0.78
Dec. 18, 1940	0.78
Jan. 15, 1941	0.72
Feb. 23, 1941	0.70
Apr. 2, 1941	0.67

TABLE XII.—A COMPARISON OF THE DEGREE OF TOTAL DETERIORATION OF SAMPLES STUDIED

Preparation	Per Cent Total Deterioration during Study			
	Clear Bottles	Green Bottles	Blue Bottles	Amber Bottles
C-5	100.00	98.80	100.00	46.68
C-7	99.63	100.00	99.64	91.05
C-6	99.81	99.81	99.80	90.04
C-8	100.00	100.00	100.00	58.65
C-9	100.00	100.00	100.00	31.02
C-10	100.00	100.00	98.85	38.83

(Table XII continued in next column)

Preparation	Per Cent Total Deterioration during Study			
	Clear Bottles	Green Bottles	Blue Bottles	Amber Bottles
C-2	100.00	74.24 ^a	100.00	28.95
C-3	100.00	100.00	100.00	90.59
C-4	100.00	100.00	100.00	98.87
C-1	100.00	100.00	100.00	36.79

^a Forty-eight days.

TABLE XIII.—COMPARISON OF DEGREE OF TOTAL DETERIORATION OF THE SAMPLES IN AMBER BOTTLES UNDER THE INFLUENCE OF DIRECT SUNLIGHT AND DIFFUSED SUNLIGHT

Preparation	Per Cent Deterioration under Direct Sunlight	Per Cent Deterioration under Diffused Sunlight
	C-2	28.95	14.38
C-9	31.02	18.19
C-1	36.79	6.93
C-10	38.83	21.82
C-5	46.68	17.91
C-8	58.65	57.75
C-6	90.04	41.52
C-3	90.59	11.62
C-7	91.05	98.48
C-4	98.87	24.78

REFERENCES

- (1) Plein, E. M., and Rising, L. W., *JOUR. A. PH. A.*, 31 (1942), 183.

Storage Factors Affecting the Deterioration Rates of Certain Chlorine Preparations of the Sodium Hypochlorite Type*

III. (A) The Effect of Constant Moderate Heat, (B) The Effect of Storage in a Dark Room and (C) The Effect of Refrigeration

By *Elmer M. Plein and L. Wait Rising*

(A) The Effect of Constant Moderate Heat

Many of the chlorine preparations used routinely in the home for hygienic purposes on the person and in the laundry, also those used in hotels, taverns, hospitals and elsewhere to protect the public against the spread of contagious diseases, are stored in warmer-than-average places. This is not intentional. It is pure coincidence that so frequently the out-of-the-way corners and cabinets convenient for storage are near steam pipes, heating units or hot water pipes. That this heat can be damaging to the activity of the chlorine preparations no one can successfully deny without previously having measured its effect. Published ac-

counts showing adequate measurements of its effect are lacking, so the work reported in this paper was undertaken to help answer the question on the basis of data collected under controlled conditions.

EXPERIMENTAL

Standard commercial packages of the ten preparations used in the previous phases (1) of this study were used. Since light was not to be considered as a deterioration factor, the products were left in their original containers. These were stored in a covered box placed over a copper chest in which small steam pipes were coiled. The temperature of the liquids in the box, without considering the few fluctuations when the steam was cut off, averaged about 42° C. The samples were analyzed according to the time intervals and method of the previous studies (1). Table I shows the results of the determinations. Table II shows the total deterioration of each over the period of investigation.

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TABLE I.—RATE OF DETERIORATION OF THE CHLORINE PREPARATIONS UNDER THE CONDITIONS OF THE STUDY

Date of Chlorine Determination	Per Cent of Available Chlorine in Preparations									
	C-5	C-1	C-4	C-3	C-2	C-10	C-9	C-8	C-6	C-7
May 23, 1940 (Initial)	4.81	1.02	3.56	4.81	4.86	4.88	5.02	4.27	5.13	2.62
June 19, 1940	4.35	0.94	3.19	4.34	4.29	4.34	4.34	3.80	4.52	2.32
July 15, 1940	3.52	0.90	2.91	3.50	3.42	3.50	3.73	1.94	3.13	1.88
Aug. 16, 1940	2.96	0.86	2.50	3.14	2.75	1.97	2.97	1.10	2.94	1.31
Sept. 19, 1940	2.23	0.72	1.87	2.39	2.06	1.92	2.49	0.68	2.67	0.94
Oct. 22, 1940	2.26	0.71	1.82	2.41	1.97	1.83	2.10	0.59	1.30	0.95
Nov. 18, 1940	2.10	0.76	1.83	2.40	1.96	1.85	2.19	0.61	1.15	0.88
Dec. 23, 1940	1.94	0.72	1.69	2.22	1.83	1.71	1.91	0.54	0.93	0.79
Feb. 12, 1941	1.70	0.65	1.48	1.85	1.49	1.41	1.63	0.44	0.75	0.65
Feb. 28, 1941	1.64	0.55	1.44	1.75	1.43	1.30	1.55	0.41	0.67	0.60
Apr. 2, 1941	1.57	0.55	1.35	1.64	1.33	1.23	1.42	0.47	0.60	0.19

TABLE II.—A COMPARISON OF THE DEGREE OF TOTAL DETERIORATION OF THE SAMPLES STUDIED

Preparation	Per Cent Total Deterioration during Study
C-1	46.08
C-4	62.08
C-3	64.66
C-5	67.36
C-9	71.71
C-2	72.63
C-10	74.79
C-6	88.30
C-8	89.99
C-7	92.75

broken only by intermittent light from electric light bulbs such as would be found in inside storage rooms and dark basements.

EXPERIMENTAL

The ten preparations under investigation were stored in a dark room in their original amber glass containers. They were exposed intermittently, as previously stated, to electric light rays. The temperature of the room was reasonably constant and never warm. Analyses were made in the usual way (1) and the results tabulated in Tables III and IV. From the data collected it will be seen that while the absence of light greatly reduces deterioration, it does not inhibit it completely.

(B) The Effect of Storage in a Dark Room

In previous phases of this study (2) it was found that the direct sunlight had a most deleterious effect on the -sodium hypochlorite preparations being investigated, even when protected by amber bottles. Diffused daylight (1) was also destructive, but not to the same degree. Amber bottles offered a great deal more protection against the ravages of diffused daylight than against direct sunlight. Since decreased light intensity resulted in greatly decreased deterioration, we tried the protective effect of total darkness

TABLE IV.—A COMPARISON OF THE DEGREE OF TOTAL DETERIORATION OF THE SAMPLES STUDIED

Preparation	Per Cent Total Deterioration during Study
C-4	10.43
C-2	17.20
C-7	17.36
C-5	17.38
C-3	17.99
C-10	19.51
C-9	23.83
C-1	30.39
C-6	33.21
C-8	64.83

TABLE III.—RATE OF DETERIORATION OF THE CHLORINE PREPARATIONS UNDER THE CONDITIONS OF THE STUDY

Date of Chlorine Determination	Per Cent of Available Chlorine in Preparations									
	C-5	C-7	C-4	C-3	C-2	C-10	C-9	C-8	C-6	C-7
May 28, 1940 (Initial)	4.89	1.00	3.45	4.78	4.67	4.92	4.91	4.35	5.42	2.65
July 16, 1940	4.60	0.96	3.27	4.63	4.46	4.62	4.57	4.08	...	2.44
Aug. 16, 1940	4.38	0.95	3.26	4.41	4.37	4.36	4.42	3.76	...	2.38
Oct. 18, 1940	4.27	...	...	4.35	...	...	4.32	3.28	4.44	...
Nov. 22, 1940	...	...	...	4.21	4.20	4.18	4.25	2.74	...	2.37
Dec. 19, 1940	4.12	...	3.14	4.13	4.12	4.03	...	2.40	4.29	2.37
Jan. 18, 1941	...	0.91	3.12	...	3.93	3.98	4.17	2.16	4.27	2.36
Feb. 21, 1941	4.10	0.86	3.06	3.98	...	...	3.97	1.83	3.62	2.31
Mar. 15, 1941	4.04	0.71	2.99	3.92	3.90	3.96	3.74	1.53	2.62	2.19

(C) The Effect of Refrigeration

Continuing our study of the factors influencing the deterioration of the commercially available sodium hypochlorite type chlorine preparations, we next investigated the effect of low temperatures on their stability. Low temperatures are considered stabilizers for most types of perishable chemicals and particularly so for those which are extremely unstable. It was presumed, therefore, that refrigeration would probably inhibit deterioration to a large degree, if not prevent it completely in our preparations. The work to be done, therefore, was looked upon as merely confirmatory.

EXPERIMENTAL

Samples of the ten preparations being investigated were refrigerated in an electric ice box of standard make and at the temperature usually used for food preservation in the home. The solutions were removed only long enough during each analysis to come to the standard temperature to be pipetted. The pipetted samples were then titrated with 0.1 *N* sodium thiosulfate in the usual way (1). Some of the data collected are shown in Table V. The solutions are identified in the first column. The original strengths of the preparations are given in the second column, and the final strengths, 260 days later, in the third column. In the last column are reported

the percentage deterioration of each solution. The percentage deterioration ranged from 1.06 to 22.03.

TABLE V.—PER CENT STRENGTHS OF THE SAMPLES UNDER THE CONDITIONS OF THE STUDY AND THEIR PER CENT DETERIORATIONS

Preparation	Initial Strength, Per Cent Available Chlorine, May 28,	Final Strength, Per Cent Available Chlorine, Feb. 12,	Per Cent Deterioration
	1940	1941	
C-9	4.71	4.66	1.06
C-7	2.64	2.59	1.89
C-3	4.76	4.64	2.52
C-4	3.52	3.43	2.56
C-1	1.00	0.97	3.00
C-2	4.60	4.31	6.30
C-8	4.55	3.90	14.29
C-5	4.73	3.97	16.07
C-6	5.77	4.72	18.20
C-10	4.72	3.68	22.03

There seems to be no correlation of the deterioration rates of the chlorine solutions under the various conditions of storage. For example, solution C-1 is the most stable of the solutions when stored under constant moderate heat (Table II), but this solution ranks eighth when stored in a dark room (Table IV) and fifth when held under refrigeration (Table V).

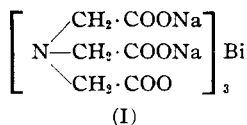
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Sodium Bismuth Triglycollamate*

By Robert A. Lehman and Reavis C. Sproull

In 1925 Hahl (1) disclosed a method for preparing a compound to which he gave the following structure:



Hahl's procedure consisted in warming together sodium carbonate, triglycollamic acid (*sym*-tricarboxytrimethylamine) and bismuth oxide until all were dissolved, and then evaporating to dryness. However, the quantities of reagents given do not agree even approximately with the structure suggested.

Furthermore, Michaelis and Schubert (2) have shown by potentiometric titration of triglycollamic acid that two of the carboxyl groups are highly ionized (*pK* 3) and indistinguishable, while the third carboxyl group exists as a "zwitterion" (*pK* 10). A solution of disodium triglycollamate is thus nearly neutral (*pH* 8), while the trisodium salt is quite alkaline (*pH* 11). In view of these properties of the acid, it seems improbable that a compound of structure (I) would give a stable and neutral aqueous solution as claimed by Hahl.

Preliminary experiments showed that sodium bismuth triglycollamate possesses pharmacological and chemical properties which, in certain respects, differentiate it

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