

because he was eminently practical. This result shows however what is possible when science and industry cooperate. Why not train men for every industry so that glass, leather, sugar, paper, steel, iron, copper, cellulose, cotton, wool, bricks, cement, laundrying, silk, fertilizers, chemicals, dyes, etc., etc., can progress and excel just as did the petroleum industry under the skillful scientific guidance of William Merriam Burton.

The cooperation of science and industry can achieve this, and in my opinion nothing else ever will achieve it. In fine, the next great advance and development that this country will witness will be in her industries when these become standardized as the result of the cooperation of the science of the university with the practice of the factory, said cooperation to begin in the university and *not* after leaving the university. May this great advance come about now when the world is paralyzed by the clash of arms and the decimation of human lives and needs the help of our country more than it ever will. Let me in conclusion suggest that the Chamber of Commerce of the United States of America, a most efficient product itself of cooperation, call a conference of the heads of all our universities and of all our great industries and at that conference proclaim the gospel of "cooperation spells success" and as well, forge the link which will weld into an indissoluble union science and industry.

INCREASE IN THE ACIDITY OF HYDROGEN PEROXIDE UPON STANDING.*

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Most brands of hydrogen peroxide which are found upon the market are labeled as conforming to the requirements of the U. S. P. In the manufacture of this product it is not a difficult matter to properly regulate the amount of free acid, which must be below 1/100 normal. In Bulletin No. 150 (1912) of the Bureau of Chemistry, by Kebler, Warren and Ruddiman the fact is brought out, that most commercial brands of peroxide are excessively acid. The samples examined by these investigators were purchased from wholesalers so that they might be obtained in as fresh condition as possible. The acidity and strength were determined upon opening and the stability was ascertained by subsequent titrations. Apparently only one determination was made of the acidity.

From observations which we have incidentally made during a period of several years, we have been lead to believe that the unusually high acidity frequently noted in peroxide which contained acetanilid, is due in most cases to an oxidation of the preservative; for we have frequently observed that samples containing this substance gradually increase in acidity on standing.

The fact is well known that hydrogen peroxide containing acetanilid often takes on a yellowish-green color, as well as a disagreeable odor, due to the oxidation of the preservative, and we have observed that this change is accompanied by a loss in the strength of the active substance. A very stable peroxide does not develop a color even on long standing, while this effect is soon noticeable in a product

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which is rapidly decomposing. In the latter case, it can be readily seen that substances giving rise to color and odor are only the intermediary steps in the attack upon the preserving body, for the solution in time again becomes colorless. We have found that a solution of hydrogen peroxide, which was practically free from all impurities will lose nearly 50 percent of its strength, if kept for a year in a glass-stoppered bottle in the dark. By adding a small amount of acetanilid to the solution, the decomposition is reduced to 3 percent. If however we added acetanilid to a peroxide containing impurities capable of affecting it catalytically, the decomposition while temporarily retarded, finally resulted in the complete destruction of the benzene ring, apparently with the formation of substances having a high acid value. Kebler, Warren and Ruddiman (Bulletin 150, p. 22) failed to find acetanilid in some samples in which its presence was admitted on the label, and in another case only traces were found. It appears from their figures that in all these cases the peroxide itself was decomposed to a great extent, and we are justified in assuming that the preservative had been destroyed by oxidation. These authors also concluded in a general way, that the effect of acetanilid upon different lots of peroxide is not the same, so far as preventing their decomposition.

Kebler, Warren and Ruddiman (Bulletin No. 150, p. 22) state that the acidity of peroxide solutions is determined preferably by direct titration using phenolphthalein as indicator. Our experience has been the same, and we have satisfied ourselves that if the titration with N/10 caustic is carried just until a faint pink is reached, the presence of the hydrogen peroxide in the solution has little influence upon the results. In the experiments described below the acidity has been determined in this way. The hydrogen peroxide was determined by means of N/10 potassium permanganate, standardized just before use.

Samples of a number of brands were purchased from wholesale supply houses in New York, with the object of obtaining as fresh material as possible. The strength of these samples as well as their acidity, were determined when they were received, and after they had stood for 1 year in subdued light at ordinary temperature. The results are as follows:

TABLE I.

Brand No.	Original Strength in H_2O_2	Final Strength in H_2O_2	Original Acidity in N/10 KOH for 50 cc.	Final Acidity in N/10 KOH for 50 cc.	Acetanilid Present and Stated
1	3.31%	3.05%	4.15 cc.	5.8 cc.	yes
2	3.21	2.59	4.6	5.6	yes
3	3.03	2.76	2.5	3.2	yes
4	3.13	2.89	4.7	7.2	yes
5	3.32	3.17	1.7	4.5	yes
6	3.51	3.18	2.5	5.7	...
7	2.93	1.41	5.5	12.6	yes
8	3.07	.94	4.1	5.0	yes
9	2.48	.30	1.4	.8	...
10	3.11	1.10	5.7	13.3	yes
11	3.02	2.81	2.8	4.4	yes
12	2.79	1.02	2.9	3.1	...
13	2.93	2.68	1.7	2.5	...
14	3.12	1.46	4.2	4.6	yes

All of these products are represented to be U. S. P. except Nos. 6, 7, 9 and 14. Product No. 9 is stated upon the label to be about 4½ percent. It probably contained no preservative as it was found to be very unstable, and there was no increase in the acidity after a year's standing. Products 6, 9, 12 and 13 contained no acetanilid according to label. Numbers 6, 12 and 13 were shaken out with ether, followed by chloroform, and a distinct residue so obtained in each case. The samples were small, so that the residues so obtained could not be positively identified. In each case they were found not to respond to the isonitrite reaction for acetanilid. Product No. 12 kept very poorly, but there was practically no increase in acidity. Numbers 6 and 13 kept tolerably well and showed considerable increase in acidity. Among the samples containing acetanilid, the relation between decomposition and increase in acidity is not uniform, although numbers 7 and 10 which show the highest increase, are seen to have been largely decomposed.

In order to test out this matter still further, we attempted to prepare a small experimental lot of hydrogen peroxide in a practical way, although we used every precaution to obtain as pure and stable a product as possible. The strength was adjusted to a little over 3 percent, the acidity to about one-half of that permitted by the U. S. P., and three grains acetanilid were added to each pint. The solution was filled into amber bottles which had been previously washed with warm water, rinsed with distilled water and allowed to dry. The exact strength and acidity of these bottles was determined at the start and they were then allowed to stand for a year, alongside the samples previously discussed.

Initial strength, 3.20 percent.

Initial acidity, 2.85 cc. N/10 KOH for 50 cc.

At the end of the year the results were as follows:

TABLE II.

Bottle No.	Final Strength in H ₂ O ₂	Final Acidity in N/10 KOH for 50 cc.	Bottle No.	Final Strength in H ₂ O ₂	Final Acidity in N/10 KOH for 50 cc.
1	3.06%	4.3 cc.	16	3.06	4.2
2	3.05	4.7	17	3.05	4.4
3	3.05	5.0	18	3.08	4.2
4	3.06	4.3	19	3.05	4.4
5	3.08	4.4	20	3.06	4.6
6	3.06	4.3	21	3.06	4.4
7	3.06	4.6	22	3.05	4.8
8	3.07	4.8	23	3.05	4.3
9	3.07	4.3	24	3.08	4.5
10	3.08	4.5	25	3.05	4.6
11	3.06	4.4	26	3.08	4.4
12	3.06	4.6	27	3.06	4.5
13	3.06	4.2	28	3.06	4.7
14	3.06	4.4	29	3.06	4.3
15	3.06	4.5			

It is evident from the results of Table II that in the case of a relatively stable product, there will be a decided increase in acidity after a year's time; however, if the initial acidity be kept low, the final value will not exceed the limit allowed

by the U. S. P. On the other hand the increase in acidity of the various commercial products shown in Table I, shows that most manufacturers have not yet been able to control the uncertain factors which effect the stability of hydrogen peroxide, and the consequent increase in acidity.

The cause of the increased acidity must be due to a disintegration of the benzene nucleins of the acetanilid. In several cases the increase is much greater than can be accounted for by simple hydrolysis of acetic acid from the acetanilid.

The objection to a high acidity for hydrogen peroxide rests upon its use as a mouth wash. The organic acids formed by the oxidation of the preservative will exert no deleterious effect upon the teeth, and it is with the original mineral acidity alone that we are concerned. However, our present knowledge of the matter affords us no practical means of distinguishing between the two.

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DISCUSSION.

Mr. Scoville: The point is these gentlemen have shown that when acetanilid is employed, in the decomposition which ultimately follows, there is more acid formed. We know that acetanilid has the temporary effect of a preservative agent. But the time comes when the hydrogen peroxide gets the best of it and decomposes the acetanilid itself, and then we have an odor and discoloration, which are the two objections to acetanilid as a preservative. They show the solution is more acid than it was before the acetanilid began to decompose; in other words, that excess of acidity in hydrogen peroxide solution does not necessarily mean that the excess has always been there; the acidity is partly formed by the decomposition of the acetanilid. Now, they don't give any recommendation or any definite explanation of that. They simply give a number of tables showing the facts, the acidity being determined when it was fresh and at the end of two years. Are there any questions on that?

Mr. Long: Do they figure out any possible reaction to account for the hydrolysis effect?

Mr. Scoville: They don't explain it; they have not attempted to give any explanation.

Mr. Long: Is it supposed to be acetic acid?

Mr. Scoville: Well, I should suppose so, but they do not say so.

Mr. Long: That is all I care to ask about.

RADIUM AND THE MEASUREMENT OF RADIUM EMANATIONS.

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As practically all substances contain traces of radium, and consequently of radium emanation, the real problem that confronts the pharmacist and the physician is the determination of *how much* radium or radium emanation a preparation, or water, must contain in order that its therapeutic value may be appreciably affected thereby. If a lower limit to this quantity can be agreed upon, and if producers are required to state in *unambiguous units* the actual radium or radium emanation, content of their preparations, then the possibilities of successful fraud will be greatly limited.

As an example of the manner in which the use of ambiguous units assists the fraudulent, consider the "Mache unit" as a measure of radium emanation. This unit has been defined as that amount of radium emanation which when mixed