ANTIPERSPIRANTS*

By Ruth R. Bien

Chief Chemist, Good Housekeeping Bureau Laboratory, New York, N. Y.

The material on antiperspirants which I want to discuss with you today is supplementary to that reported to the Toilet Goods Association last December. I said then that the behavior of these products was a complicated problem, and the work we have done since has certainly re-emphasized this. Time—the commodity of which a chemist is always short—has seriously limited the additional work we have been able to complete. I hope, however, that today's discussion may result in some constructive suggestions for further studies—preferably cooperative.

Our further efforts to correlate the ironing procedure with exposures in a hot air oven have not been entirely conclusive. Although continued study may change the picture we are doubtful at this point that a time of exposure in an oven can be found which will *always* correspond to the ten-second ironing for every product. While some of the formulas we have worked with give relatively comparable results with the two procedures, others do not. This is evident in the results recorded in Table 1. When we first used an oven at 100°C. as the source of heat, we attempted to humidify it, in order to prevent undue drying out of the strips. We noted, however, that the strips were very dry at the end of two hours. A larger, deeper pan of water was used in the series summarized in Table 1, which caused a significant drop in the oven temperature. The temperature held steadily, however, at 67–70°C., so we continued the exposure for two hours, hoping that the results might be interesting. Of the eight formulas included in this series, four had given satisfactory results with the ironing technique, two had shown partial destruction (25 and 33%) and two had caused complete destruction. Of the four satisfactory formulas, two gave about the same results in the ironing and oven procedures—the other two showed slightly higher destruction after the oven exposure than after pressing. As all the results were under 10%, however, these differences may not be significant. On the other hand, the two formulas which had caused complete destruction after pressing showed only 32 and 24% destruction, respectively, after the oven exposure. While the other two (which had caused partial destruc-

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tion when ironed) both showed somewhat less damage in the oven test, their positions were reversed. The one which had shown 24% destruction when ironed dropped to 16%, and the other dropped from 33% to only 12%. These results are confusing, and might easily lead to false conclusions on unknown products.

TABLE 1—COMPARATIVE LOSSES IN TENSILE STRENGTH BETWEEN IRONING FOR 10 SEC. AT 275–295°F. AND EXPOSURE IN A HUMIDIFIED HOT AIR OVEN FOR 2 HR. AT 67–70°C.

Sample No.	Average Loss Ironer, %	Average Loss Oven, %	High Loss Ironer, %	High Loss Oven, %
1	5.99	4.83	13.46	11.85
2*	8.31	6.68	30.35	14.99
3	1.05	7.51	7.63	9.80
4	7.11	9.12	17.70	17.06
5†	24.59	16.11	47.73	27.43
6	32.61	12.44	49.79	27.24
7	100.00	32.58	100.00	37.79
8	100.00	24.73	100.00	58.53

* Slight irregular bleed.
† Extensive bleeding.

We ran a second series of oven tests (Table 2) with no attempt to humidify. Only two formulas, both giving satisfactory results in the ironing procedure, were used, and the destruction at four time intervals—30 minutes, 1 hour, $1^1/_2$ hours and 2 hours was determined. While the results with these two products by the ironing procedure—not once but many times—have been so close as to be considered excellent checks, they did not seem to react to the oven exposure quite so uniformly. Formula No. 1 gave very little increase in destruction after the first hour—the level rose only four per cent in the second hour. Formula No. 2 showed little increase between 1 hour and $1^1/_2$ hours, but jumped 10% between $1^1/_2$ hours and 2 hours.

The net result so far seems to be this: While a well formulated cream will give reasonably comparable results with the two procedures, we cannot yet conclude that all formulas will show the same degree of progressive destruction by both methods. Therefore, we cannot yet adopt the oven procedure as a standard, even if a known satisfactory formula is used as a control. There is too much danger of a false evaluation of an unknown product.

Hoping to throw some light on these differences in behavior, a careful study of pH changes under varying conditions was made on the eight formulas used in the first oven series (Table 1). After the pH of the creams themselves had been

TABLE 2—LOSSES RESULTING FROM EXPOSURE IN A DRY HOT AIR OVEN AT 100°C. AT VARYING TIME INTERVALS

Time	Sample No. 1*, %	Sample No. 2,† %
30 min.	9.06	17.62
1 hr.	30.66	40.18
$1^1/_2$ hr.	34.70	42.74
2 hr.	34.35	52.82

* Loss by ironing procedure—5.99%.
† Loss by ironing procedure—8.31%.

Table 3—pH Changes in Antiperspirants

Sample No.	pH as Purchased	pH on Fabric After 24 Hr. Incubation at 85% RH and 80°F.	pH on Fabric After Ironing at 275–295°F. for 5 Sec.	8 Sec.	10 Sec.	12 Sec.	15 Sec.	pH on Fabric After Exposure in a Dry Hot Air Oven at 100°C. for 15 Min.	30 Min.	1 Hr.	1½ Hr.	2 Hr.
1	3.20	4.55	4.61	4.36	5.05 [5.51]	4.15	4.26	4.66	4.66	4.51	4.80	5.70
2	3.12	3.85 (3.85)	4.44 (3.94)	4.71 (4.06)	4.51 (3.61) [4.76 (4.42)]	4.26 (3.55)	4.43 (3.62)	4.41 (3.91)	4.38 (3.91)	4.46 (3.91)	5.01 (4.65)	4.56 (4.76)
3	3.42	4.05	4.31	4.31	4.11 (4.56)	4.02	4.05	4.20	4.16	4.11	4.31	5.01
4	4.32	5.03	4.98	4.86	4.41 [5.51]	5.36	5.03	5.05	5.02	4.61	5.16	5.46
5	3.06	3.75 (3.69)	3.51 (3.46)	3.91 (3.71)	3.81 (3.52) [4.52 (4.31)]	4.16 (3.61)	3.81 (3.55)	3.96 (3.85)	3.73 (4.02)	4.38 (3.86)	4.16 (3.91)	4.38 (4.39)
6	2.81	4.18	3.72	3.72	3.65 [4.16]	3.36	3.65	4.18	3.95	4.11	4.26	4.08
7	2.22	3.31	3.50	3.46	3.35 [4.35]	3.46	3.52	3.41	3.98	4.21	4.07	4.11
8	3.12	3.61	3.76	3.56	3.40 [4.29]	3.71	3.46	3.31	3.71	4.21	4.51	4.21

Figures in parentheses are the pH values for "bled" areas.
Figures in brackets (column 6) are pH values for strips ironed for 10 sec., and reconditioned for 3 hr. at 85% RH—80°F.

recorded, they were applied to cotton strips in the usual manner, and incubated for 24 hours at 85% R.H. and 80°F. A section of the treated area was then cut out and the pH determined directly on it. If the cream had "bled," as occurred in two cases, the pH of that portion of the strip was also taken. Other sections of each strip were pressed—with the ironer set at 275–295°F.—for periods of 5, 8, 10, 12 and 15 seconds. Other sections were exposed in the oven at 100°C. for 15 minutes, 30 minutes, 1 hour, $1^1/_2$ hours and 2 hours. pH values were recorded on all of them. One set, after pressing for the standard 10 seconds, was reconditioned for three hours at 85% R.H. and 80°F. before the pH readings were taken. The results are summarized in Table 3.

The source of heat—ironer or oven—appears to have a definite bearing on the picture of pH change. This may explain to some extent our difficulties in correlating the two methods. These results may also be helpful, in the formulation of new products, through study of the pattern and level of pH change in formulas giving minimum fabric destruction. I was particularly interested in the figures for samples Nos. 1 and 2. These were the same two creams used in the second series of oven tests (Table 2). The pH of cream No. 1, which showed little increase in destruction after the first hour, rose steadily in the oven during the second hour. On the other hand, there was a significant drop in the pH of cream No. 2 between $1^1/_2$ and 2 hours—the period during which the destruction jumped 10%. Also interesting is the drop in pH which occurred in seven out of the eight cases between 8 and 10 seconds' ironing, and the sharp rise which occurred when the strips were reconditioned for three hours. This points up the importance of accurate timing in these investigations.

Since all this emphasizes the present necessity for sticking to the ironing procedure, while re-emphasizing the need for further standardization of the method, perhaps the next step is to bring out even more clearly the points in the procedure where inaccuracies may occur, leading to lack of agreement in the results of different workers. The idea occurs to me that lowering of the ironing temperature with proportional extension of the pressing time might be something to look into.

We have long wanted to collect more complete data on the effects of perspiration itself on fabric. This has not been easy since we have trained our testing groups to habits of good grooming so well that they are now completely unwilling to go without deodorant protection. We have managed to get, at long last, a set of figures. The usual procedure for practical use investigation was used, with two modifications. Nothing except distilled water was used on the armpits, and an attempt was made to record pH values in the axillar area. This latter was done at the end of each day, by swabbing the underarms with a piece of filter paper, and determining pH on a water suspension of it. It was hoped that some comparison could be drawn between the pH values and the amount of destruction produced by the perspiration in each case. That this hope was vain is shown all too clearly by the figures in Table 4. There was some fluctuation from day to day—more marked in some individuals than others. In five instances, there was a sharp *rise* in pH on the third day. Unfortunately, none of this seemed to have any direct bearing on the losses in tensile strength produced by the perspiration. These losses were in general considerably higher than we had anticipated. The average loss for the right arms of the 15 subjects was 16.52%, ranging from a low of 0.66% to a high of 26.80%. For the left arms the average was 17.79%, with a low of 9.37% and a high again of 28.60%. Twenty-seven out of the 30 shields showed losses of over 10%, 21 of over 15% and 8 of over 20%. Many of the actual shields were badly discolored.

These results become even more interesting—and vastly more puzzling—when they are compared with the results on the same group in a routine practical use investigation (Table 5). A powder, which had shown significant destruction in the laboratory procedure was used on the right arms and a cream which had shown negligible destruction under the left. When the powder afforded the subject good to fairly good protection (and by protection I mean the extent to which the flow of perspiration was checked) the fabric destruction dropped significantly below that caused by perspiration alone. Where the protection was poor, the amount of destruction was about the same, or slightly exceeded that caused by perspiration alone. The picture presented by the cream was somewhat similar, except that the increase in destruction (where protection was poor) over perspira-

Table 4—Fabric Destruction Caused by Perspiration Alone

Subject No.	Type of Perspiration Flow	Right Arm pH 1st Day	Right Arm pH 2nd Day	Right Arm pH 3rd Day	Right Arm % Destruction	Left Arm pH 1st Day	Left Arm pH 2nd Day	Left Arm pH 3rd Day	Left Arm % Destruction
1	Light	5.21	5.98	5.28	20.74	6.11	5.82	5.62	18.96
2	Heavy	5.14	5.88	5.32	25.06	5.30	6.29	5.51	18.96
3	Normal	4.95	6.12	5.81	14.60	5.02	5.48	5.41	16.34
4	Slight	5.72	5.67	5.81	13.73	5.28	5.31	5.88	19.38
5	Normal	5.31	5.61	5.42	24.19	5.89	5.60	6.62	18.96
6	Slight	5.28	6.28	5.62	21.57	5.21	6.18	5.41	17.21
7	Heavy	5.36	5.71	5.52	7.63	5.42	5.41	5.31	18.08
8	Slight	6.45	5.46	5.69	19.38	5.91	5.52	5.66	11.12
9	Normal	5.52	5.61	5.38	16.34	5.02	5.58	5.51	26.80
10	Normal	6.98	5.95	7.76	11.12	6.52	5.52	7.22	14.60
11	Normal	5.98	5.72	7.41	0.66	5.71	5.41	7.58	9.37
12	Heavy	6.04	6.02	8.11	19.38	5.98	5.46	7.42	24.18
13	Normal	5.91	5.56	7.88	16.34	5.72	5.36	6.95	19.38
14	Normal	6.11	6.61	5.82	26.80	5.62	5.72	5.52	17.21
15	Normal	5.78	5.46	7.90	10.25	5.48	5.52	8.31	16.34

TABLE 5—COMPARISON OF AMOUNTS OF DESTRUCTION PRODUCED BY PERSPIRATION ALONE AND TWO ANTIPERSPIRANTS

		Right Arm			Left Arm		
Subject No.	Type of Perspiration Flow	% Destruction Perspiration Alone	% Destruction Powder X	Amt. of Protection	% Destruction Perspiration Alone	% Destruction Cream Y	Amt. of Protection
1	Light	20.74	5.14	Good	18.96	8.84	Good
2	Heavy	25.00	5.19	Poor	18.96	19.78	Poor
3	Normal	14.60	1.54	Good	16.34	14.31	Good
4	Slight	13.73	1.54	Fair	19.38	36.18	Fair
5	Normal	24.19	8.84	Good	18.96	12.48	Good
6	Slight	21.57	12.48	Good	17.21	38.01	Good
7	Heavy	7.63	14.31	Poor	18.08	14.31	Poor
8	Slight	19.38	14.31	Good	11.12	17.85	Fair
9	Normal	16.34	14.31	Fair	26.80	48.95	Fair
10	Normal	11.12	12.48	Poor	14.60	14.31	Good
11	Normal	0.66	8.84	Poor	9.37	8.84	Fair
12	Heavy	19.38	16.13	Fair	24.18	7.93	Fair
13	Normal	16.34	10.66	Good	19.38	7.93	Good
14	Normal	26.80	12.48	Poor	17.21	48.95	Poor
15	Normal	10.25	12.48	Good	16.34	34.36	Fair

tion alone was much more marked in several instances—two particularly where the level rose from 26% and 17%, respectively, to almost 50%. And with a product that had shown less than 5% damage in the laboratory procedure!

This indeed, gives pause for thought. Must we consider not only the effect of an antiperspirant *alone* on fabric, but also that same product in combination with perspiration? That this is *not* necessary in many cases we know, because of the excellent correlation of laboratory and practical use results. But it seems equally true that in other instances it may be very essential.

Obviously, we are not suffering from a dearth of new fields to explore. Which ones to tackle, and how to tackle them are the next questions to be decided.