EFFECT OF LAUNDERING ON THE PROPERTIES OF GLUTARALDEHYDE-CHROME-TANNED SHEARLINGS*

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ABSTRACT

Data are presented on the changes in the chemical and physical properties of shearlings that occurred during a three-year hospital service test. The shearlings under study were tanned with alum, chrome, glutaraldehyde and glutaraldehyde in combination with chrome. Changes in the ash, fat, and chrome content and in the shrink temperature, pH, slit tear strength and torsional stiffness are given. The shearlings tanned with glutaraldehyde or with this aldehyde in combination with chrome had excellent durability and were serviceable for as long as 28 months with as many as 54 launderings. This is substantially longer than is possible when using conventional shearlings tanned with alum or chrome.

INTRODUCTION

Previous reports have shown that the glutaraldehyde-modified leather and wool of glutaraldehyde-tanned shearlings have increased stability to alkaline solutions (1, 2, 3) and rapidly absorb and desorb significant quantities of water vapor (4).

The increased durability of glutaraldehyde-tanned shearlings to laundering has expanded their use by hospitals as medical pads for the prevention and treatment of bed sores. Decubitus ulcers are uncomfortable and may become serious. If neglected they can penetrate to the bone. Shearling pads, together with medical treatment, aid in arresting and healing these sores (5, 6, 7, 8).

To determine the durability of glutaraldehyde-chrome-tanned shearlings under normal clinical conditions, a service test was conducted over a three-year period in cooperating hospitals and a nursing home. Shearlings tanned with alum, chrome, glutaraldehyde, and with glutaraldehyde in combination with various amounts of chrome were evaluated. This paper reports the changes in the chemical and physical properties of the shearlings after various periods of hospital service.

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EXPERIMENTAL

Tanning of Shearlings.—To provide the large number of shearling pads required for the hospital service test, two production packs of 84 skins each were tanned; one with 15 percent glutaraldehyde (25 percent solution) for 24 hours, raising the pH gradually to 8.5; the other in the same way using ten percent glutaraldehyde followed by acidification and retanning with four percent basic chromium sulfate in the presence of one percent sodium formate for 24 hours as shown in Table I. The percent of chemicals was based on the drained weight of

TABLE I

TANNING OF SHEARLINGS

Pack No.	No. of Skins	Glutaraldehyde* %	Chrome† %	Sodium‡ Formate %	Processed** T_s °C.
1	84	15	0	0	82
2	84	10	4	1	85
3	8	10	8	2	86
4	8	10	12	3	89
5	8	10	16	4	90
6	8	10	20	5	92
7	84	10	20	5	101

*25% solution on weight of pickled shearlings.
†33% basic chromium sulfate on weight of pickled shearlings.
‡Amount used with chrome on weight of pickled shearlings.
**T_s after processing into finished bedpads.

the scoured, pickled shearlings. Shrink temperatures of the finished leathers were 82° and 85°C., respectively. It was later thought that shearlings with a shrink temperature of at least 100°C. may be more durable in hospital use. Accordingly packs of eight skins each were tanned with ten percent glutaraldehyde, and then retanned with various amounts of chrome. A 3-minute boil test was obtained when 20 percent chrome was used for retannage. Then a pack of 84 skins was tanned with ten percent glutaraldehyde and retanned with 20 percent chrome. The shrink temperature after fatliquoring was 110°C., which decreased to 101°C. after processing. All packs were tanned at a shearling tannery and processed into bedpads.

Two hundred and thirty of the experimental shearlings were distributed in the Philadelphia area to seven general hospitals, a rehabilitation hospital and a nursing home. Thirty-two commercial shearlings tanned with alum, chrome or a combination of glutaraldehyde and chrome were also distributed for comparison. Several shearlings from each tannage were stored under ambient room conditions for use as controls. The pads were used during a three-year period under various clinical conditions including incontinence.

Hospital Laundering and Drying Procedures for Shearlings.—Recommended hospital laundering and drying procedures for shearlings are presented in Table II. A pre-wash rinse was used if the bedpads were heavily soiled. The shearlings were washed with a mild soap or a detergent at a temperature of not over 120°F. to prevent shrinkage of the wool or hardening of the leather. A disinfectant was used either during washing or in the final rinse. The shearlings were soured to a skin pH of nearly neutral, spun dried, then tumble dried at a stack temperature of not over 130°F., or the shearlings were hung to air-dry. Excessive matting of the wool and over-heating should be avoided. One hospital exposed the shearlings to ethylene oxide after each laundering and drying to obtain complete sterilization.

TABLE II

HOSPITAL LAUNDERING AND DRYING PROCEDURES FOR SHEARLINGS

Operation	Temp. °F.	Time Min.	Compounds
Rinse	100	3	None
Wash	120	10	Detergent + disinfectant
Rinse	100	3	None
Rinse	100	3	None
Sour*	100	3	Commercial-sour
Spin dry			
Tumble dry	130 Stack temp.		

*Sour was used to reduce the alkalinity to near neutrality.

The shearling pads were examind at regular intervals and were removed from service after various periods of use. Eighty of the used bedpads, representative of the various tannages were selected for evaluation. Samples were cut from the neck, butt, shank and belly areas of each shearling. The wool was removed by clipping and a composite sample of the leather of each shearling was prepared for chemical analysis by grinding through a two mm. mesh sieve.

CHEMICAL AND PHYSICAL TESTS

The Official Methods of Analysis of the ALCA (9) were used to determine pH, moisture, total ash, total nitrogen, chloroform extract and chromic oxide.

Slit Tear Resistance.—The ALCA-ASTM "Standard Method of Test for Slit Tear Resistance of Leather" (10) was used to determine the slit tear strength of the shearlings. Samples were cut from an area five inches from the butt end and two inches on either side of, and parallel to, the backbone.

Torsional Stiffness.—A Williamson torsion instrument modified for leather by Witnauer and Palm (11) was used to determine torsional stiffness. The wool

was clipped off and the degree of twist of the wire used to rotate the sample of leather 90° was measured.

RESULTS AND DISCUSSION

The effects of repeated use, laundering and drying on the chemical and physical properties of the shearlings during various periods of service in several hospitals and a nursing home are presented. Each line in the following tables presents the data from a single pad. The fat and chrome were calculated on the hide substance basis. This was necessary for comparison of leathers since processed shearlings contain salt which is washed out during laundering, as indicated by the decrease in ash content.

The slit tear strength of shearlings immediately after processing is usually in the range of 11 to 14 lbs. The tables show averages of six slit tear tests for each skin. The slit tear strength of the controls was determined after storage.

In determining torsional stiffness, the higher the degree of twist the stiffer the skin. The soft control skins of all the tannages had a range of 75 to 160° twist. A reading of 400 to 500° twist indicated moderately stiff skins; 1400° or above, very hard, inflexible skins. The averages of four torsional stiffness measurements are given for each skin. The stiffness of the controls was determined after storage.

The shrink temperature of each shearling was determined after processing. However, it was not practical to remove from each bedpad, prior to hospital service, the relatively large sample that would have been required for chemical analysis. Therefore, the values given in the following tables do not indicate the part played by skin-to-skin variations.

Shearlings Tanned with 15 Percent Glutaraldehyde.—The fat content of all but three pads dropped to approximately half that of the control and remained at that level through 54 launderings as shown in Table III. Two pads were low in fat. The wool contained considerably less fat than the leather and laundering reduced this slightly. The wool of the control had 1.24 percent fat and that of the pad laundered 54 times had 1.05 percent fat, on the moisture-free basis. The alkaline launderings maintained the shrink temperature at a level of 52 to 59°C., whereas the shrink temperature of the control dropped to 39°C. after 41 months storage under ambient room conditions. The $\triangle T_s$ shows the decrease from the processed shrink temperature after hospital use or laboratory storage. The $\triangle T_s$ values of the laundered pads varied from -23 to -30°C.; that of the control was -43°C. The pH of the various skins ranged from 5.4 to 8.5 and had no relation to the number of launderings but merely reflects the degree of souring used in the last wash before the shearlings were removed from service. The pH of the control dropped from 3.8 after processing to 3.1 during storage. At the present time the authors have no adequate explanation for the drastic drop in shrink temperature and pH of the control skins.

TABLE III

EVALUATION OF SHEARLINGS AFTER HOSPITAL SERVICE TANNED WITH 15 PERCENT GLUTARALDEHYDE

(Pack of 84 Skins; Overall Age 41 Months)

Launderings No.	In Service Mos.	Ash* %	Fat† %	T_s °C.	$\triangle T_s$‡ °C.	pH	Slit Tear Lbs.	Stiffness Twist°
Control		10.1	21.9	39	−43	3.1	9	105
7	19	2.4	12.5	57	−25	6.6	5	80
15**	14	3.2	26.7	55	−27	5.4	7	60
18	19	3.2	12.9	52	−30	6.3	12	150
20	18	1.0	6.4	56	−26	6.8	10	355
25	27	0.9	5.6	56	−26	6.6	6	210
29	27	2.8	12.7	59	−23	8.5	9	195
36	28	2.1	11.8	55	−27	7.5	20	430
54	27	2.6	13.3	52	−30	8.3	10	130

*Moisture-free basis.

†Moisture-free, hide substance basis.

‡$\triangle T_s$ refers to the change from the processed T_s after hospital service or storage under ambient room conditions.

**Sterilized with ethylene oxide after each laundering and drying.

Three of the laundered pads were slightly weaker than the control, which also showed a slight decrease in slit tear strength during the 41 month storage. However, all pads had acceptable strength when removed from service. In some cases laundering caused a moderate increase in stiffness but none of the pads was hard.

Shearlings Tanned with Ten Percent Glutaraldehyde and Four Percent Chrome.—The fat content of the shearlings varied considerably and showed no correlation with the number of launderings, as presented in Table IV. Laundering caused a substantial reduction in the fat content of the wool (not shown in Table IV); the wool of the control pad had 3.11 percent fat and the wool of the pad laundered 46 times had 0.58 percent fat, on the moisture-free basis. Laundering may have caused the 5 to 32 percent reduction in chromic oxide content, compared to the control. The shrink temperatures of the laundered pads (52 to 61°C.) were in the same range as those of the laundered pads tanned with 15 percent glutaraldehyde. However, the shrink temperature of the glutaraldehyde-chrome control (50°C. after 39 months storage) was considerably higher than that of the glutaraldehyde control (39°C.) in Table III. The $\triangle T_s$ values of the laundered pads varied from −24 to −33°C.; that of the control (−35°C.) was less than that of the glutaraldehyde control (−43°C.). The pH of the laundered pads varied from 5.9 to 8.2; the pH of the control was 3.6.

The control and seven of the laundered pads had acceptable slit tear strength. Three laundered pads showed a slight loss in strength. Only one skin became moderately stiff and only after 16 launderings.

TABLE IV

EVALUATION OF SHEARLINGS AFTER HOSPITAL SERVICE TANNED WITH 10 PERCENT GLUTARALDEHYDE AND RETANNED WITH 4 PERCENT CHROME

(Pack of 84 Skins; Overall Age 39 Months)

Launderings No.	In Service Mos.	Ash* %	Fat† %	Cr_2O_3† %	T_s °C.	$\triangle T_s$‡ °C.	pH	Slit Tear Lbs.	Stiffness Twist°
Control		11.5	27.4	2.2	50	−35	3.6	9	140
6	17	2.7	7.7	1.6	57	−28	6.8	7	180
8**	12	6.1	46.7	1.8	53	−32	5.9	9	135
10	12	3.0	16.3	2.1	59	−26	6.6	7	175
13	12	5.5	13.1	1.9	52	−33	7.6	14	115
16	20	3.0	11.7	1.7	54	−31	7.1	12	595
19	22	6.2	9.6	1.9	56	−29	7.4	7	35
26	23	5.1	31.5	1.8	53	−32	6.9	11	310
30	23	4.3	6.2	1.5	61	−24	8.2	12	240
35	23	4.9	15.4	1.9	53	−32	7.4	10	150
46	24	3.0	26.0	1.6	56	−29	6.9	11	65

*Moisture-free basis.

†Moisture-free, hide substance basis.

‡$\triangle T_s$ refers to the change from the processed T_s after hospital service or storage under ambient room conditions.

**Sterilized with ethylene oxide after each laundering and drying.

Shearlings Tanned with Ten Percent Glutaraldehyde and Retanned with 8, 12, 16 or 20 Percent Chrome.—Table V presents data of laundered shearlings and controls from the 8-skin packs and shows the effects of tanning with ten percent glutaraldehyde, then retanning with 8, 12, 16 or 20 percent chrome. The fat content varied considerably and was apparently not affected by the variation in chrome or the number of launderings. The chromic oxide content of the pads increased as the amount of chrome used in retanning was increased. Laundering may or may not have reduced the chromic oxide content of the pads. Pads retanned with 8 percent, 12 percent and 16 percent chrome showed a reduction of 20 to 24 percent, 12 percent and 6 to 13 percent, respectively, when compared to the controls. However, the laundered pad retanned with 20 percent chrome had 7 percent higher chromic oxide than the control pad, indicating skin-to-skin variation.

The shrink temperatures of the laundered pads (56 to 64°C.) were slightly higher than those of the ten percent glutaraldehyde-four percent chrome pack (Table IV); those of the controls (67 to 73°C. after 29 to 33 months storage) were considerably higher. Higher chrome content favored or resulted in a higher shrink temperature even after laundering. The $\triangle T_s$ values of the laundered pads varied from −28° to −32°C.; those of the controls were −15 to −23°C. The pH of the laundered pads varied considerably and showed no correlation

TABLE V

EVALUATION OF SHEARLINGS AFTER HOSPITAL SERVICE TANNED WITH 10 PERCENT GLUTARALDEHYDE AND RETANNED WITH 8, 12, 16 OR 20 PERCENT CHROME

(Packs of 8 Skins Each; Overall Age 33, 33, 29 and 29 Months, respectively)

Launderings No.	In Service Mos.	Chrome Retan %	Ash* %	Fat† %	Cr_2O_3† %	T_s °C.	$\triangle T_s$‡ °C.	pH	Slit Tear Lbs.	Stiffness Twist°
Control		8	9.0	10.3	2.5	71	−15	3.5	13	95
4**	6	8	3.5	25.0	1.9	56	−30	6.1	9	95
5**	6	8	3.9	23.8	2.0	57	−29	5.9	9	85
Control		12	8.9	14.8	3.3	73	−16	3.5	13	95
9	16	12	6.4	10.5	2.9	57	−32	7.8	13	220
Control		16	10.6	34.3	5.2	67	−23	3.5	9	75
6	18	16	9.4	4.9	4.5	60	−30	8.2	10	120
6	12	16	7.7	22.9	4.9	61	−29	7.8	14	60
Control		20	11.4	30.4	5.8	70	−22	3.5	12	75
10	12	20	10.5	24.5	6.2	64	−28	8.2	16	190

*Moisture-free basis.

†Moisture-free, hide substance basis.

‡$\triangle T_s$ refers to the change from the processed T_s after hospital service or storage under ambient room conditions.

**Sterilized with ethylene oxide after each laundering and drying.

with the chromic oxide content or the number of launderings. The pH of the control pads was not affected by the variation in chromic oxide. All of the laundered pads and the control had acceptable slit tear strength and stiffness and were the softest of the various packs.

Shearlings Tanned with Ten Percent Glutaraldehyde and Retanned with 20 Percent Chrome.—The effects of hospital service on the pack of 84 skins tanned with ten percent glutaraldehyde and retanned with 20 percent chrome are shown in Table VI. The fat content of the pads varied considerably and showed no correlation with the number of launderings. Laundering may have reduced the chromic oxide content of the pads by zero to nine percent, compared to the control, and remained at the high range of 5.3 to 5.8 percent even after 45 launderings. The shrink temperatures of the laundered pads (63 to 84°C.) were considerably higher than those of all the laundered pads containing less chrome (Tables IV and V); that of the control (80°C. after 21 months storage) was also considerably higher. The $\triangle T_s$ values of the laundered pads varied from −17 to −38°C.; that of the control was −21°C. The pH of the laundered pads varied from 4.9 to 7.5; that of the control (3.9) was higher than those of the controls of the other tannages (Tables III, IV and V). All of the laundered pads and the controls had acceptable slit tear strength and stiffness.

TABLE VI

EVALUATION OF SHEARLINGS AFTER HOSPITAL SERVICE TANNED WITH 10 PERCENT GLUTARALDEHYDE AND RETANNED WITH 20 PERCENT CHROME

(Pack of 84 Skins; Overall Age 21 Months)

Launderings No.	In Service Mos.	Ash* %	Fat† %	Cr_2O_3† %	T_s °C.	$\triangle T_s$‡ °C.	pH	Slit Tear Lbs.	Stiffness Twist°
Control		12.4	28.3	5.8	80	−21	3.9	10	160
2	14	6.0	23.0	5.7	83	−18	6.3	14	85
3	14	5.9	13.3	5.6	72	−29	7.2	18	240
6	2	5.5	26.2	5.3	63	−38	7.2	16	215
10	13	5.8	19.9	5.8	84	−17	6.2	12	70
15	13	4.4	22.3	5.5	75	−26	4.9	15	130
16	13	5.9	35.0	5.7	74	−27	7.5	10	80
45	13	6.5	46.2	5.6	64	−37	6.4	12	155

*Moisture-free basis.

†Moisture-free, hide substance basis.

‡$\triangle T_s$ refers to the change from the processed T_s after hospital service or storage under ambient room conditions.

Commercially Tanned Shearlings.—The fat content of the pads of all three tannages showed great variation and no correlation with the number of launderings. The chromic oxide contents of the low-chrome pads were in the same range as those of the ten percent glutaraldehyde-four percent chrome pack (Table IV); those of the high-chrome pads were in the same range as those of the 10 percent glutaraldehyde-20 percent chrome pack (Table VI); those of the commercial glutaraldehyde-chrome pads equalled those of the ten percent glutaraldehyde-eight percent chrome pack (Table V). The chromic oxide content of the laundered pads, compared to the control pads, showed the following differences: low-chrome, +6 percent, −6 percent and −28 percent; high-chrome, +2 percent, +15 percent and +19 percent; glutaraldehyde-chrome, zero percent, −4 percent and −22 percent. This indicated considerable skin-to-skin variation that obscured the effect of laundering on the chrome content. The shrink temperatures of the laundered low-chrome pads were considerably lower than those of the laundered pads of all the experimental packs, which indicates insufficient chrome to withstand alkaline washing; those of the laundered high-chrome pads were slightly lower than those of the ten percent glutaraldehyde-20 percent chrome pack; those of the laundered glutaraldehyde-chrome pads were in the same range as those of the ten percent glutaraldehyde-four percent chrome pack. The $\triangle T_s$ values of the low-chrome pads were in the same range as those of the 15 percent glutaraldehyde pack; the $\triangle T_s$ values of the laundered high-chrome and the glutaraldehyde-chrome pads were equivalent to those of the ten percent glutaraldehyde +8 to 20 percent chrome packs. The pH's of the laun-

dered and control pads of all three tannages were approximately the same as those of all of the experimental packs. All pads except one laundered, low-chrome pad had acceptable slit tear strength. One of the low-chrome pads and two of the high-chrome pads became firm and stiff while all of the pads with glutaraldehyde remained soft with use.

The commercial alum-tanned control pad had a shrink temperature of 47°C., a slit tear of 7 lbs. and a stiffness value of 60° twist after 37 months storage at room temperature (not shown in Table VII). An alum pad of the same age, after 7 launderings during 3 months hospital use, had a T_s of 53°C. and a slit tear of 14 lbs. The pad became hard with a stiffness value of 1360° twist and was no longer serviceable.

The moderate detanning action of ethylene oxide has been reported (12). Under the conditions of this hospital test, any detanning action that could have been attributed to the ethylene oxide was overshadowed by changes caused by laundering, and/or aging since the T_s, $\triangle T_s$, slit tear strength and stiffness values of the shearlings that were sterilized with ethylene oxide after each laundering

TABLE VII

EVALUATION OF SHEARLINGS AFTER HOSPITAL SERVICE COMMERCIALLY TANNED SHEARLINGS

(Overall Age 36 Months)

Launderings No.	In Service Mos.	Ash* %	Fat† %	Cr_2O_3† %	T_s °C.	$\triangle T_s$‡ °C.	pH	Slit Tear Lbs.	Stiffness Twist°
Low-chrome									
Control		12.2	29.4	1.8	45	−29	3.5	10	130
4**	3	3.7	38.9	1.7	47	−26	5.3	13	110
5	5	2.2	14.0	1.3	49	−27	5.1	12	565
6**	3	4.7	47.3	1.9	47	−23	6.0	8	165
High-chrome									
Control		5.1	12.4	4.8	70	−24	3.8	19	45
5	6	7.8	7.9	5.7	63	−31	7.1	26	1135
8	10	6.4	9.1	5.5	65	−37	6.6	14	45
14	20	5.4	14.6	4.9	63	−34	6.3	17	435
Combination Glutaraldehyde-chrome									
Control		3.5	31.4	2.3	61	−25	3.0	12	90
5**	7	3.8	37.9	2.3	50	−35	5.7	13	125
13	18	7.4	12.8	2.2	51	−38	8.1	11	80
22	20	2.7	10.5	1.8	56	−28	6.4	15	165

*Moisture-free basis.

†Moisture-free, hide substance basis.

‡$\triangle T_s$ refers to the change from the processed T_s after hospital service or storage under ambient room conditions.

**Sterilized with ethylene oxide after each laundering and drying.

and drying were not significantly different from those of the other pads not sterilized by this procedure (see Tables III, IV, V and VII).

The high fat content of several of the laundered shearlings may be due to the build-up of chloroform-soluble material within the leather. This may have been caused by precipitation of calcium and magnesium soaps formed by the relatively hard water used in laundering. Viola et al., of this laboratory reported a similar build-up during washing tests with suede and grain garment leather (13).

A few pads became stiff or hard when the recommended laundering and/or drying temperatures were exceeded or when tanned with alum or small amounts of chrome. There was no apparent correlation between stiffness and the number of launderings. However, there appears to be a relationship between the stiffness and the individual hospital that used the pad. This is indicative of the variations in procedure and the care and attention to details that each hospital was able to provide in laundering and drying the shearlings. The nursing home took excellent care of all of their shearlings.

The shearlings in this hospital test were tanned with glutaraldehyde, then retanned with chrome. However, shearlings of equal durability can be obtained by tanning with glutaraldehyde and chrome simultaneously under conditions of conventional chrome tannage or the aldehyde may be applied as a retannage to chrome tanned skins.

SUMMARY

Data on the changes in the chemical and physical properties of shearling medical pads tanned with alum, chrome, glutaraldehyde, and glutaraldehyde in combination with chrome, that occurred during a service test conducted over a three-year period in cooperating hospitals have been presented.

Laundering caused great variation in the fat content of the leather and reduced the fat content of the wool. The chrome content was only slightly to moderately affected by laundering regardless of the amount present.

Aging alone caused a drastic drop in shrink temperature which was often further decreased by laundering. A high shrink temperature immediately after processing resulted in a relatively high shrink temperature after any given period of service. Laundering maintained the shrink temperatures of the pads tanned with glutaraldehyde alone at a level above those of the glutaraldehyde controls. Laundering raised the pH and maintained it close to neutrality which probably accounts for the higher shrink temperature.

Shearlings tanned with alum or with small amounts of chrome failed after a short time in service. Pads with the high chrome had increased durability, but their length of service was not as long as the pads containing glutaraldehyde and they became stiffer.

Glutaraldehyde aids in maintaining the shearling in a soft, flexible condition during prolonged use and laundering whether or not chrome is present. All of

the pads tanned with glutaraldehyde alone or in combination with various amounts of chrome were quite durable. However, it was found advantageous to have sufficient chrome present with the glutaraldehyde to maintain the shrink temperature well above the washing-drying temperature range. The shearlings had excellent durability and were serviceable for as long as 28 months with as many as 54 launderings. This was considerably longer than the 6-month service period and/or 10 launderings that one large hospital stated was economically acceptable.

The launderable glutaraldehyde-chrome-tanned shearling pads were widely accepted by the patient, the nurse, the physician and the laundry supervisor.

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DISCUSSION

MR. MEO: Leader of discussion of this paper will be Mr. Merton Bell, A. C. Lawrence Leather Company.

MR. BELL: I'd like to thank Mr. Happich and his co-workers for an interesting paper. Bill, you stated that it was found advantageous to have sufficient chrome present with the glutaraldehyde to maintain a shrinkage temperature well above the washing and drying range. What minimum amount of chrome do you consider necessary to have with the glutaraldehyde?

MR. HAPPICH: We would recommend a minimum of two percent Cr_2O_3 on a hide substance basis be present with the glutaraldehyde.

MR. BELL: Before we go any further, are there any questions from the floor?

DR. LUDWIG SELIGSBERGER (U. S. Army Natick Laboratory): Does chrome in the table where you indicated a range from four to 20 percent mean dry powdered extract?

MR. HAPPICH: Yes, basic chromium sulfate, dry powder.

DR. SELIGSBERGER: And the 37°C. shrinkage was, if I recall, on the shearlings which had no chrome. Is that correct?

MR. HAPPICH: Yes, that is correct, but the shrink temperature was 39°C.

DR. SELIGSBERGER: Oh, 39°C. But that means the control was lower than the laundered shearlings?

MR. HAPPICH: Yes.

DR. SELIGSBERGER: Did you not have higher shrinkage temperatures on the laundered shearlings?

MR. HAPPICH: Yes, that is true. The laundering with the alkaline soaps and detergents tended to maintain a shrink temperature well above that of the controls stored under room conditions.

DR. SELIGSBERGER: And even on the shearlings which had 20 percent chrome extract, you found a drop from 101 to 80° in storage?

MR. HAPPICH: Yes, that is correct.

DR. SELIGSBERGER: How was the storage?

MR. HAPPICH: Just ordinary room conditions in our laboratory storage room. This is air-conditioned during the working day in the summer but not at other times.

DR. SELIGSBERGER: In your laboratory, not in the hospital?

MR. HAPPICH: No.

MR. BELL: Are there any other questions?

MR. MALCOLM H. BATTLES (A. C. Lawrence Leather Co.): It is interesting that a stiffness measurement was selected as a means of judging a deterioration phenomenon. We have done the same thing with a Tinius Olsen stiffness test, and it would be interesting to compare our results.

We might recommend a stiffness measurement, when properly conducted, to others working on deterioration problems, such as the type of problem Dr. Stubbings' group reported upon this morning.

MR. HAPPICH: Yes, that would be interesting to compare; thank you.

MR. BELL: I have one more. Bill, how would a chrome-tanned shearling perform under these service conditions?

MR. HAPPICH: A full chrome-tanned shearling would hold up well in service, but from the data we have, it would not last as long as a shearling that's been tanned with glutaraldehyde and chrome.

MR. BELL: Thank you again, Bill, for another fine paper.