STERIS®

LABORATORY REPORT #4222

SUBSTRATE COMPATIBILITY OF SPOR-KLENZ® READY-TO-USE COLD STERILANT

OBJECTIVE

The objective of this study was to evaluate the effect of full immersion exposure to a neat solution of Spor-Klenz Ready-To-Use (RTU) Cold Sterilant at both ambient conditions and 40°C (104°F) using a variety of common cleanroom materials.

BACKGROUND

Substrate compatibility is a serious issue for cleanroom personnel. To properly maintain the environmental control necessary for cleanrooms, frequent cleaning with microbial control agents is essential. However, frequent exposure to corrosive materials may lead to substrate damage, which in turn makes cleanroom control more difficult. This study was designed to evaluate possible effects of Spor-Klenz RTU sterilant on common cleanroom materials.

Spor-Klenz RTU sterilant is a hydrogen peroxide/peracetic acid-based cold sterilant which is commonly used to disinfect cleanroom surfaces. Spor-Klenz RTU sterilant may be diluted at a 1:50 ratio and used as a disinfectant. However, for purposes of this study, the neat material was utilized. Spor-Klenz RTU solutions are typically mopped or wiped onto a surface and allowed to air dry. The drying process typically takes 10 minutes or less. In this study, substrate exposure was obtained by full immersion in the Spor-Klenz RTU solution for a full seven days, to simulate a worst-case scenario.

This study was designed to detect compatibility in a systematic and quantitative manner through gravimetric, thickness and hardness evaluations pre-exposure and post-exposure. A microscopic analysis was also done to determine changes in the appearance of the surface of the plastics and elastomers. In all instances, the results were compared with material exposed to Milli-Q® water[1] as a blank.

PROTOCOL

Materials

The following elastomer, plastic and metal substrates were used:

Acrylonitrile-Butadiene-Styrene (ABS), Buna-Nitrogen (Buna-N), Butyl Rubber, Kynar®[2] Polyvinylidene Fluoride (PVDF), Lexan®[3] (polycarbonate), Neoprene, Nylon 101, Plexiglas®[4] (poly methyl methacrylate), High Density Polyethylene (HDPE), Low Density Polyethylene (LDPE), Polypropylene, Polyvinyl Chloride (PVC), Pyrex®[5], Teflon®[6] Polytetrafluoroethylene (PTFE), Silicon Rubber, and Viton®[6] (fluroelastomer).

The metals used were 416 and 316 Stainless Steels, Copper (CDA 110), Brass (CDA 443), Aluminum 1100 (AL 1100), Anodized Aluminum 1100 (AL 1100 anod.) and chrome plated steel (C1010 CP).

All of the coupons used in the study were 1/2" x 1/16" x 3", and either were solid or had a hole punched in them. The surface area of the coupons was 22.20 cm^2 (solid) or 22.06 cm^2 (with hole), respectively.

The Spor-Klenz RTU sterilant used in this study was from lot number S6Z351.

Coupon Precleaning

A Manu-Klenz® Instrument Detergent solution, manufactured at STERIS, composed of 8 mL of detergent per 100 mL of tap water was used to clean the plastics and elastomers, while acetone was used to cleanse the metals before the studies began. All materials were rinsed with Milli-Q® water[1] and allowed to air dry overnight before the studies commenced. Two coupons of each type of metal were used as controls to see if the cleansing solution attacked the base metal.

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[1] *Milli-Q® is a registered trademark of Millipore Corporation.*
[2] *Kynar® is a registered trademark of Arkema, Inc.*
[3] *Lexan® is a registered trademark of GE Corporation.*
[4] *Plexiglas® is a registered trademark of Altuglas International.*
[5] *Pyrex® is a registered trademark of Corning Inc.*
[6] *Teflon® and Viton® are registered trademarks of DuPont.*

Coupon Cleaning (post-exposure)

After exposure to Spor-Klenz RTU sterilant, all materials were once again cleaned, rinsed in Milli-Q® water[1], and allowed to dry overnight prior to taking measurements. In addition, after exposure to Spor-Klenz RTU sterilant, the metals were cleansed with acidic solutions. This was done to ensure that any oxide deposits would be removed before reweighing the coupons. Either hydrochloric, sulfuric acid or nitric acid was used for cleaning.

Measurement

Gravimetric studies were conducted using the ANL Analytical Balance #3 Mettler AT400 SN: 1115450634.

The thickness of the plastic and elastomeric coupons was determined using a micrometer, and the hardness was found by using Shore Instruments durometers. A sharp-ended durometer and a blunt-ended durometer were used depending on the hardness of the material. The durometer with a sharp end is a Durometer Type O ASTM D2240 S/N: 106429, and the durometer with a blunt end is a Durometer Type A ASTM D2240 S/N: 106090.

Microscopic analysis was done with a Nikon SMZ-U Zoom 1:10 compound microscope made by Fiberoptic Specialties Inc. The camera is a Javelin MOS Solid State. The images observed were viewed on a Sony Trinitron screen and printed on a Sony Color Video Printer by Mavigraph.

To conduct gravimetric studies, the coupons were weighed. A weigh boat was used on the balance so that the coupon would not touch the balance or be contaminated by the balance in any way. Between different coupon types, the balance was re-zeroed and the measurements were taken to as many significant figures as the balance allowed. Weights of the plastic, elastomeric and metal coupons were taken after being cleansed, before being exposed to Spor-Klenz RTU sterilant or Milli-Q® water[1], and after the final cleansing process was completed. Metal degradation rates, although based upon weight change, were calculated in mils per year (mpy), per the following formula:

$$mpy = \frac{(\text{weight loss, g}) \times (3.45 \times 10^6)}{(\text{metal density, g/cm}^3) \times (\text{metal area, cm}^3) \times (\text{exposure time, hour})}$$

Corrected corrosion rates were obtained by subtracting the corrosion rate for the water control from the calculated corrosion rate for the product.

A micrometer was used to measure the thicknesses of all of the plastics and elastomers both before and after exposure to the product. The micrometer was tightened on the coupon until the slightest bit of tension was felt. At that point, a measurement was taken. The micrometer measurements were taken to two decimal places and three measurements were taken on each coupon. An average was then taken of the three measurements. Thickness studies were done on all of the plastics and elastomers, except Pyrex®[2], since it was known to be unaffected in this dimension.

Two types of durometers were used to determine hardness depending on whether the surface was hard or soft. A harder surface needed a sharp-ended durometer, and softer surfaces needed a blunt-ended durometer. Either way, the operation of the durometer was the same. To take measurements, the durometer was grasped between the thumb and middle finger, with the index finger resting on the mounting knob. The durometer was then applied to the test article with an even and steady pressure until there was firm contact of the presser foot with the test article. Application pressure was about 2-3 lb on the test article. The test article was on a clean, hard surface so firm contact could be made. Hardness measurements of the test articles were taken approximately one second after the presser foot was in firm contact with the test article. Three readings were taken on each sample. The results were then averaged. Hardness studies were done on all of the plastics and elastomers, except Pyrex®[2], since it was known to be unaffected in this dimension.

Product Exposure

Eight-ounce glass jars were used to house the samples while they were exposed. Eight coupons were used to test each plastic, elastomer and metal. Two coupons were placed in each jar of each solution.

Four conditions existed for the exposure:

- Control: Room temperature in Milli-Q® water[1]
- Control: 40°C (104°F) in Milli-Q® water[1]
- Test Sample: Room temperature in Spor-Klenz RTU sterilant (neat)
- Test Sample: 40°C (104°F) in Spor-Klenz RTU sterilant (neat)

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[2] *Pyrex® is a registered trademark of Corning Inc.*

Two hundred milliliters of either Spor-Klenz RTU sterilant or Milli-Q® water[1] were measured in a graduated cylinder and then placed into each of the sample and control jars. The conditions were labeled on the jar. Two of each type of plastic, elastomer and metal were placed in the solution in each jar. The time that the jars were sealed was noted so that an exposure time could later be calculated. The coupons were then exposed to the specified condition for approximately seven days.

Upon completion of the seven-day period, the coupons were taken out of the jars. The coupons were then cleaned as described above and observed for any changes from the original condition. The solutions that the coupons had been exposed to were also observed.

RESULTS

Visual Observation

The coupons were examined under a microscope to detect changes after submersion in Milli-Q® water[1] and the Spor-Klenz RTU sterilant. Coupons that had been cleaned only, and not exposed to any disinfectant solution, coupons exposed to Milli-Q® water[1], and coupons exposed to the disinfectant solution were all examined. The magnification used for all coupons was 7.5x, and the camera used to view the coupons on the screen was set at 4.95x. Pictures were taken of the coupons and printed out when drastic changes took place. The condition that each coupon was subjected to was then noted on the back of the picture for future reference.

Three of the coupons seemed to change their microscopic appearance. When Buna-N was exposed to Spor-Klenz RTU sterilant at 40°C (104°F), little bumps seemed to appear on the surface of the coupon that had not been seen before. Spor-Klenz RTU sterilant exposed Viton®[2] at 40°C (104°F) also seemed to develop large raised bumps with depressions in the middle of each. Spor-Klenz RTU sterilant exposed Neoprene at 40°C (104°F) seemed to lose some of the vividness that appeared to be characteristic of the same type of coupon under other conditions.

In the remaining coupons, no visual difference between the controls and the exposed samples was noted.

Weight Changes Plastics of Elastomers (Tables 1a through 1b)

NOTE: In these tables, weight percentage decrease is noted in parentheses.

Three of the coupons exposed to Spor-Klenz RTU solutions demonstrated weight changes of 5% or greater. Buna-N, when exposed to Spor-Klenz RTU sterilant under ambient conditions demonstrated a weight increase of 42.3%; when exposed at 40°C (104°F), the weight of the coupons increased by 48.4%. The Milli-Q® water[1] controls demonstrated no appreciable difference in weight at either exposure condition.

Neoprene, when exposed to Spor-Klenz RTU sterilant at ambient temperature, demonstrated a weight increase of 14.6; at 40°C (104°F), the neoprene coupon weight increased by 18%. The Milli-Q® water[1] controls demonstrated no appreciable difference in weight at either exposure condition.

Viton®[2], when exposed to Spor-Klenz RTU sterilant at ambient temperature, demonstrated a weight increase of 11.5%; at 40°C (104°F), the Viton®[2] coupon demonstrated a weight increase of 16.8%. The Viton®[2] controls in Milli-Q® water[1] demonstrated no appreciable difference in weight at either exposure condition.

All other nonmetal coupons (metals coupon results are reported in **Table 4**) demonstrated weight increases or decreases of less than 5%.

Hardness Changes (Table 2a through 2b)

NOTE: In these tables, a percentage decrease in hardness is noted in parentheses.

Six materials showed hardness changes of approximately 5%. Butyl Rubber, when exposed to Spor-Klenz RTU sterilant at 40°C (104°F) demonstrated an increase in hardness of 5.6%. The Milli-Q® water[1] controls demonstrated an increase in hardness of 4.6% when exposed at 40°C (104°F).

HDPE, when exposed to Spor-Klenz RTU sterilant at 40°C (104°F), demonstrated an increase in hardness of 5.7%. When exposed to Milli-Q® water[1] at 40°C (104°F), the HDPE demonstrated an increase in hardness of 4.5%.

Buna-N, when exposed to Spor-Klenz RTU sterilant, demonstrated decreases in hardness of 4.6 and 11.5% at ambient and 40°C (104°F) temperature exposures, respectively. The Milli-Q® water[1] exposure produced an increase in hardness of 5.9 and 9.9% at ambient and 40°C (104°F) temperatures, respectively.

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2. *Viton® is a registered trademark of DuPont.*

Nylon 101, when exposed to Spor-Klenz RTU sterilant, demonstrated a decrease in hardness of 6.7 and 5.3% at ambient and 40°C (104°F) temperatures, respectively. The Milli-Q® water[1] exposure produced a decrease in hardness of 7.4 and 8.5% at ambient and 40°C (104°F) temperatures, respectively.

Silicon Rubber, when exposed to Spor-Klenz RTU sterilant, demonstrated increases in hardness of 5.1 and 8.1% at ambient and 40°C (104°F) temperatures, respectively. Exposure to Milli-Q® water[1] produced an increase in hardness of 6.3 and 4.6%, at ambient and 40°C (104°F) temperatures, respectively.

ABS, when exposed to Spor-Klenz RTU sterilant, demonstrated increases in hardness of 10.9 and 9.7%, at ambient and 40°C (104°F) temperatures, respectively. Exposure to Milli-Q® water[1] produced an increase in hardness of 10.6 and 6.1%, at ambient and 40°C (104°F) temperatures, respectively.

Thickness Changes (Table 3a through 3b)

NOTE: In these tables, a percentage decrease in thickness is noted in parentheses.

Three of the materials tested demonstrated changes in thickness of greater than 5%. Buna-N, when exposed to Spor-Klenz RTU sterilant, demonstrated increases in thickness of 13.3 and 12.9%, at ambient and 40°C (104°F) temperatures, respectively. The water controls were not significantly affected.

Neoprene, when exposed to Spor-Klenz RTU sterilant, demonstrated increases in thickness of 8.5 and 10.3%, at ambient and 40°C (104°F) temperatures, respectively. The water controls were not significantly affected.

Viton®[2], when exposed to Spor-Klenz RTU sterilant, demonstrated increases in hardness of 8.9 and 11.3%, at ambient and 40°C (104°F) temperatures, respectively. The water controls were not significantly affected.

Corrosion Rates of Metals (Table 4)

NOTE: In these tables, a negative corrosion rate is noted in parentheses.

Only 316 and 416 stainless steel showed essentially no reaction to the Spor-Klenz RTU under either ambient or 40°C (104°F) exposure conditions.

When exposed to Spor-Klenz RTU sterilant: chrome plated steel (C1010 CP) demonstrated corrected corrosion rates of 6.8 and 25.1 mpy, at ambient and 40°C (104°F) temperatures, respectively; brass (CDA 443) demonstrated corrected corrosion rates of 22.5 and 22.8 mpy, at ambient and 40°C (104°F) temperatures, respectively; copper (CDA 110) demonstrated a corrected corrosion rate of 59.1 and 92.5 mpy, at ambient and 40°C (104°F) temperatures, respectively; aluminum (AL 1100) demonstrated corrected corrosion rates of 23.9 and 38.0 mpy, at ambient and 40°C (104°F) temperatures, respectively; anodized aluminum (AL 1100) demonstrated corrected corrosion rates of 22.5 and 22.8 mpy, at ambient and 40°C (104°F) temperatures, respectively.

CONCLUSIONS

The data summarized in this report are based upon a continuous exposure to neat Spor-Klenz RTU sterilant for a period of seven days at both ambient and elevated temperatures. This data is intended to provide assistance in terms of evaluating this product for compatibility with various substrates. Consideration should be given to the absolute changes following exposure, as well as to the changes relative to the water control. In addition, the relevance of this data should be considered in light of the actual application procedures used at a given facility, which typically involve much less rigorous (time, temperature) exposure conditions.

Table 1a: Weight Change of Plastics

Material	Condition	Temp.	Avg. Initial Wt. (g)	Avg. Wt. Change (g)	Avg. Percent Wt. Change
Butyl Rubber	Control	Ambient	1.9015	0.0032	< 1.0
	Control	40°C (104°F)	1.8889	0.0081	< 1.0
	Spor-Klenz RTU	Ambient	1.8975	0.0320	1.7
	Spor-Klenz RTU	40°C (104°F)	1.8907	0.0327	1.7

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[2] *Viton® is a registered trademark of DuPont.*

Table 1a: Weight Change of Plastics

Material	Condition	Temp.	Avg. Initial Wt. (g)	Avg. Wt. Change (g)	Avg. Percent Wt. Change
PVC	Control	Ambient	2.0986	0.0017	< 1.0
	Control	40°C (104°F)	2.1051	0.0019	< 1.0
	Spor-Klenz RTU	Ambient	2.0986	0.0091	< 1.0
	Spor-Klenz RTU	40°C (104°F)	2.1072	0.0027	< 1.0
HDPE	Control	Ambient	1.3444	0.0024	< 1.0
	Control	40°C (104°F)	1.3435	0.0008	< 1.0
	Spor-Klenz RTU	Ambient	1.3489	0.0001	< 1.0
	Spor-Klenz RTU	40°C (104°F)	1.3285	0.0003	< 1.0
Polypropylene	Control	Ambient	2.5339	0.0074	< 1.0
	Control	40°C (104°F)	2.4918	0.0023	< 1.0
	Spor-Klenz RTU	Ambient	1.9172	0.0031	< 1.0
	Spor-Klenz RTU	40°C (104°F)	2.5242	0.0026	< 1.0
Kynar	Control	Ambient	2.5574	0.0000	< 1.0
	Control	40°C (104°F)	2.5798	0.0011	< 1.0
	Spor-Klenz RTU	Ambient	2.5209	0.0002	< 1.0
	Spor-Klenz RTU	40°C (104°F)	2.5821	0.0011	< 1.0
LDPE	Control	Ambient	2.7282	0.0008	< 1.0
	Control	40°C (104°F)	2.7126	(0.0008)	< (1.0)
	Spor-Klenz RTU	Ambient	2.7264	(0.0003)	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	2.7197	(0.0006)	< (1.0)

Table 1b: Weight Change of Plastics

Material	Condition	Temp.	Avg. Initial Wt. (g)	Avg. Wt. Change (g)	Avg. Percent Wt. Change
Plexiglas	Control	Ambient	3.4379	0.0103	< 1.0
	Control	40°C (104°F)	3.4377	0.0178	< 1.0
	Spor-Klenz RTU	Ambient	3.4425	0.0112	< 1.0
	Spor-Klenz RTU	40°C (104°F)	3.4378	0.0178	< 1.0
Lexan	Control	Ambient	1.7479	0.0035	< 1.0
	Control	40°C (104°F)	1.6910	0.0000	< 1.0
	Spor-Klenz RTU	Ambient	1.7423	0.0024	< 1.0
	Spor-Klenz RTU	40°C (104°F)	1.6909	0.0000	< 1.0
Buna-N	Control	Ambient	1.5645	0.0393	2.5
	Control	40°C (104°F)	1.5749	(0.0091)	< (1.0)
	Spor-Klenz RTU	Ambient	1.5786	0.6674	42.3
	Spor-Klenz RTU	40°C (104°F)	1.5561	0.7533	48.4
Pyrex	Control	Ambient	7.8913	0.0006	< 1.0
	Control	40°C (104°F)	7.4480	(0.0001)	< 1.0
	Spor-Klenz RTU	Ambient	7.6971	0.0004	< 1.0
	Spor-Klenz RTU	40°C (104°F)	7.6182	0.0002	< 1.0

Table 1b: Weight Change of Plastics

Material	Condition	Temp.	Avg. Initial Wt. (g)	Avg. Wt. Change (g)	Avg. Percent Wt. Change
Nylon 101	Control	Ambient	1.6365	0.0705	4.3
	Control	40°C (104°F)	1.6579	0.0656	4.0
	Spor-Klenz RTU	Ambient	1.6538	0.0592	3.6
	Spor-Klenz RTU	40°C (104°F)	1.6389	0.0810	4.9
Teflon	Control	Ambient	3.3166	0.0163	< 1.0
	Control	40°C (104°F)	3.3118	0.0027	< 1.0
	Spor-Klenz RTU	Ambient	3.3116	0.0019	< 1.0
	Spor-Klenz RTU	40°C (104°F)	3.3155	0.0016	< 1.0
Silicon Rubber	Control	Ambient	2.1588	0.0021	< 1.0
	Control	40°C (104°F)	2.0063	(0.0015)	< (1.0)
	Spor-Klenz RTU	Ambient	1.9911	0.0080	< 1.0
	Spor-Klenz RTU	40°C (104°F)	2.0000	(0.0036)	< (1.0)
Neoprene	Control	Ambient	1.5359	0.0234	1.5
	Control	40°C (104°F)	1.5507	0.0207	1.3
	Spor-Klenz RTU	Ambient	1.5474	0.2252	14.6
	Spor-Klenz RTU	40°C (104°F)	1.5454	0.2776	18.0
ABS	Control	Ambient	1.5471	0.0117	< 1.0
	Control	40°C (104°F)	1.5515	0.0007	< 1.0
	Spor-Klenz RTU	Ambient	1.5488	0.0085	< 1.0
	Spor-Klenz RTU	40°C (104°F)	1.5469	0.0032	< 1.0
Viton	Control	Ambient	2.8379	0.0077	< 1.0
	Control	40°C (104°F)	2.9734	0.0027	< 1.0
	Spor-Klenz RTU	Ambient	2.5960	0.3440	11.5
	Spor-Klenz RTU	40°C (104°F)	2.9890	0.5022	16.8

Table 2a: Hardness Change of Plastics

Material	Condition	Temp.	Avg. Initial Hardness Reading	Avg. Final Hardness Reading	Avg. Percent Hardness Change
Butyl Rubber	Control	Ambient	66	68	4.3
	Control	40°C (104°F)	65	68	4.6
	Spor-Klenz RTU	Ambient	65	68	3.9
	Spor-Klenz RTU	40°C (104°F)	63	67	5.6
PVC	Control	Ambient	81	82	1.2
	Control	40°C (104°F)	80	80	< 1.0
	Spor-Klenz RTU	Ambient	81	83	2.5
	Spor-Klenz RTU	40°C (104°F)	80	81	1.9
HDPE	Control	Ambient	59	62	4.5
	Control	40°C (104°F)	61	64	3.5
	Spor-Klenz RTU	Ambient	59	62	5.7
	Spor-Klenz RTU	40°C (104°F)	61	64	3.5

Table 2a: Hardness Change of Plastics

Material	Condition	Temp.	Avg. Initial Hardness Reading	Avg. Final Hardness Reading	Avg. Percent Hardness Change
Polypropylene	Control	Ambient	70	71	1.2
	Control	40°C (104°F)	70	72	1.9
	Spor-Klenz RTU	Ambient	71	72	2.4
	Spor-Klenz RTU	40°C (104°F)	69	72	3.1
Kynar	Control	Ambient	75	76	1.6
	Control	40°C (104°F)	74	75	< 1.0
	Spor-Klenz RTU	Ambient	74	77	4.1
	Spor-Klenz RTU	40°C (104°F)	74	75	1.8
LDPE	Control	Ambient	49	50	3.4
	Control	40°C	49	50	2.4
	Spor-Klenz RTU	Ambient	48	50	3.5
	Spor-Klenz RTU	40°C (104°F)	48	49	< 1.0
Plexiglas	Control	Ambient	87	89	2.9
	Control	40°C (104°F)	88	87	< (1.0)
	Spor-Klenz RTU	Ambient	88	90	2.3
	Spor-Klenz RTU	40°C (104°F)	88	89	1.1
Lexan	Control	Ambient	80	82	2.9
	Control	40°C (104°F)	80	82	2.5
	Spor-Klenz RTU	Ambient	81	83	2.7
	Spor-Klenz RTU	40°C (104°F)	81	82	1.7
Buna-N	Control	Ambient	59	63	5.9
	Control	40°C (104°F)	59	65	9.9
	Spor-Klenz RTU	Ambient	59	56	(4.6)
	Spor-Klenz RTU	40°C (104°F)	60	53	(11.5)
Nylon 101	Control	Ambient	77	71	(7.4)
	Control	40°C (104°F)	79	72	(8.5)
	Spor-Klenz RTU	Ambient	78	73	(6.7)
	Spor-Klenz RTU	40°C (104°F)	76	72	(5.3)
Teflon	Control	Ambient	59	59	< 1.0
	Control	40°C (104°F)	58	59	2.3
	Spor-Klenz RTU	Ambient	59	59	1.1
	Spor-Klenz RTU	40°C (104°F)	57	59	3.8

Table 2b: Hardness Change of Plastics

Material	Condition	Temp.	Avg. Initial Hardness Reading	Avg. Final Hardness Reading	Avg. Percent Hardness Change
Silicon Rubber	Control	Ambient	55	58	6.3
	Control	40°C (104°F)	54	56	4.6
	Spor-Klenz RTU	Ambient	53	56	5.1
	Spor-Klenz RTU	40°C (104°F)	52	56	8.1

Table 2b: Hardness Change of Plastics

Material	Condition	Temp.	Avg. Initial Hardness Reading	Avg. Final Hardness Reading	Avg. Percent Hardness Change
Neoprene	Control	Ambient	63	65	3.2
	Control	40°C (104°F)	61	66	8.2
	Spor-Klenz RTU	Ambient	61	64	3.5
	Spor-Klenz RTU	40°C (104°F)	60	59	(2.5)
ABS	Control	Ambient	65	72	10.6
	Control	40°C (104°F)	66	70	6.1
	Spor-Klenz RTU	Ambient	64	71	10.9
	Spor-Klenz RTU	40°C (104°F)	64	70	9.7
Viton	Control	Ambient	71	75	6.6
	Control	40°C (104°F)	69	76	9.7
	Spor-Klenz RTU	Ambient	74	74	< 1.0
	Spor-Klenz RTU	40°C (104°F)	70	70	0.0

Table 3a: Thickness Changes in Plastic

Material	Condition	Temp.	Avg. Initial Thickness Reading	Avg. Final Thickness Reading	Avg. Percent Thickness Change
Butyl Rubber	Control	Ambient	1.71	1.72	< 1.0
	Control	40°C (104°F)	1.72	1.72	< (1.0)
	Spor-Klenz RTU	Ambient	1.72	1.75	1.8
	Spor-Klenz RTU	40°C (104°F)	1.71	1.73	1.2
PVC	Control	Ambient	1.61	1.59	(1.0)
	Control	40°C (104°F)	1.66	1.59	< (4.1)
	Spor-Klenz RTU	Ambient	1.60	1.59	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	1.61	1.59	< (1.2)
HDPE	Control	Ambient	1.58	1.54	< (2.6)
	Control	40°C (104°F)	1.59	1.54	(3.4)
	Spor-Klenz RTU	Ambient	1.58	1.54	< (2.6)
	Spor-Klenz RTU	40°C (104°F)	1.56	1.53	(1.8)
Polypropylene	Control	Ambient	3.02	3.00	< (1.0)
	Control	40°C (104°F)	3.05	3.00	< (1.7)
	Spor-Klenz RTU	Ambient	2.30	2.27	< (1.2)
	Spor-Klenz RTU	40°C (104°F)	3.01	3.00	< (1.0)
Kynar	Control	Ambient	1.55	1.53	(1.2)
	Control	40°C (104°F)	1.57	1.54	(1.6)
	Spor-Klenz RTU	Ambient	1.53	1.50	(1.4)
	Spor-Klenz RTU	40°C (104°F)	1.58	1.55	(1.9)

Table 3b: Thickness Changes in Plastic

Material	Condition	Temp.	Avg. Initial Thickness Reading	Avg. Final Thickness Reading	Avg. Percent Thickness Change
LDPE	Control	Ambient	3.24	3.21	< (1.0)
	Control	40°C (104°F)	3.23	3.22	< (1.0)
	Spor-Klenz RTU	Ambient	3.24	3.21	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	3.23	3.21	< (1.0)
Plexiglas	Control	Ambient	3.02	3.00	< (1.0)
	Control	40°C (104°F)	3.01	2.99	< (1.0)
	Spor-Klenz RTU	Ambient	3.01	3.00	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	3.00	3.00	< (1.0)
Lexan	Control	Ambient	1.54	1.55	< 1.0
	Control	40°C (104°F)	1.51	1.51	< (1.0)
	Spor-Klenz RTU	Ambient	1.54	1.54	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	1.51	1.51	0.0
Buna-N	Control	Ambient	1.41	1.43	1.2
	Control	40°C (104°F)	1.45	1.43	(1.6)
	Spor-Klenz RTU	Ambient	1.45	1.64	13.3
	Spor-Klenz RTU	40°C (104°F)	1.43	1.62	12.9
Nylon 101	Control	Ambient	1.55	1.57	1.1
	Control	40°C (104°F)	1.56	1.58	< 1.0
	Spor-Klenz RTU	Ambient	1.54	1.56	1.4
	Spor-Klenz RTU	40°C (104°F)	1.54	1.56	1.2
Teflon	Control	Ambient	1.64	1.63	< (1.0)
	Control	40°C (104°F)	1.63	1.63	< 1.0
	Spor-Klenz RTU	Ambient	1.65	1.63	< (1.2)
	Spor-Klenz RTU	40°C (104°F)	1.64	1.63	< (1.0)
Silicon Rubber	Control	Ambient	1.69	1.69	< (1.0)
	Control	40°C (104°F)	1.67	1.67	< 1.0
	Spor-Klenz RTU	Ambient	1.68	1.68	< 1.0
	Spor-Klenz RTU	40°C (104°F)	1.68	1.67	< (1.0)
Neoprene	Control	Ambient	1.46	1.45	< (1.0)
	Control	40°C (104°F)	1.44	1.45	< 1.0
	Spor-Klenz RTU	Ambient	1.45	1.57	8.5
	Spor-Klenz RTU	40°C (104°F)	1.45	1.60	10.3
ABS	Control	Ambient	1.60	1.62	< 1.0
	Control	40°C (104°F)	1.63	1.60	(1.5)
	Spor-Klenz RTU	Ambient	1.61	1.60	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	1.61	1.59	(1.2)

Table 3b: Thickness Changes in Plastic

Material	Condition	Temp.	Avg. Initial Thickness Reading	Avg. Final Thickness Reading	Avg. Percent Thickness Change
Viton	Control	Ambient	1.62	1.63	< 1.0
	Control	40°C (104°F)	1.70	1.71	< 1.0
	Spor-Klenz RTU	Ambient	1.70	1.85	8.9
	Spor-Klenz RTU	40°C (104°F)	1.70	1.89	11.3

Table 4: Corrosion Rates of Metals

Material	Condition	Temp.	Avg. Initial Weight (g)	Avg. Weight Change (g)	Corrosion Rate, mpy	Corrected* Corrosion Rate, mpy
C1010 CP	Control	Ambient	11.0358	0.0013	(73.8)	N/A
	Control	40°C (104°F)	11.0959	0.0020	(76.2)	N/A
	Spor-Klenz RTU	Ambient	11.0346	0.0550	(66.9)	6.8
	Spor-Klenz RTU	40°C (104°F)	11.0487	0.1954	(51.1)	25.1
316 SS	Control	Ambient	11.1009	0.0009	< 1.0	N/A
	Control	40°C (104°F)	11.1019	0.0001	< 1.0	N/A
	Spor-Klenz RTU	Ambient	11.1072	0.0008	< 1.0	0.0
	Spor-Klenz RTU	40°C (104°F)	11.0999	0.0007	< 1.0	< 1.0
416 SS	Control	Ambient	13.0691	0.0092	1.1	N/A
	Control	40°C (104°F)	12.8132	0.0085	1.0	N/A
	Spor-Klenz RTU	Ambient	13.0703	0.0024	< 1.0	< (1.0)
	Spor-Klenz RTU	40°C (104°F)	12.8757	0.0034	< 1.0	< 1.0
AL 1100 anod.	Control	Ambient	3.9154	0.0000	< 1.0	N/A
	Control	40°C (104°F)	3.9179	(0.0009)	< (1.0)	N/A
	Spor-Klenz RTU	Ambient	3.9129	0.0675	22.5	22.5
	Spor-Klenz RTU	Ambient	3.9178	0.0648	22.5	22.8
CDA 443	Control	Ambient	12.6780	0.0013	< 1.0	N/A
	Control	40°C (104°F)	12.6464	0.0019	< 1.0	N/A
	Spor-Klenz RTU	Ambient	12.6693	0.9732	102.6	102.5
	Spor-Klenz RTU	40°C (104°F)	12.6317	0.8611	93.6	93.4
CDA 110	Control	Ambient	13.1716	0.0032	< 1.0	N/A
	Control	40°C (104°F)	13.1749	0.0034	< 1.0	N/A
	Spor-Klenz RTU	Ambient	13.1559	0.5893	59.5	59.1
	Spor-Klenz RTU	40°C (104°F)	13.0735	0.8906	92.9	92.5
AL 1100	Control	Ambient	3.9133	(0.0345)	(11.4)	N/A
	Control	40°C (104°F)	3.8664	(0.0701)	(24.0)	N/A
	Spor-Klenz RTU	Ambient	3.8795	0.0380	12.5	23.9
	Spor-Klenz RTU	40°C (104°F)	3.9060	0.0411	14.1	38.0

** Corrected corrosion rates were obtained by subtracting the corrosion rate for the water control from the calculated corrosion rate for the product.*

For further information, please contact:

STERIS Corporation
5960 Heisley Road
Mentor, OH 44060-1834 ▪ USA
440-354-2600 ▪ 800-548-4873
www.steris.com