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(54) **PROCESS TO PRODUCE HYGIENICALLY
CLEAN TEXTILE**

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(57) **ABSTRACT**

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Textiles are hygienically cleaned by subjecting them to a low-temperature wash, generally less than 140°, and typically about 100° F. Once cleaned, they are subjected to a low temperature bleaching step at a pH of generally around 9 or less. The bleaching step is again conducted a low temperature, such as 140°, 100° F. Treated textiles can then be rinsed and treated to any typical post-washing operations. By conducting the washing and the bleaching at low temperatures, energy is saved. Further, maintaining the low temperature and low pH for the bleaching solution achieves better disinfection and, at the same time, minimizes damage to the textile.

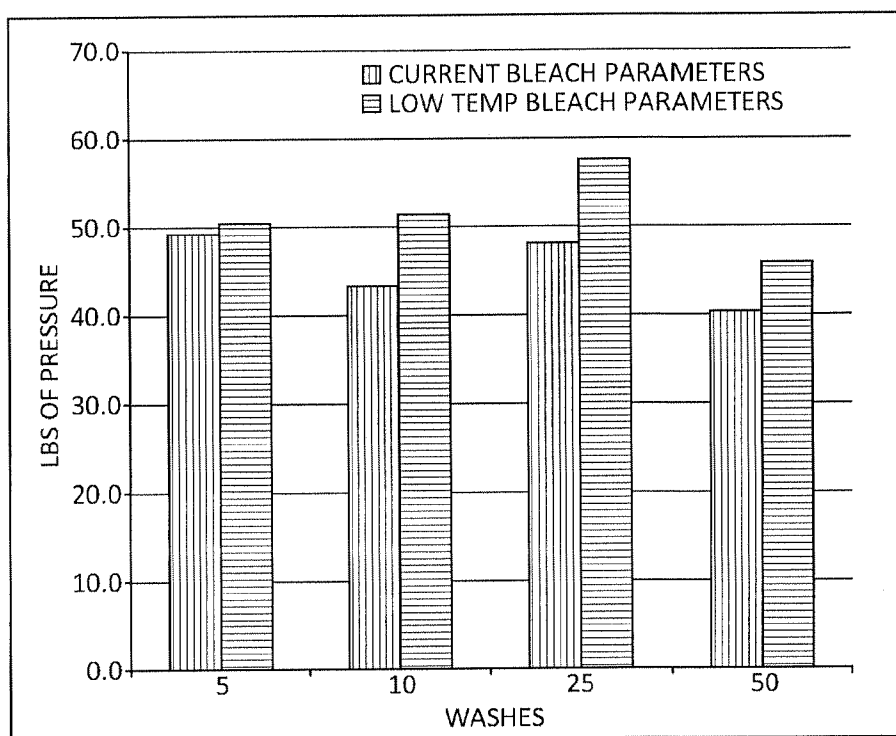


FIG. 1

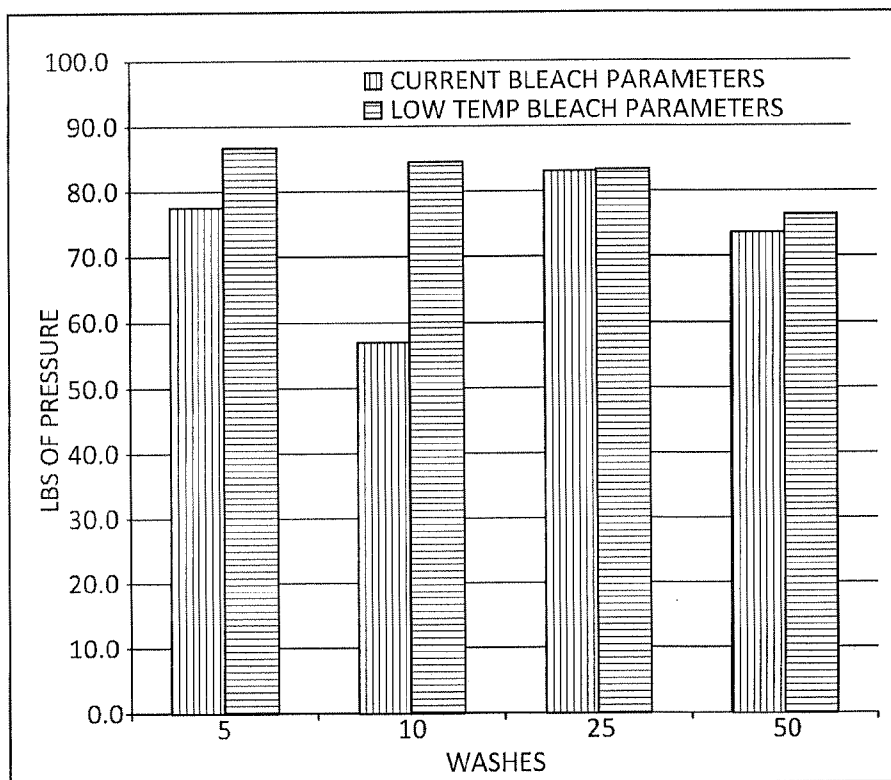


FIG. 2

PROCESS TO PRODUCE HYGIENICALLY CLEAN TEXTILE

BACKGROUND OF THE INVENTION

[0001] Hygienic cleanliness of textiles has become an increasingly important aspect of the laundering process. Presently, much of the United States and European Union rely on thermal disinfection as the means to verify that textiles have been properly washed and are hygienically clean. In the US, the CDC guidelines state that one way to help achieve hygienic disinfection for hot-water washing is to wash at 160° F. for a minimum of 25 minutes. The CDC also states that several studies have demonstrated that lower water temperatures of 71° F.-77° F. can reduce microbial contamination when the cycling of the washer, wash chemistry are controlled.

[0002] Due to production demands, textiles processed through continuous batch washers (CBW's) do not typically meet the CDC thermal disinfection requirements of 160° F. for 25 minutes. In addition, although washing machines are programmed to reach 160° F., many lack a mechanism to verify that 160° F. is reached and maintained.

[0003] Thermal disinfection has been shown to be insufficient in killing spore forming bacteria, such as *C. diff*. *C. diff* can survive extended heating at 160° F. Temperatures of 145-160° F. may actually enhance spore germination of some aged spores.

[0004] EPA registered sanitizers/disinfectants are sometimes used in healthcare laundries. When used properly, these sanitizers/disinfectants have kill claims on certain organisms. The deficiency in using these sanitizers/disinfectants is that they do not have kill claims on many organisms present in the healthcare environment. One such sanitizer/disinfectant has kill claims for *Staphylococcus aureus*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, methicillin resistant *Staphylococcus aureus* (MRSA), *Acinetobacter baumannii*, *Listeria monocytogenes*, *Escherichia coli*, and *Salmonella enterica*. This sanitizer/disinfectant does not address other significant problematic organisms, such as *C. diff*, *Giardia*, *Legionella*, fungi, and molds.

[0005] In commercial laundries, textiles are typically laundered at elevated temperatures, such as 150° F. under alkaline conditions. There are certain detergents on the market which permit the textiles to be laundered at lower temperatures.

[0006] Certain textiles require a bleaching step. This is particularly required for white textiles such as white linen. Chlorine-based bleaches, such as sodium hypochlorite, are typically used. Generally the commercial laundries bleach such textiles at temperatures about 150° F., similar to the laundering temperature, and at relatively high pHs, around 10.2 to 10.8. If the chlorine bleaches are used at lower pHs, the textiles are damaged by the bleach.

[0007] Also, once a textile is laundered at a high temperature, it must be brought down to room temperature gradually or wrinkles will set in. Generally, the temperature of the textiles is lowered by going through a series of rinsing steps wherein in each step the temperature of the rinse water is slightly lower than the previous temperature. This allows the temperature of the textile to be lowered to room temperature without setting in wrinkles.

[0008] This operation is relatively expensive, requiring a significant amount of energy to raise the temperature of the textiles to the effective laundering temperature. It also requires a great deal of time for step down rinsing.

SUMMARY OF THE INVENTION

[0009] The present invention is premised on the realization that one can effectively launder and bleach textiles by initially washing the textile at a low temperature, generally 140° F. or lower, and subsequently bleaching the textiles, again at a low temperature of less than 140° F., at a pH less than 9.5, generally from about 7 to 9. This effectively launders and bleaches the textile without causing any damage to the textile, which typically would be expected when bleaching at such a low pH.

[0010] In one embodiment of the present invention, particularly suitable for laundering hospital linens, the linens are cleaned in a four zone process, the first zone designed to remove chlorhexidine also referred to as Hibiclens, wherein a concentrated high-performance detergent is used, along with a Hibiclens remover, such as Hibiclear, to remove any chlorhexidine from the fabric, preventing it from setting in subsequent zones. In the second zone, the linens are washed, again at a low temperature, generally 140° F. or less, such as 100° F., down to 85° F. In this zone, a high performance laundry detergent, along with a concentrated alkali, is added. This zone helps to reduce microorganism contamination. In the third zone, the textiles become hygienically clean by treating the textiles with sodium hypochlorite, a bleach activator, at a pH of less than 9.5, generally 7 to 9, more particularly 7-8, again at a temperature less than 140° F., generally 100° F. or less. Finally, in the fourth zone, the linens are rinsed and the pH adjusted to about 7. At this stage, softeners can be added if required.

[0011] The objects and advantages of present invention will be further appreciated in light of the following detailed description and brief description of the Figures, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. 1 is a graph showing tensile strength of a cotton fabric after repeated washes; and

[0013] FIG. 2 is a graph showing tensile strength of a 65/35 polyester/cotton blend after repeated washes.

DETAILED DESCRIPTION OF THE INVENTION

[0014] According to the present invention, textiles are laundered in a manner that ensures destruction of bacteria and other pathogens to provide hygienically clean textiles. The washing process will be conducted in typical commercial laundry facilities. Generally, any commercial laundry equipment can be used in the process of the present invention. One such typical apparatus is a tunnel washing apparatus, generally one having at least four zones.

[0015] The textiles are initially subjected to a low temperature, low pH laundering. In this first zone, the textiles are treated in a manner, well-known to remove chlorhexidine, an antimicrobial agent typically used in hospitals, also referred to as Hibiclens. In this process, the textiles are subjected to a wash at an acid pH to prevent the chlorhexidine from setting. The wash washing solution can include Hibiclear, a commercially available product which is designed to facilitate removal of chlorhexidine.

[0016] This initial zone washing is conducted generally at a lower temperature, preferably at 140° F. or less, such as 130, 120, 110 and generally about 100° F. The initial wash is conducted for a time effective to remove any chlorhexidine present and generally from about 2 to about 8 minutes and generally about 8 minutes. This step is unnecessary for textiles that do not include chlorhexidine.

[0017] Once the textiles are treated in the initial zone, they pass to a wash zone, where they are washed using a high-performance, low temperature laundry detergent, generally a nonionic surfactant-based detergent at an alkaline pH. This washing step is conducted at a temperature of 140° to 85° F., generally 130° F. to 95° F., 120° F. or less, 110° F. or less and preferably at about 100° F. The time during which the textiles are treated in the wash zone may vary, depending upon the materials being laundered. In most applications, the time is from 6 to about 15 and generally about 12.

[0018] After the laundry passes through the wash zone, the washing liquid is separated from the textiles. The textiles are then passed to a third zone, which is a pathogen removal zone or a bleaching zone. In this zone, the textiles are treated with a bleach solution, typically sodium hypochlorite at a pH of 6.5 to 9.5, generally 8 to 6.5 and, in particular, a pH of 7. The pH is adjusted as needed by the addition of an appropriate water soluble buffer, such as urea sulfate.

[0019] The concentration of the bleach will be about 5 ounces to 30 ounces per hundred weight textile or 25 to 500 ppm. In addition to the sodium hypochlorite, a bleach activator is added, such as Pathfree. This will effectively established the pH within the desired range. The temperature in this zone will be maintained at 140° F. or less, generally 130° F. or less, 120° F. or less, 110° F. or less and typically at about 100° F. In addition to sodium hypochlorite, other suitable bleaches include powdered bleaches such as lithium hypochlorite, trichloroisocyanuric acid and hypochlorous acid.

[0020] The washing solution in zone three should have a minimum oxygen reduction potential of 665 MV, which is achieved by establishing sufficient sodium hypochlorite and an effective pH. The clothing is subjected to the hypochlorite solution for about 4 to about 30 minutes, which is more than adequate to destroy potential pathogens on the textile.

[0021] Once the textile has passed through the third zone, it is rinsed in a fourth zone or a finishing zone. In this zone, which is optional, any remaining wash chemicals are removed from the textiles and the pH is adjusted to a proper finish pH of 6-7. Softener may be added as required by the end-user.

[0022] The present invention has many different advantages. In particular, all the zones are operated at lower temperatures, generally around 100° F. This eliminates the need for either adding or removing energy from the textiles during the laundry procedure. In addition to effectively cleaning the textiles, they are disinfected, destroying pathogens utilizing the third zone which effectively kills the pathogens with the hypochlorite at a relatively low pH and low temperature. Again, the low temperature reduces costs because the temperature of the textile does not have to be adjusted in going from the wash zone to the pathogen destruction zone.

[0023] Finally, the present invention reduces the damage to the textiles, as compared to current bleach parameters which operate at a higher temperature and higher pHs. As shown in FIG. 1, the tensile strength of cotton is measured after repeated washes, either under current bleach parameters or the low temperature bleach parameters as discussed above for zone three. Particularly after 10 or 25 launderings or washes, the tensile strengths of the textiles bleached with the bleach parameters of the present invention are substantially higher than those bleached using current bleach parameters (i.e. higher temperatures and pHs). Likewise with the 65/35 polyester cotton blend, similar improved results are achieved, as shown in FIG. 2.

[0024] In Examples 1 and 2 below, the effectiveness of these wash parameters reduce known amounts of microorganisms was studied.

Example 1

Objective

[0025] The objective was to evaluate the effectiveness of the present invention as a means of reducing known amounts of microorganisms.

[0026] Test Parameters:

[0027] The effect of the present invention on known quantities of microbes was tested to examine how the different wash parameters affect the different organisms. One by one inch square swatches of linen were inoculated. After inoculation the swatches were allowed to dry for thirty minutes in a sterile petri dish. Upon completion of the dry time, the swatches were pinned to a mesh net and subjected to the differing wash parameters.

[0028] Preparation of Inoculum:

[0029] Each organism was grown in tryptic soy broth for approximately 24 hours at 32.5° C. in a sterile baffled flask, while shaking on a Thermo Scientific multipurpose orbital shaker. After the incubation period the suspension was diluted with tryptic soy broth, to yield a specific absorbance with the Hach DR 2700 spectrophotometer. The adjusted suspension contains approximately 5.0×10^8 CFU/mL.

[0030] Sample identification—Hospital/Hotel linen 70% cotton 30% polyester 1.0x1.0 square swatches.

[0031] Test Organisms—

[0032] *Escherichia coli*—ATCC #8739

[0033] *Pseudomonas aeruginosa*—ATCC #9027

[0034] *Staphylococcus aureus*—ATCC #6538

[0035] *Klebsiella pneumoniae*—ATCC # BAA-1144

[0036] *Salmonella enterica* subspecies *typhimurium*—ATCC #13311

[0037] Method—Membrane filtration (sterile elution 45 mL), total aerobic plate count

[0038] Wash and Chemistry Tested:

[0039] Classification: Sheets

[0040] Load weight: 100% capacity

Process 2 oz/cwt Bleach-8 minute contact time					
Operation	Time	Temperature	Level	Chemical	Usage/35 lb
*Bleach-Sub	8/1	100	Low	Bleach 85% urea sulfate	22 mL 4 ml
Rinse	2/1	split	High		
Rinse	2/1	cold	High		
*Sour-Soft	4/1	cold	Low	Pinn. A/C Pinn. Sour	9 mL 0 mL
Total Time: 22 Minutes					
Inoculum	CFU/mL	Inoculum Volume	Calculated CFU/Swatch	Log10/Swatch	
<i>E. coli</i>	3.0×10^9	40 µL	1.9×10^8	8.28	
<i>P. aeruginosa</i>	2.0×10^8	40 µL	8.1×10^6	6.91	
<i>S. aureus</i>	2.0×10^8	40 µL	8.0×10^6	6.90	
<i>K. pneumoniae</i>	2.0×10^9	40 µL	8.2×10^7	7.90	
<i>S. typhimurium</i>	3.1×10^9	40 µL	1.29×10^8	8.1	

[0041] Results:

Treatments (3 replicates each)	CFU/Swatch	Log ₁₀ Survivors	Log Reduction (calculated CFU/Swatch)
<i>E. coli</i>	1-1	<10	<1.0
<i>E. coli</i>	1-2	<10	<1.0
<i>E. coli</i>	1-3	<10	<1.0
<i>P. aeruginosa</i>	1-1	<10	<1.0
<i>P. aeruginosa</i>	1-2	<10	<1.0
<i>P. aeruginosa</i>	1-3	<10	<1.0
<i>S. aureus</i>	1-1	<10	<1.0
<i>S. aureus</i>	1-2	<10	<1.0
<i>S. aureus</i>	1-3	<10	<1.0
<i>K. pneumoniae</i>	1-1	<10	<1.0
<i>K. pneumoniae</i>	1-2	<10	<1.0
<i>K. pneumoniae</i>	1-3	<10	<1.0
<i>S. typhimurium</i>	1-1	<10	<1.0
<i>S. typhimurium</i>	1-2	<10	<1.0
<i>S. typhimurium</i>	1-3	<10	<1.0

Example 2**Objective**

[0042] The objective was to evaluate the effectiveness of resource conservation wash parameters as a means of reducing known amounts of microorganisms.

[0043] Test Parameters:

[0044] The effect of eight separate laundry processes on known quantities of microbes was tested to examine how the different wash parameters affect the different organisms. One by one inch square swatches of linen were inoculated. After inoculation the swatches were allowed to dry for thirty minutes in a sterile petri dish. Upon completion of the dry time, the swatches were pinned to a mesh net and subjected to the differing wash parameters.

[0045] Preparation of Inoculum:

[0046] Each organism was grown in tryptic soy broth for approximately 24 hours at 32.5° C. in a sterile baffled flask, while shaking on a Thermo Scientific multipurpose orbital shaker. After the incubation period the suspension was diluted with tryptic soy broth, to yield a specific absorbance with the Hach DR 2700 spectrophotometer. The adjusted suspension contains approximately 5.0×10^8 CFU/mL.

[0047] Sample identification—Hospital/Hotel linen 70% cotton 30% polyester 1.0x1.0 square swatches Test organisms—

[0048] *Escherichia coli*—ATCC ft 8739

[0049] *Pseudomonas aeruginosa*—ATCC #9027

[0050] *Staphylococcus aureus*—ATCC #6538

[0051] *Klebsiella pneumoniae*—ATCC # BAA-1144

[0052] *Salmonella enterica* subspecies *typhimurium*—ATCC ft 13311

[0053] Method—Membrane filtration (sterile elution 45 mL), total aerobic plate count

[0054] Wash and Chemistry Tested:

[0055] Formula:

[0056] 2 oz/cwt Bleach and 100° F.

[0057] Classification: Casino/Hotel sheet

[0058] Load weight: 100% capacity

RC Formula 2 oz/cwt Bleach-8 minute contact time

Operation	Time	Temperature	Level	Chemical	Usage/Cwt
*Bleach-Sub	10/1	100	Low	spectrum	0 mL
				Express	0 mL
				Bleach pH 6	22 mL
Rinse	2/1	split	High		
Rinse	2/1	cold	High		
*Sour-Soft	4/1	cold	Low	Pinn. A/C	9 mL
				Pinn. Sour	0 mL

Total Time: 22 Minutes

Inoculum	CFU/mL	Inoculum Volume	Calculated CFU/Swatch	Log10/Swatch
<i>E. coli</i>	3.0×10^9	40 µL	1.9×10^8	8.28
<i>P. aeruginosa</i>	2.0×10^8	40 µL	8.1×10^6	6.91
<i>S. aureus</i>	2.0×10^8	40 µL	8.0×10^6	6.90
<i>K. pneumoniae</i>	2.0×10^9	40 µL	8.2×10^7	7.90
<i>S. typhimurium</i>	3.1×10^9	40 µL	1.29×10^8	8.1

[0059] Results:

Treatments (3 replicates each)	CFU/Swatch	Log ₁₀ Survivors	Log Reduction (calculated CFU/Swatch)
<i>E. coli</i>	1-1	<10	<1.0
<i>E. coli</i>	1-2	<10	<1.0
<i>E. coli</i>	1-3	<10	<1.0
<i>P. aeruginosa</i>	1-1	<10	<1.0
<i>P. aeruginosa</i>	1-2	<10	<1.0
<i>P. aeruginosa</i>	1-3	<10	<1.0
<i>S. aureus</i>	1-1	<10	<1.0
<i>S. aureus</i>	1-2	<10	<1.0
<i>S. aureus</i>	1-3	<10	<1.0
<i>K. pneumoniae</i>	1-1	<10	<1.0
<i>K. pneumoniae</i>	1-2	<10	<1.0
<i>K. pneumoniae</i>	1-3	<10	<1.0
<i>S. typhimurium</i>	1-1	<10	<1.0
<i>S. typhimurium</i>	1-2	<10	<1.0
<i>S. typhimurium</i>	1-3	<10	<1.0

RC Formula 2 oz/cwt Bleach-4 minute contact time

Operation	Time	Temperature	Level	Chemical	Usage/Cwt
*Bleach-Sub	10/1	100	Low	Bleach pH 6	22 mL
Rinse	2/1	split	High		
Rinse	2/1	cold	High		
*Sour-Soft	4/1	cold	Low	Pinn. A/C	9 mL
				Pinn. Sour	0 mL

Total Time: 22 Minutes

Inoculum	CFU/mL	Inoculum Volume	Calculated CFU/Swatch	Log10/Swatch
<i>E. coli</i>	2.4×10^9	40 µL	9.6×10^7	7.98
<i>P. aeruginosa</i>	5.6×10^8	40 µL	2.2×10^7	6.34
<i>S. aureus</i>	2.4×10^9	40 µL	9.6×10^7	7.98
<i>K. pneumoniae</i>	1.1×10^9	40 µL	4.3×10^7	7.60
<i>S. typhimurium</i>	2.4×10^9	40 µL	9.5×10^9	7.97

Treatments (3 replicates each)	CFU/Swatch	Log ₁₀ Survivors	Log Reduction (calculated CFU/Swatch)
<i>E. coli</i>	1-1	190	2.27
<i>E. coli</i>	1-2	212	2.32
<i>E. coli</i>	1-3	199	2.29
<i>P. aeruginosa</i>	1-1	<10	<1.0
<i>P. aeruginosa</i>	1-2	<10	<1.0
<i>P. aeruginosa</i>	1-3	<10	<1.0
<i>S. aureus</i>	1-1	<10	<1.0
<i>S. aureus</i>	1-2	<10	<1.0
<i>S. aureus</i>	1-3	<10	<1.0
<i>K. pneumoniae</i>	1-1	TNTC	N/A
<i>K. pneumoniae</i>	1-2	TNTC	N/A
<i>K. pneumoniae</i>	1-3	TNTC	N/A
<i>S. typhimurium</i>	1-1	<10	<1.0
<i>S. typhimurium</i>	1-2	<10	<1.0
<i>S. typhimurium</i>	1-3	<10	<1.0

[0060] These examples demonstrate that the process of the present invention effectively destroys pathogens in textiles. Further this is accomplished using a low temperature wash and a low temperature bleach which significantly reduces energy costs, as well as time required, because there is no need to have the step down cooling to prevent wrinkles. Thus, the present invention provides not only an effective method to destroy pathogens and textiles, but at the same time reduces costs and laundry time. This has been a description the present invention, however, the invention itself should only be defined by the appended claims.

What is claimed is:

1. A method of laundering and bleaching textiles comprising:

- washing said textiles at a temperature less than or equal to 140° F. in an alkaline detergent;
- bleaching said textile in a chlorine bleach solution at a temperature less than 140° F.; and
- wherein said chlorine bleach solution has a pH less than 9.5.

2. The method claimed in claim 1 wherein said textiles are washed at a temperature of from 85 to 140° F.

3. The method claimed in claim 2 wherein said textiles are washed at a temperature of 95 to 120° F.

4. The method claimed in claim 1 wherein said textiles are bleached a temperature of 85 to 140° F.

5. The method claimed in claim 4 wherein said textiles are bleached a temperature of 95 to 120° F.

6. The method claimed in claim 1 where in a buffer is added to said chlorine bleach solution to establish a pH, said pH less than 9.5.

7. The method claim and claim 1 wherein an acid is added to said chlorine bleach solution to lower said pH to less than 9.5.

8. The method claimed in claim 1 wherein said pH is from 7 to 9.5.

9. The method claimed in claim 8 wherein said pH is from 7-8.

10. The method claimed in claim 9 wherein said pH is from 7 to 7.5.

11. The method claimed in claim 1 wherein said chlorine bleach solution is a hypochlorite solution.

12. The method claimed in claim 11 wherein said hypochlorite is sodium hypochlorite.

13. The method claimed in claim 1 wherein said chlorine bleach solution has a concentration of 25 to 500 ppm.

14. A method of bleaching textiles comprising contacting said textiles with a chlorine bleach solution at a temperature less than 140° F. and a pH less than or equal to 9.5, for a time effective to bleach said textile.

15. The method claimed in claim 14 wherein said temperature is from 100-120° F. and said pH is from 7 to 9.

16. The method claimed in claim 14 wherein said time is from 4 to 30 minutes.

17. The method claimed in claim 14 wherein said textile is linen.

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