Washing Of Disposable Gowns For Reuse

Observing the effects of laundering various disposable gowns with Nikwax products to extend their service life.

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Aim

To investigate the design and construction of disposable gowns, and determine whether it is possible to prepare and enhance the gowns for re-use by washing them in Nikwax products.
To determine whether temperature or chemical disinfection protocols can be applied to disposable gowns.

Material and Products Used for Testing

- *Nikwax ID 196_001:* Medline EN13795 Surgical Gown (With reinforced chest panel)
- *Nikwax ID 196_004:* Heavy Weight Gown (Unwashed)
- *Nikwax ID 196_006:* Heavy Weight Gown (Washed for 80 minutes at 60°C)
- *Nikwax ID 196_008:* Heavy Weight Gown (Washed for 80 minutes at 75°C)
- *Nikwax ID 196_010:* Heavy Weight Gown (Autoclave 130°C)
- *Nikwax ID 196_005:* Light Weight Gown (Unwashed)
- *Nikwax ID 196_020:* Heavy Weight Gown (Unwashed)
- Nikwax Cleaning Product A
- Proprietary Chlorine Dioxide Disinfectant
- Bosch Classix 6 1200 Washing Machine (30°C Delicates Cycle, Speed Perfect)

Method

Observation, benchmarking and measurement

Gowns were initially visually assessed for differences, from their washed and unwashed forms.
The gowns were assessed for water repellency using ISO 4920:2012 (see Appendix). Air permeability was measured across the gowns to establish their potential resistance to high-velocity particulate matter, and in the case of the EN13795 gown (ID 196_001), to understand the function of the additional chest piece. Air permeability also has a close relationship to the hydrostatic head of a fabric (the height of a column of water that a fabric can support, before water seeps through). It is a combination of the contact angle given by a surface treatment (water repellency tested by spray rating), and fabric construction.
By understanding the effect of different temperatures of washing on the air permeability, some potential methods of wash processing can be identified, without damaging the structure of the fabric, compromising protection.

Wash Durability

Based on the air permeability data collected for the hot-washed gowns, and experience of polypropylene material in FFP2 and FFP3 masks, Gown IDs (196_001, 196_004, 196_005) were taken and washed five times in Nikwax Cleaning Product A, on a 30°C delicates 'Speed Perfect' (shortened) cycle. Gowns were then each cut in half, with a half of each gown tumble dried on low heat, and the other half left to air dry for 3 hours.

Spray ratings and air permeability data were then collected for the three gowns, to make a recommendation for aftercare.

According to data collection, temperature sterilisation could not be employed with these gowns, so chemical sterilisation was investigated. There are several options regarding appropriate chemical sterilisation, and the first option employed was a chlorine dioxide-based product. Work is ongoing with standard sodium hypochlorite, and Nikwax will issue an update in due course.

Gown 196_020 was taken and washed once on a 30°C delicates 'Speed Perfect' cycle, with a proprietary chlorine dioxide disinfectant introduced into the main wash. It is a two component system, one part being citric acid, and the other sodium hypochlorite. When the two components react, chlorine dioxide is formed, which is a very effective disinfectant. To this end, the citric acid component was added in a wash ball before the cycle started, and once the machine had filled, the sodium hypochlorite component was introduced through the detergent drawer, followed by 1L of water.

Once the cycle had finished, a second cycle was run with Nikwax Cleaning Product A. The gown was then taken and assessed for spray rating and air permeability.

Results

Table 1. – Initial Observations

Nikwax ID	Short Description	Observations
196_001	Disposable EN13975 gown, reinforced chest.	Adhesion between chest panel and main construction looks poor.
196_004	Heavy gown	No chest panel, same material throughout.
196_005	Light gown	Very light weight, and flimsy.
196_006	Washed 60°C Heavy Gown	Softer feel to material.
196_008	Washed 75°C Heavy Gown	Softer feel to material.
196_010	Autoclaved 130°C Heavy Gown	Softer feel to material.
196_020	Heavy gown	No chest panel, same material throughout.

Fig 1. – Microscopy of 196_001

Showing polypropylene outer layer (left), and the air-resistant liner (right). Fibres appear to be microfibre (circa 1 decitex) in both cases.

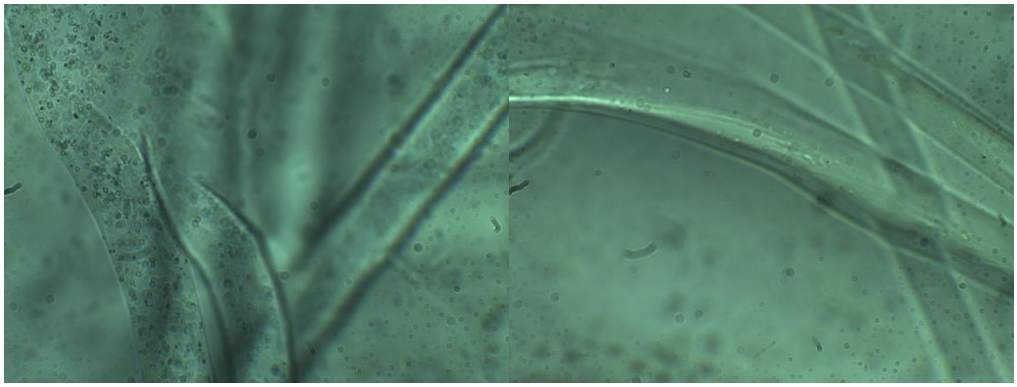

Table 2. – Air Permeability before, and after washing 5x (if appropriate)

Nikwax ID	Short Description	Initial Air Permeability (CFM/F^2)	5x Nikwax Cleaning Product A Air Permeability (Tumble Dry)	5x Nikwax Cleaning Product A Air Permeability (Air Dry)
196_001	Disposable EN13975 gown, reinforced chest.	Chest – 0 Rest of gown - 40	Chest – 0 Rest of gown – 40.2	Chest – 0 Rest of gown - 34.7
196_004	Heavy gown	10.7	17	10.8
196_005	Light gown	70.0	71.5	68.5
196_006	Washed 60°C Heavy Gown	47.0	N/A – Not washed	N/A – Not washed
196_008	Washed 75°C Heavy Gown	51.2	N/A – Not washed	N/A – Not washed
196_010	Autoclaved 130°C Heavy Gown	90.0	N/A – Not washed	N/A – Not washed

Figure 2. Chart showing air permeability of heavy gowns, after treatments.

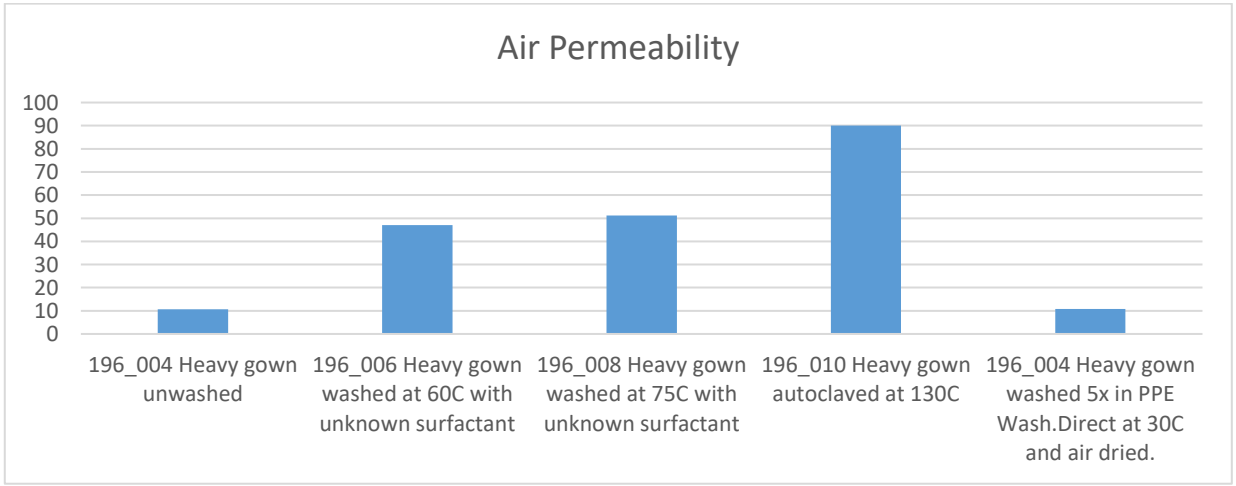

Table 3. Spray rating of gowns, before and after washing (as appropriate).

Gowns 196_006, 196_006, 196_008, and 196_010 had already been processed, and therefore weren't washed further. *ISO scores (ASTCC Score)*

Nikwax ID	Initial Spray Rating	5x Nikwax Cleaning Product A Spray Rating (Tumble Dry)	5x Nikwax Cleaning Product A Spray Rating (Air Dry)
196_001	5 (100)	4 (90)	4.5 (95)
196_004	5 (100)	3.5 (85)	4 (90)
196_005	5 (100)	5 (100)	5 (100)
196_006	3 (80)	N/A – Not washed	N/A – Not washed
196_008	4.5 (95)	N/A – Not washed	N/A – Not washed
196_010	5 (100)	N/A – Not washed	N/A – Not washed

Table 4. Air permeability and spray rating of 196_020

Data for untreated item, and item washed 1x in chlorine dioxide disinfectant followed by 1x in Nikwax Cleaning Product A. *ISO scores (ASTCC Score)*

Nikwax ID	Initial Air Permeability	Post Disinfectant+Nikwax Cleaning Product A	Initial Spray Rating	Disinfectant + Nikwax Cleaning Product A Spray Rating (Tumble Dry)	Disinfectant + Nikwax Cleaning Product A Spray Rating (Air Dry)
196_020	56.3	59.3	5 (100)	3.5 (85)	4 (90)

Discussion and analysis of results

Initial results and impressions

There was a very large difference in terms of air permeability between all the available types of gowns. The lightweight gowns offered little resistance to airflow, which could be very serious in a situation where high velocity particulates may be emitted.

The heavyweight gowns offered more protection, with reduced air permeability. The EN13975 gown was the best by far, with a completely windproof chest panel which would offer significant protection.

The unwashed gowns all had a very good level of water repellency. It appears to be some form of PFAS (per and poly fluorinated compound) based on the level of beading observed. There are significant health risks associated with the use and applications of PFAS substances.
Essentially it appears that the majority of these gowns only serve as a matrix for water repellency, and offer little in the way of other protection.
Therefore, if it is possible to maintain the water repellency on the gowns without degrading the air permeability there the gowns should be reusable.

Wash Resistance

Based on the air permeability and DWR of the gowns, it is clear that the temperature of washing, and choice of surfactant, has a significant impact on the performance of the gown. It is well known that certain surfactant preparations and detergents destroy water repellency, and therefore choosing the correct product for washing these highly water repellent gowns is key to successful re-use.

As can be seen in Figure 2, the higher the temperature the gown was exposed to, the higher the gown's air permeability, meaning protection is reduced. The autoclaved gown had an air permeability of nine times the original item. Visually and from a fabric-handle perspective, there is very little evidence of a change to the gown, but the air permeability result suggests a significant change has occurred to the fabric. The increased air permeability would make these gowns unsuitable for re-use in a clinical setting.

Items that were washed at 30°C in Nikwax Cleaning Product A did not experience the same large increases in air permeability, and therefore maintain their protective properties against high-velocity particulates. The Nikwax Cleaning Product A maintained a very reasonable level of water repellency, again maximising available protection. There was not a large difference between samples air dried, and those tumble dried – but across the board, the air-dried samples performed to a higher standard. This would further reinforce the theory that temperature management is critical to maintaining the performance of disposable gowns.

Sterilisation Options

Sterilisation is a challenge with gowns, as they cannot be heat-treated in the same way that linen items can. There is a need to sterilise gowns, as while the soap-based nature of Nikwax Cleaning Product A will destroy coronavirus particles, without extensive biological testing (which is not achievable in the timeframe we find ourselves working to) there is a need to disinfect the gowns to ensure there is no other biological contamination. This leaves the option of chemical sterilisation.

A two-pack chlorine dioxide (sodium chlorite / citric acid solution) was trialled in this experiment, as a potential solution, that may be kinder to washing machines than sodium hypochlorite (bleach). In terms of air permeability, there was no significant change. However, there was a slight reduction in water repellency, most likely due to the surfactant content in the product leaving behind hydrophilic residue. The performance of these items is reduced in comparison to a new item, but in an extreme emergency situation, re-use of a clean gown is preferable to extended use of a soiled gown. The gowns washed in disinfectant and Nikwax Cleaning Product A performed significantly better in terms of air permeability and water repellency, than those washed at a high temperature in a standard surfactant.

There are several solutions available. WHO guidelines suggest that a 1% solution of 5% Sodium Hypochlorite solution will be sufficient for disinfecting purposes. Nikwax are investigating whether this is a viable option, as standard household bleach contains surfactants which can damage water-repellent finishes.

Recommendations

Nikwax suggest that in an emergency situation, gowns can be washed and reused with a higher level of safety than using a soiled gown for an extended period. The recommended process would be:

- Wash the gowns in a short, cool wash (30°C or less), with 1% bleach (4-5% sodium hypochlorite) solution or 1% chlorine dioxide solution.
- Wash the gowns in Nikwax Cleaning Product A on a short, cool wash (30°C or less).
- Air-dry the gowns for 3 -6 hours, or until dry, in a sterile environment.

Conclusion

As an absolute last resort, gowns can be re-used with Nikwax Cleaning Product A, as long as they are disinfected with a surfactant-free bleach solution, and washed at very low temperatures.

The effect of using a disinfectant product in combination with Nikwax Cleaning Product A at low temperatures significantly enhances performance compared to disposable gowns washed at high temperature in a standard surfactant.

Appendix

1) Spray Rating Test - ISO 4920:2012 Textile fabrics: Determination of resistance to surface wetting (spray test)

This provides an indication of the degree of water repellency. The fabric being tested is fastened in position in the ISO spray rating equipment. Deionised water (250 ml) is sprayed at the fabric through a nozzle of defined intensity. The fabric is then compared to standards and rated. The rating range is from 5, where there is “no sticking or wetting to the upper surface” to a rating of 0, where there is “complete wetting of upper & lower surfaces”.