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Textile Laboratory Report on Brits Nonwoven IPU D15 masks
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Introduction

The purpose of this report is to evaluate the suitability of cloth face masks, and specifically the novel design Brits Nonwoven IPU D15 masks to prevent the transmission of small droplets from the wearer to the environment. The primary purpose of the mask is to prevent the transmission of the COVID-19 virus from an infected patient to the environment and those around them.

The mask is seen as part of a solution and must always be used in combination with other methods of prevention and are not considered as PPE or to replace any other recommended precautionary measures.

Background:

According to a scientific brief published by the WHO on 29/3/2020 on the modes of transmission of the COVID-19 virus, this type of respiratory infection can be transmitted through droplets of different sizes. For clarification purposes, droplet particles more than 5 µm in diameter are thus referred to as "respiratory droplets" and those less than 5 µm in diameter "droplet nuclei". According to current evidence, the COVID-19 virus is primarily transmitted between people through respiratory droplets and contact routes. Indirect transmission also occurs through any object or substance capable of carrying infectious organisms (e.g. skin, textiles, food packaging, door handles, seat rests, thermometers, etc.,) in the immediate environment around the infected person. Therefore, transmission of the COVID-19 virus can occur by direct contact with infected people and indirect contact with surfaces in the immediate environment.

Droplet transmission typically occurs when an infected person who has respiratory symptoms such as sneezing or coughing, are in close contact (less than 1m) with another. (WHO-2019-nCoV-Sci_Brief-Transmission_modes-2020.2-eng[1].pdf. The purpose of the cloth face masks discussed in this report would be to address this type of transmission.

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Types of masks

Surgical (medical) face masks (varying from fluid shield masks to the N95 rated masks generally used in hospital environments) can be described as “a physical barrier” with the purpose of protecting the wearer against a visible splash or spray of fluid or large droplets or smaller airborne particles. These masks are usually classified as PPE.

The amount of protection is directly related to the permeability of the fabrics that make up the different layers in the mask as well as the proper fitment of the physical mask. The textile structures consist of textile fibres in the form of yarns or nonwoven fibre webs and the permeability relates directly to the interstitial spaces ~~is~~ between the textile fibres in the mask and in the case of surgical masks this is usually indicated by the “grading” of the mask (e.g. N95 meaning 95% effective). Masks that does not fit tightly over the face around the edges can allow small airborne particles or germs to enter, making it unsafe. Because of the dense structure of the textiles the masks are made of wearers often experience thermo-physiological discomfort and difficulty in breathing normally.

Most surgical masks are designed for single use and should be discarded after use or when wet or contaminated during use.

The use of surgical masks for normal daily wear to reduce the transmission of COVID-19 virus is discouraged mainly for the following reasons:

- Wearers experience discomfort and touch their faces or the mask frequently – presenting a further risk for infection.
- price and scarcity,
- single use masks are often used more than once, posing a risk of self-infection

“**Cloth masks” or non-medical facial masks made of textile fabrics** does not fall in the same category as surgical masks and are thus not considered suitable as PPE. The WHO though has recently agreed that the wearing of cloth masks is recommended to prevent transmission from infected people to their surroundings, emulating some of the “winners’ to date: China, Japan, Singapore, and South Korea. In the Czech Republic precautionary measures such as face covering in public was rigorously enforced from the start of the outbreak, resulting in surprisingly low infection cases. It is now generally believed that the wearing of cloth masks in public can interrupt the chain of transmission between infected and healthy people.

Cloth masks are low cost, more easily available, easy to clean and disinfect and normally have a fair level of thermo-physiological comfort and also allows for individual preferences (skin feel as well as visual appearance – it can even become a fashion statement), etc.

The dangers associated with the use of cloth masks should however not be ignored. Examples include:

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- A false feeling of protection, together with a lapse in the application of preventative measures like personal hand hygiene, respiratory hygiene and social distancing are probably the main concerns.
- The danger of misinformation and misinterpretation about the make-up of the masks and fabric composition. The appearance of common textile structures can often be very deceptive, and it is very difficult to estimate the amount of protection (or barrier function) a structure can provide by visual inspection. Fibre composition and properties, yarn structure, fabric structural properties as well as combination of different layers play an instrumental role in the determination of the properties of the end-product (in this case the size and maintenance of integrity of the porosity (or lack thereof) of the mask.
- Thermo-physiological comfort properties, such as skin irritation or the build-up of heat or moisture between the mask and the skin. Poor moisture management can lead to condensation in the fabric or on the skin allowing the structure to absorb moisture and pose further risks in the transmission of moisture through the fabric and the spreading of the virus. The wet structure can then pose further risks in the transmission of moisture through the fabric and the spreading of the virus. Potential to absorb water should thus also be considered in fibre selection – this will also impact on the rate of drying after wetting or washing.

Keeping the above into mind, the essential–**requirements for a suitable cloth face mask that can reduce or stop transmission** from an infected person to the environment includes the following:

1) It should act as a barrier to droplets larger than 5 µm secreted at a speed similar to what happens if a person exhibits respiratory symptoms such as sneezing or coughing (approx. 30m/sec).
2) Disinfection of all the components should be easy to carry out at home.
3) Cleaning (soil or stain removal) of outer material must be easy
4) All components should be durable (should maintain physical integrity during the full expected life span). The barrier layers should not increase in permeability and resultantly decrease in functionality.
5) The mask should be comfortable to wear – discomfort will lead to touching of the face and intermittent removal or pulling on the mask during wear.

Evaluation of Brits Nonwoven IPU D15 reusable face masks

Product description:

An independent evaluation was done on request for this locally produced, low cost reusable system, consisting of a filter material that fits comfortably into a reusable fabric mask. The filter unit is reusable and can be removed to be disinfected between uses.
The filter unit can be described as a polypropylene spunbond base on to which a polyester fibre layer is needled. An acrylic finish acts as a binder to hold the latter in place and ensure integrity of the system. The final product is about 2-3mm thick with

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areal density 100g/m^2. (Fibre composition: 39% polypropylene, 50% polyester, 11% PAA)

Methodology

The following tests were executed either at accredited testing facilities or in the textiles research facilities at the University of Stellenbosch.

The ability of the filter cloth to filter (stop) micro-droplet penetration at the given wind speed (30m/s) was measured using the same test equipment used to verify clean room facilities. An anemometer (Testo 425) was used to verify wind speed and a light scattering airborne particle counter (LSAPC) were used as the basis for determining the size and concentration of (not filtered) airborne particles at designated sampling locations. According to ISO 14644 standards, air cleanliness for clean rooms are classified in terms of concentration of airborne particles and only particles ranging from 1 – 5 μm are considered for classification purposes. All equipment was calibrated according to SANA standards within the last 3 months.

Further testing includes the thermo-physiological comfort measurements like water vapor permeability rate (WVPR) and thermal resistance (R_t). WVPR is measured as a percentage and indicates the ability of the fabric to allow water vapor to pass. Together with Rt, this gives a fair indication of how “comfortable” it would be to wear the mask, i.e. whether the wearer will experience moisture build-up in the micro-climate between the skin and the mask or thermal discomfort. A decrease in WVPR after repeated wash/wear cycles will indicate a change in the physical fabric structure and can be used to measure its durability. The Permetest Instrument, well-known for easy and effective testing of the water vapor permeability and thermal resistance of samples, was used to determine the water permeability of the samples before and after 20 disinfection cycles. The filter samples were tested individually and within different textile layers as it would be during use.

Results

The filter unit passed under ISO 8 conditions for 0,5 and 1,9 micron and ISO7 for 5 microns (according to ISO14644 standard). The micro-particle count indicated an efficiency rate of more than 95% for particles size 5 μm, for the IPU D15 filter. The rating improved for IPU D15 tested in combination with the fabrics for the mask. 100% of particles >5 μm were filtered.

The WVPR of the IPU D15 filter unit fabric is compared to that measured on the D95 surgical masks as well as on popular splash resistant mask worn by HCW and surgeons. The filter was also “sandwiched” between 2 layers of fabric (to simulate the proposed cloth masks) to evaluate the effect of the added fabric layers on the WVPR. The results are depicted in Fig.1. There was no difference between the WVPR of the IPU D15 (when tested alone) and the surgical masks. As expected, the WVPR decreased in

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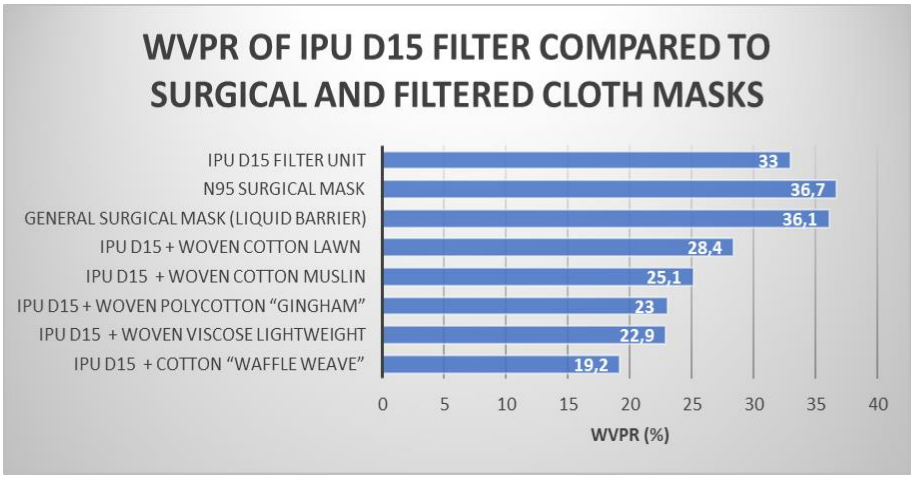
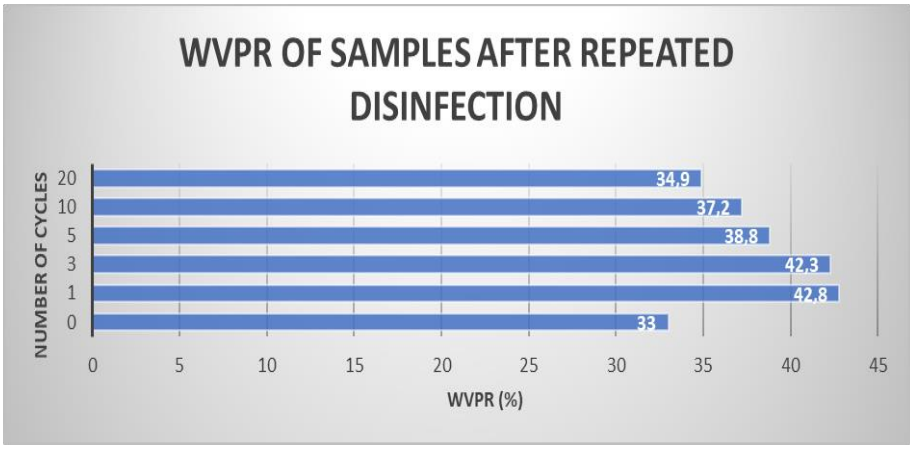
different amounts in the simulated mask systems, depending on the fabric structural properties.



A comparison of the filter material after repeated disinfection cycles (during which the sample was treated with boiling water for at least 5 minutes and airdried before the next treatment) showed an initial increase in WVPR, but after 20 disinfection cycles the value was almost the same as for the control. This might indicate an initial relaxation or slight "opening" of the structure and further investigation is recommended to make sure the barrier function is not compromised.



thermal resistance of the D15 sample was higher than that of the N95 surgical mask and increased slightly when it was "sandwiched" between two layers of fabric. This was expected as any increase in the amount of trapped air in a fabric structure leads to higher thermal resistance. This should have to be further addressed in wear trials as the design of the mask will also have an effect on the comfort levels experienced by the wearer. Experimentation with different fabrics can lead to the selection of the optimum

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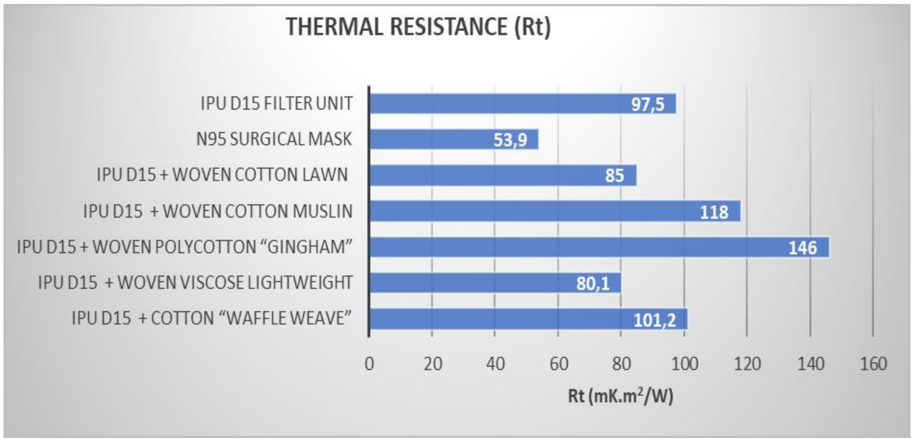
combination to enhance comfort. The perception of the wearer regarding the “feel” of the fabric against the skin (which might differ between individuals) can also play a role.



Conclusion

The proposed cloth mask with filter insert meets the requirements as follows:

1) The mask proves to be successful as a barrier to droplets larger than 5 μm (secreted at a speed similar to what happens if a person exhibits respiratory symptoms such as sneezing or coughing).
2) Disinfection of all the components are easy to carry out at home as the only requirement is to expose the fabric for more than 5 minutes to boiling water. Care should be taken to avoid wringing or harsh handling though to prevent distortion of fabric structure during cleaning.
3) Cleaning (soil or stain removal) of outer material must be easy. Any laundering method is suitable as the filter fabric can be removed for the cleaning process.
4) All components are expected to be durable for the intended use cycle.
5) The mask should be comfortable to wear – this could be addressed by proper design of the item according to wearers’ requirements.
6) An economical and available option – both were confirmed by the supplier in terms of the present situation.
7) It is important the proper instructions on wearing and use, cleaning and disinfection, maintaining precautionary measures like hand hygiene, respiratory hygiene and social distancing accompanies the product.