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RESEARCH ARTICLE

ANALYSIS OF THE EFFECTIVENESS OF BARRIER MASKS MADE OF FABRIC

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Abstract

Masks for general public use served to stem the cruel shortage during the Corona Virus 2019 (Covid19) pandemic. Their fabric making took off sporadically with the designers/seamstresses with the presentation of the models. Manufacturing methods and performance efficiency testing become worrisome for these manufactured face masks. The control is based on the pattern and the constituents of each mask.Visual inspections, filtration and breathability control are recognized in manufactured masks. Washing gives the possibility of reuse extending the life of the mask. The purpose of this article is to present the effectiveness of fabric face masks.

Introduction:-

The whole world experienced a severe pandemic from 2019. Several virus species circled around the world. Research has been done all over the world to stem this evil. Several resolutions are proposed such as the confinement of the population, the health restriction of the population, the washing of hands with hydro alcoholic gel, the wearing of masks, etc.... Some have been adopted washing hands with hydro alcoholic gel and wearing face masks. The latter seems and has considerably reduced the rate of contamination and the number of deaths.

The 2019 corona virus disease called Covid 19 has progressed drastically and claimed many victims. The disease varies from person to person, of different age groups and according to the variant of Covid 19. Several symptoms are recordable among others sore throat, runny nose, sneezing, appearance of cough followed of its aggravation, shortness of breath or difficulty breathing, feeling of fever, weakness or fatigue, muscle pain, loss of smell, diarrhea and vomiting, etc. A person carrying the virus may not exhibit these symptoms. Faced with this menace, resolutions of protection are urgent but based on the means of struggle.

The systematic wearing of masks is favored as an effective means and barrier. Masks, in all forms, are deployed. Masks are used in several areas, some of which are inappropriate. Analyzes have shown that FFP2 masks, surgical masks are not appropriate because of the possibility of virus transmission [1]. Faced with the increased need for protective masks, activities have developed with seamstresses and dressmakers in the making of all kinds of masks. The composition and quality of these masks vary from one craftsman to another.

Abrar A. Chughtai and all, in October 2020 spoke about the filtration efficiency of masks made of cloth during Covid 19. The debate over the filtration efficiency of cloth masks declares the performance of these cloth masks to be inferior to medical masks and respirators. Cloth masks can provide some protection if properly designed and used.

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In December 2020, **Phillip W. Clapp**, reported on evaluating the filtration efficiency of improvised face masks, as well as several popular modifications of medical procedure masks intended to improve the fit or comfort of the mask. There has been considerable confusion and disagreement regarding the extent to which masks protect the wearer from airborne particles.

At the start of the pandemic, major issues around the world were the supply of medicalmasks. The few masks in stock were reserved to protect healthcare workers. Finding themselves in need, the designers and/or craftsmen started making masks for the public.

In order to regulate the production or manufacture of resident masks, the need to verify and test to conform local/resident manufactures with industrial manufactures becomes a challenge for scientists. Studies have been made on both sides to find ways to fight and regress the spread of the pandemic. But studies on the manufacturing process have not been done on fabric face masks. The way to evaluate the effectiveness of these masks made by the locals is not yet accessible because of the lack of control devices or tests of aero particles contained in the air. The few breathability test devices remain very expensive for the vulnerable layer.

This article presents the contribution of the scientific world to making locally manufactured masks credible without any fear, recommendable, effective and available to the population.

Materialand Methods:-

Our materials are **the face mask and the control bench** that we have designed.

The material studied is the face mask made locally in fabric by handcrafts.Thecraftsmen mentioned are the dressmakers and/or seamstresses with a diploma in sewing. Their primary occupation is sewing. The pandemic leads to the need to use masks as barrier measures, craftsmen have imagined several models of masks due to the shortage and the increasing price of masks. Face masks are among the objects used to protect human being by covering the nose, mouth and chin. It is a bib made of loincloth fabric of different qualities which can take all the shapes of the face. The different forms of fabric masks are shown in Figure 1.

a. Duckbill masks b. Pleated masks

Figure 1:- Manufactured Masks Models.

The second piece of equipment is **the control bench** for the masks produced. Figure 2 shows the control bench components and its accessories. The bench is made up of a 50L T856 PRODIF coaxial compressor, a spray and/or a blower, connection pipes, a cellule and talc. The compressor is electric (figure 2.a) with power 1.5 kw, voltage 230 V, admissible pressure 8 bar. It weighs 24 kg. Its role is to produce air for blowing or spraying talc.

The cellule is a reserved space carrying the mask having an open or closed lid. The cellule carrying the closed lid will be used for the filtration test. The open lid will be used for the breathing (blowing) test. Figure 2.d shows us the different components.

The spray (figure 2.c) will be used to test talc filtration (particle deposition). The blower (figure 2.b) is used to concentrate the air pressure on the flame. These tests are the limit conditions that cannot be reached.

a. Compressor ; **b.**Complete control bench ; **c.**Blower ; **d.**Spray
Figure 2:- The control bench and its components.

The masks are made with different fabrics with varying thicknesses. A mask is made up of envelope fabrics (outer fabric) and one or more internal fabrics. The fabrics do not have the same flexibility. Fabric porosity varies from fabric to fabric. The internal tissue acts as a filter. The quality of the fabrics is not the same. The size of the jig varies from masks to masks. The models and shapes are different. The performance of manufactured face masks is unknown. But human life is important. The masks made must be effective in terms of filtering capacity for microparticles. The effectiveness, in addition to filtering, must be demonstrated in the way of breathing easily when wearing the masks. Apart from the number of layers or intermediate fabrics, certain fabrics must have higher particle retention properties.

A visual physical control is made to compare the words to the practice. The face masks have been tested experimentally in order to measure the breathing efficiency of these masks. They are tested on a control bench. At the design of the bench, a surgical mask is taken as a reference mask and tested according to an exercise of blowing at constant pressure and filtering talc.

Tests are carried out on the masks drawn from the batches. Ten (10) batches are tested. A batch of masks is a group of ten masks of the same size, different colors or not, made of the same fabric. Five (05) masks are taken from a batch. One mask of the five is torn to show the constituent tissues and the two by two (02) are taken to the control bench for the various tests. Figure 3 shows the torn "Duckbill" mask with the polypropylene filter fabric.

Figure 3:- Demonstration Exhibition.

To test the flexibility of the mask, a candle is placed 5 cm behind the mask. The mask is placed in the cellule into which the nozzle of the blower or the mouth of the spray arrives. A surgical mask is considered to be a reference. At a given constant pressure, air is blown through the reference mask in the direction of the lit candle. When the candle flame goes out, the pressure is considered too high. We reduce it. The experiment is repeated up to the pressure which will no longer extinguish the flame. This pressure becomes the reference. Figure 4 shows the elements that go into the blowing exercise.

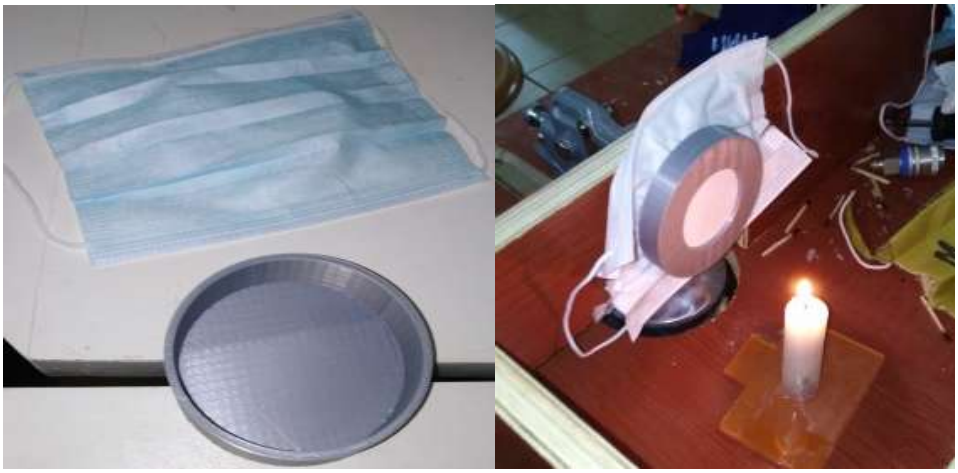

Figure 4:- Calibration exercise for blowing.

The samples are subjected to the test with the flame of a lighted candle and placed in the direction of propagation of the blown air. The air pressure is 160 bar. The air is sent three times over the sample. For a surgical mask, taken as a

reference, the flame of the candle moves without going out. So all the samples tested and whose candle flame exhibited such behavior are similar to surgical masks; on the other hand, those whose flame goes out are therefore too breathable. The samples tested behaved like surgical masks. The candle flame simply moved without going out.

The masks are subjected to the flame test with a lit candle. The air pressure is 2 bars. The air is sent three times over the sample. The candle does not go out. This allows you to appreciate the flexibility to be able to breathe easily while wearing this mask. This figure (**fig. 5**) shows two different samples during a control exercise. This is a breathability test. The air is blown on the candle without it going out.

Figure 5:- Blow Trial By Breathability Test.

The exercise of filtering or retaining particles by the masks is done using talc spray. The talc is sprayed under pressure through the mask into a cellule with a closed cover. For the effectiveness of the bench, the talc is sprayed at a given pressure (pressure considered above) through the mask. At this pressure p, with the surgical mask, a deposit of particles is recorded in the lid. The pressure p is reduced to the pressure p' where no particle is visible to the naked eye in the lid. Not having the value of the allowable pressure on the surgical face mask, this allowable pressure is considered as a reference without deposition of particles. The bench is said to be calibrated. Figure 6 shows the surgical mask at the tip of the spray during calibration.

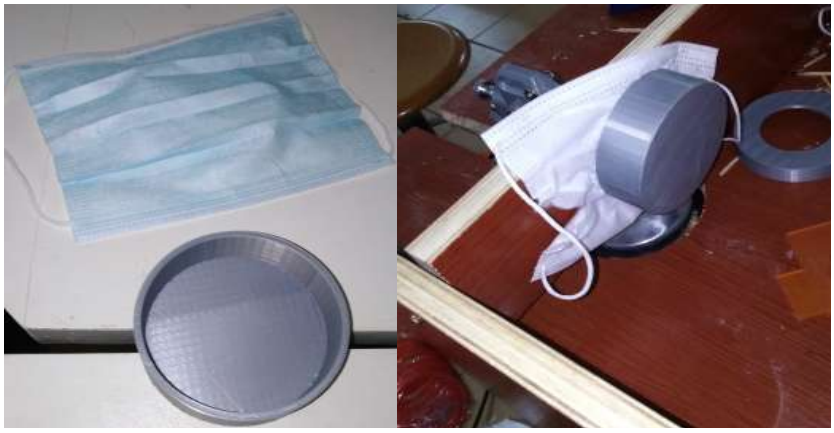

Figure 6:- Calibration of the bench for spraying talc.

As before, the twenty (20) masks taken from the batches to be tested are appreciated. The talc is sprayed into the trial cellule through the mask placed at the end of the spray. The trial is carried out at the selected pressure. The result will relate to the observation of the presence of talc deposit in the lid. The side of the mask covering the nozzle receives the talc. The talc deposit in the lid will be observed if the lid is opened. The presence of talc in the lid attests that the particles were able to cross the tissues see Figure 7.

Figure 7:- Filtration test by particles retained.

Results And Discussions:-

The purpose of the test methods is to validate the performance of the face masks. They should be based on existing methods and available test equipment. During the test, comfort in wearing the mask is examined by noting efficiency in filtration and flexibility during breathing.The efficiency of the filtration remains based on the penetration of the particles into the layers of fabrics used. For reuse, a certain number of washes is recommended.

The masks made by the locals are made of poplin fabric compared to the AFNOR standard but the number of lines is unknown. The presence of masks constitutes an approach to solutions in the shortage of masks. Wearing these masks should not suffocate users. However, in the human organism, the artificial pressure in the human heart is different from one ventricle to another. The pressure in the left ventricle towards the arteries is about 0.16 bars. In the right ventricle, towards the lungs, the pressure is lower, around 0.033 bars. For a same surface, the force of a pressure of 0.16 bar is greater than that of a pressure of 0.033 bar. A particle subjected to a pressure of 0.16 bar is more solicited by a greater force than the particle under 0.033 bar. These pressures are lower than the pressure used in our case.

The result of the visual test is shown in Figure 7 where a mask is torn showing the polypropylene fabric.Filtering efficiency can be obtained by crossing fabrics. Crossing of fabrics retains a filtration rate of 50-60% for unbonded spunbonded polypropylene (PP); 47% for nonwoven polypropylene (PP); 30% for nylon; minus 20% for polyethylene terephthalate (PET); 10-30% for cotton; 13% for the four-ply cotton handkerchief.

Figures 4 and 5 show the materials and conduct of the breathability test simulated here by blowing tests. For breathability, the extinction of the flame of the candle at a pressure p' leads to the judgment of a bad face mask. Because the pressure p' is considered as the pressure at which the candle must not go out. It was the pressure considered for the surgical mask considered as reference. Approximatively90% of the masks tested are correct or respect our established protocol. Comfort in wearing, ease in breathing, the lightness of the mask and the coverage of a large part of the face (nose-mouth-chin) are the essentials of a mask.

Figures 6 and 7 present the basis of the process then the detail of the methodology.The talc sprayed at the retained pressure is supposed to pass through the fabrics if the meshes are large or the crossing of the fabrics does not have a high retention power. The talc passes through the mask and settles in the lid. A white spot is in the lid showing the talc deposit. The effectiveness must attest to the way of breathing easily when wearing the masks. Apart from the number of layers or intermediate fabrics, certain fabrics must have higher particle retention properties. To do this, the intermediate fabric is made of polyester capable of retaining particles by electrostatic effect. The manufacturers are designers who have not necessarily learned how to make masks. They do not have the knowledge or the power to retain particles. But their ingenuity in crossing the cloths won the bet. The arrangement and the number of layers are not studied.

Conclusive results have come out of the tests showing that90% of the masks tested are good. It is true that exposure of masks to dust leads them to ineffective due to the clogging of particles and the clogging of the fabrics that make up the filters. To solve these risks, the washing of masks is systematic for a reusable one. Face masks for the general

public or fabric masks lend themselves easily to the exercise of washing (at least 10 times) and can be used for nearly twenty (20) days; the inner fabric is usually polyester.

It is true that electrostatic techniques can make it possible to capture particles: the superposition of fabrics. But there is no way to know the electrostatic capture power of the loincloths. An advanced study by the scientists or the will of the manufacturers of loincloths leave signs in the process of their choice could be an adequate solution.

This experimental pressure is greater than the human breathing pressure. The particles in this case can easily pass through or move. The bench is calibrated at a pressure at which we do not record any deposit of talc particles in the lid. As true as the fixed pressure is greater than human pressure, a particle deposit can lead to advanced study. The masks, during which the particles are recorded, are judged to be a mask whose filtration is poor. It is rejected and the lot in question is considered as a bad lot. Masks tested where no talc particles are recorded are considered good and effective.

Conclusion:-

The manufacture of local barrier masks is a feat on the part of seamstresses and designers during the coronavirus pandemic crisis (Covid 19).The filtering efficiency comes from the presence of polypropylene fabric and the crossing of tissues. Breathability, filtration and facial hold areattested on the designed bench whose results are satisfactory. The bench would suffer from some precision coming from the absence of these detectors.But it suffers from some imperfections summarized in the lack of means to test the presence of deposited particles. Reuse is made possible thanks to the multiple washes offered to the user.

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