Development Of Anti Odor and Air Filtering Work Wear Using Activated Charcoal

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Abstract - *This study is done to design and develop a prototype of self-air filtering and odor controlling work wear i.e., Gown with invertible technology (both sides of gown could be used depending upon the wearer's need and utility) using activated charcoal finish. The finishing is done by the screen printing technique followed by pad-dry-cure method. Activated charcoal finishes results in the formation of anti-odor properties which is best suited work wear for the people working in stinky and polluted environment. In this work, the gown is made up of 100% cotton fabric which is the commonly opted choice for work wear manufacturing. It consists of three layers of fabric, the innermost or the middle layer is 100% cotton woven fabric which is activated charcoal finished on both sides and the outer layers which sandwiches the middle layer is digital printed water repellent fabric and cotton fabric. The size of activated charcoal particles were identified by laser diffraction method and it is found that it consists of varied pore sizes ranging from 90 µm to 250 µm. The test results also proves that the activated charcoal used shows maximum efficiency in terms of toxics absorption and air filtration.*

Key Words: Air filtering, Anti odor, work wear, activated charcoal, etc…

1. INTRODUCTION

The derivative from charcoal as a result of high heating is called as activated charcoal. The interchangeable terms as activated carbon, activated coal, activated coke etc. commonly represents activated charcoal which is actually the leftovers of incomplete combustion. These kind of carbon particles are highly porous in nature. Due to its high porosity and small as well as low volume pores, the internal surface area of activated carbon particles are higher and thus it increases the level of adsorption as well as are prone to conduct or take part in chemical reactions.[4]

The application of activated charcoal in textile fields depends upon its high surface area, that is, on its micro porosity. Apart from its inbuilt adsorption behavior, it can be further enhanced by some chemical treatments. [5][10]

One of the major uses of activated charcoal is air purification. We can see the common usage of activated charcoal in decaffeination, respirators, medicines, air filters etc. [9]

The application of activated charcoal on textiles will be remarkable in the field of medical textiles, industrial wears, and automobile textiles and in textile based filters. Thus by using activated charcoal on industrial wear, this study suggest and promote the heights of activated charcoal and discuss its efficiency in air filtering and anti-odor properties.[1][2]

This work focuses in the development of industrial work wear for the ones working in noisome environment as fisheries, chemical and toxic handling sites, fertilizers or manure manufacturing site etc., where the presence of fresh air is less and more contaminated. Induction of activated charcoal on the work wear enhances air filtering and it also controls odor (unpleasant), which is proved with some test results as detailed.

1.1 MATERIALS

1.1 Fabric

In this work, two types of fabrics were used,
100% cotton fabric
Water repellent fabric

The cotton fabric is for the middle layer on which both its sides are finished with activated charcoal paste. The water repellent fabric and cotton fabric forms the outer layers in such a way that it sandwiches the activated charcoal treated cotton fabric between them.

1.2 Activated Charcoal Powder

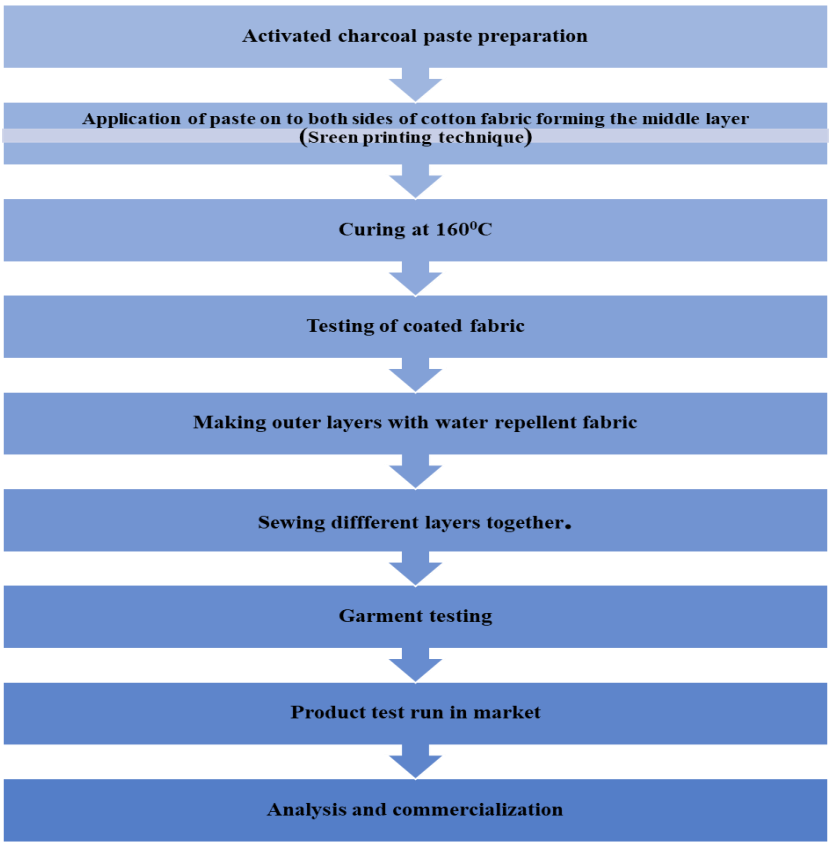
Coconut shell based activated charcoal powder is used in this work.

1.3 Fibrillated acrylic fibers and auxiliary chemicals

Fibrillated acrylic fibers are used as binders. It was converted into soluble form and processed along with other needed chemicals for the activated charcoal paste preparation.

2. METHODOLOGY

2.1 Process Flow



2.2 Activated Charcoal Particle Size Analyzing- Laser diffraction method

It is a multiple scattering technique (Laser Spectroscopy) used to find the particle size distribution of the powder.
Procedure: The activated charcoal powder will be dispersed in de-ionized water and kept in an ultrasonic vibrator in order to get a homogenous solution. The experiment will be carried out in computer controlled particle size analyzer to find out the particles size distribution.

2.3 Pre-washing the fabric

To remove the added impurities in the fabric, it will be pre washed and subjected to relaxation process as well.
Recipe:

Nonionic detergent: 2 gpl
Temperature : 70°C

Time : 20 min
M: L Ratio : 1:20

2.3 Activated charcoal paste preparation procedure

The paste of activated charcoal powder sourced from coconut shell in fibrillated acrylic binder is made and is applied on both sides of cotton fabric sample by screen printing technique. Then the coated sample is dried under 100^0C and further subjected to Pad-dry-cure process.

Recipe:

Solution concentration : 1%
Fibrillated acrylic binder : 0.5%
Wetting agent : 1%
M: L Ratio : 1:20

De-ionized water is used for the preparation of charcoal particle solution.

2.5 Testing for coated fabric

The coated fabric was tested for the following parameters

2.6 Anti-Odor Measurements Test- Organoleptic Evaluation (In House Method)

The test was done on working professionals. Each was given an activated charcoal finished swatch of fabric to wore under shoe insole daily during the test period (8 hrs.). At the end of workday, they reported and were asked to remove the shoe insole for analysis. Odor evaluation was done and recorded. The judges used individual scoring sheets and new sheets were used every day of the evaluation. On a grading scale of 0 (Repulsive) to 10 (Ideal) the evaluation was made.

2.7 Moisture Absorbency of coated fabric

A swatch piece from the activated charcoal treated fabric is taken and fixed on the testing clamp. Over it a drop of water is made to fall from a particular height. Then with the help of a stop watch the time taken by water droplet to completely get absorbed on to the fabric surface is noted and analyzed.

3. GARMENT PRODUCTION PROCEDURE

3.1 Pattern Making

a) Using standard measurements of industrial gown (S-size) paper patterns are drafted and cut down.
b) The paper patterns were transferred on to fabric pieces and cut down.
c) The cut fabric pieces where assembled in such a way that the activated charcoal coated fabric was sandwiched in between the other two water repellent fabric and cotton fabric and taken for sewing.

Fig -1: Activated charcoal treated sleeve pattern and bodice patterns

3.2 Gown construction

a) While sewing all inseams are secured and sewn in visible in such a way that no inseams are visible from either sides and the gown could be wore inside out and normal. It allows the wearer to opt the cotton side or water repellent side as the outer layer in regards with his/her working environment.
b) Then all closures were attached to the back side of gown.
c) The finished gown is shown below

Fig -3: Activated charcoal treated finished gown as cotton fabric out side (front and back)

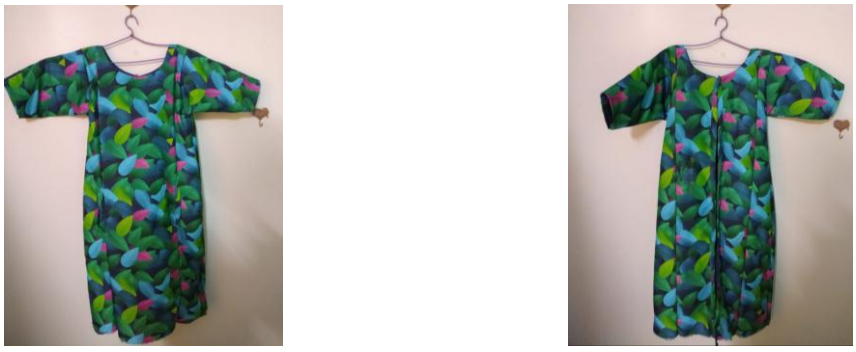


Fig -4: Activated charcoal treated finished gown as digital printed water repelent fabric out side(front and back)

4. RESULT

4.1 Particle size of activated charcoal by laser diffraction method

From the laser diffraction method, the particle size of activated charcoal particles was derived. It was found to have different sized carbon particles which ranges from 90 micrometers to 250 micrometers mesh size. Among those the commonly present pore sizes was 0.25mm, 0.21 mm, 0.18 mm and 0.15mm.

Table -1: Laser Diffraction (Values Observed)

Sample	Particle size/ µm	Particle size/ mm
AC	180	0.18
AC 1	250	0.25
AC 2	210	0.21
AC 3	150	0.15

From the result of laser diffraction, different size ranges of activated charcoal particles and the diffraction angle informs about the size of particles from 90µm to 250µm. When the laser light fall over the particles it get reflected and those reflected lights

give the size of activated charcoal particles. Here the Fraunhofer theory could be used as the particle size is between 60µm to 100µm. For identifying the pore size the following parameters were used by the system, (a) Index of refraction of light 1.53, and (b) absorption coefficient 0.1.

4.2 SEM analysis

The SEM analysis image is shown below. The inferences from SEM analysis clearly show that those particle sizes of all activated charcoal atoms are not identical. The varied pore structure could be easily derived from the SEM images which thoroughly support the inferences from the Laser diffraction test results.

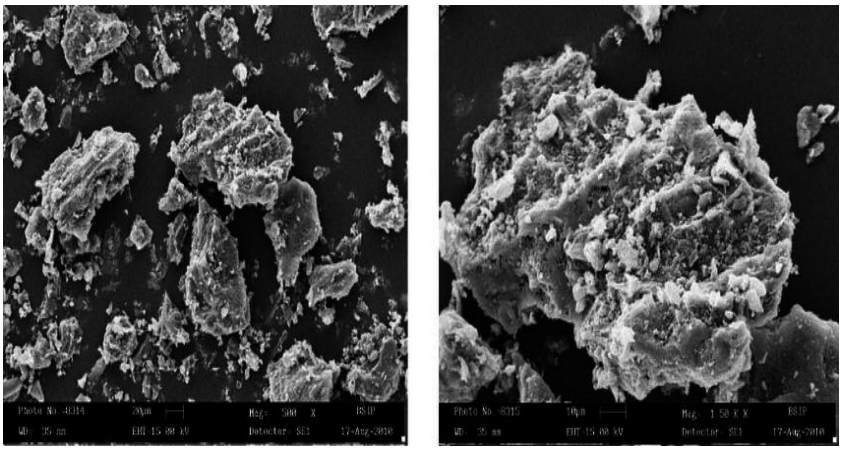


Fig -5: SEM images of activated charcoal particles showing varied particle sizes

4.2 Evaluation of Odor Control - After 8Hrs (in House Method)

The following result was obtained from the Odor Control assessment. Table 2.3.3.1 shows the activated carbon finished fabric result.

Table-2: Evaluation of Odor Control - After 8Hrs (in House Method)

Subjects	Day 1	Day 2	Day 3	Day 4	Average
1	8	8	7	6	7.25
2	9	9	7	7	8
3	8	8	8	6	7.5
4	8	8	7	7	7.5

Interpretation:

0 – Repulsive, 1 – Very Poor, 2 – Poor, 3 – Poorly Fair, 4 – Fair, 5 – Acceptable, 6 – Fairly Good, 7 – Good, 8 – Very Good, 9 – Excellent, 10 – Ideal

4.4 Evaluation of Absorbency Test

For the activated charcoal coated fabric, the moisture absorbency test data shows that the time taken for complete droplet absorption on to the fabric surface is lesser than 2 seconds. It means the specimen absorbs water quick and fast without affecting any comfort parameters of the user. Hence, based upon the test result activated carbon have a good moisture absorbency character. It is shown in table

Table -3: Evaluation of Absorbency Test

S.No.	Time Taken for absorption(sec)
1	1.5
2	1.9
3	2
4	1.6

Thus the activated charcoal coated fabric will possess better and quick water and moisture absorption. So the major comfort factor is achieved by the sample.

5. CONCLUSIONS

The industrial work wear using activated charcoal finish was developed. It was a three layered gown with activated charcoal coated fabric forming the middle layer, cotton fabric and digital printed water repellent fabric forming the outer layers. It was developed using invertible technology, i.e. both sides of gown could be used and all the seams were made in such a way that the inseams are secured and not visible from any sides. The finishing of activated charcoal on cotton fabric was done using screen printing technique followed by pad- dry- cure. To identify the pore size of activated charcoal particles laser diffraction test was done and it was concluded that the sample of activated charcoal consists of varied pore sizes ranging from 90µm to 250 µm. It was also derived from the test that the maximum occurring pore size was 90µm indicating the activated charcoal used will show maximum efficiency in terms of toxics absorption and air filtration.

The result of Anti odor assessment value for the activated charcoal finished fabric is 7.5 as an average which means it is showing good air filtering properties. Moisture absorbency also shows the better result. Thus the industrial work wear produced is best suited for the ones working in polluted and stinky conditions either if it is in house activity or an industrial activity.

REFERENCES

[1] T S M Eza[1], W Y Wan Ahamd[1], K Omar[1], and M N Ahamd[2]. "Effectiveness of activated carbon produced from coconut and oil palm shells as anti-odor on textile fabrics". Indian Journal of Textile Fibre and Research, Vol. 39, June 2014, pp. 190-195

[2] R. Pragadheeswari[1] Dr. K. Sangeetha[2], "Functional Properties of Activated Carbon Treated Textile Material", (IJSRD/Vol. 5/Issue 04/2017/432).

[3] Ilze Baltina, Ausma Vilumsone, Anna Tarasenko, Liene Silina, "Fabric Selection for Work Wear During Procurement Procedure", ISSN 1691-5402 © Rezekne Academy of Technologies, Rezekne 2017http://dx.doi.org/ 10.17770/etr2017vol3.2552

[4] V.Parthasarathi," Development of dual layered nonwoven mask with activated charcoal finish for healthcare", IJPT| Jan-2015 | Vol. 6 | Issue No.3 | 7155-7163.

[5] Nagesh K. Tripathi, Virendra V. Singh, Manisha Sathe, Vikas B. Thakare*, and Beer Singh," Activated Carbon Fabric: An Adsorbent Material for Chemical Protective Clothing", Def. SCI. J., Vol. 68, No. 1, January2018. 6.

[6] Dianchen Gang, P.E., M.ASCE ; Ravi K. Kadari ; and Baolin Deng, "Quaternized Poly„4-Vinylpyridin Coated Activated Carbon: Diffusion Controlled Sorption of Chromium„VI", 834 / JOURNAL OF ENVIRONMENTAL ENGINEERING © ASCE / AUGUST 2007.

[7] Thierry Le Blan and Arnaud Vatinel, "Odor reduction thanks to textile materials", 6th RESET,"New materials and new applications" Huddersfield, 31.01.2018

[8] Robert D. Giglia, Rye, N.Y.; Edward A. Battistelli," NON-WOVEN ACTIVATED CARBON FABRIC", 4,565,727, Jan. 21, 1986.

[9] Shujuan Zhang · Ting Shao · Tanju Karanfil · Bingcai Pan," The correlation between structural characteristics of activated carbons and their adsorption of organic solutes from aqueous Solutions", Department of Environmental Engineering and Earth Sciences, Clemson University, 342 Computer Court, Anderson, SC 29625, USA, DOI 10.1007/s10450-012-9396-0.

[10] R Rathinamoorthy and G Thilakavathi," Effect of anti microbial on odor control properties of apparel fabric",JTATM, vol9,issue 1, fall 2014.

[11] Annu Kumari and Karan Khurana, "Regenerated Cellulose-Based Denim Fabric for Tropical Regions: An Analytical Study on Making Denim Comfortable, Hindawi Publishing Corporation Journal of Textiles ,Volume 2016, Article ID 4614168

[12] https://www.google.com/search?source=hp&ei=qffAXdfvN8imwgOK_Yv4Dg&q=nptel&oq=np&gs_l=psyab.1.0.0l10.2548.2831..4558...0.0..0.109.210.0j2.....0....1..gws-wiz.....0i131.NLcQMKyxprw
[13] https://www.google.com/search?source=hp&ei=E_jAXaiXDsGSwgOO_ouICg&q=fibre2fashion&oq=fibre&gs_l=psyab.1.7.0l10.8107.10045..13110...0.0..0.130.702.5j6.....0....1..gws-wiz.....0..0i131j0i10.C3CQoflPZIw
[14] https://www.google.com/search?ei=IPjAXcz2MsX2vgTgm7zYCw&q=wikipedia&oq=awiki&gs_l=psyab.1.1.0i10l10.113699.118191..120566...3.1..0.116.895.0j8.....0....1..gws-wiz.....0i71j0i67j0j0i131.wLWrUQPjsns
[15] https://www.google.com/search?ei=mvjAXZODNc2WwgP3xYjoCg&q=activated+charcoal&oq=activated+&gs_l=psyab.1.0.0l10.62930.64984..67341...0.1..0.129.1144.0j10.....0....1..gws-wiz.....0i71j0i67j0i131.uHx0srlU5o4
[16] Malvern Operators Guide, Malvern Instruments Ltd., Malvern, UK 1999.
[17] Bieganowski A, Ryżak M, Witkowska-Walczak B. Determination of soil aggregate disintegration dynamics using laser diffraction. Clay Miner. 2010;45:23-34. DOI: 10.1180/claymin.2010.045.1.23.
[18] Sochan A, Bieganowski A, Ryżak M, Dobrowolski R, Bartmiński P. Comparison of soil texture determined by two dispersion units of Mastersizer 2000. Int. Agrophys. 2012;26:99-102. DOI: 10.2478/v10247-012-0015-9.