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Nonwovens from Usher ⁄ Ester Fibres

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Abstract: This research was conducted to evaluate thermal bonded nonwoven fabrics manufactured from usher - Ester fibers. The effect, of some key processing variables, including blending ratio and bonding temperature on peak loads of the product were studied. The results showed that, appropriate selection of combinations of fibers and process conditions resulted in excellent performance properties. High Strong usher (Ester /pp) nonwoven fabrics can be obtained by using usher and Ester /pp at a blend ratio of 50/50 and a thermal calendaring temperature of 110 °C under a pressure of 0.33 M Pa. Further, the results emphasized the economic and industrial potentials of usher plants in the Sudan.

Keywords: *binder, cellulose, Easter, peak, Nonwovens, web*

مستخلص:

أجريت هذه الدراسة لتقييم الأقمشة الغير منسوجة المصنعة من الياف العشر واستر. باستخدام طريقة الربط الحرارى. تم دراسة تأثيربعض المتغيرات الاساسية التى تضمنت نسبة المزج ودرجة الحرارة الربط على أحمال الذروة للمنتج .أظهرت النتائج أن الاختيار الامثل للألياف والظروف المحيطة بعملية التصنيع أسفرت عن خصائص أداء ممتازة للمنتج. كما يمكن انتاج اقمشة غير منسوجة ذات متانة عالية باستعمال العشر واستر/ بي بي في نسبة خلط 50/50 ودرجة حرارة 110 درجة مئوية تحت ضغط 0.33 ميغا باسكال. هذا بالاضافة إن النتائج أكدت الجدوى الاقتصادية والصناعية لنبات العشر في السودان.

Introduction:

Production of nonwoven fabrics can be achieved through continuous processes, using fibres as input materials, and obtaining fabric in a roll form. Nonwoven fabrics are usually constructed by three basic methods mechanical, chemical and thermal bonding (1).

The basic fibrous layers to be reinforced mechanically or chemically are formed mostly of plenary fibrous products including carded webs, sandwich webs and isotropic webs (7). The common features of these fibrous systems are fibers arrangement, surface uniformity and fibers orientation.

The formation of the web is achieved either mechanically, aerodynamically, Hydro-dynamically or by an electrostatic field. The arrangement of the fiber web may be longitudinal, crosswise, longitudinal and crosswise or random. The fiber web is affected by the properties of the fibers, the amount of fibers in a surface or volume unit and the arrangement of the fibers. The present investigation was undertaken to study the effects of some key processing variables including blend ratio and bond temperatures on fabrics obtained from usher (clatropis Procera) using four production methods namely thermal bonding, stitch bonding, thermal with bonding thread and laminated fabrics.

MATERIALS and METHOD:

The usher fibres used in this experiment were collected from different locations in the Sudan. The Usher fibres, scoured and bleached, had a moisture content of 3.2%, a micronaire value of 6.4%, and a mean fiber length of 26 mm. The bicomponent (Ester /pp) staple fibers carded webs were thermally point-bonded using a Ramisch kleinewefers calendered with a bonded area of 16.6%. Three blend ratios (85/15, 70/30 and 50/50 usher/ Binder fibers) were used with three calendering temperatures (100°C, 110°C and 120°C,). Two nip pressures (0.33MPa, and 0.4MPa) were used. All the webs were calendered at a speed of 10 m/min.

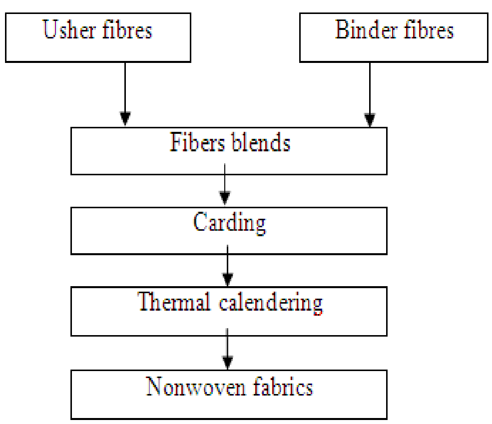

Figure 1: Flow chart of processing procedures

The tensile properties of nonwoven fabrics were tested according to ASTM D 1117-80 standard methods (4). All tensile tests were carried under standard atmospheric conditions for testing textiles (temperature 21±1°C and relative humidity 65 ± 2%).The thermal analysis of the binder fiber was performed using Mettler DSC25 machine at scanning rate of 10°C/min. The weight of nonwoven fabrics was determined according to INDA Standard Test 130.1-92 Method for mass per unit area of nonwoven fabrics. Scanning Electron Microscopy (SEM) images were taken for bonded points and failure structure was indicated using a Hitachi S-3500N Scanning Electron Microscope. An electronic beam of 20.0 KV vacuumed at 50 MPa was employed and a magnification of 80 was used for these images.

used were produced by Eastman Chemical Company. The process flow chart is shown in Figure 1. Firstly, the fibres were opened by hand, and then weighed according to the desired blend ratio and fabric weight. The blended fibers were carded to form a web using a modified Hollingsworth card. The

Results and Discussion:

Fiber Properties:

The Physical properties of fibers used in this research are listed in Table 1. From the table it can be seen that the tenacity and peak strength of usher fiber and Ester unicomponent fibre are nearly the same. However, they were by far less than those of Ester bicomponent (Ester/pp) fiber. The peak extension of usher fibres was much less than those of the Ester unicomponent and bicomponent. The melting point of usher fibres is around 110°C which is much lower than that of the cellulose acetate fiber The latter has a melting point around 250°C. The low melting point of usher fiber is advantageous and facilitates its use as a binder fiber [5].

Fabric Properties:

The produced nonwoven fabric had a weight of 18 g/m^2, and a tensile strength of 124 N/m. The manufactured nonwoven fabric and its physical properties are shown in Figure 2 and Table 2.

Table 1: Physical Properties of fibers used (single filament)

Property	Usher	Ester	Ester /PP
Filament density g/cm³	0.787	1.2	1.1
Filament count (tex)	0.19	0.44	0.44
Peak extension (%)	3.6	144.0	96.0
Peak strength(mN/tex)	132.1	138.0	269.6
Initial modulus (mN/tex)	232.7	204.6	392.5
Staple length (inches)	1.05	1.0	1.5
Crimps (/inch)	-	Not measurable	11

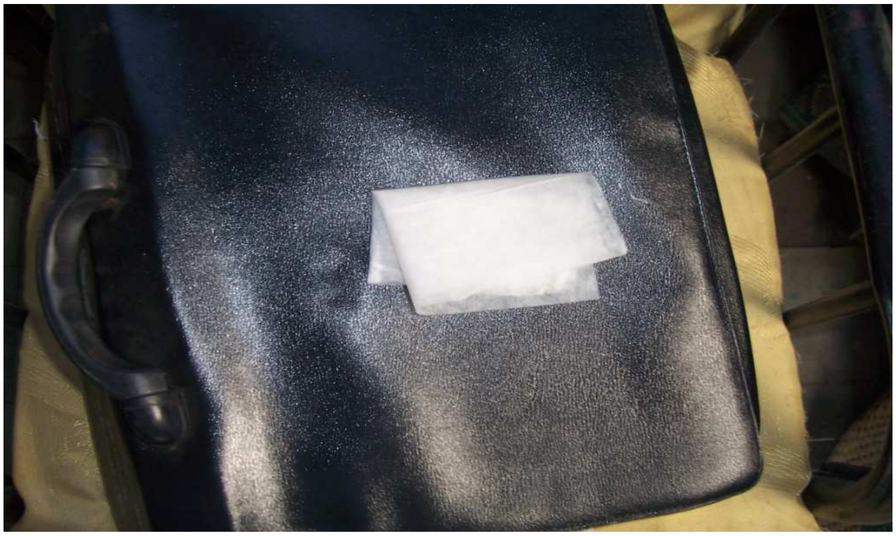

Figure 2: Nonwoven fabric of usher - Ester fibers (85%E - 15%U)

Table 2: Physical Properties of nonwoven fabric (U/E)

Property	Value
Weight (g/m^2)	18
Thickness (mm)	0.12
Tensile strength (N/m)	124
Breaking elongation (%)	28
Liquid strike through (sec/5ml)	6.2

Effect of Bonding Temperature on Peak Load of Usher/Ester Nonwoven Fabric: The effect of bonding temperature on fabric peak load along the machine direction is shown in Figure 3. At lower binder fiber component percentage (< 30%) the peak load increased with increasing calendaring temperature. However, at higher binder fiber component percentage, the peak load decreased with higher bonding temperatures.

The increase in the strength of the fabrics at lower binder fiber component with temperatures could be attributed to the formation of better-developed bonding structure. The regular shape of bonded points and smooth surface of the fabric bonded at high bonding temperatures resulted in the well-

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developed bond structure. The decrease of peak load at higher binder fibre component with bonding temperatures may be due to various failure mechanisms of the nonwoven fabric including loss of fiber integrity, formation of film-like spots at high temperatures and the reduction in the load transferred from fibre to fibre via bonding points [6,8].

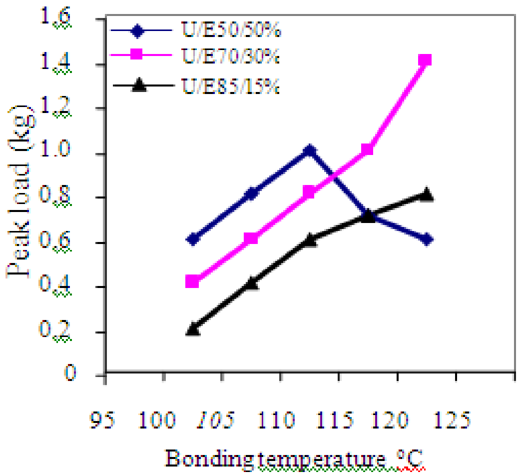

Figure 3: The effect of bonding temperature on peak load

The well and uniform distribution of the fibres inside the web due to high elasticity of the fiber (high peak extension and low modulus), leads to low tensile properties of the final nonwoven fabrics. So a bicomponent fiber, Ester with Ester Bio, GP copolyester as the sheath, and polypropylene as the stiffer core was selected as the binder fiber instead of Ester unicomponent fiber [3].

Figures 4 and 5 show that at the two blend ratios usher/binder fiber of 15/85 and 30/70 at the three bonding temperatures (100, 110, 120°C) the peak loads of usher/ Ester/pp nonwoven fabrics were much higher than that of usher/ Ester nonwoven. Therefore, using Ester/pp bicomponent fiber as a binder fiber can improve the tensile properties of Usher/ Ester nonwoven Fabrics. The improvement in tensile properties is a result of better binder properties as well as improved processing characteristics of the modified binder fiber.

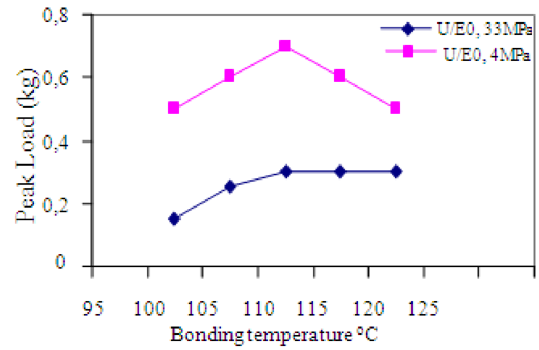

Figure 4: Relations between Bonding temperature and peak loads for 15/85 Usher / ESTER (Calendering Pressure = 0.33 ~ 0.4 MPa, Calendering speed =10 m/min)

Failure of nonwoven fabrics occurs due to failure of fiber (fiber breakage) or within bond failure (bond breakage or cohesive failure) at the fiber-binder bonding interface, or by a combination of these modes. Structure and fabric deformation mechanisms can lead to a variety of unique failure mechanisms for nonwoven fabrics [5].

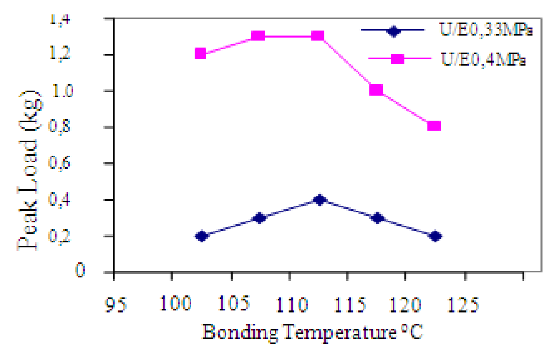

Figure 5: Relations between bonding temperature and peak loads for 30/70 Usher/ESTER (Calendering Pressure = 0.33 ~ 0.4 MPa, Calendering speed =10 m/min)

The nonwoven fabric failure mechanisms are influenced by fiber physical properties such as adhesive properties, structural properties (including the relative frequency and structure of the bonding elements), fiber orientation and the degree of liberty of movement of the fibers between the bond points. Physical properties of the nonwovens would be controlled by the first failure occurring in the fabric sample.

Based on this assumption it could be argued that the failure mechanism of nonwoven fabrics of high Ester binder fiber component bonded at a higher temperature, is different from that of the nonwoven fabrics bonded at a lower calendaring temperature.

The difference in failure mechanism was clear from SEM images obtained for the failed structures of the fabrics produced with different binder fiber compositions. These observations are consistent with other findings reported on the failure mechanism of thermal point-bonding temperature. At low binder fiber component and low bonding temperatures, the bond failure mechanism was found to be due to the loss of interfacial adhesion at the bond site leading to bond disintegration. At high binder fiber component and high bonding temperatures, the failure mechanism was attributed to cohesive failure of the fibers near the bond periphery (7).

Conclusions:

- Usher fibre has special properties that make it a suitable raw material for many products. Nonwoven fabrics of high quality performance were produced from usher fibre blended with other fibres.
- High strong Usher/Ester/pp nonwoven fabrics can be produced by using usher/Ester/pp at a blend ratio of 50/50 and a thermal calendering temperature of 110˚C under a pressure of 0.33MPa.
- The tensile properties of usher / Ester/pp nonwoven fabrics are comparable to and/or better than those of Usher/Cellulose Acetate nonwovens and the fabrics produced could be used in various areas.
- Future research should be focus on the technical and economical aspects of producing nonwoven fabric from usher.

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