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2nd International Mediterranean
SCIENCE AND ENGINEERING CONGRESS
OCTOBER 25-27, 2017
ÇUKUROVA UNIVERSITY, CONGRESS CENTER, ADANA / TURKEY

2. Uluslararası Akdeniz
BİLİM VE MÜHENDİSLİK KONGRESİ
25-27 EKİM 2017
ÇUKUROVA ÜNİVERSİTESİ, KONGRE MERKEZİ, ADANA/TÜRKİYE

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2. Uluslararası Akdeniz BİLİM ve MÜHENDİSLİK KONGRESİ

Bildiri Kitabı

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Individual and Triple Interaction Analysis of Blended OE-Rotor yarns

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Abstract

Acrylic fiber is used to be the synthetic opponent of wool fiber in textile industry especially at clothing and carpets. It has thermal benefits which made it useful in cold weathers. At clothing production it is generally used with alone (%100) or with one other fiber as binary mixtures. Viscose is mostly mixtured fiber with it and polyester is the most used fiber among all man-made fibers. In this study the individual and triple interactions with polyester and viscose were investigated. Hairiness (H) and strength properties were chosen to focus for investigating usage properties of acrylic fiber and it's interaction with polyester and viscose. Unlike previous studies, this study was focused to investigate acrylic fibers' interactions in ternary blends with polyester and viscose. In addition to ternary blends, we have produced single and binary blends of these three fibers to compare.

Keywords: Triple interaction, OE-Rotor, blended yarn, fiber mixtures, mixture analysis

1. INTRODUCTION

Hairiness is one of the most important quality parameter of spun yarns. It does not only affects the quality of yarns, but also the weaving and knitting performance of yarns as well as the quality of the resultant fabrics [1]. Factors influencing yarn quality, mainly yarn hairiness, are correlated and therefore the conclusions depend on all production conditions [2]. Various variables of the rotor spinning system were optimised to produce cotton yarn from ginning waste with the lowest hairiness level by Hasani and Tabatabaei [3]. Spinning components like take-off nozzle, rotor type, twist stopper type are highly effective on hairiness of OE-Rotor yarns [4]. According to Zhu [5], the dominant effect from fiber properties is fiber length when predicting the hairiness of ring and rotor spun yarns. Electrokinetic properties of acrylic contented textile fabrics were investigated and reported that are crucial for dyeing and finishing processes [6]. Baykal et.al. (2007), obtained a successful prediction model for the Hairiness of Cotton/Polyester Blended OE Rotor Yarns with 0.98 R^2 [7]. There are many prediction methods used to predict hairiness and other yarn properties. Haghiat et.al. (2012), used the fuzzy logic method and managed to get high R^2 values for prediction models [8]. Zhao (2012) used a back-propagation (BP) artificial neural network model for the purpose of predicting the polyester/cotton yam hairiness [9]. Haghiat et.al. (2012) used an artificial neural network and multiple linear regression for modelling and predicting the hairiness of polyester/viscose blended yarns based on various process parameters [10]. A previous study was published about different blend ratios and types on the properties of Polyester/Viscose/Acrylic blended Open-End Rotor spun yarns [11]. Hairiness and strength properties were chosen because of the usage areas of acrylic based textile products.

2. MATERIALS AND METHODS

Polyester (PES), Viscose (CV), and Acrylic (PAN) fibers with 1.3 dtex fineness and 38 mm length were used as raw materials in the study. A Simplex Centroid design was created with two replicates at each point [12]. The production of yarn samples were performed at a combination of PES, CV, and PAN fibers with five different blend ratios (100% - 50/50% - 33/33/33% - 67/33% - 67/16.5/16.5%), two mixture methods (fiber sandwich blending by carding machine and sliver blending by draw frame), two different number of draw frame passages (one and two passages), and three different yarn counts (Ne 16, 24, and 32).

(*) Corresponding author

Totally, 48 different yarn samples with addition of the draw frame mixtures (one and two passages), the sum of all samples was reached to 144 and after removing the mixtures in carding machine and in draw frame which are equivalent, 135 unique design points were obtained.

The process parameters were like: 136 αm Twist Coefficient, 80,000 rpm Rotor Speed, 80 m/min Yarn Delivery Speed, 8,300 rpm Opening Roller Speed, OS21 DN Opening Roller Type, KN4 Take-Off Nozzle Type and Black Torque-Stop Type (for weaving).

270 yarn samples (135 unique yarn samples with two replication points) were used to create prediction model for Hairiness (H) and Strength (Rkm) after regressional analysis. Uster Tester 4SX and Tensorapid instruments were used to test Hairiness (H) and Strength (Rkm) values. Uster Tester 4SX tests were runned according to ASTM D1425.96 standard, and Uster Tensorapid tests were runned according to TS 245 EN ISO 2062 standard.

3. RESULTS AND DISCUSSION

Three-component mixture graphics were given in Figure 1 for Hairiness (H) values and Figure 2 for Strength (Rkm) values which can be used to predict the properties of yarns with these three fiber blends. At the graphics the A corner is where the PES ratio is 100% and the cross edge of this corner is where the PES ratio is 0%. Same for the B and C corners and their cross edges.

Graphics in Figure 1 shows that at all yarn counts when PAN ratio is increasing, the hairiness is increasing too. And the highest hairiness values were obtained at highest PAN ratios. But same situation is not seen for Strength values (Figure 2). Highest PAN ratios have mid or low-mid strength values among all samples. On the other hand, highest Strength values were obtained with highest PES ratios which is an obvious result when the strength property comes forward for yarns.

The obtained prediction models from regressional analysis are presented below for Hairiness (H) (Equation 1) and Strength (Rkm) (Equation 2). The coefficients of determination were obtained as R^2=0,8452 for the H model and R^2=0,8967 for the Rkm model.

$$H = +4.86 * A +4.66 * B +5.76 * C -0.70 * A *C -0.60 * A *D -0.55 * B *D -0.71 * C *D +1.71 * A *C +3.38 * B *C +2.05 * B *C \quad (1)$$

$$\sqrt{Rkm} = +0.23 * A +0.30 * B +0.26 * C -0.051 * A * B +0.031 * A * C +0.011 * A * D +0.057 * B * C +8.330E-003 * B * D -3.142E-003 * B * E -0.14 * B * C * (B-C) \quad (2)$$

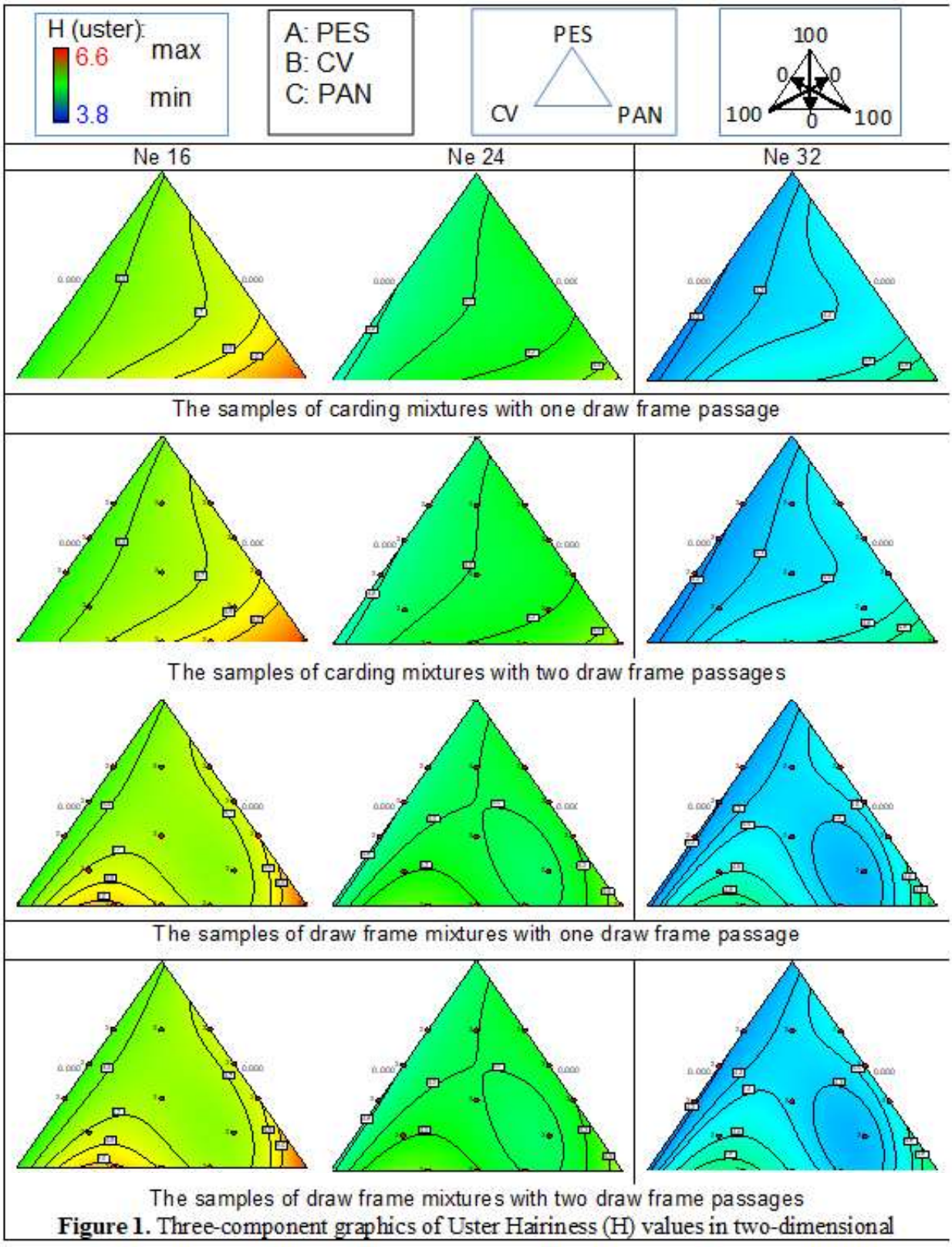


Figure 1. Three-component graphics of Uster Hairiness (H) values in two-dimensional

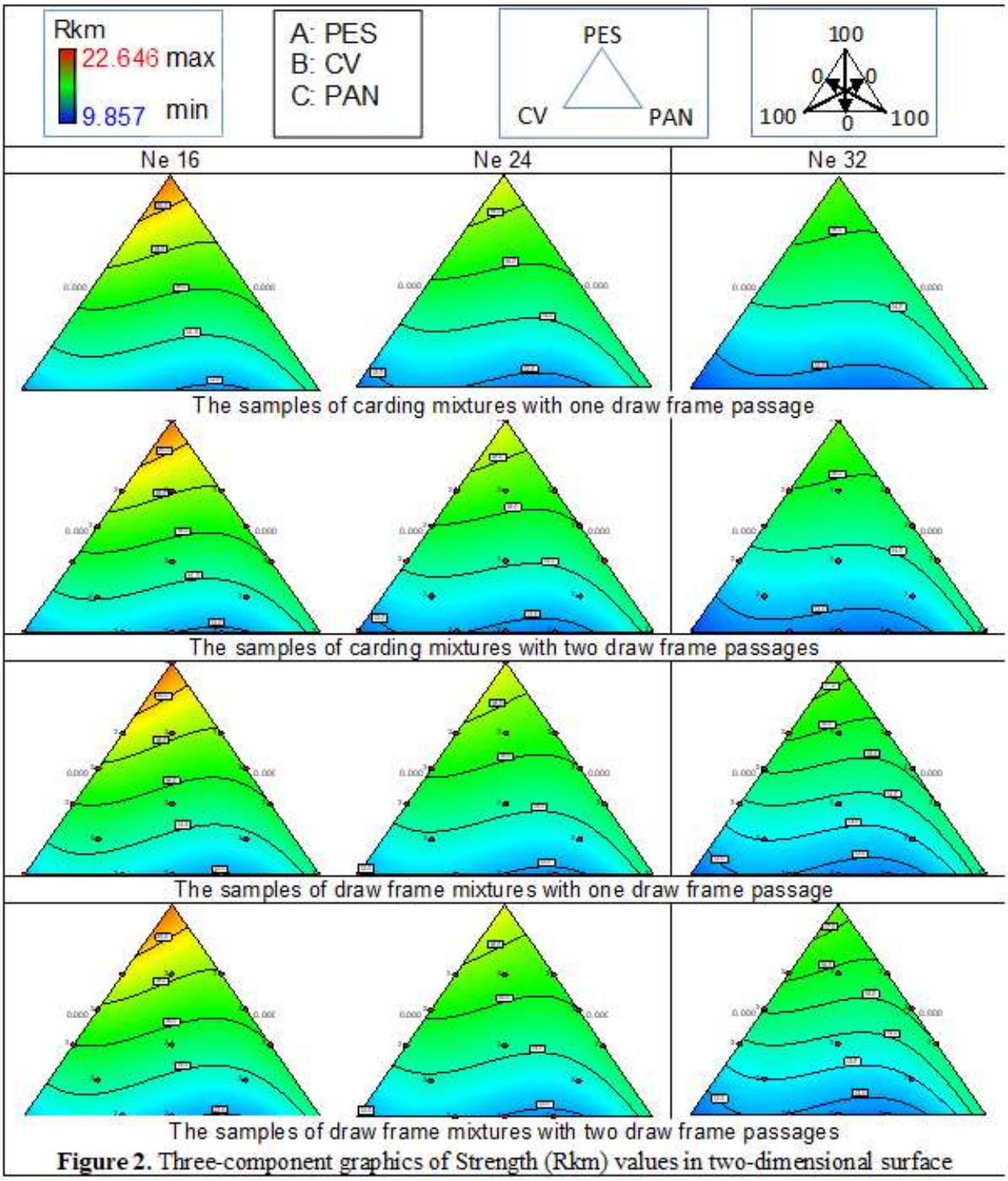


Figure 2. Three-component graphics of Strength (Rkm) values in two-dimensional surface

The equation 1 and two both have high R^2 values which show the highest significance levels for predictions made from them. The fiber types in mixture (PES, CV, and PAN) were coded as A, B, and C in the model. The blend ratio of each mixture component was ranged from "0" to "+1.00" and the sum of all three mixture components (A, B, and C) is always equal to "1" at each design point. For example, if the mixture ratio was 67/16.5/16.5% for PES/CV/PAN, the values must be entered to the software as 0.67 for A, 0.165 for B, and 0.165 for C. Yarn count (D) is a process component in the model and the samples were produced at three different count levels as Ne 16, 24, and 32. In all the analysis, "-1", "0", "+1" values represent Ne 16, 24, and 32 respectively. The mixture method (E) is a categorical component in the model. It has two levels and "-1" represents the mixtures by carding machine, and "+1" represents the mixtures by draw frame in all the analysis. The number of passages at draw frame (F) is also a categorical component. It has also two levels and "-1" represents one time passage and "+1" represents two times passages at draw frame for all the analysis.

CONCLUSIONS

Strength (Uster H) and Hairiness (Rkm) properties of ternary blend (PES/CV/PAN) yarns were successfully analysed at

this study. Also, prediction models obtained with higher success rates. In a general view, to obtain high Hairiness values from Acrylic mixed yarns, Acrylic ratio must be at least 80% or over with Polyester and/or Viscose blended yarns. But if strength is also important, the ratio of acrylic can be lowered to 50% levels to gain mid-level hairiness and best strength values from these fiber blends. Lowest hairiness values were obtained from highest Polyester and/or Viscose ratios in blends for all yarn counts in the study. Viscose fibers have similar results for strength with acrylic. The thinner yarn counts have lower strength values compared to thicker counts which is caused from fiber number at the cross-section of yarns. Also card machine mixtures have high strength than drawframe mixtures which is because of better mixing of different fibers in cross-section of yarn. Card machine mixtures also have lower hairiness values than drawframe mixtures which is because of better placement of fibers in the sliver and in the yarn continuously.

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