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INNOVATIVE RESEARCH AND APPLICATIONS IN YARN WINDING/DYEING

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Abstract: *The yarn dyeing process has a large part in the coloring of the product. The most important factor in evaluating the quality and efficiency of dyeing in the yarn dyeing process is the quality of the winding process. Combining technology with traditional bobbin dyeing processes results in higher quality and lower cost production processes and products. In this study, the determination of optimum points in parameters such as winding properties, density, density and yarn count were investigated in order to ensure high quality dyeing and reproducibility. It is aimed to develop a test device to analyze the cone technical information with the image processing method and to technologically examine the cone winding process before cone dyeing. Image processing technique was used to add a technological perspective to the winding measurement process. Density measurements made with the developed device and the traditional method were archived and compared. The measurements made with the traditional method and the values measured by the software were compared and it was determined that the system performed these measurements with an error margin of approximately 2.42%. Cone winding density measurements were made with the device designed to minimize dyeing errors caused by cone winding. In the bobbin dyeing unit, the difference between the windings is determined with this device and checked before starting the production.*

Key words: *Cone dyeing, winding density, image processing, density measurement*

1. INTRODUCTION

Dyehouse is important for businesses in the supply chain in the textile industry. The yarn dyeing process has a large part in the coloring of the product. The dyeing of the yarns (bobbin dyeing) is advantageous due to the high production capacity and the easier transition to the production stages to be made after dyeing. The most important factor in evaluating the quality and efficiency of dyeing in the yarn dyeing process is the quality of the winding process, which is the initial stage of bobbin dyeing. The quality of the winding of the bobbins obtained at this stage affects the correct dyeing and repeatability of the yarn dyeing [1].

Yazir, in his study in 2003, carried out experimental studies to determine the effect of the winding density of the cone and the structure of the pattern on dyeing. As a result of the studies, color difference was observed to be lower in bobbins with winding density of 0.41 and 0.43 g/cm3 during dyeing at 2 bar pressure. It has been observed that the color difference that occurs during the

use of the dyeing pattern with a high useful surface coefficient is less than the use of the existing coating with a low useful surface coefficient [2].

In his study conducted in 2008, Tomruk stated that the most important factor in evaluating the quality and efficiency of bobbin dyeing is the quality of the winding process, which is the initial stage of bobbin dyeing. The quality of the winding structure of the bobbins affects the highly efficient dyeing of the yarn during dyeing. In this study, the winding structure of the bobbins prepared for dyeing was examined from a technical point of view [3].

In Yeltekin's (2016) study, it was aimed to estimate the ster value of the tree-laden vehicles on the scales with computerized systems using image processing techniques. A special real-time software has been developed using various image processing techniques. While the calculations were made, the pixel/cm calibration was determined as 521/470 [4].

Praček and Pušnik (2019), gave a simple mathematical model for simulating the unwinding process. Simulation studies was done with experimentel studies in the scope of explaining between the angular velocity of the yarn and the tension [5].

In their study, FETTAHOV et al. investigated the overlapping winding errors in the windings of the coils mathematically. Using two different methods, turns of package per double traverse were calculated and no big differences were observed. Calculations were used to determine possible belt formation diameters on the spinning machine. [6].

2. MATERIAL AND METHOD

In this study, brand name of SSM winding machine (Figure 1) and the most requested yarn numbers (such as 16/1 Ne, 12/1 Ne, 20/2 Ne) were used. The cabinet design was made with a three-dimensional printer in our R&D Center, the software was developed by our research team using MS Visual Basic C# software language and a cone density measuring device was designed with image processing technique. Density measurements of ready-to-dye coils were made with the developed image processing device. The study was carried out under three headings, which is given below, respectively.

1. Implementation of software for density measurement with image processing and cabin design with 3D printer.
2. Using the density measuring cabinet and saving data.
3. Optimization studies in the yarn dyeing process

Fig. 1: *SSM winding machine*

3. RESULTS AND DISCUSSION

3.1. Implementation of software for density measurement with image processing and cabin design with 3D printer.

Software of the density measurement was done with the MS Visual Basic C# software language. After the cabinet design was done Solidworks, cabinet parts were printed by 3D printer. The design of the density measurement cabinet given in Figure 2 was done with Solidworks.

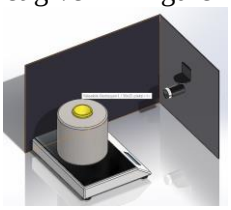

Fig. 2: *Virsual of cabinet basic design*

3.2. Using the density measuring cabinet and saving data.

After the software, design and 3D printing studies were completed, pre-studies were begun. While the system was calculated volume of the bobbin with image processing, weight of the bobbin was taken by weighing machine, which was under the cone. Density was calculated by using d =m/v equation. Software visual was given in Figure 3 when measurement of density in the cabinet. The lower and upper limits of the coil from the video frames taken from the cabinet were determined in pixels and converted to cm values with software. The real data along the measured cones were compared with the values measured by the software and it was determined that the system performed these measurements with an error margin of approximately 2.42%.

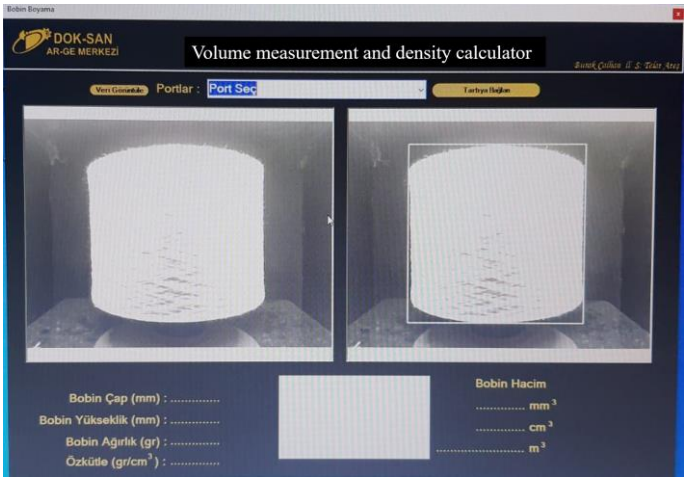

Fig. 3: *Measurement of density in the cabinet*

3.3. Optimization studies in the yarn dyeing process

With the help of the device developed by our researchers, the density measurements of the bobbins were made before dyeing. Research was done in light color dyeing studies in our enterprise. In addition, measurements were made according to different yarn counts and types. The lower and upper limit bobbin density values that will provide the maximum dyeing efficiency have been determined. Yarn tension values that meet these density values were defined to the winding machine. The data obtained in this study were given in Table 2.

Table 2: *Lower and upper limit values of density for different yarn counts and types*

#Yarn (Ne)	Yarn type	Density (g/L)		Tension (cN)
		Lower limit	Upper limit	
6/1	Ring	400	410	18
12/1	Low twist	420	445	15
	Open end	400	430	12
	Ring	410	420	12
16/1	Open end	430	450	10
	Ring	390	405	20
20/1	Organic	410	430	12
	Ring	375	390	15
20/2	Open end	385	395	27
	Carded	390	405	35

5. CONCLUSIONS

A system has been designed by our R&D center in order to reach optimum data on dyeing performance in the yarn dyeing department. Optimum points in parameters such as winding properties, density, density and yarn count were investigated in bobbin dyeing pre-preparation processes. While doing this, it has benefited from 3D printing and image processing to add a technological and different perspective. First of all, a cabin design was made with the help of a 3D printer. On the other hand, software studies for image processing continued. The main topic in the software was on the volume calculation of the cone. The weight of the cones was recorded with the help of the scale in the designed cabin. Density calculation was made by dividing the weight taken from the scale by the volume calculated with the help of image processing. For the field studies, the most used yarn types in the enterprise were measured before dyeing. Optimum bobbin densities with high dyeing efficiency were classified.

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