REDUCTION OF COST IN PLANE TISSUE DYEING IN STRONG COLORS USING ALKALINE SODIUM SILICATE

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Abstract *– Nowadays, with the globalized and highly competitive market, organizations are looking for ways to improve their processes in order to reduce costs to ensure their survival. The goal of this work is to reduce cost in dyeing flat fabric in strong colors. For this, the substitution of the neutral sodium silicate by alkaline sodium silicate was carried out in the paddling phase. In order to develop the present study, we used the spectrophotometer to measure the color intensity, Maple software to simulate samples and Minitab software to analyze the normality of the collected items. The obtained results show that there was a reduction in the amount of dye used in the dyeing process, thus reducing R$ 0,03 cents in the meter of the fabric.*

Keywords: *Cost Reduction, Dyeing, Neutral Sodium Silicate, Alkaline Sodium Silicate.*

I. INTRODUCTION

In a highly competitive world, companies are increasingly worried about staying in the market and making a difference in their industry, so it is necessary to establish an increase in the efficiency of the production process in order to optimize its resources.

Spending is one of managers' biggest concerns, so there is an incessant search to reduce it. In the textile sector the discussion about cost is important considering the economic factors involved.

According to [1], Brazil is the largest complete Textile Chain in the West, ranging from cotton planting to fashion shows, through spinning, weaving, dressing and garment making. The textile industry has almost 200 years in the country and has an average production of 1.3 million tons of fabric.

The objective of the present search is to reduce the cost of dyeing flat tissue through the exchange of a chemical compound, the sodium silicate. For this purpose, a company that acts in the textile sector was used as the object of study and is a reference in its field of activity, where dyeing tests were carried out in the laboratory. The specific objectives of the study are to carry out the dyeing test in the laboratory using the neutral and alkali sodium silicate and make a cost analysis comparing it before and after the dye reduction.

II. LITERATURE REVISION

A. Dyeing

The company from this study uses the process of dyeing Pad-Bach, that according to Moraes (2010), this process consists of four stages, foulardagem, resting, washing and drying.

B. Foulardagem

According to [2] the foulard is a machine used in textile processing, its function is to make the dyeing bath. This bath is carried out in two stages: in the first stage the fabric is submerged so that there is a complete impregnation, in the second stage it passes through the squeegee rollers so that the elimination of the air occurs, to force the penetration of the dye in the fabric and to remove the excess liquid.

C. Rest and Wash

For the [3] rest is the time the fabric takes to react with the chemicals being applied in it. After this period the fabric roll of tissue will go to the washer where it will be washed with water and the excess of unreacted products in the process will be removed.

D. Sodium silicates from their application in the textile industry

According to the company [4] sodium silicate is an aqueous solution consisting of SiO2 (silicon dioxide) and Na2O (sodium oxide), whose variation in the weight ratio between both constituent oxides and the solids content of the solution, can obtain various specifications, with specific characteristics for each use in the various market segments.

Also, according to [4] in the textile industry sodium silicate and/or sodium metasilicate pentahydrate is used as a stabilizer for hydrogen peroxide in the cotton bleaching process and in the denim washing and stoning, due to its action as sequestrant of iron, manganese and copper. Due to its alkalinity, it has detergency and buffering action and functions as an ant redeposition agent. The silicate also assists the washing process as a buffering agent, maintaining the required process pH.

E. Neutral sodium silicate

Neutral sodium silicate is applied in the detergent industry in formulations to increase the efficiency of active tensions in the pulp and paper industry in the construction industry for manufacturing industrial floors. [5]

F. Alkali Sodium Silicate

Alkaline sodium silicate is a combination of sodium and silica. The molar ratio of the sodium silicate is 2.15. It is a viscous liquid translucent, between yellowish and lightly roseate and is represented by the molecular formula SIO2: Na2O. In the textile industry it is used as detergent to increase the efficiency of the surfactant. [5]

III. METHODOLOGY

For the development of this study were carried out bibliographical research, through scientific articles, magazines and academic sites from February to October 2018, having as object of study a textile based in the Zona da Mata Mineira.

A follow-up of flat tissue dyeing test was performed in 12 samples at the company's laboratory for 7 days in June. In the first step of the test, samples of an x fabric with a 100% cotton composition, containing 50cm in length and 20cm in width each were cut, all the tests that the company does of dyeing is carried out in that fabric x due to its composition and structure. Subsequently, the chemical used was weighed, including neutral and alkaline sodium silicate.

The next step was to dye the fabric in the foulard, as shown in fig. 1.

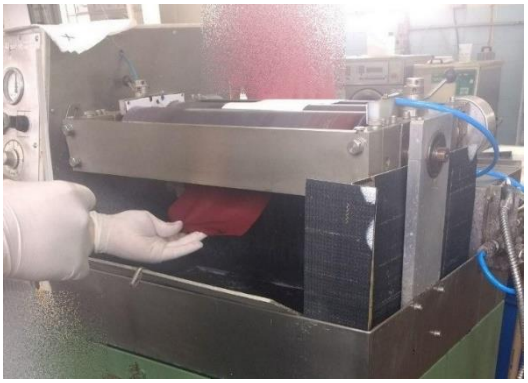

Fig. 1: Dyeing the sample in the *foulard*.

After dyeing, the samples were allowed to stand for a period of 16 hours in a dry and out-of-light place. The next step was to wash the tissues to remove the chemical excess. Fig. 2 illustrates this step.

Fig. 2: Washing of tissue samples.

After washing the samples were placed in a dryer to remove excess water, as shown in fig. 3.

Fig. 3: Drying the samples.

To finish the tests, an iron was used to follow the drying process of the samples. Fig. 4 illustrates this step.

Fig. 4: Final drying process of the samples.

It should be noted that all stages of the test were performed according to the conditions and equipment available in the laboratory. Nowadays, this is the procedure adopted by the company.

After finalizing the tests, the samples were analyzed in the spectrophotometer, a very effective device in the measurement of colors, through the results of its test it is possible to obtain complete information about the colors, such as the values of intensity of reflectance within a certain range of spectrum. [6]

In order to achieve the desired reliability in the obtained results we used the sample calculation for simple random sampling that according to [7] are all elements that have the same possibility of being chosen and it was verified that for a population of 93 colors 76 samples are necessary considering a confidence level of 95%.

Since it was possible to collect only 12 samples, the Maple software was used. [8] states that softwares such as Matlab, Maple and Fortran allow the generation of random samples through the input patterns of the variables, and it is possible to statistically reproduce an order of random values that respect a normal distribution. The same was used to simulate 64 possible samples to complete the portion required to validate the study.

In order to verify the normality of the collected data, a control chart was constructed in the Minitab 16 statistical software. The chart used was the variable control chart. According to [9] this graph is used for individual data where each point of the graph represents an individual measurement; therefore, the size of the subgroup is 1.

IV. RESULTS AND DISCUSSION

From the results obtained in the tests and the data collected in the company, calculations were made to evaluate the cost reduction. Table 1 shows the cost of the meter of the fabric using the neutral sodium silicate.

Product	Consumption g/L	Price/Kg	Price/g	Price of the product/L
Dye	70	23,57	0,024	1,65009
Chemist 1	3	3,03	0,003	0,00908
Chemist 2	0,3	22,99	0,023	0,00690
Neutral Sodium Silicate	60	1,28	0,001	0,07684
Chemist 3	16,5	1,97	0,002	0,03252
Chemist 4	2	2,43	0,002	0,00485
		Total price per liter		1,78
		Total price per meter		0,25

Table 1: Cost of the *foulard* using neutral sodium silicate.

As shown in table 1 to perform the dyeing process by applying 70 g / l of dye and using neutral sodium silicate the company has a cost of R$ 0.25 cents per meter of tissue.

Through the tests carried out in the spectrophotometer it was verified that the colors dyed with the alkali sodium silicate had a higher yield of the color causing the hue to be more pronounced compared to the standard colors used by the company. So, the company will apply a smaller amount of dye using the alkali sodium silicate so that the dyed colors can stay in the standard shade.

The results of the tests performed on the samples were used to make the control chart.

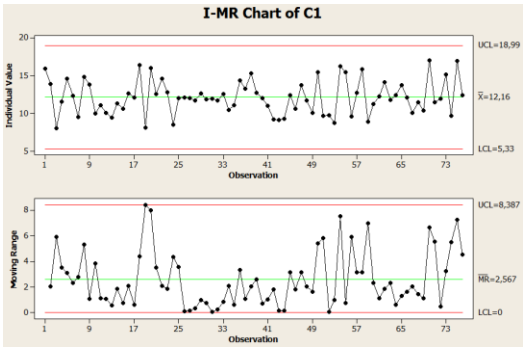

Fig. 5: Control chart.

By analyzing the control chart, it was found that on average the colors dyed with alkaline sodium silicate obtained a yield of 12.16%. Based on this yield a new calculation of the cost of the tissue was made by reducing 8.512 g/L of the amount of dye used and using the alkali sodium silicate. Table 2 shows this calculation.

Product	Consumption g/L	Price/Kg	Price/g	Price of the product/L
Dye	61,49	23,54	0,024	1,44776
Chemist 1	3	3,03	0,003	0,00909
Chemist 2	0,3	22,94	0,023	0,00688
Neutral Sodium Silicate	60	1,60	0,002	0,09600
Chemist 3	16,5	1,98	0,002	0,03266
Chemist 4	2	2,50	0,002	0,00499
		Total price per liter		1,60
		Total price per meter		0,22

Table 2: Cost of the *foulard* using alkaline sodium silicate and reducing the amount of dye.

Analyzing table 2 it was found that by dyeing the fabric using the alkali silicate it was possible to reduce the amount of dye used in the process. Considering that this product represents 90% of the dyeing expenses, it was found that it was possible to reduce by R$ 0.03 cents of the standard cost of the meter of the fabric in the foulard and also reduced by R$ 0.18 cents of liter of the products used.

The company under study has an installed production capacity of 559,956 meters of red fabric per month. Currently it is producing a monthly average of 379,106 meters, that is, only 68% of its capacity, the production of fabrics with dyeing in strong colors represents 57% of this production.

The current monthly average of dyeing in strong colors is 217,148 meters, with this reduction of R$ 0.03 cents we estimate that the company will have a monthly cost reduction in the dyeing of strong colors in the foulardagem phase of R$ 6,514.44.

V. CONCLUSIONS

In this study was presented an approach on cost reduction in dyeing of strong colors in flat fabric, having as object of study a textile industry leader in the market of cotton fabrics for haute couture shirt.

Through the tests carried out in the laboratory and cost analysis, it was found that by changing the sodium silicate neutral by the alkali sodium silicate in the dyeing of strong colors, they presented a better yield. With this it was possible to reduce the amount of dye used in the process reducing the cost by R$ 6,514.44 per month in the foulard.

Furthermore, it was concluded that the project presented an economic feasibility, since it was not necessary an initial investment and it is emphasized that at the moment the company does not produce its total capacity, so, having a reheating in the market this reduction will be even greater.

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