Implementation of a pilot plant for the dyeing of accessories

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Course: Thesis seminar I

Textile Engineering Program

ABSTRACT

Due to the growing unsatisfied demand to serve customers who require dyeing services for small-scale accessories, whether SMEs, craftsmen, among others by companies that provide dry cleaning services, is the proposal for an alternative of Investment for the implementation of a pilot plant for the dyeing of accessories, using the environments and infrastructure of laboratory No. 24 of the Faculty of Chemical and Textile Engineering of the National University of Engineering.

INTRODUCTION

The motivation to carry out this project is the desire on the part of the students and teachers to provide a service to the community.

Since within the College there is the necessary knowledge to apply this project and generate benefits not only in the academic and intellectual field but also economic in the long term. The field of dry cleaning is wide and varied due to the diversity of existing fibers, both natural, regenerated and synthetic, as well as the methods of application of the dyes on them and the wide range of dyes, auxiliaries and behavior on each of these fibers.

For this work of pre-investigation, the study of the dyeing of polyester accessories will be carried out, because they are inexpensive accessories, they abound in the market and there is a high consumption index by the garment factories, who obey the demands of fashion, changing industry and competitive in terms of designs such as texture, color, shape, etc.

REFERENTIAL BACKGROUND

As a reference for the development of this project, the work done by students of the same Faculty the previous semester "Implementation of a pilot plant for laundry service of cotton garments."

In carrying out this project, the deficiencies of the exhaustion machines present in the Nª 24 Laboratory as well as their poor matching, homogeneity of temperature in all vessels and false display temperature are revealed. Therefore it is a project that obeys a need produced by the poor state of the current teams and opens the debate to acquire modern equipment that allow the development of the project and meet the demands of the market.

METHODOLOGY

A study of all the sewing accessories used in the preparation of garments and the process of dyeing in polyester articles is carried out. The colorants, auxiliary chemicals, dyeing process selected for this purpose.

In order to carry out the attention of orders in dry cleaning service, the pilot plant must have the necessary machinery and instruments. For this, the acquisition of these equipment will be evaluated and a budget will be elaborated.

Finally, a proposal of distribution of plant in CAD format will be developed where the equipment layout will be observed.

HYPOTHESIS

Through the implementation of the pilot plant will provide the service of dyeing of accessories for customers who require dyeing these on a small scale (1kg) to companies that handle large volume orders every day so that they do not attend in time to these small customers.

OBJECTIVES

GENERAL OBJECTIVE

Implement the pilot plant for dyeing accessories for polyester objects and also in other types of fibers laboratory No. 24 of the College of Chemical and Textile Engineering.

SPECIFIC OBJECTIVES

To perform the provision of dry cleaning services for customers of small lots of the textile community.

To train and train the students of the Textile Engineering specialty in the management of the equipment involved in the dry cleaning processes. As well as giving them the necessary knowledge to carry it out.

Carry out the design and redistribution of the laboratory plant through the use of the AUTOCAD software, for a better use of the current space.

Prepare a sample of dyed fabrics to adequately serve customers who require the service.

To promote the academic and economic growth of the Faculty of Chemical and Textile Engineering through the training of its students and teachers of the specialty and the generation of own resources.

DEVELOPMENT OF PRE-INVESTIGATION WORK

Fibers

COTTON

Natural vegetable fiber, its crystallinity is 70% due to the linearity of its chain, it is relatively rigid but when wet it is foldable and smooth. Its humidity rate is 7-9.5%, its absorption of water by imbibition is 42-53%, it presents great resistance to alkaline solutions, it is hydrolyzed by acids concentrated in cold and by hot weak ones; Oxidants such as chlorite and sodium hypochlorite damage it. Its glass temperature is 50 ° C. Before dyeing requires bleaching, de-gumming, etc. To remove the natural impurities and obtained in the fabric and pre - fabric to increase the affinity for the dyes.

VISCOSE

Regenerated cellulose fiber presents little crystallinity between 25-30% and higher amorphous ratio and therefore absorb more moisture than cotton and more absorption of water by imbibition. It loses resistance when wet, has a moisture content of 11-13%, moisture absorption 14-18%. It is hydrolyzed by acids concentrated in cold and by weak in hot. They are well resistant to bleaching with peroxide and sodium hypochlorite.

POLYESTER

The polyester fiber results from the polymer which is obtained by polycondensation of terephthalic acid and ethylene glycol. The polyester fiber is compact and highly crystalline. With rigidity in amorphous areas giving a high glass transition point (80 ° C). The fibers are hydrophobic, exhibit minimal swelling. They are stained with dyes dispersed by a dyeing mechanism by solid solids dissolution.

ACRYLIC

Acrylic fiber is a synthetic fiber made from acrylonitrile. Acrylic fibers are less hygroscopic than natural fibers, less than nylons 6 and 6.6 and more than polyester fibers. The retention of water by imbibition is 5 - 10%. The glass transition temperature is 90 ° C. The different types of acrylic fibers are all stainable with cationic (basic) dyes.

NYLON

It is an artificial polymer belonging to the group of polyamides. It is formally generated by polycondensation of a diacid with a diamine. Glass temperature of 50 ° C for nylon 6 and nylon 6,6. They have a relatively high melting temperature of 245 ° C. They have low water retention power, so they get wet quickly. It loses resistance by prolonged exposure to sunlight. Fibers can absorb up to 2.4% water.

Substrates for dyeing

The dyeing process can be carried out in different stages of textile processing, in different substrates: fibers, threads, fabrics and garments.

FIBERS:

When the dyeing process is carried out during the first processing steps, for example on loose fibers (before spinning) a better color fastness can be achieved. This process is performed in perforated baskets and although there may be areas where the dye does not completely penetrate, in subsequent spinning operations these areas are mixed thoroughly with the stained fibers, thus ensuring a uniform color. For this, it is important to know the characteristics of our material before dyeing, for example, the type of structure of the fiber, the degree of whiteness or maturity (cotton case) and the affinity for the dye.

THREADS:

Dyeing of yarns is preferred for the manufacture of listed fabrics, plaids or jacquard fabrics. This dyeing method gives good solidity, as the dye reaches the yarn core. The yarn can be dyed in the form of skeins, in reels (using autoclaves) and even, if warp, perforated folds are prepared that are loaded in autoclaves. Before the dyeing we are interested in knowing the intensity of torsion, pilosity and presence of impurities since it will influence the dyeing.

CLOTH

The dyeing in piece or cloth is carried out in several types of machines and the material can appear open wide or in the form of rope. Here we have some factors that can influence the success of dyeing such as the type of fabric presented, the coverage factor, and the density of threads or meshes.

A good dyeing is carried out strictly depends on different parameters and conditions that can be evaluated immediately (as reproducibility) or that a specific evaluation of solidity (use, dry or wet processes) performed only by means of later tests in laboratory.

ACCESSORIES

Accessories in textile confection are known as materials that complement a cloth and give it greater enhancement during the manufacturing process or in the finished product. These can be closures, buttons, interlinings, tapes, biases, taches, among others are clear examples of this type of inputs.

The accessories of the finished product are part of the presentation and therefore must be chosen according to the qualities desired in the material and of course following the specifications and design features stipulated for a particular fashion production.

The machines used are chosen according to the material to be processed. The fundamental requirements are:

- Substrate protection
- Repeatability of results
- Cost of the process (depending on the time, degree of automation, ratio of bath, cost of products used, etc.)

Types of accesories:

Blonde laces

The lace fabric of bobbins that are made and adorned with women's dresses and other clothes, with which they are made dyed, fists and blankets with drawings appropriate to the shape of the garment.

Buttons

Element used to fasten or adjust clothing, such as shirts, pants, jackets, coats, among others. They are usually of different sizes and shapes. Can be coined in high or low relief. They can be classified in push buttons or simple to rivet.

Zipper

Toothed accessory used in the industry of making various pieces of clothing, luggage, among others. It serves to join or separate two pieces of a fabric or fabric, in addition to being used as part of the decoration. This accessory has a locking mechanism that prevents the handle from slipping.

Label

It is a graphic and descriptive material, which is attached to a garment, in order to make known the information regarding the specific characteristics that have to be seen in the article as the brand, quality assurance, data on materials and treatments.

Lace

It is called randa, from the German rand (border or border), because it usually borders another piece. It can be defined as an ornamental and transparent fabric, traditionally handmade that is decorated with embroidery.

Velcro

Quick and simple opening and closing accessory. It consists of two fabric ribbons, one has small, hook-shaped, flexible prongs and is pressed against another tape covered with tangled fibers that form loops and allow for grip.

Tincture Process

Dyeing method by exhaustion.

It is a method of discontinuous dyeing in which diverse items or lots are treated as threads, fabrics and garments. The tincture is carried out in three different ways: With movement only of the bathroom, with movement of only the merchandise, and with the movement of both. It is based on a traditional method in which the dye is dissolved in a bath to which the garment is then immersed in which it is fixed after a time. Given the different advances, new reagents and needs have diversified the methods of staining by depletion.

The method is based on achieving the necessary conditions for the dissolved dye to attach to the surface of the submerged fiber and to allow a stable dynamic equilibrium between the fiber and the dye to be established.

This method of dyeing is divided into 4 stages:

1. Dye solution or dispersion.

   It is the stage in which the dye passes from its solid to liquid phase. The difficulty of this stage lies in the chemicals or thermal conditions that slow down the ideal behavior. So it is important to know them, to be able to control the solution or dispersion sought. The dyes that can be used are soluble or dispersed. The soluble ones have good affinity with water because they have sulfonic, amino and hydroxyl groups that facilitate the dissolution process. The dispersed ones do not dissolve in the bath, since they have a low solubility in the bath.

2. Absorption.

   At this stage the most significant fact is the adsorption of the dye by part of the fiber surface. In this phase of adsorption is essential to know the interrelationship between affinity, dissolution and depletion as a function of temperature.

3. Diffusion.

   At this stage the dye that has been adsorbed by the fiber is diffused through it, gradually distributed in the form of a circular crown towards the center. The electrostatic bonds formed on the surface also take place within the fiber, the dye attaching to the fiber. These joints are carried out in the amorphous areas of the fiber.

4. Migration.

   It occurs when the dye has reached the surface of the fiber. It consists of the movement of the dye from zones of accumulation (high concentration) to others with less concentration, either on the surface of the fiber, or from the surface to the interior.

Impregnation dyeing method

They are a variety of ennoblement systems whose main characteristic is the continuous and semi continuous treatment of the textile material. The process is complete, ranging from pre-treatment to finishing

Unlike dyeing by exhaustion where the dye weight used is proportional to the amount of cloth (being the weight its constant weight), using this method the material enters continuously, so the parameter to be controlled is the volume of Dye bath, which must always be constant.

Impregnation

The impregnation basically consists of the immersion of the textile material in a dyeing bath, passing through it. As it traverses the bath, it absorbs some of it by dragging the dye. The excess bath is then removed from the material by a pair of fulard cylinders. Achieving a good dyeing will depend on the good work of the fulard, the amount of dye dissolved in the bath, the amount of bath retained in the fabric, etc.

Pick up

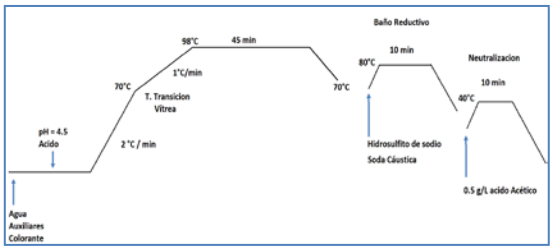
It is defined as pick up is the amount of bath that will be retained in 100g of cloth after passing through the fulard. This will depend on the type of material, some retain better than others to the bathroom. And the pressure exerted by the rollers of the fulard, because at higher pressure, less amount of bath will be retained.

Calculation of the required bath according to the amount of cloth

Once this parameter is known we can determine the volume of bath that we will use to dye an item. To begin with we need the weight per linear meter of the fiber, which is equal to the product of the weight and the width of the fabric. Then proceed with the following expression:

$$\text{Volumen (L)} = \frac{\left(\text{peso } \left(\frac{\text{grs}}{\text{m}}\text{lineal}\right) * \text{ mts de tela} * \text{ pick} - \text{up (\%)}\right)}{100 \text{ x densidad } \left(\frac{\text{grs}}{\text{lt}}\right)}$$

Dyeing Curve:



Rolling up

It is applicable to semi continuous processes pad batch and pad roll. The merchandise is developed and by regulating the temperature and the residence time, the necessary conditions of fixing of the dye are established.

Pre Drying and Drying

Applicable to continuous processes such as pad dry, pad steam and pad thermofix. The pre-drying consists of removing the water from the bath impregnated in the fabric. This stage should be monitored with special care because an error would cause a stoppage of the line in subsequent processes. In the drying, the fabric is supplied with the energy necessary for the dye to be fixed in the fiber.

Thermofixed

Applicable to the continuous process pad thermofix. Some dyes (such as those dispersed with polyester) require a greater amount of energy to fix. Temperatures can be between 190-210 ° C.

Vaporized

It is another method used for fixation in continuous processes. It is carried out in a vaporization chamber, where the merchandise is subjected to the action of the vapor during a time, that depends on the type of merchandise and the colorant used.

Continuous washing

It is a process applied at the end of the continuous processes pad dry, pad steam and pad thermofix. It consists in the removal of unfixed dye. In the continuous processes the washing is made to the width, that is to say maintaining the fabric in the same conditions that it brings of the previous processes.

Colorants

They are colored organic substances, which are able to dye the different natural or synthetic fibers, which selectively absorb part of the total of the luminous radiations of the visible area of the spectrum.

Types of dyes used in the textile industry:

Acids: They are anionic dyes, soluble in water. They are used to dye wool, silk, polyamide.

Basic: They are cationic dyes, soluble in water. They are used to dye acrylic fibers and cationic polyester.

Metallic complex: Used to dye wool, silk and polyamide.

Direct: They are colorants used to dye cotton. They do not use mordant in their process, they are applied in an aqueous bath with electrolyte. They are also known as substantive dyes.

Azoic: They are dyes that develop inside the substrate to be dyed (used for the dyeing of cotton), starting from an azo coupler and a diazonium salt.

Tubes: These are water-insoluble dyes which are converted into soluble salts by reduction and are impregnated in the fiber and which, when exposed to air or an oxidizing agent, is reoxidized (on the fiber) and takes its initial insoluble form. They have different chemical constitution. They have a high fastness to the wash, and especially to the concentrated caustic soda, that allows to realize a posterior mercerized.

Sulfur: These are insoluble dyes in water. They are used to dye cotton fibers.

Reagents: These are colorants for dyeing cotton and regenerated cellulosic fibers. They are called reactants because they react with the cellulose forming a covalent bond and can also react with water (by hydrolysis). They may react with the cellulose by an addition or substitution mechanism.

Dispersed: These dyes are insoluble in water. They are organic nonionic compounds. They are used to dye synthetic fibers (polyester and polyamide). They have a large margin of shades. They have good fastness to light, to washing. They are classified into groups according to the size of the molecule. Most dispersed dyes sublimate which can cause dyeing problems if not properly selected.

Machinery

Dyeing machine by depletion:

AHIBA IR

Equipment Description

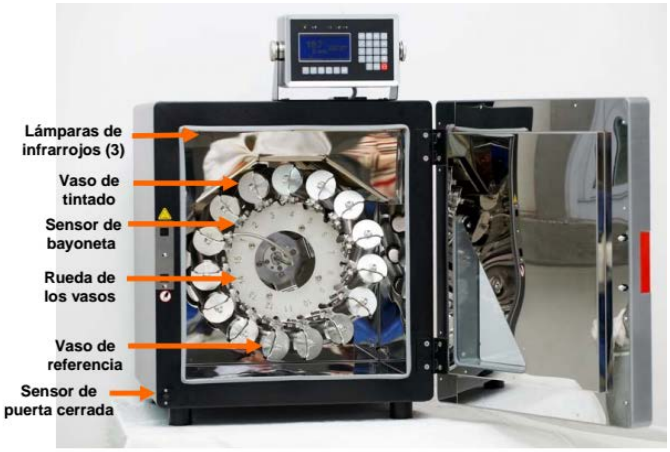
AHIBA IR is a depletion dyeing machine for small samples of substrates whether in piece, skeins, fiber tapes and loose material for all types of fibers, usually used in product development laboratories as it was visualized in Swiss Chemistry. This equipment consists of a heat source (3 infrared quartz 1000 W lamps) and a cooling source (fresh air outlet driven inside the unit by a CMF blower). It can work at different bath ratios: 1: 3 (Synthetic) and 1: 5 (Natural).

It has a digital programming panel with memory on which can store 99 personalized programs, each with a maximum of 15 steps.

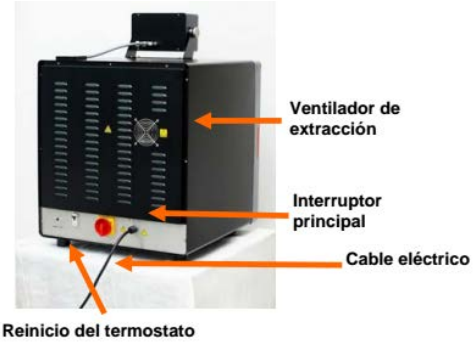
Parts of the equipment

Front of Unit

Inside the unit



Back of the unit



ACCESSORIES

Standard Accessories

The following accessories are included in the system:

- Hexagon screwdriver to tighten and release the lid of the cups.
- Reference glass.
- Complete set of glasses. Note: If optional dosing cups are ordered, all necessary accessories will be included to complete the dosing process.
- Replacement set of O-rings for cup lids.
- Spare bayonet sensor.
- Printed User's Guide.

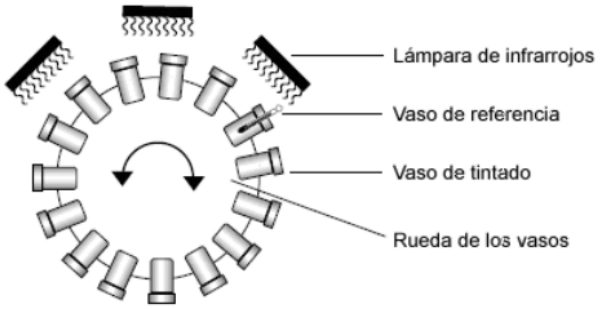
Optional Accessories

Optional accessories for the AHIBA IR include:

- Cup preparation tray
- Auto refillable dosing syringe
- Accessories for membrane dosing
- Accessories for injection dosing

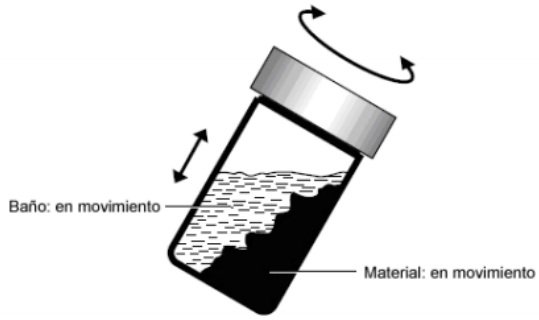
Operating principle

It consists of a rotating wheel in which a maximum of 20 glasses can fit. The unit uses infrared irradiation heating technology to heat the bath inside the vessels and uses a cooling system. This design reduces energy consumption while allowing temperature control and greater accuracy.



- The design of the cups ensures that cup-to-cup temperatures are uniform.
- A reference glass mounted with a temperature sensor is used to measure the temperature of the dye bath. The temperature of the moment is transmitted to the controller via a rotary switch.
- A large CMF fan is used to introduce fresh air into the chamber and cool the vessels. The hot air is expelled through an extraction channel at the rear of the unit. The fan has a cycle on and off, necessary to regulate the temperature.
- A multiple safety system monitors the temperature and protects the equipment and samples from overheating.

Rotation of the vessel



- ✓ Rotation Speed: 5 - 50 rpm (variable)
- ✓ Vessel Movement: The direction of the wheel is automatically reversed every minute.

The vessels have different bathing capacities, these being illustrated in the following tables:

Maximum / Minimum Vessel Load

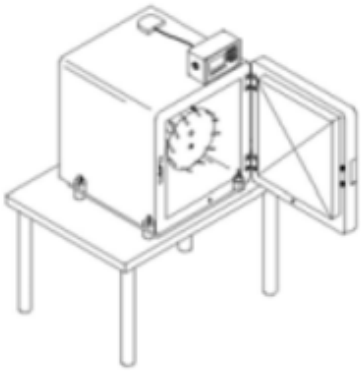
Tamaño del Vaso	Nº Mínimo de Vasos
150cc	3 vasos
300cc	3 vasos
500cc	2 vasos
1000cc	2 vasos

Minimum Vessel Load

Tamaños de los Vasos (máx.)	# Máximo de Vasos	Tamaño Ideal de la Muestra
150 ml	20 vasos	5 gramos
300 ml	15 vasos	10 gramos
500 ml	8 vasos	25 gramos
1.000 ml	8 vasos	50 gramos
5 litros	1 vaso	200 gramos

System Location

The AHIBA IR should be placed on a flat and stable table. The table should have enough height to allow easy opening and closing of the door, and easy to see the controller.



There must be a minimum of 6 inches (152 mm) between the rear of the unit and the wall or other obstructions, for proper air ventilation and exhaust.

Cost: $10,000

Continuous process dyeing machine

MATHIS mtf-mini-plt-B

Description

Compact Pilot Machine for the dyeing and finishing of elastic and rigid belts in continuous process, used to develop colors and products and very small lots. Roll width 200mm for one to six tapes, depending on the width of the tapes. It can produce up to 500 meters of stained and / or finished tapes (polyester or polyamide) per hour, with Thermosol hot air process and steam-pad-steam. It has automatic tension control for the tapes. Transport speed is 2 - 12 m / min. Width of belts: from 8 mm up to 160 mm. Heating of the drying and heat setting chambers is electric. Steam chamber receives direct steam injection. Washer steam heated. Machine composed of various modules of stainless steel with: IHM controller, impregnating pad, vaporizing chamber and / or thermosetting machine, washing machine with several washing boxes, hot air dryer (or drying drums) and foulard for the removal of tapes.

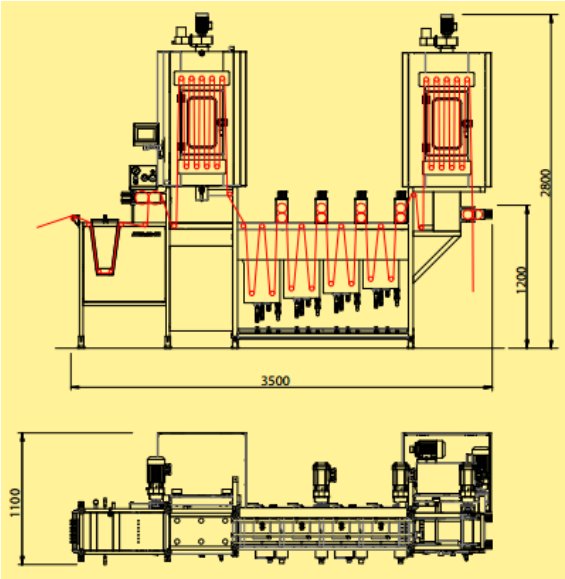
Technical data:

Width of rollers	200 mm
Number of tapes	1 - 6
Width of tapes	8 - 160 mm
Shipping speed	2 - 12 m/min
Thermosol Camera Temperature	hasta 210 ºC
Vapor Chamber Temperature	hasta 110 ºC
Washer temperature (steam)	hasta hervor (100 ºC)
Electrical power supply	3 x 220 V o 3 x 380 V (50 / 60 Hz)

Parts of the machine:

1- Touch screen controller

2- Dyeing Foulard
3- Vaporizer & Heat Sealer
4- Washing machine with 4 boxes
5- Hot air dryer chamber (or drying drums)
6- Foulard for removal of tapes



Cost: $85,000

Distribution plant

An alternative distribution to the current status of Laboratory No. 24 is proposed.

Plan AutoCAD.

Cost Study

Implementation of budget plan:

MACHINERY	OBSERVATION	COST $
DYEING MACHINERY BY DEPLETION	Ahiba IR	10,000
WATER SOFTENER	Salt base	2,000(aprox)
STOVE (FOR VOLUMES OF 1-5KG)		3,000
DYE SUPPLIES	**135°C x 45 ó 60 min**	**Cost $/kg**
ALBATREX AB-45	Buffer	3.50
UNIVADINA TOP	Dispersing / Equal / Migration	9.50
UNIVADINA DFM	Accelerating Diffusion / Migration	9.50
ALBAFLOW CIR	Deaireante	6.50
ALBAFLUID CD	Antiquiebre	1.00
SUPPLIES FOR REDUCING WASHING	**90°C x 20 min**	**Cost $/kg**
SODIUM		

HYDROSULPHITE		
CARBONATE		
SODA CAUSTICA AL 50%		
ERIOPON OS	Backwashing agent	9.50
COLORANTS	**Disperse**	**Cost $/kg**
TERASIL BLACK	25kg	15.00
TERASIL BLUE	25kg	37.00
TERASIL BRILLIANT RED	25kg	59.00
TERASIL DARK BLUE	25kg	22.00
TERASIL NAVY	25kg	19.00
TERASIL ORANGE	25kg	19.00
TERASIL RUBINE	25kg	20.00
TERASIL TURQUOISE	25kg	110.00
TERASIL YELLOW	25kg	19.00
TERASIL GREY	25kg	45.00

* *The costs do not include IGV*

It should be noted that the total cost obtained is for a dye from depletion of 100% polyester supplies considering the acquisition of AHIBA IR Data Color equipment that is less expensive than the equipment for impregnation dyeing that amounts to $ 85,000.

The total cost of the equipment to acquire is approximately $ 15,000, this price includes the acquisition of a depletion machine, a water softener and a stove of characteristics and easy calibration.

Provision of Service

1. - Manufacture of goods by commission

To that service whereby the provider of the service takes care of all or part of the process of production, production, manufacture or transformation of a good. For this purpose, the user of the service will deliver all or part of the raw materials, inputs, intermediate goods or any other good needed to obtain those who would have been responsible for elaborate, produce, manufacture or transform. Included in this definition is the sale of goods, when raw materials, inputs, intermediate goods or any other goods with which the seller has produced, produced, manufactured or transformed the goods sold, have been transferred under any title by the seller. Buyer of the same. It is not included in this definition:

a. The operations by which the user delivers only textile supplies, while the lender takes over the entire manufacturing process of textile garments. For the purpose of this provision, the following goods are labels, hangtags, stickers, interlinings, elastic, applications, buttons, brooches, buckles, buckles, clips, hangers, laces, twill tapes, fasteners, Souls, bags, platforms and packing boxes.

b. The operations by which the user delivers only designs, plans or any intangible good, while the lender takes over the entire process of processing, producing, manufacturing, or transforming a good.

The present project is accompanied by the production of a sample of primary polyester supplies stained with disperse dyes of the Terasil family, obtained from the warehouse of inputs of Laboratory N°. 24.

Conclusions and recommendations

- The provision of dry cleaning service is a feasible alternative to generate own resources for the faculty. This project is justified, because in the long term the investment can be recovered, as orders from small-scale customers are captured.
- It is important to emphasize that the conditions for dyeing are the most adequate to achieve reproducibility of the process.
- Manage the acquisition of a kit for the evaluation of water hardness or through the completion and development of another project to install a water softening system.
- The acquisition of the dyeing machinery by exhaustion is more economical than the acquisition of a continuous dyeing machine. For the project, the AHIBA IR machine is chosen, which meets the required specifications.
- It is advisable to produce samples of polyester stained substrates and other fibers or mixtures thereof to visualize the final dyeing and / or finishing result on these substrates. For the project, it is important to make a sample of the supplies because it serves as a guide and teaches the students to catalog and keep in order the different samples treated.
- It is necessary to carry out this pre - investigation technical visits are made in order to find the necessary information to evaluate the equipment and supplies needed for the project. For this case, a technical visit was made to Química Suiza Corp.
- The acquisition of protective and safety equipment (masks, gloves, aprons, protective glasses, etc.) should be managed for students and teachers. As well as installing a first aid kit inside the laboratory and periodically checking that the fire extinguishers are operational. In addition, it is necessary to mark the spaces of the laboratory and identify the safe areas in the event of an earthquake or earthquake.
- The training of students and teachers must be constant to properly manipulate the equipment acquired because they are property of the faculty and deserve to be cared for by those who use it.
- It must be verified that the electrical installations of the laboratory are in suitable conditions of use. For this project, the laboratory has a well to earth. Each laboratory environment has its box of keys.
- After performing the dyeing process of the enhancements, a softening or impregnating resin process can be performed as a finishing process to improve the feel and gloss properties of the substrates. This gives added value to the product.
- Just as the primary colors are worked in the laboratory, it is important for students to learn how to develop colors by coloring them.

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