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An Overview of Carpets Printing Using Inkjet Technique

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Abstract

Carpet is a textile floor covering usually consisting of the top layer of a pile attached to a support. A pile was traditionally made of wool, but since the 20th century, synthetic fibers such as polypropylene, nylon, or polyester are often used, as these fibers are less expensive than wool. Due to exceptional properties such as flexibility and dimensional stability, carpet tiles and broadloom are the most often used Textile covering floorings. So in the first, we will talk about Carpet fiber structure and characteristics then the yarn of carpet and the printing processes that take place on it and we will specialize in the inkjet printing process. Manufacturers of printing carpets employ three different types of printing carpets: flat screen printing machines, rotary screen printing machines then Using inkjet printing carpets which have several benefits for all types of carpets. For example, Inkjet printing for nylon gives several Features using thickener. Carpet printing using printing ink including a minimal amount of thickener offers an excellent color yield and fastness. When printing ink with a polyacrylate-based thickening is used in practical applications, the concentration of the thickener can be modified to meet the needs of the printing effects and the textile qualities. develop a viable thickener for nylon carpet printing.

Keywords: Carpets, Classification, Inkjet printing

Introduction

Carpets

A heavy often tufted fabric is used as a floor covering. [1] All textile materials that are not specified as rugs and are used as floor coverings. [1, 2]

Carpet fiber structure and characteristics

Fibers from nature

Today, the most common natural animal and plant fibers utilized in carpet manufacture are wool and cotton. Cotton is widely utilized in carpets and bath mats. Even though wool makes up less than 1% of the fiber used to produce carpet today, some people still consider it to be the best. Due to the low output of wool across the world, it is frequently more expensive. The biggest wool-producing countries are New Zealand, Argentina, China, and the United Kingdom. Rugs can also be made using sisal, jute, coir, and hemp fibers. [1, 3]

Wool is a protein fiber made up of polyamide polymer made up of 20 amino acids and keratin organized in a helical form. [4]

Wool is a composite fiber with fibrils and a polypeptide matrix from a macromolecular standpoint. Alpha-keratin (a protein with an alpha helix) is found in wool. The wool fiber's morphological structure is exceedingly complicated.

Wool, more than any other animal fiber, includes a significant quantity of grease that is difficult to remove and has a complicated makeup. it's made up of spindly cortical cells and cuticle cells that overlap like roof tiles. Wool is known for its ratchet-like surface structure, which is also responsible for its felting capabilities. Wool fiber has crimps due to the unequal distribution of orthocortical and paracortical

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cells, which have different structures. Wool is a naturally fire-resistant fiber.

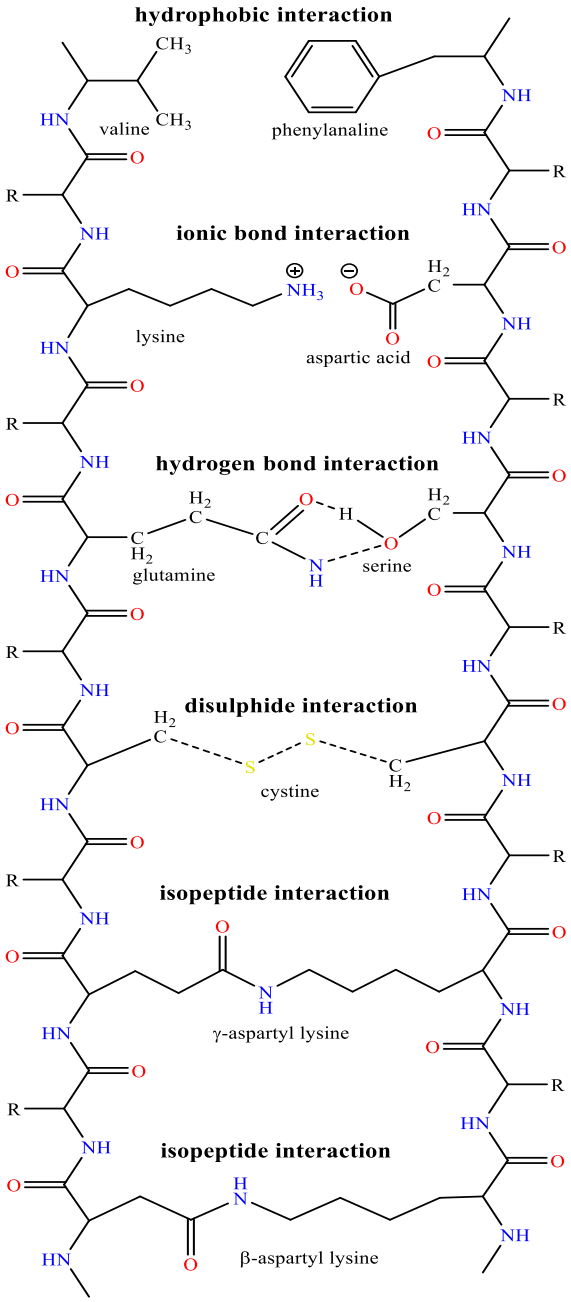

Figure 1: The chemical make-up of wool [1, 5, 6]{Reda, 2022 #7636}3

Wool is largely divided into two types: wool for garments, which is 23 m and lower, and wool for interior textiles, which includes carpets and rugs, which is 24 m and higher. it's utilized in the production of carpets in large quantities across the world.

Much of this wool is utilized in the traditional woven carpet business, which includes loop and cut pile carpets from Axminister, Wilton, and Tufted. Wool is also a possible customer in the hand-knotted rug/carpet sector. So far, the world's tufted carpet industry has been the largest user of carpet-grade wool.

The proper type and grade of wool is an incredibly significant criterion for determining the quality and price of the finished rugs and carpets. Overspecification costs more money, while underspecification degrades the quality of the yarn and, as a result, the quality of rugs and machine-made carpets. The proper sort of raw wool must be chosen with care, and numerous quality features of the fiber must be considered before making a decision. wool's qualities may so be stated as follows :

- It has a built-in resiliency.
- Exquisite "hand"
- Long-lasting.
- The scaly nature of the fiber scatters light and hides filth.
- hen burnt, it will mostly self-extinguish; it will char rather than melt or drip.

Synthetic fibers

Synthetic fibers are created by extruding or forcing molten polymer through microscopic pores in a spinneret, or metal plate. The filaments are chilled, pulled, and texturized when they emerge from the spinneret to add bulk and cover. Depending on the design and form of the spinneret holes, synthetic fibers can be extruded in various shapes or cross-sections, such as round, trilobal, pentagonal, octagonal, or square. The gloss, bulkiness, texture retention, and soil-hiding characteristics of a carpet can all be affected by the cross-sectional forms. To achieve different qualities, fiber makers might combine additives with melted polymer before or during extrusion. Such as Color pigments for solution-dyed color or delustering additives for whiter, less translucent fibers with a more natural appearance are two examples of such additives. Post-treatments like drawing and annealing (heating/cooling) boost tensile strength and improve the fiber's physical qualities after extrusion. The filament bundle is subsequently crimped or textured, which turns straight filaments into ones with a kinked, curled, or saw-tooth pattern. [7]

Nylon

Nylon is a polyamide-based synthetic thermoplastic with recurring amide groups that form fibers as an

inherent feature of the polymer chain. In both BCF and staple yarn forms, this yarn is often used as a carpet face yarn. Two chemical types are employed in carpet: nylon-6,6 and nylon-6 which both are polycaprolactams and polyhexamethylene adipamides.

HOOC(CH2)4COOH + H2N(CH2)4COOH + H3N(CH2)NH

Figure 2: The chemical make-up of Nylon66 [5, 6]

Distinct makers of carpet nylon fibers utilize two different ways. Nylon 66 is manufactured via polycondensing adipic acid and hexamethylenediamine, while nylon 6 is made by self-condensation of caprolactam and was invented in Germany.

Both fibers have a good recovery, making them ideal for manufacturing pile yarn for rugs and carpets since their resilience is ideal for making carpets and rugs. The resilience of carpet fiber is one of its most essential properties because it provides a spring back action that allows the carpet fibers in the pile to stand upright.

Nylon fibers come in a variety of forms, including filaments and staples. Because there is no way to combine the filament yarn with the nylon filament yarn, more caution is required. This line might be modified to make it more orderly. [8]

Different carpet products have different parameters, thus while choosing a fiber, one must be aware of quality criteria as well as other characteristics. The three most significant criteria to consider when choosing the proper fiber staple length, are fiber microns, and luster. Nylon's qualities may so be stated as follows :

- Available in BCF or staple form, for both home and commercial use.
- A solution-dyed fiber or yarn can be used.
- Used extensively in commercial carpet, accounting for about 60% of all carpet face fibers.

Carpet Characteristics

- Sturdy and tough
- Resistant to abrasion
- Coloration options are diverse.
- Wet-cleaning friendly
- Excellent colorfastness
- Color clarity is excellent.

Polyester

is a thermoplastic synthetic polymer that forms fibers. Polyester carpet fiber is almost entirely stapled, and the yarns are spun yarns. Polyester for carpet is chemically known as polyethylene terephthalate and is manufactured from terephthalic acid and ethylene glycol (P.E.T.).

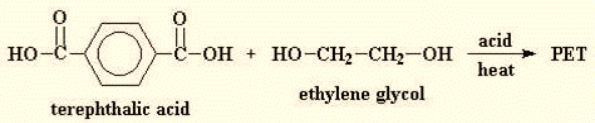

Figure 3: The chemical make-up of polyester [5]

polyester's qualities may so be stated as follows **:**

- Available in BCF, although mostly as a staple.
- Used in low-traffic residential and commercial settings.
- Color clarity is excellent.
- Outstanding colorfastness.
- Water-resistant stains are not a problem.
- Known for its exquisite "hand."

Yarn

A continuous thread is made up of fibers or filaments that are used to make carpets and other materials via tufting, weaving, and knitting. Carpet yarn is frequently plied and is available in both spun and continuous filament forms.

Woolen Yarn

Spun yarn is made by the woolen system spinning technique from any natural or synthetic fiber. Woolen yarns are soft, dense, and hairy as compared to the worsted system or parallel-spun yarns, which are typical in most tufted carpets. Woolen spinning staples are short, ranging from 3.5 to 5.5 inches in length.

Spun Yarn

Spun yarn is made by the worsted or parallel spinning method from any natural or synthetic fiber. The majority of tufted carpet yarns are parallel spun. A staple for worsted spinning is typically 6 to 8 inches long. The fibers of worsted yarns are relatively parallel, and the yarns have a smooth and compact structure.

Synthetic yarn spinning is a phrase used to describe the process of making yarn or fiber. Spinning is defined by the extrusion of the polymer through the tiny pores of the spinneret into synthetic fiber by the

fiber maker. Spinning is the process of converting staple fiber into spun yarn in a traditional textile yarn mill. [9]

Terms used in weaving

- Rows or wires per inch: The number of tufts per inch in a woven carpet's length. Numbers are expressed in whole numbers. The number changes depending on the weave.
- Pitch: Across the breadth of the carpet, the number of warp strands or yarn ends per unit. In tufted carpet, it's similar to gauge.
- Warp: A yarn beam that runs longitudinally through the carpet and alternates between crossing over and under the weft threads.
- WEFT: Yarns flung from selvage to selvage by the shuttle through the warp yarns.
- Shot: Each row of pile tufts in connection to the amount of filling "weft yarns" shuttled over the carpet. Two weft yarns have been passed through the wires or rows in a two-shot structure.
- Frames: Spools of yarn are fed into the Wilton loom through racks at the back of the loom. A three-frame Wilton has three colors in the pattern since each frame carries a different color. [10]

Carpet Specifications

Structure and appearance may be used to categorize rugs.

- Different dyeing techniques, such as fancy, resist, uneven, and space.
- Different washing techniques, such as soft, tea, herbal, semi-antique, and antique. [1]
- Different thickness, fiber, and the mixture of different yarn in one or more cut and/or loop pile or pick, pile height, the mixture of the pile, and plain surface in a rug.
- Different carvings/embossings/sculpturings, such as hairline, deep, beveled, and stenciled. [1]

Fase styles for carpets

- Level Loop Pile: The loops are of the same height, giving the pile an unstructured appearance. In high-traffic areas, this carpet usually lasts a long time. Many of today's popular Berber fashions have level loops with darker color specks on a lighter backdrop.
- Plush: With a smooth, level surface that provides a formal ambiance, this rich-looking cut pile is deep and opulent.
- Saxony: A clean, even finish characterizes this top-selling cut pile carpet. Pile yarns have a higher twist, allowing the yarn ends to show through, giving it a less formal appearance. Footprints are kept to a minimum.
- Friezé: The strands in this cut pile are severely twisted, resulting in a "curly" textured appearance. Footprints and vacuum marks are also reduced with this casual look.
- Sliced and loop pile: A mix of cut and looped yarns create a range of surface textures, including sculptured effects. This carpet is perfect for high-traffic areas because of its clear definition, which hides damage. [7, 11-13]

Construction of carpet fabric

Handmade carpets

Conventional

Hand-knotted, woven, tufted, hooked, or embroidered carpets are the norm. Handmade rugs fall within this category. They are predominantly produced in Asian and European nations and are divided into three types. [13, 14]

Flatweave

It is the most basic rug weaving technique, with only two dimensions: warp and weft. Dhurrie, kilim, sumac, and nomadic rugs, are an example of these types of rugs. These rugs are created using a variety of horizontal and vertical looms, equipment, and weaving techniques. [14]

Hand-knotted

A few thousand years after the flatweave rug originated, the third dimension pile was introduced. Hand-knotted carpets are woven on horizontal and vertical looms, using a variety of knotting techniques. [14]

Handloom

The handloom carpet process is based on a machine-made carpet concept. However, rather than utilizing electricity to insert and beat a row of piles, it is done by hand. [14]

Hand-tufted (hand-hooked)

the pile is formed on cloth using a tufting instrument. This approach has revolutionized the face of carpet

consumption since this is today the most popular handmade carpet. If the carpet contains a loop pile, some people refer to it as hand-hooked. [14]

Figure 4: Hand-tufted carpet. [14]

Table-tufted

With the sewing machine fitted on a table, the pile is formed on a piece of fabric. This technique is especially popular for shags having large pile heights. [14]

Figure 5: Table-tufted carpet. [14]

Machine carpet industry

Tufting

The most common carpet manufacturing method is tufted, which accounts for over 90% of all carpets produced. Tufting machines are comparable to large sewing machines in that they use hundreds of threaded needles in a row across the machine's breadth. Machines are becoming more complicated and sophisticated, with a broad range of forms and structures available. The creel, which is positioned in front of the tufter, may consist of many big spools, referred to as beams, containing many individual strands of yarn, or racks of many yarn cones. The yarns are transferred aloft through guide tubes to puller rollers from the creel. The amount of yarn fed to the tufter is controlled by the speed of the puller rollers, which, together with other parameters, defines the pile height of the carpet. [13]

Knitting

A double needle bar knitter, also known as a carpet knitting machine, features a row arrangement of hundreds of clasp needles that move up and down in tandem with yarn guide bars. The pile face yarns and weft backing yarns are laid down using yarn guide tubes attached to a guide bar that carries the yarns between and around the needles. Knitting, backing, and face yarns are all controlled by separate sets of guide bars. Color and design diversity may be added with additional bars. Knitted carpet, also known as woven interlock, is mostly utilized for commercial loop construction. It's a term that's frequently used in school applications. [7]

Weaving

The warp yarns pass through a heddle, which is a series of holes in the loom. While there are many different weaving procedures and types of looms, the weft threads constitute the foundation of a woven carpet. the warp beams, which gently unravel as the weaving advances The carpet back is made up of two types of warp yarns: chain and stuffer. Stuffer warp yarns add bulk and rigidity to the fabric, while chain yarns offer structure and stability. Pre-dyed warp yarns are generally put onto the loom from a yarn creel, and the face yarns of woven carpets are also pre-dyed warp yarns. The warp yarns are strung through a heddle, which is a set of vertical wires with a hole in the middle through which the yarn is threaded. [1, 7, 15]

Needle punching

Several webs of staple fibers are layered during the needle punching process to generate a thick, loose batting. Before being put into the machine, the batting is tacked or softly needled, to minimize its thickness. Batting travels between two plates as it is fed into the machine. The lower plate, which is immobile, has many holes, but the higher plate, or headboard, has multiple rows of barbed needles. The batting slides up and down between the plates, sending the barbed needles through the fibers as the headboard swings up and down. When the needles travel through the fibers, they carry fiber ends from the top to the bottom of the batting, and vice versa

when they are removed. As the batting travels through the machine to produce the carpet, needles are run through it repeatedly. Needle punch carpet is mostly utilized for outdoor purposes, such as entry mats, maritime applications, wall coverings, and automobiles. Surface patterning gives up a plethora of design options. [15]

Modern

With mechanization, new types of handmade carpet manufacture evolved. We began to use metal in weaving equipment, looms, and other procedures. In comparison to earlier times, modern processes take less time. This allowed for the introduction of new carpet-making techniques. [14]

Carpet Printing

A carpet with colored patterns printed on it using techniques similar to those used to create flat textiles and paper. Flatbed screen printing, which uses woven fabric screens, rotary screen printing, which uses perforated sheet steel screens, Stalwart printing, which uses sponge rubber pattern components on hardwood rollers, and current, computer-programmed jet printing are all examples.

Carpet printing is done with technology that is essentially a repurposed textile printing press. Screen printers, both flatbed, and rotary are widely used. Printed carpet comes in a wide range of designs and textures that may mimic woven patterns for a fraction of the expense. Color jets are positioned in rows across the width of the carpet using jet printing gear. As the carpet moves underneath them, computer-controlled valves may open or close the tightly spaced jets. The jets spew color over the carpet surface but do not break the pile, resulting in controlled patterns without direct machine contact. Rapid pattern changes are possible with computer-controlled jet printing, and practically any patterning effect may be achieved. Area rug designing typically employs jet printing. [1]

Carpet printing machines

Carpet printing machines are bigger and modified textile printing machines. Computerized printing (chromo jet and digital printers) and traditional printing (flatbed and rotary screen printers) are both widespread. Printed carpet comes in a wide range of designs and textures that may mimic woven patterns for a fraction of the expense. [6]

Carpet printing technique

Traditional

Flat silk screen printing

Peter Zimmer invented the first flat screen printer for carpet, the renowned TDA62, which was installed in 1962 in Barwick, Lafayette, Georgia, in the United States. For a long period, this machine was the industry's workhorse. Some of these devices are still in use today. printing on a flat-screen The screen is flat and travels up and down in Flat Screen Printing Technology. The Squeeze technique is employed. Flat Screen Printing is used to print small-width fabrics (45-50). Only 6 to 8 color printing patterns are available. [12]

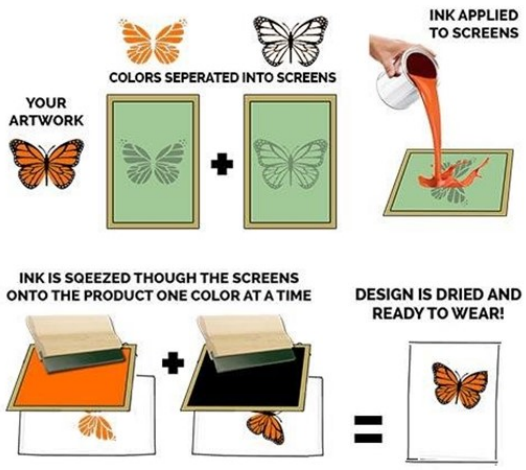

Figure 6: Silk screen printing Process [12]

Rotary screen printing

Long-run manufacturing costs were reduced because of this type of printer. Speeds of up to 30 meters per minute are conceivable, and screen printing machines now generate the majority of printed carpets. In 1969, Zimmer exported the first rotary printer for the carpet business to the United States. [12]

Computers

Chromo jet

In the 1970s, Zimmer introduced the Chromo-Tronic Carpet Printing Machine, which was a significant technological advancement. For the first time, a design was printed using computer-controlled jets rather than conventional screens. This was Zimmer's first digital jet printer. There were three units on the job. The issue at the time was not only the computer control but also the chemistry and other components. The unit was innovative and ahead of its time.

Johannes Zimmer was responsible for the development and success of Chromo-Jet. The main concept was adapted from the Chromo-Tronic, but with a lot of enhancements and new technology. Since its inception in the early 1980s, Chromo-jet has been continuously developed and refined, with over 600 units sold to date. Chromo-Jet is presently the most popular way of producing unique carpets all over the world. In the carpet and textile industry, digital printing has a bright future.

High-speed magnetic valves created by Zimmer are regulated at speeds of up to 1000 cycles per second and inject pressured color deep into the carpet pile. [16] Chromo JET is now the most widely used printing technology for wall-to-wall carpets, custom-sized carpets, matting, and carpet tiles. Printing widths of 2 to 5 meters and production rates of 1 to 10 meters per minute at a resolution of 25 dpi are offered on a variety of machine types.

The company offers full production lines for the carpet industry, including fabric feeding systems, Chromo JET printers, Steamers, washers, dryers, fabric discharge, color kitchens, and in-line mixers SupraMIX and SupraFOAM. Electromagnetic currents open and close jets, and a nozzle creates a dye jet. Various nozzles are available for various uses. The color is pressured (1-3 bar) and delivered directly to the jets through a pump and filter system. Jets are grouped in bunches on a moving printhead that, like a shuttle, traverses the carpet. The manufacturing speed is determined by the number of jets per group. There are up to 16 color groupings to choose from. [12]

Basic Functions of the ChromoJET400

ChromoJET is a printing method that uses computer-controlled high-speed valves. Without any machine components contacting the fabric, the pre-mixed pressure spot colors are injected with great accuracy deep into the face of the pile. As a result, the print has the best color penetration and print definition.

a) Printing Rates

The number of jets employed per color is almost related to production speed. More jets mean faster manufacturing.

b) Single-Speed Mode (SSM)

Operation Modes Each group of jets are utilized for a single color.

c) DSM (Double Speed Mode)

combines two sets of jets and fills them with the same color. When compared to a single-speed model, the linear production speed is nearly doubled. [12]

ChromoJET400's Benefits

- Full penetration.
- Pile weight from 250 to 1,500 g/m2.
- For polyamide, wool, acrylic, and (to a degree) Polyester yarns.
- Complete print line from one source.
- High Resolution. [11]

Digital Printing on a computer

Digital textile floor coverings printing is a method of printing colorants into carpet fabric using inkjet technology. As an alternative to screen-printed cloth, this technology enables single pieces, mid to small-run cycle manufacturing, and even long-runs. Pretreating the cloth with liquid solutions to prepare it to take the dye and absorb the color is the first stage in digital textile printing. [11] The fabric is then put through a printer, which sprays small droplets of color onto the material. The final step is to attach the cloth, which assures that the pattern will last. Fixing might entail steam, dry heat, or pressure, depending on the kind of material and color used. It may be necessary to use a mix of two or more of these. Now Manufacturing printing solutions provide a simple and rapid digital printing procedure that doesn't require any before or post-processing. It makes printing a breeze. The printing quality, speed, and performance of Zimmer's DTG printing solutions are unrivaled. [12]

The digital printing process is divided into:

- Printing directly on fabric
- Paper Heat transfer printing
- Roll to roll printing

From one roll to the next

Printing on individual pieces

Printing directly on the fabric, roll to roll

Zimmer's next carpet collection will be directly printed. [12]

Inkjet Technologies Simplified Chart
Continuous Inkjet (CIJ)

- Raster
- Hertz
- Binary

Drop on Demand

- Piezo
- Valvejet
- Thermal

The most prevalent type is drop-on-demand piezo inkjet.

- Drop-on-Demand – velvet jet
- Drop-on-Demand – Piezo inkjets are employed in carpet printing. [12]

Figure 7: Inkjet printing on carpet [12]

Inkjet printing for nylon carpet

Inkjet printing on nylon carpets is becoming popular. Although carpets do not require the same level of accuracy as fabrics, sufficient ink must be injected into the pile to provide a decent result. As a result, the ink's qualities are crucial. To avoid freezing and dye migration between the piles, it must retain the dye on top of the fiber. Meanwhile, the pile must be sufficiently colored to allow the printing ink to penetrate. The qualities of the thickener are important determinants of the printing result. [16]

As a result, the best thickener for inkjet printing should have a high color yield, cause no frosting due to the printing ink's strong flowing ability, resulting in barely any printing ink remaining on the surface of the carpet and color on the upper surface of the carpet pile that is lighter than the color in the inner parts of the carpet, and have a highly stable viscosity that is not affected by electrolytes and will not change easily with the extension of storage. The majority of thickeners used in carpet inkjet printing are currently pricey. The thickening process of the polyacrylate-based thickener.

The carboxyl groups in the molecule of the polyacrylate-based thickener are many. In the presence of alkali, the carboxyl groups might make the solution viscous. Meanwhile, the solution's viscosity is sensitive to acids, alkalis, and electrolytes because of these carboxyl groups. As a result, the characteristics of polyacrylate-based thickeners must be investigated. [8]

Experimental & Materials

Hangzhou Honghua Digital Technology Stock Co., Ltd provided the thickening mechanism for the polyacrylate-based thickener Cut-pile carpet (pile length of 8 mm) composed of 100 percent nylon, which was utilized for printing (China). [16] Shanghai Textile Science Research Institute supplied polyacrylate (average molecular weight 15000; molecular weight distribution 8000–18000, including a copolymer of methyl methacrylate, acrylic acid, butyl acrylate, ethyl acrylate, and acrylonitrile) (China). Sinopharm Chemical Reagent Co., Ltd provided the triethanolamine and magnesium chloride ($MgCl_2$) (China). Shanghai Textile Science Research Institute provided sodium alginate, while Sigma (China) provided Synthetic Thickener 201, a commercially available thickener for inkjet printing. Hangzhou Arondyes Chemicals Co., Ltd provided CI Acid Blue 113. (China). [17]

Printing ink formulation with various thickener concentrations

Inkjet printing ink was made using various quantities of polyacrylate-based thickener (the polyacrylate-based thickener was prepared by mixing polyacrylate, triethanolamine, and surfactant in proportions of 8:0.8:0.2). A polyacrylate-based thickener liquid was mixed with deionized (DI) water in an 800 ml beaker and stirred with an SDF400 dispersion machine (Shanghai Firefly Energy Technology Co., Ltd, China) to ensure that no thickener stuck to the container wall and that the thickener dispersed evenly in the water. The stirring speed was gradually raised from 100 to 500 rpm until all of the thickeners had been poured into the beaker. [17]

After 40 minutes of stirring at 500 rpm, the printing ink was created. Printing inks with thickener concentrations of 0.15, 0.30, 0.40, 0.45, 0.60, 0.66, 0.75, 0.80, 1.00, 1.20, 1.60, 1.80, 2.00, 2.50, 2.80, 3.00, and 3.20 percent (w/w) were prepared (500 g,

without dye). (25 2 °C) and relative humidity (RH) (65 2 percent). This test employed printing inks (without colour) with thickener concentrations of 0.15, 0.30, 0.45, 0.60, and 0.75 percent (w/w). [18-20]

The electrolyte's effect

The difference in printing ink was noticed when different volumes (2, 6, 10, and 20 ml) of 2.50 percent (w/w) magnesium chloride solution were added per 100 g of printing ink (without color) [made with 1.0 percent (w/w) polyacrylate-based thickener) with stirring. [17] The effects of electrolytes in water on the characteristics of printing ink were investigated using a VT-04F portable viscometer (Rion Co., Ltd, Japan) at a shear rate of 62.5 rpm and three rotors (rotor 1: 0.3–15 Pa s; rotor 2: 10–400 Pa s; rotor 3: 0.03–1.3 Pa s). [19]

Tension at the surface

At constant temperature, the surface tension of printing ink was evaluated with a 322W surface tension contact angle instrument using the slide insertion method. In a beaker containing 400 g of printing ink [made with 1.0 percent (w/w) polyacrylate-based thickener], 0.6, 0.8, 1.0, 1.2, and 1.4 g of acid dye (CI Acid Blue 113) were added. The viscosity of each beaker of printing ink was evaluated after swirling for 4 minutes at 200 rpm with an SDF400 dispersion machine. [17]

Colorfastness of printed carpet

The K/S number may be used to assess the coloring efficiency of a printed carpet. A higher K/S number indicates a greater color yield and darker color. [17] The color yield on nylon carpet after printing was measured using an UltraScan PRO spectrophotometer fitted with a D65 light source. The diffuse/8° geometry system was employed, along with automatic specular component inclusion. The instrument's resolution was 5 nm, allowing it to be carefully measured. [18]

Discussion and Findings

Tension at the surface

The next figure depicts the connection between printing ink surface tension and polyacrylate-based thickening concentration. The surface tension of the printing ink reduces as the thickening concentration increases, as seen in Figure 2. When the thickening concentration in the printing ink is less than 0.60 percent (w/w), the surface tension drops quickly. When the printing ink has a thickening concentration of more than 0.60 percent (w/w), the surface becomes rough. [17]

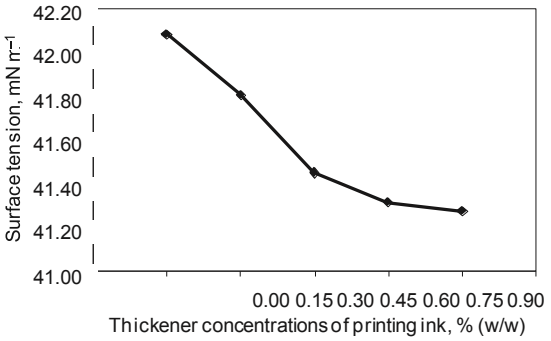

Figure 8: The printing ink's surface tension [17]

The tension gradually reduces until it is virtually constant. The presence of surfactant in the printing ink causes this. The surfactant achieves its critical micellar concentration when the thickener concentration in the printing ink reaches 0.60 percent (w/w), and the surface tension does not vary appreciably when the thickening concentration increases. Figure 2 shows that all of the printing inks had a surface tension of less than 43 mN m1. As a result, this thickening is suitable for printing polyester and nylon carpets. The reason for this is that to wet the surface enough, the surface tension of the printing ink must be lower than the surface energy of the fiber, which is 43 mN m1 for polyester and 46 mN m1 for nylon. Inkjet printing, on the other hand, should not have a low surface tension since this causes the ink to saturate the faceplate surrounding the nozzles and precludes the development of a steady droplet stream. As a result, the polyacrylate-based thickener may be utilized to print hydrophobic fabrics like polyester and nylon inkjet. [17]

The electrolyte's impact

The carboxyl groups in the polyacrylate thickener utilized in this study make the thickening electrolyte sensitive. Dyes and electrolytes in water are two major electrolytes in printing ink that alter the qualities of the ink. [8] In water-based ink, water quality is critical because mineral elements in the water can form complexes with the thickener, affecting the viscosity and rheological qualities of the ink. [19]

Stability of storage

Over 10 days, the viscosity of printing inks was prepared using polyacrylate-based thickening, sodium alginate, and Synthetic Thickener 201. The viscosity of polyacrylate-based printing ink increases on the second day due to thickening swelling. The viscosity remains steady from the second to the sixth day. [17]

The viscosity starts to rise again after the seventh day, which is due to the evaporation of water in the printing ink, which raises the thickening concentration (some small water droplets were observed on the plastic wrap). The viscosities of sodium alginate and Synthetic Thickener 201, on the other hand, decline noticeably with time. Additionally, during storage, sodium alginate printing ink and synthetic Thickener201 had deteriorated, and on the seventh day, some black patches formed on its surface, possibly due to mildew, but printing ink containing polyacrylate-based thickener remained stable. [19]

The predicted viscosity dispersion for printing inks includes sodium alginate, Synthetic Thickener 201, and a polyacrylate-based thickener. The viscosity dispersion of polyacrylate-based thickeners is substantially smaller than the sodium alginate and Synthetic Thickener 201. As a result, printing ink with a polyacrylate-based thickener is the most stable. This is because printing ink with a higher viscosity dispersion has lower stability. [20]

Colorfastness of printed carpet

When the dye concentration remains constant, printing ink with a greater viscosity yields a higher K/S value (i.e. a higher color yield). [17] When the viscosity is the same, comparing experiments 3 and 4 reveals that printing ink with a greater thickening concentration produces a better color yield. This is because a greater thickening concentration causes net structures to develop, and a higher viscosity decreases ink mobility. As a result, the printing ink's permeability into the carpet is limited, allowing the dye to mix with the surface fibers and improving color yield. [18, 21]

The fastness of printed carpet

For carpets, color fastness is critical. the influence of thickening concentration on printed carpets' dry and wet rubbing fastness It can be observed that when the thickening concentration is reduced, both dry and wet rubbing fastness improves. This is because nylon fibers have a limited number of acid dye absorption sites, and the connections produced between acid colors and nylon fibers are salt linkages.

Because of the presence of triethanolamine in the printing ink, the carboxylic ions in the polyacrylate molecules compete with the acid dyes in the ink for the opportunity to interact with the nylon fiber. This decreases the interaction of acid dyes with nylon fibers through salt linkages and causes hydrogen bonding to absorb some other acid dyes onto the fibers. [17]

More acid dyes interact with nylon fibers through salt linkages in printing inks with a lower thickening concentration than inks with a greater thickener concentration. In addition, hydrogen bonds are weaker than ionic ones. As a result, acid colors absorbed by hydrogen bonding on nylon carpets are not as quick as dyes mixed through salt connections. That is, carpets printed with low-thickener printing ink have superior rubbing fastness. [21]

Advantages / Disadvantages in carpet Inkjet printing

- Only 4 colors
- Highest flexibility
- Kitchen with no colors
- Penetration is limited
- Only a few inks are available.
- Repairing a printhead is a last resort.
- The printer must be used in a controlled and clean environment. [11]

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نظرة عامة على طباعة السجاد باستخدام تقنية الطباعة النافثة للحبر

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السجاد عبارة عن غطاء أرضي من القماش يتكون عادة من الطبقة العليا من الوبر المتصل بدعامة. كان الوبر يصنع تقليديًا من الصوف ، ولكن منذ القرن العشرين ، غالبًا ما تستخدم الألياف الاصطناعية مثل البولي بروبلين أو النايلون أو البوليستر ، لأن هذه الألياف أقل تكلفة من الصوف. نظرًا للخصائص الاستثنائية مثل المرونة وثبات الأبعاد ، فإن بلاط السجاد والنول العريض هما أكثر أرضيات تغطية النسيج استخدامًا. لذا في البداية سنتحدث عن هيكل وخصائص ألياف السجاد ثم خيوط السجاد وعمليات الطباعة التي تتم عليها وسوف نتخصص في عملية الطباعة النافثة للحبر. يستخدم مصنعو طباعة السجاد ثلاثة أنواع مختلفة من سجاد الطباعة: آلات طباعة الشاشة المسطحة ، وآلات طباعة الشاشة الدوارة ، ثم استخدام سجاد الطباعة النافثة للحبر الذي له فوائد عديدة لجميع أنواع السجاد. على سبيل المثال ، توفر الطباعة النافثة للحبر للنايلون العديد من الميزات باستخدام مثخن. توفر طباعة السجاد باستخدام حبر الطباعة بما في ذلك الحد الأدنى من مادة التكثيف إنتاجية ألوان وثبات ممتازين. عند استخدام حبر الطباعة بسماكة تعتمد على البولي أكريليت في التطبيقات العملية ، يمكن تعديل تركيز المثخن لتلبية احتياجات تأثيرات الطباعة وخصائص النسيج. تطوير مثخن قابل للتطبيق لطباعة سجاد النايلون.

الكلمات الدالة: السجاد ، التصنيف ، الطباعة النافثة للحبر