

## The Dyeing of Acetate Silk

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On account of its characteristic dyeing and physical properties acetate silk is an interesting and valuable addition to the number of available textile fibres. Like all kinds of artificial silk it is of vegetable origin, but is distinguished from other representatives of this class of fibres—cotton, ramie or the older varieties of artificial silk—by being an acetylated cellulose and not, like these, a regenerated cellulose. This difference in chemical composition is responsible for its entirely different dyeing properties and made it necessary to work out for acetate silk new dyeing and finishing processes.

Acetate silk, being an acetic acid compound of cellulose (acetyl cellulose), is very susceptible to all chemical processes involving saponification, i. e. splitting off of acetyl groups. Alkalis, specially at high temperatures, affect acetate silk to such an extent, owing to the saponification of the surface of the fibre, that the typical dyeing and other properties—lustre, tensile strength, solubility in acetone etc.—are completely lost. Acetate silk is sensitive to boiling water and steam, which is also due to its chemical character. It becomes dull and opaque and loses much of its tensile strength. The dyeing is therefore carried out

in baths which, as far as possible, are not alkaline and not too hot, the temperature being preferably not above 175° F.

Acetate silk is dyed in the form of yarn, pure acetate silk fabrics and mixed fabrics together with cotton, wool, silk or the other kinds of artificial silk. Hanks are dyed in the bark or on hank dyeing machines, piece-goods on the winch, the star-frame and on the jigger.

*Cleansing.* Goods which come direct from the manufacturer as a rule require only a preliminary wash as a preparation for dyeing. The case is different with worn goods which sometimes require to be cleaned only and frequently must also be re-dyed. A large number of stainremoving agents are available for the purpose of dry cleaning: pure organic solvents and preparations consisting of fat solvents with a base of soap or soap-like products. Great care must be exercised when these agents are applied to the cleaning of acetate silk, as many of them contain organic components which may dissolve acetate silk. No injurious effect is exercised on acetate silk, e. g. by ether, carbon tetrachloride, trichlorethylene, benzol, benzin, petrol ether and turpentine. On the other hand, methyl alcohol (Methanol), acetone, ethyl acetate and chloroform are very harmful, as they dissolve acetate silk even in the cold. Alcohol, acetic acid, amyl ester or chlorbenzol have some solvent action in the cold, but more at a higher temperature. On this account it is recommended to carry out preliminary trials with all detergents before they are applied to cleansing the whole piece and also because some acetate silk dyestuffs are soluble in these detergents, which only might make the trouble worse.

*Preliminary washing.* Before dyeing, the material is suitably washed. For this purpose a bath is prepared containing 3—5 lbs. Marseille soap and ½—1 pint concentrated ammonia per 100 gallons, the goods treated in it for about ½ hour at 100—110° F and rinsed thoroughly.

*Bleaching.* Acetate silk, as a rule, is a good white, and so bleaching before dyeing is not often required, but with mixed fabrics of cotton or wool it may be necessary. Two processes are employed for bleaching acetate silk: the permanganate and the hypochlorite of soda process.

The bath is prepared with 1—2 lbs. potassium permanganate and 1—2 pints concentrated sulphuric acid per 100 gallons. In this liquor the goods are treated for 1 hour at ordinary

temperature, rinsed and bleached in a fresh bath to which 2½—5 pints sodium bisulphite 72° Tw. and 1¼—2½ pints concentrated sulphuric acid have been added. The bleaching is finished in ½ hour. Subsequently the goods are rinsed thoroughly and, if desired, blued with a little Alizarine Irisol R, Alizarine Sky Blue B or Alizarine Supra Blue A. The hypochlorite of soda process is specially used for bleaching vegetable fibres in mixture with acetate silk. As acetate silk cannot be boiled off like cotton, being sensitive to boiling water, it is washed for 1 hour, at about 110° F, in a bath to which 3—5 lbs. soap, 1—2 lbs. Nokal BX dry and ½—1 pint concentrated ammonia per 100 gallons have been added. It is then rinsed and bleached for 1—1½ hours in a hypochlorite of soda solution containing 1—3 lbs. available chlorine per 100 gallons, rinsed again thoroughly, soured cold with 1—1½ pints hydrochloric acid per 100 gallons and rinsed once more.

*Dyeing.* After this preliminary treatment the goods are dyed.

The usual dyeing processes and — with a few exceptions — the ordinary dyestuffs cannot be employed for dyeing acetate silk. New dyestuffs and new dyeing processes had therefore to be invented. The following will be considered within the scope of this article:

1. Celloxane and Mordant for Acetate Silk for basic dyestuffs.
2. Cellit Fast dyestuffs.
3. Celliton and Celliton Fast dyestuffs.
4. Cellitazols.

*Celloxane and Mordant for Acetate Silk.* The basic dyestuffs have a certain affinity for acetate silk, but even from concentrated dyebaths only comparatively light shades can be obtained. With the aid of Celloxane and Mordant for Acetate Silk, however, it is easy to produce full dyeings with basic colours.

Celloxane is added to the hot (160° F) dye bath containing the necessary dyestuff, best in several portions, according to the depth of shade desired. Dyeing is carried out in ¼—1 hour, the goods rinsed and finished as usual. The quantities of Celloxane required vary between 3—16 pints per 100 gallons.

The use of Mordant for Acetate Silk is similar to mordanting with Katanol O as practised in dyeing cotton with basic dyestuffs. The goods are treated for 15 minutes at 120—160° F in a volume of liquor of 1 : 20, the bath containing 40—80 lbs. Mordant for Acetate Silk per 100 gallons. Subsequently the material is hydroextracted and dyed with

out rinsing. In addition to the dyestuff, 1—2% acetic acid is added to the cold dyebath, the temperature of which is gradually raised to 160° F. After dyeing the silk is thoroughly rinsed and, if desired, scooped.

Nevertheless, the use of basic dyestuffs is practically limited to pure acetate silk for the production of very bright shades. Both these processes are unsuitable for dyeing mixed fabrics.

*Cellit Fast dyestuffs.* The Cellit Fast dyestuffs dissolve readily in hot water to a clear solution without any addition. They are dyed similar to direct cotton dyestuffs without soda, for  $\frac{3}{4}$ —1 hour at 160—170° F. According to the depth of shade 20—50% calcined Glauber's salt or chloride of ammonia are added, the proportion of goods to liquor being 1 : 30. Acetic acid may also be added to the bath. When dyeing Cellit Fast Yellow GGN it is absolutely necessary (in order to utilise the dyestuff completely) to add 3—5% acetic acid 30%, in addition to 20—30% Glauber's salt. After dyeing the goods are well rinsed and scooped as usual. Apart from this very simple method of working, the Cellit Fast dyestuffs are remarkable for good fastness to washing, very good levelling and from good to very good fastness to light. The Cellit Fast dyestuffs as a rule are employed for dyeing pure acetate silk fabrics and hanks. Cotton and kindred fibres generally are not very strongly tinted and it is possible to produce on mixed fabrics of these fibres and acetate silk solid or two-colour effects in one bath on stockings, knitted goods or linings. Wool and silk are strongly dyed by Cellit Fast dyestuffs which, therefore, cannot be used for mixed goods containing these fibres.

*The Celliton and Celliton Fast dyestuffs,* on the other hand, are insoluble in water and are supplied to the trade in the form of fine pastes. Dyeing is best carried out for  $\frac{3}{4}$ —1 hour at 160—170° F in soft water containing 2—3 lbs. Marseilles soap per 100 gallons, the dyestuff paste, which previously has been well stirred and mixed with soft water, being added through a fine sieve. After dyeing the goods are rinsed and, if necessary, scooped. The feature of these dyestuffs is: good levelling, good fastness to washing and water, from good to very good (and in the case of the Celliton Fast colours excellent) fastness to light. As they are also highly suitable for dyeing mixed fabrics of *animal* fibres and acetate silk (in addition to their use for pure acetate silk fabrics or hanks) these dyestuffs

deserve special attention, the more so as they may also be employed, like the Cellit Fast dyestuffs, for dyeing mixed fabrics of acetate silk and cotton or the older qualities of artificial silk.

If the goods are required to satisfy the highest demands in fastness to washing and water, or if effects are to be produced which, in addition to being fast to cross-dyeing, must to some extent withstand acid boiling, the *Cellitazols* must be used. These dyestuffs, to give fast shades, are diazotised and developed on the fibre.

The *Cellitazols* are dissolved and dyed according to the method mentioned in the respective I. G. patterncards.

The dyestuffs discussed in the foregoing are typical acetate silk colours. Their affinity for animal and vegetable fibres, on the other hand, is small. Only the Cellit Fast dyestuffs possess a great affinity for wool and silk. With the above acetate silk dyestuffs and suitable cotton, wool or silk colours it is therefore possible to produce, on mixed fabrics of every description, multicoloured effects or solid shades in one or several baths, according to the kind of material in question.

*Acetate Silk mixed with cotton or artificial silk.* Such mixtures are used for stockings (e. g. acetate silk stockings with cotton heels, toes and tops) knitted goods of every description, linings and hangings. If the acetate silk is required to remain white, dyestuffs are used which do not stain acetate silk. A large number of them is available.

When using *direct cotton dyestuffs* the dyebath is prepared with the necessary dyestuffs and dyeing carried out, according to the depth of shade, for  $\frac{1}{2}$ —1 hour at 120—170° F. with addition of 5—20% Glauber's salt. Additions of alkalis, such as soda, must be avoided.

*Diazotising dyestuffs* are dyed as mentioned above. After dyeing the goods are rinsed, diazotised cold as usual and treated with a suitable developer. Beta naphthol developed dyeings, to obtain a clear white on acetate silk, after developing must be soaped warm. If the dyeings must be very fast, *Indanthren dyestuffs* may be used. For this purpose the required quantity of such Indanthren dyestuffs (which may also be dissolved according to the IW or IK process) are reduced in the usual way with caustic soda and Hydrosulphite. 5—20 lbs. Glauber's salt fused and 5—10 lbs. Resist for Acetate Silk (to prevent the staining of the acetate silk) are then add-

cd per 100 gallons dyeliquor according to the depth of shade required and dyeing carried out *cold* for about  $\frac{1}{2}$ —1 hour. The material is then rinsed, aired, rinsed again and soaped at about 160° F with 2—3 lbs. Marseilles soap per 100 gallons. Care must be taken that not more than  $\frac{2}{5}$  pint caustic soda 72—76° Tw. are contained in 100 gallons dyeliquor.

If, on the other hand, the cotton or artificial silk is to be left white, the acetate silk is dyed with suitable Celliton or Celliton Fast dyestuffs or Cellitazols, best in a light soap lather at about 160° F. The cotton or artificial silk, according to this method, will be slightly tinted after dyeing. If desired, it may be cleared by the following method: The goods are either treated for a short time at about 120° F with  $1\frac{1}{2}$  pints sulphuric acid 168° F per 100 gallons and rinsed well, or for  $\frac{1}{4}$  hour at 100° F in a bath containing about 3 lbs. Blankit I per 100 gallons, keeping them in motion, and finally rinsed.

For the production of solid shades and two-colour effects the acetate silk dyestuffs referred to and also direct, diazotising and Indanthren dyestuffs which do not, or only slightly, stain the acetate silk may be used.

Direct dyestuffs are preferably dyed in one operation, either in the soap-Glauber's salt bath along with Celliton and Celliton Fast dyestuffs (dyeing temperature 140—160° F) or in a Glauber's salt bath with Cellit Fast dyestuffs at the same temperature. After dyeing the material is rinsed and finished. The Cellitazols are used less frequently, as the process requires the use of two baths. They are, as a rule, employed only for the production of solid blacks.

If diazotising dyestuffs have been used for the cotton, the acetate silk is dyed in a fresh bath, at 120—170° F, with Celliton or Celliton Fast dyestuffs with addition of 2—3 lbs. soap per 100 gallons, or with Cellit Fast dyestuffs in the Glauber's salt bath at 120—170° F. The clearness of the effects is increased by a thorough rinsing.

The cotton being dyed with Indanthren dyestuffs, the acetate silk is advantageously dyed in the soap bath with Celliton or Celliton Fast dyestuffs, or with Cellit Fast dyestuffs in a fresh bath with the addition of Glauber's salt.

*Mixed fabrics of wool and acetate silk.* If the wool only is to be dyed, neutral dyeing wool colours which exhaust from a Glauber's salt bath at 160—175° F and dye the wool

only, may be used. Acid colours may also be employed which, when dyed with 3—5% formic acid and 10—20% Glauber's salt, give sufficiently dark shades at a dyeing temperature of not more than 175° F. This dyeing temperature must not be exceeded, particularly if clear effects are desired. Boiling must be avoided under all circumstances. Two-colour effects or solid shades are dyed either by using the Celliton and Celliton Fast dyestuffs in conjunction with suitable neutral dyeing wool colours, at about 160—175° F, or by first dyeing the acetate silk in the soap bath, rinsing and then covering the wool with weakly acid dyeing brands which affect acetate silk only slightly or not at all.

*Fabrics of silk and acetate silk* which are already being produced to a large extent, may be dyed both in one and in two baths. The one-bath method is preferably used for solid shades, suitable direct or acid dyestuffs being combined with Celliton and Celliton Fast dyestuffs. When acid dyestuffs are used, the dyebath is prepared with 10—15% Glauber's salt cryst. and 4—8% acetic acid 30% or 1—2% formic acid 85% and the necessary quantities of dyestuff. If the dyeing is to be done with direct dyestuffs they are applied either in a neutral bath or in one acidulated with about 1—2% acetic acid 30%.

If very clear effects are required the two-bath process is preferable to the one-bath process. The real silk in this case is filled up in a fresh bath, using dyestuffs which leave the acetate silk unstained.

*Unions and half-silk fabrics*, i. e. materials consisting of wool or silk with artificial silk and acetate silk, are dyed as described above. Very striking three-colour effects can be produced on mixed fabrics composed of *real silk*, *acetate silk* and *viscose*. In the case of such goods the viscose and acetate silk is at first dyed at about 85° F. Subsequently the silk is filled up with suitable dyestuffs in a fresh, slightly acid bath at about 140° F.

Particularly clear three-colour effects are best produced in three baths, acetate silk, viscose silk and silk being covered consecutively. If it is desired to have the real silk effects very clear, the use of Katanol W is recommended; this product prevents the direct dyestuffs being taken up by the silk.

Mixed fabrics which, in addition to acetate silk, contain wool and artificial silk or cotton are dyed similarly.

As regards the dyeing of fancy tissues consisting of *wool*, *real silk*, *acetate silk* and *vis-*

cose, the wool and silk are dyed first, the viscose and the acetate silk are then covered in a fresh bath with direct and Celliton or Celliton Fast dyestuffs. If it is desired to obtain particularly clear effects, the acetate silk is covered first and then the viscose with addition of Katanol W.

The processes discussed show the many possibilities open to acetate silk in the textile industry.

When dealing with this kind of artificial silk a certain amount of care must always be exercised. It is greatly affected by heat and also too hot water and steam, so that it is necessary to use great care when ironing or pleating acetate silk as otherwise its feel and lustre is impaired. Too hot drying on the

drying cylinder, hot calendering or strong decatizing should as far as possible be avoided. Acetate silk has only poor absorbent properties and aqueous solutions, consequently, penetrate into it only with difficulty. The usual sizing and finishing agents therefore cannot be used in connection with it. Sizes and finishes made up with glue or tragacanth as a base have proved to be most suitable in this respect.

The silk-like appearance, the agreeable feel and a very great fineness of thread are properties of acetate silk which, in addition to its peculiar behaviour in mixed fabrics, have given to this latest kind of artificial silk an importance in the textile industry which bids fair to be permanent.