Dyeing machinery

Contemporary wool dyeing and finishing

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Summary

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1. Introduction

Principles of different dyeing machines

- Wool may be dyed using a number of different types of dyeing machines and in numerous forms from loose fibre to woven and knitted fabric or even garments.
- As a rule it is preferable to carry out dyeing as late in the manufacturing chain as possible as this leads to just-in-time deliveries and reduced inventories. However, there are a number of reasons why this is not always desirable or possible.

2. Loose stock dyeing

Loose stock dyeing

- Wool is often dyed in fibre form. This of course means that the dyeing is done at the earliest stage of processing and colouration commitments must be made well in advance of the finished product.
- Loose stock dyeing is most often used these days as a pre-colouration method in the production of woollen spun yarns in the carpet manufacturing industry where large lots of up to 12 tonnes per colour are produced.

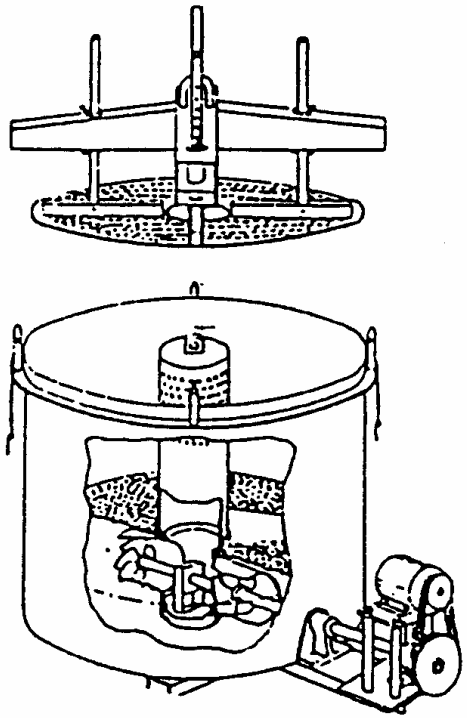
Advantages of loose stock dyeing

a) It is possible to dye very large lots of up to 12–14 tonnes per colour. This is done by dyeing numerous batches of perhaps 500 kg each and then blending all of these batches together.
b) This method is ideal, for instance when supplying carpet to large commercial installations such as hotels, where many thousands of metres of the same colour may be required.
c) This dyeing method provides the ability to even out any colour irregularities within the individual dyebatches during subsequent blending
d) It provides a simple way of dyeing blends of different fibres as the optimum dyeing procedure may be employed for each of the individual fibres.
e) By this method it is possible to mix different colours together to produce heather mixtures.

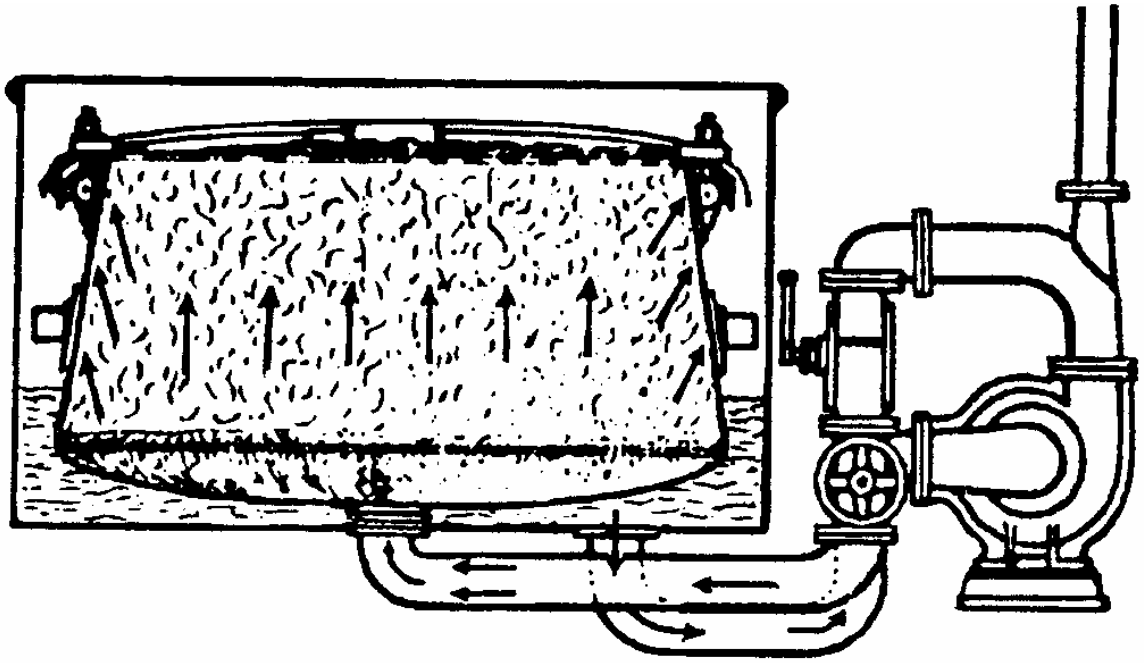
Disadvantages of loose stock dyeing

- Economy of scale is lost if small lots are dyed.
- Very long lead times are required between time of dyeing and production of finished product.

Radial flow loose stock dyeing machine



Conical pan loose stock dyeing machine



3. Top dyeing

Top dyeing

- Wool is often dyed in top form. Wool tops are produced after combing which is a preparatory stage before worsted spinning. The tops are actually balls of sliver which weigh anywhere between 3 and 10 kg or are more commonly made into bump tops of up to 20 kg.
- Modern top dyeing machines are multipurpose machines, which may be used for dyeing yarn on packages and also loose fibre. They are able to dye at high temperatures under pressure so may be used for dyeing fibres other than wool.

Advantages of top dyeing

- Top dyeing shares similar advantages to loose stock dyeing and is the first opportunity to dye the fibre in the worsted spinning production chain.

Disadvantages of top dyeing

- As with loose stock dyeing, the economies of scale are lost if small lots are required.
- Once wool tops have been dyed they then need to be re-combed prior to spinning which adds an additional cost.

4. Yarn dyeing

Yarn dyeing

- Dyeing is often carried out in yarn form for a number of reasons. For colour woven fabrics such as checks and fancy designs and also for multicoloured knitted garments, the requirements for some individual colours may be very small and there may be a large number of colours in the design. In this situation it is not practical or cost effective to dye large lots of tops for each colour.
- Yarn can be dyed in lots of from 1 kg to 500 kg or 1000 kg, depending on the size of the machines available.

Package dyeing

- Package dyeing is now a very widely used technique for producing coloured yarn for colour woven fabrics and knitgoods.
- Modern package dyeing machines have a high degree of versatility with regards to batch sizes and the fibres which may be dyed.
- The machines may be operated under pressurised conditions at temperatures up to 140^{o}C making it possible to dye fibres such as polyester.
- The yarn to be dyed is wound onto perforated dye centres which may be disposable plastic or stainless steel springs which are reused.

Package dyeing (cont.)

- The packages may be in the form of cones, cheeses, muffs or bobbins. The packages are loaded onto a carrier with with perforated spindles and are normally compressed by about 30% to reduce the possibility of channelling and leakage between packages.
- These machines have very efficient pumping systems with the facility to reverse the flow direction and can dye at liquor ratios down to 1:6.
- A general rule of thumb for flow rates is that 30 litres per kilogram of yarn per minute is about optimum.

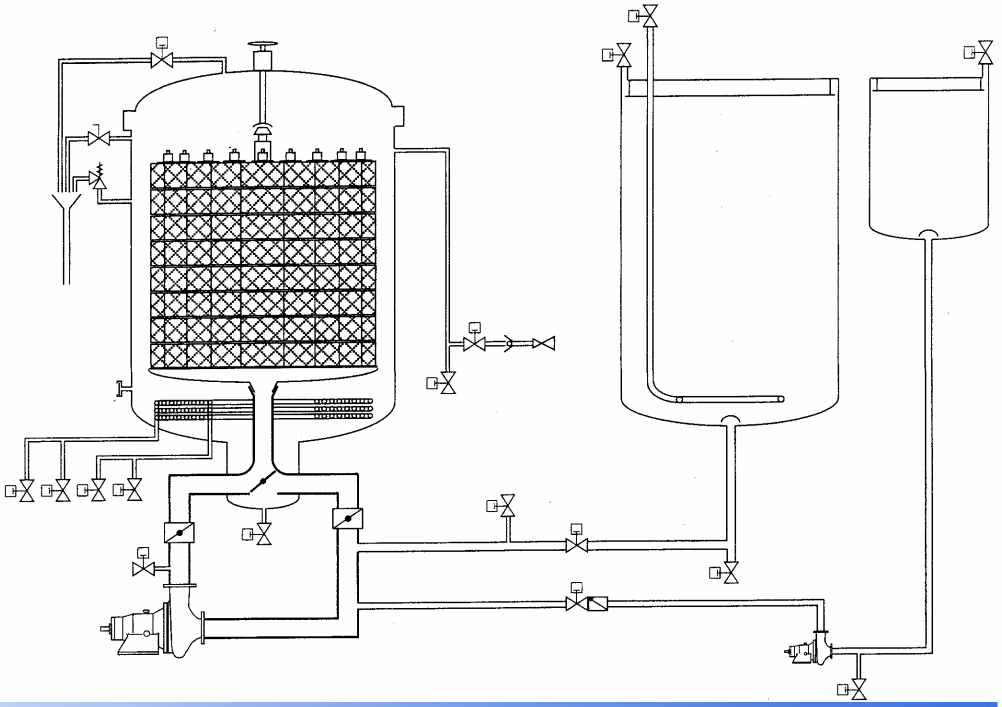
Advantages of package dyeing

a) Reduced lead times from order to finished product - reduced stock holding.
b) Extremely versatile in batch sizes – any size lot from one to 1000kg, depending on machinery available.
c) Yarn packages may be assembled on two for one twisters thereby saving a winding operation.
d) Improved spinning yields as fibre is not damaged prior to spinning.

Disadvantages of package dyeing

a) Loss of yarn bulk if special dyeing methods are not used.
b) Yarn flattening on inside of package.

Schematic of pressure package dyeing machine



Hank dyeing

- The traditional method of dyeing yarn is to do it in hank form.
- It is carried out in machines with fairly gentle liquor flow so as to reduce channelling.
- The hanks of yarn are supported by sticks (steel rods) at the top and bottom of the machine to cater for reversal of the liquor flow direction.

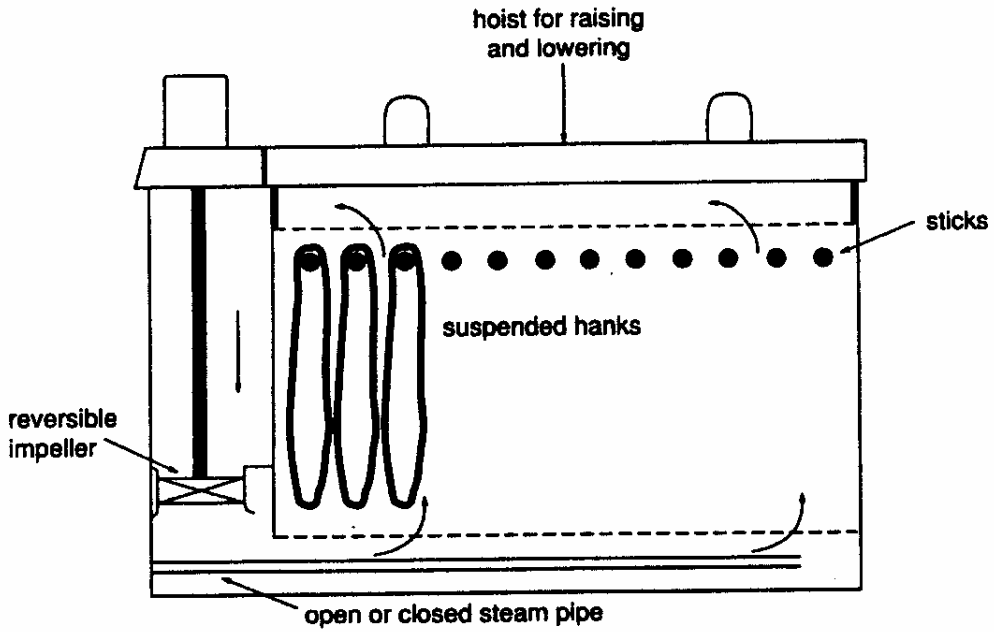
Advantages of hank dyeing

- Low liquor flow rates and very little tension on the yarn provides a very gentle action during the dyeing cycle and maintains the yarn bulk or loftiness.
- Improved spinning yields.
- Reduced lead times and inventories.
- Ideal dyeing system for wool and acrylic yarn which is easily deformed during dyeing.

Disadvantages of hank dyeing

- Little flexibility in batch sizes as machines must be fully loaded.
- Hanking and backwinding operations add extra cost.
- Loading material carriers is slow and labour intensive.

Schematic of hank dyeing machine



5. Fabric dyeing

Fabric dyeing

- Fabric is dyed using a number of different types of machines including winches, beam dyeing machines, jigs and jet dyeing machines.
- For wool fabrics which are produced from woollen spun yarns, winches are often preferred as they can have a positive effect on fabric consolidation.
- However, for wool and wool blend fabrics produced on the worsted system, soft action jet dyeing machines are usually preferred.
- In special cases with wool fabric which is very delicate or prone to creasing it is sometimes necessary to dye them on a beam dyeing machine.

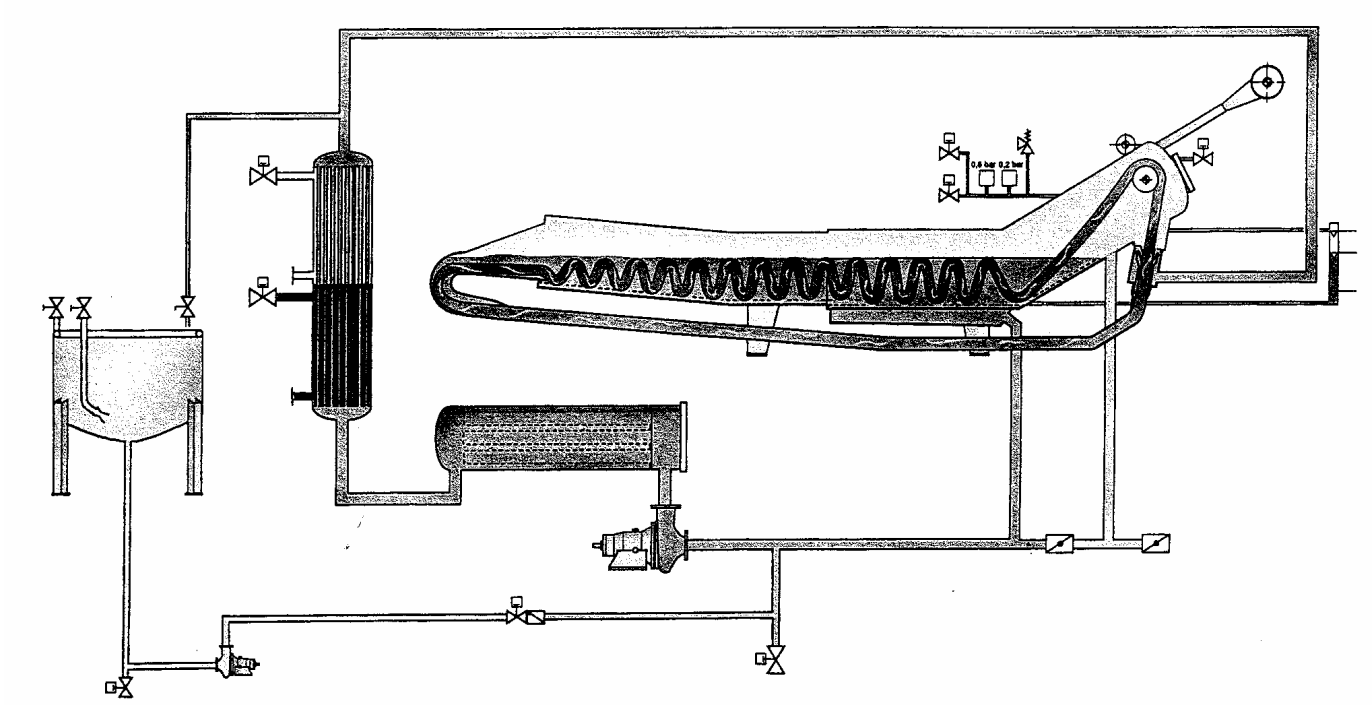
Advantages of fabric dyeing

- Very short lead times and minimum stockholding of finished goods.
- Amounts exactly matching the size of the order may be dyed.
- Leads to highly efficient processing as only white fabric needs to be woven or knitted.

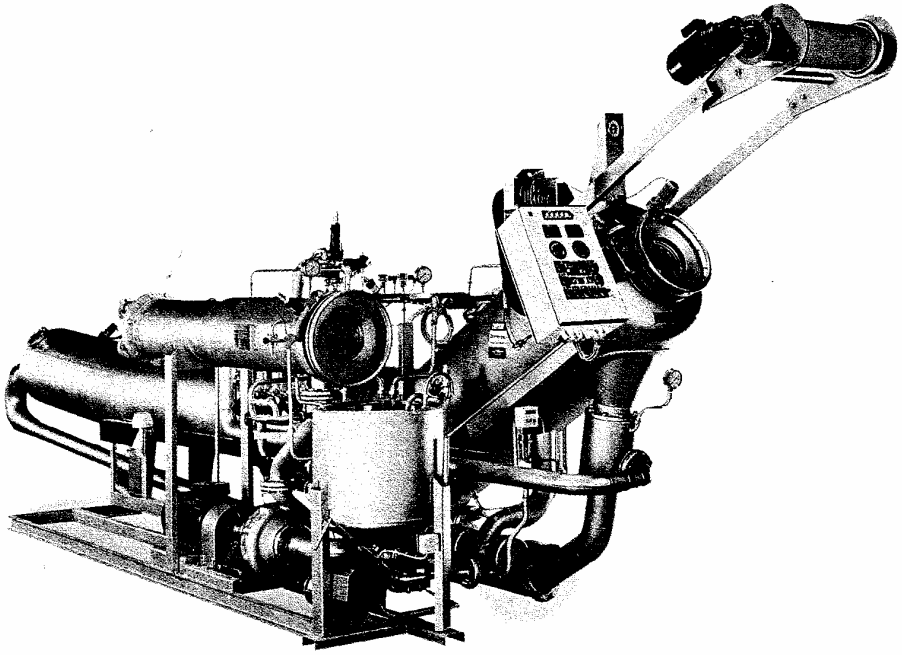
Disadvantages of fabric dyeing

- Restricted colouration flexibility as only solid colours can be dyed unless blends of different fibres are used.
- A certain amount of permanent set may be imparted to the fabric which may prove undesirable in later finishing operations.

Schematic of a jet dyeing machine



Modern softflow jet dyeing machine



6. Garment dyeing

Garment dyeing

- Garment dyeing machines have long been used for dyeing socks, stockings and pantyhose and are sometimes used for dyeing fully fashioned knitted garments.

- There are a number of different types of machines, from rotary drum machines to side and overhead paddles and the more modern front-loading rotary drum garment dyeing machines.

Garment dyeing (cont.)

- The front-loading rotary drum machines have the advantage that they are also used for extracting water from the dyed goods.

- Garment dyeing is not widely used for dyeing wool or wool blend products except for shrink resist treated fully fashioned knitted garments or socks.