Fatty Acid Derivatives as Textile Auxiliaries

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INTRODUCTION

The textile industry, consists of many manufacturing processes[a] involved in the production of fibers, yarns and fabrics (*Figure 1*). It involves the use of diverse types of specialty chemicals, also known as textile auxiliaries, to perform various functions. A large and significant amount of these textile auxiliaries are based on fatty acid derivatives, which are used as detergents, wetting and penetrating agents, lubricants, anti-static agents, dyeing assistants, softeners and water repellents.

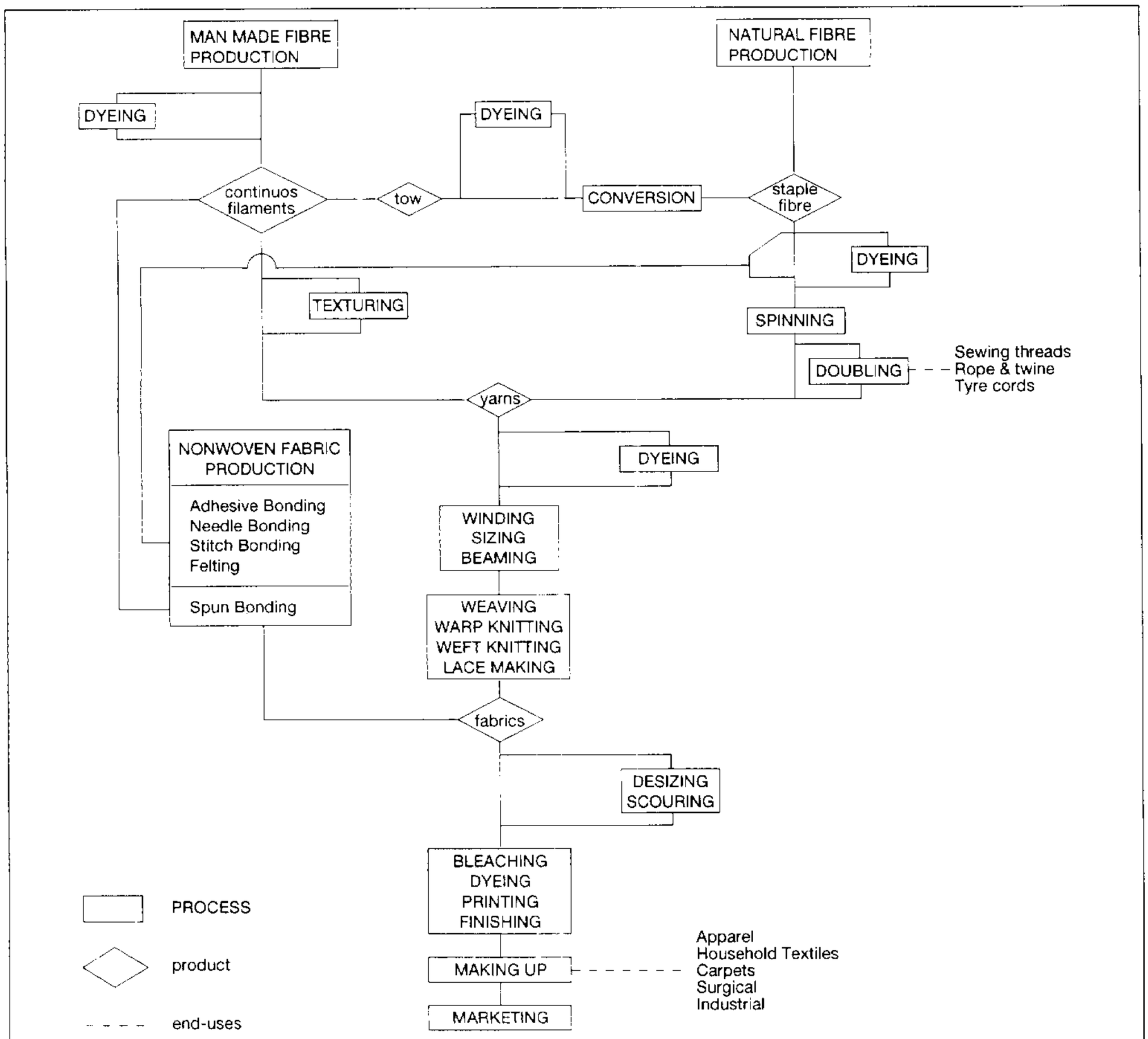

Figure 1. Textile processes – Simple Flow Chart.

[a]*Textile glossary as listed in Appendix A*

This paper describes various uses of textile auxiliaries based on fatty acid derivatives.

DETERGENTS

Detergents (Nettles, 1983; Palmer, 1977; Patterson *et al.,* 1989) are used to remove unwanted impurities on the textile products prior to a wet processing or mechanical finishing operation. This is a scouring operation where soap was formerly used but has been replaced largely by synthetic detergents. Soap is still being used in scouring cotton to remove natural wax and extraneous materials introduced during preceding operations, in scouring wool to remove wool grease and in silk degumming.

The use of detergents has resulted in an increase in pollution problems. Hence biodegradable fatty acid based detergents such as alcohol sulphates are assuming greater importance.

Fatty acid based anionic detergents are also widely used in textile scouring. For example, N-methyloleyltaurine is used in the preparation of material for dyeing due to its high and excellent dye-levelling properties. The sulphonated mono-ethanolamides and alcohol sulphates are used in scouring of synthetics and final washing of printed material. In textile scouring, cationic detergents are not used, while amphoteric detergents have little significance.

WETTING AND PENETRATING AGENTS

A wetting agent is added to achieve a rapid wetting of the fabric by the treating solution such as cleaning, dyebath and finishing. Chemically wetting agents are similar to the detergents except that those having lower ratio of hydrophobic to hydrophillic character are more efficient than detergents. Sulphated fatty acid esters (Nettles, 1983) such as isopropyl oleate and sulphated butyl oleate are the most powerful wetting agents. Sulphated oleic acid is also used sometimes. Phosphate esters such as lauryl alcohol phosphate are particularly efficient and stable in alkaline solutions. However, fatty acid based nonionic compounds do not possess high wetting power.

LUBRICANTS

Fiber lubricants are applied to textile fibers, filaments and yarns to minimize breakage during high speed operations such as spinning, twisting, winding, texturing, weaving and knitting. It is called "spin finishes" when applied to fiber surfaces in the production of man-made fibers and "processing finishes" when applied to natural or man-made during subsequent processing steps.

The spin finish protects the newly formed fiber by coating it with a multicomponent formulation. A common formulation includes a lubricant, a fiber-to-fiber friction aid, an antistatic agent and emulsifier and other additives such as soil release agents. They cover a wide range of chemical types *e.g.* fatty alcohols, esters, amides, ethers, ethoxylates and quaternary compounds. Chemicals commonly used in each category are listed in *Table 1* (Nettles, 1983; Rosnah, 1995).

ANTISTATIC AGENTS

During the course of carding, spinning and winding, the lubricated fibers, filaments or yarns, as a result of sliding contacts between fibers and between fibers and other surfaces, static electrical charges are generated and accumulated. This may cause the fibers to repel each other or to be attracted to oppositely charged machine parts. In most cases, it is necessary to develop means for keeping static charges at low level.

TABLE 1. SPIN FINISH COMPONENTS (Nettle, 1983; Rosnah, 1995)

Component	Products Commonly Used
Lubricant	Mineral oil and waxes, Vegetables oils and waxes, fatty acid esters, dicarboxylic acid esters, neoalcohol esters, polyoxyalkylene derivatives
Fiber-to-fiber friction aid	Mineral oils, linear esters, branched esters, polyalkylene glycols, polyoxyalkylene monoethers
Antistatic agents	
Anionics	Alkyl alcohol sulphates, alkyl alcohol phosphates, alkyl alcohol ethoxylates
Nonionics	Alcohol ethoxylates, alkyl phenol ethoxylates, alkyl amine ethoxylates, polyalkylene glycol derivatives
Cationics	Imidazoline quaternaries, alkyl quaternaries
Emulsifiers	
Anionics	Alkylbenzene sulphonates, alkyl alcohol phosphates, alkyl alcohol sulphates, alkyl alcohol ethoxylates, sulfosuccinates, fatty acid soaps
Nonionics	Alkyl alcohol ethoxylates, alkyl phenol ethoxylates, fatty acid ethoxylates, sorbitol-sorbitan, alkyl amine ethoxylates, alkanolamides, alkanolamide ethoxylates
Cationics	Quaternary fatty amines, quaternary fatty amine ethoxylates, quaternary imidazolines

A number of anionic, cationic and nonionic surfactants and their blends have been suggested in patent literatures (Dollinger *et al.,* 1976; Johnson, 1976; Patterson *et al.,* 1989; Rosnah, 1995) as suitable and effective antistatic agents. These include a wide choice of fatty acid soaps, sulphated fatty acid, quaternary salts, phosphate alkyl esters and ethylene oxide condensates of fatty esters.

EMULSIFIERS

Emulsifiers (Nettles, 1983; Paterson *et al.,* 1989; Profitt *et al.,* 1988) are used to provide stable aqueous dispersions and to aid in the scouring of 'finish' from fibers. They are common anionic, cationic, amphoteric or nonionic surfactants.

ADDITIVES

Some additives (Patterson *et al.,* 1989; Profitt *et al.,* 1988; Rosnah, 1995) are used in small amounts to achieve supplemental effects. Some examples of additives based on fatty acid derivatives used as antioxidants, microbial agents and corrosion inhibitors, pH buffer and viscosity controller are indicated below:

Function	Examples
Antioxidant	Alkyl phosphites
Antimicrobial agent	Quaternary ammonium chlorides
Corrosion inhibitor	Fatty alkyl phosphates.
pH buffer	Fatty acid soap
Viscosity controller	Esters

DYEING ASSISTANTS

Surfactants are used widely in the preparation and application of dyestuffs in dyeing. The addition of surfactants is to assist in maintaining stability and also solubilization of certain dyes. Nonionic

fatty acid surfactants-emulsifiers, such as oleic acid polyethoxylate (Nettles, 1983; Patterson *et. al.,* 1989), can also act as dyeing assistants. Cationic surfactants like octadecyltrimethyl ammonium bromide (Nettles, 1983; Patterson *et. al.,* 1989) have been used to level the basic dye coloration of wool and acrylic fibers by retarding dye pickup.

FINISHING AGENTS

Finishing is the last stage of fabric production. The type of finishing required depends on the final usage of the fabric or the customers expectation. Chemical finishing agents facilitate mechanical finishing, modify surface feel of the fabric, increase textile utility, change chemical and physical properties, and increase textile marketability. Commonly used finishing agents based on fatty acids are softeners and water repellents.

Fabric softeners

Softeners are added in textile finishing to improve the surface feel of the fabric. Cationic softeners are derived from amides of stearic acid and amino compounds such as diethylenetriamine. The intermediate aminoamides are converted to water dispersible reagents by quaternization with diethylsulphate, neutralization with acetic acid or formation of ethoxylates with ethylene oxide. Quaternary ammonium compounds (Petterson *et al.,* 1989; Profitt *et al.,* 1988) are the most prevalent softeners. Anionic softeners are usually a mixture of stearic acid soap and glycerol mono-stearates. They have good resistance to yellowing. Nonionics, such as stearic acid ethoxylates, have been used but must be applied at a higher amount on fabric.

Water repellents

Water repellents (Palmer, 1977) are used on textile finishes such as raincoats, upholstery and carpets to reduce wetting by water and aqueous solutions. Most of these are based on derivatives of stearamide. One type utilizes a mixture of methylol stearamide in trimethylol-melamine. Another type is based on steroxymethylpyridinium chloride and is used in rainwear because of its durability.

FUTURE AND PROSPECT

Elias *et al.* (1995) showed that the world's total demand for oils and fats during the last 10 years to 1992/1993 has risen by 27% to reach 81 million tonnes and the demand for oleochemicals has risen even faster to reach 10.7 million tonnes or 13% of the total. This coincides with the rapid growth of palm oil which has become the second most important oil in the oils and fats market. The use of oils for oleochemical production showed that South East Asia has also doubled its share during the last 10 years from 15% in 1982/1983 to 30% in 1992/1993.

The Asia-Pacific region has also been established as the world's largest producer of synthetic fibers and intermediates (Dobson, 1994) since 1980. In 1993 the region accounted for 46% of the 19.35 million tonnes of the world's synthetic fiber production and 44% of mill consumption. It is forecasted (Dobson, 1994) that the region will account for no less than 53% of the world's total production of 29.07 million tonnes by year 2002 when Amoco puts up new plants in Malaysia, India and China with a total of 1.1 million tonnes/annum capacity of polyester production. A new plant for nylon intermediates is also being planned in Singapore by Du Pont.

Thus it is obvious that both the oleochemicals and the textile industries are set to grow especially in the Asia-Pacific region. Based on the estimated consumption (Gander, 1984; Leonard *et al.,* 1984; Patterson *et al.,* 1989) of 1 lb of fatty acid products to every 8 lb of textiles produced, the volume of oleochemicals

used for textile production will be almost 2.0 million tonnes by the year 2000. As the market demand and concern are turning towards water soluble and environmentally friendly products, the future of oleochemicals looks brighter by the year 2000 and beyond. ■

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Appendix A

TEXTILE GLOSSARY

Bleaching : The process of removing natural color or stains from fibers or fabrics by chemical action in order to render them white.

Carding : An operation which opens and cleans fibers, separate the individual fibers and deliver them in sliver form or as a carded web.

Degumming : The process of removing natural gum from silk (the sericin from fibroin).

Desizing : The process of removing the sizing used on the warp yarn in weaving.

Doubling : The operation of combining several strands to form a single strand without twisting.

Dyeing : The process of coloring materials.

Felting : The process of producing a nonwoven fabric containing natural and/or man-made fibers treated by a suitable combination of mechanical action, pressure, heat and moisture without spinning, weaving or knitting.

Filament : A variety of fiber having an extreme length, not readily measured.

Finishing : General term for variety of processes by which woven fabrics are converted into finished goods.

Knitting : The art of producing fabric on more than one needle by a method of interlopping one or more yarns.

Lace making : A process of making open mesh fabric made by hand or on a lace machine.

Printing : Process of producing designs of one or more colors on yarns, warp or fabrics.

Scouring : Cleansing raw fiber, yarn and fabric by mechanical and chemical means.

Sizing : Operation consisting of applying onto yarns compounds such as starch, gelatin, oil, wax, or any other suitable ingredient to aid the process of fabrication or to control fabric characteristics.

Spinning : The process of making yarns or cordage from fibers, tow or liquid materials.

Texturing : The process of giving a particular texture (loopy) to synthetic fiber.

Twisting : The process of producing turns about their axes of fibers, yarns, or cords.

Warp : The yarn running lengthwise in a woven fabric.

Weaving : The process of manufacturing a fabric by interlacing a series of filling (weft) with a series of warp (lengthwise) yarns at right angles.

Weft : The yarn running from selvage to selvage at right angle to the warp in a woven fabric.

Winding : Transfer of a yarn or thread from one type of package to another e.g. from cake to cone.