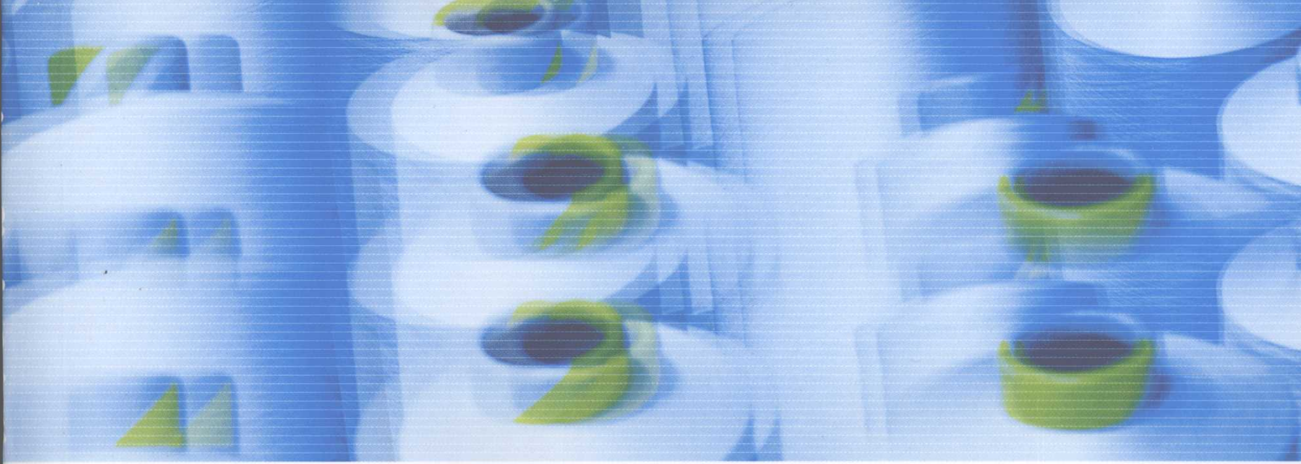

纺纱原理（英文版）

Principles of Spinning

| 编著 于修业 · Xiuye Yu |

東華大學出版社

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About the author

Yu Xiuye: Professor of textiles in Donghua University (China Textile University) and also a consultant professor of Zhejiang Textile and Fashion Institute. He graduated from East China Institute of Textile Science and Technology for undergraduate in 1960 and postgraduate in 1963, majoring textile engineering. He was as a visiting scholar in North Carolina State University of U.S.A. from 1981 to 1983 and as a visiting professor in the same university from 1991 to 1993.

During the past 40 years, he has been teaching in China Textile University and has delivered many new courses as well as has been undertaking research areas on theoretical and practical of textile engineering and new spinning techniques. Meanwhile, he had written many main research papers, some of which were awarded by Textile Engineering Society of China as excellence papers, and published many books. The book of Principles of Spinning of Chinese edition was awarded as outstanding book.

In 1991, the Ministry of Textile Industry of China awarded the honorable designation and certificate to him for his devotion to textile science!

Preface

The English edition of Principles of Spinning is a sister book of the Chinese edition of Principles of Spinning, that is in order to realize the requirement of double-language education for speciality course in institutions of higher learning and universities.

The author refered relative speciality books of the U.S.A., the U.K., Germany and India during he was in the U.S.A. as visiting scholar and visiting professor, and started to write this book.

This book can be applied to university students and teachers as teaching material, and also can provide reference for textile scientific and technical workers.

Owing to the limited professional skill of the author, some mistakes and problems in this book can hardly be avoided.

So, the author sincerely wishes all readers to give comments and advices.

Xiuye YU
Dec. 2007

前　言

英文版纺纱原理是中文版纺纱原理的姐妹书，是为适应高等教育对专业课"双语"教学的需要。

本书的作者在美国北卡罗莱纳州立大学纺织学院学习和工作时，参考了美国、英国、德国、印度等有关书籍，加之自己的教学积累，综合编写而成。

本书可供高等院校纺织工程专业的学生和教师"双语"教学以及纺织科技人员学习和参考用。

由于业务水平有限，书中错误和不当之处在所难免，热忱希望读者批评指正。

作者　于修业
2007.12

Contents

Chapter 1

Yarn Definition and General Consideration

1.1 Yarn, Thread and Classification

1.1.1 Definition of yarn

In general, yarn may be defined as a linear assemblage of fibers or filaments formed into a continuons strand, having textile-like characteristics. The textile-like characterisitics refer to include good tensile strength and high flexibility. To be considered a yarn, however, these strands must be processable on conventional textile equipments or must possess visual and tactile characteristics (aesthetics) that are usually associated with textile products.

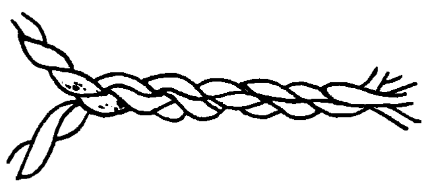
As illustrated by the idealized models in Fig. 1-1, yarn may be composed of one or more continuous filaments or of many non-continuous and rather short fibers (staple). To overcome fiber slippage and to be formed into a functional yarn, staple fibers are usually given a great amount of twist or entanglement. Yarns made from staple fibers are often referred to as spun yarns. Two or more single yarns can be twisted together to form ply or plied yarns (Fig. 1-1 d and e). Plied yarns can be further twisted into various multiples. Combination yarns are plies of dissimilar components such as staple and continuous filament yarns.

(a) Monofilament—solid, single strand of unlimited length

(b) Multifilament—many continuous filaments with some twist

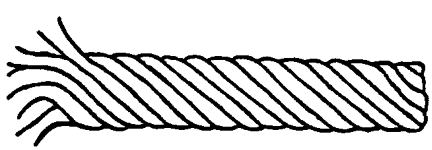
(c) Staple—many short fibers twisted together tightly

(d) Two-ply yarn—two single yarns twisted together

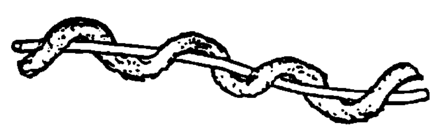


(e) Multiply yarn—plied yarns twisted together

(f) Thread—hard, fine ply yarn



(g) Cord or cable—many plied yarns twisted into a coarse structure



(h) Combination—two dissimilar yarns plied together

Fig. 1-1 Idealized diagrams of various yarn structures

1.1.2 Classification of yarns

From the variety of yarns that are made commercially, it appears that there is no limit to the number of functional and aesthetic design possibilities and to the number of distinctly different yarns. Natural, regenerated and synthetic fibers are processed alone and in a multitude of blend combinations on staple yarn systems. Several combinations of continuous filament and staple fiber yarn blends are also made. Even when a yarn is made from a particular staple fiber or continuous filament, a great number of variations are possible. Through subsequent processing of a chemical or mechanical nature, basic staple or continuous filament yarns can acquire substantially different structural features that can dramatically change the appearance and functional performance of original yarns.

Yarns can be classified by different methods:

(1) By materials composed of: There are cotton yarns, wool and worsted yarns, flax, jute and ramie yarns, spun silk (waste silk) yarns, polyester yarns, blended yarns, ceramic yarns, carbon fiber yarns, glass fiber yarns, and asbestos yarns, etc.

(2) By spinning system: There are carded yarns, combed yarns, semi-combed yarns and combination carded yarns.

(3) By type of spinning frame used: There are ring spun yarns, mule yarns, OE yarns, air-jet spun yarns and friction spun yarns, self-twist yarns, etc.

(4) By yarn fineness: There are coarse yarns and medium, fine, extra-fine yarns.

(5) By structures and methods of yarn forming: There are core yarns, wrapped yarns, sheath yarns, air textured yarns, interlaced yarns, fancy yarns, tape yarns, grenadine yarns, simple and complex yarns.

(6) By end uses of yarns: There are knitting yarns, warp and filling (weft) yarns, fishing-net yarns, sewing yarns and crochet yarns.

Notwithstanding the seemingly infinite variety, yarns may be conveniently classified according to their physical properties and performance characteristics. The physical properties and performance characteristics of yarns depend on physical properties of constituent fibers or filaments and yarn structures. A classification of yarns, based on physical properties and performance characteristcs, is given in Table 1-1.

(1) Staple yarns

There are four basic staple yarn manufacturing systems that have become fairly well standardized. These staple yarn systems are carded cotton, combed cotton, woolen(carded woolen), and worsted(combed woolen). The carded and combed cotton systems were developed to convert short(25 mm) and long (38~51 mm) cotton and cotton-like fibers into yarn. The woolen and worsted

Table 1-1 Yarn Classification by Physical Properties and Performance Characteristics

Yarn Type	General Yarn Properities
Staple yarns	Excellent hand, covering power, comfort and textured appearance.
Combed cotton	
Carded cotton	Fair strength and uniformity.
Worsted	
Woolen	
Continuous filament yarns	Excellent strength, uniformity, and possibility for fineness.
Natural(silk)	
Man-made or synthetic	Fair hand and poor covering power.
Novelty yarns	Excellent decorative features or characteristics.
Fancy	
Metallic	
Special end-use or industrial yarns	Purely functional; designed to satisfy a specific set of conditions.
Tire cord	
Rubber or elastic	
Core	
Multiply	
Coated	
High bulk yarns	Great covering power with little weight, good loftiness or fullness.
Staple	
Continuous filament(Taslan)	
Stretch and textured yarns	Stretchability and cling without great pressure, good hand and covering power.
Twist-heat set-untwist	
Crimp-heat set	
Stress under tension	
Knit-de-knit	
Gear crimp	

systems were developed to convert short(up to 65 mm) and long(76~229 mm) wool and wool-like fibers into yarn. Most other staple yarn manufacturing systems are adaptations of one of the four basic systems. Man-made fibers are usually tailored to a fiber length, diameter, and crimp resembling that of cotton or wool for processing on these systems. A yarn made on any one of these systems has a specific structural geometry (fiber contiguity) characteristic of the system regardless of fiber content.

In a fabric, staple yarns categorically have excellent tactile qualities (hand, good covering power, and excellent comfort factor) and are aesthetically pleasing(a natural textured appearance). However, staple yarns as a group are not as strong or as uniform as continuous filament yarns of equal linear density. Finally, because staple fibers are processed as a mass rather than individually, the number of fibers per yarn cross section varies considerably along the yarn length. This condition limits the fineness of staple yarn that can be spun on a commercial basis.

(2) Continuous filament yarns

Before the advent of man-made fibers, silk was the only continuous filament yarn available. Briefly, a given number of the naturally occurring double filaments of a specific fineness is extruded and extended by unwrapping selected cocoons. The desired frequencies and directions of twist are then added to form the singles and, subsequently, multiply yarns.

In the manufacture of man-made filaments, a solution is forced through very fine holes in a spinneret, at which point the solution solidifies by coagulation, evaporation, or cooling. Usually, the number of holes in the spinneret determines the number of filaments in the yarn. Also, the size of each hole and amount of drawing, if any, determine the diameter of each filament. As the individual filaments solidify, they are brought together with or without slight twist or entanglement to form a continuous filament yarn.

If the filaments are to be processed on a staple yarn system, several thousand filaments are brought together into a twistless linear assemblage known as tow, for subsequent crimping and cutting. One of the advantages of man-made fibers is that the control is possible to exercise over each step of the production process. Fibers can be tailored to fit a wide variety of end-uses that require physical or chemical properties not found in parent fibers or natural fibers.

Continuous filament yarns in fabric form usually have excellent strength and uniformity. As indicated by the fine monofilament and multifilament yarns that have found commercial acceptance, continuous filament yarns can be made much finer in linear density and diameter than staple yarns. In an untextured form, however, continuous filament yarns are not thought to possess a combination of good covering power, tactile quality, comfort, and pleasing appearance, except for limited apparel applications such as sheer hosiery and lingerie. In industrial and non-apparel applications, however, this combination of properties is usually not important, and the continuous filament yarns excel quite often.

(3) Novelty yarns

Effect threads or novelty yarns are designed for decorative rather than functional purposes. Very seldom is a fabric composed entirely of novelty yarns, except possibly in drapery applications. Most novelty yarns are basically either of a fancy effect or metallic type. Combination yarns are used quite often to obtain the desired effect.

Fancy yarns are usually made by the irregular plying of staple or continuous filament yarns and are characterized by abrupt and periodic effects. The periodicity of these effects may be random or uniform. Often quite large or noticeable, the novelty effect is brought about by programmed variation in twist frequency or input rate in one or more components during the plying of yarns. This usually results in different bending or wrapping among the components or in segments of buckled yarn permanently entangled in the composite structure. Another variation is to entrap short segments of a novelty-effect material into regularly plied base yarns. Examples of fancy yarns are shown in Fig. 1-2.

Metallic novelty yarns are characterized by glittering appearance and rectangular cross-sectional shape. Durability is added to the metallic yarn by protecting with a transparent film, the aluminium foil or metallized material, that produces the glittering effect. It can be durable glossy yarn used for decorative designs.