Swicofil AG Textile Services
Gerliswilstr. 23
CH-6021 Emmenbrücke

Reference for Spinning, Dyeing and Finishing of milk fiber

1. Spinning technological process (example of yarn with 163tex)

Scutching	A002D---A006B---A036C (card wire)
Carding	A186D
Drawing	FA302 (two lines)
Roving	A454G
Spinning	FA502
Winding	

2. Main technical measure for each process

1). Pretreatment

As seen in Table 1, the mass specific resistance of milk protein fiber is larger, so the pretreatment before scutching is more important. After opening bales, the milk protein fiber needs some water and antistatic agent. Based on the tests of fiber property and the choice of antistatic agents, the moisture regain of pure spinning with milk protein fiber is controlled about 16%, and the add-on of chosen composite antistatic agent is about 1%. Meanwhile, the relative humidity in the workshop is controlled within 68~70% to reduce the electrostatic influence.

2). Process of opening and picking

With good uniformity and less impurity, the milk protein fiber is bulky and it is easy to open, and the friction coefficient between fibers is low, and the cohesion force is relatively weaker. Thus, the process of opening and picking should adopt the process of precise picking, less beating and low speed.

During production, the height of the beater in the grab machine stretched rib is 2.5mm, and the picking should be precise and the blending should be uniform. In the opening machine model A036C, the card beater is adopted to reduce fiber damage and the constant volume of laps should be smaller to avoid neps during opening and picking so the lap quality can be stable. In order to make laps uniform, the anti-stick rollers are used and the pressure of tension rollers is increased to avoid the influence caused by sticking. It can be wrapped with plastic film after lapping to prevent volatilization of finishing oil and water. Its main technological parameters are shown in Table 1.

Table 1: Main technological parameters of opening and picking

Item	Technological parameters	Item	Technological parameters
Dry weight of laps (g/m)	380	Speed of evener roller A092 (r/min)	300
Speed of beater A036C (r/min)	420	Speed of lap roller (r/min)	11.5
Gauge of feed roller and beater (mm)	14	Extension percentage (%)	1.5
Speed of beater A076C (r/min)	395		
Speed of stripping beater A092 (r/min)	400		

The milk protein fiber has the features of high strength, good breakage elongation, low friction coefficient between fibers, weaker cohesion force, low moisture regain and smooth and full. During the operation on the carding machine, fiber always concentrates among pins to make fiber's movement difficult. So, the speed ratio between licker-in and cylinder should be increased properly and the speed of cylinder and licker-in should be reduced to improve the resultant yarn quality, decrease fiber damage and it is favorable for fiber to move from licker-in to cylinder and the card sliver is with clear web and the flying or nep is reduced. Reducing short fiber content in card sliver and noil and card strips, and cutting down the gauge between cylinder and doffer resolves the problem of worse movement and web's floating. During production, the technological principle of "small quantum, low speed and light pressure" should be adopted. Its main technological parameters are shown in Table 2:

Table 2: Main technological parameters in carding machine

Item	Technological parameters	Item	Technological parameters
Linear weight of card sliver (g/5m)	16.3	Flat speed (mm/min)	96
Cylinder speed (r/min)	310	Gauge of feed plate and licker-in (mm)	0.26
Doffer speed (r/min)	28.9	Gauge of cylinder and flat (mm)	0.28 0.25 0.23 0.23 0.25
Licker-in speed (r/min)	850	Gauge of cylinder and doffer (mm)	0.25

4). Drawing

Since the milk protein fiber is bulky and with weaker cohesion force, the extended parallelization of fiber in card sliver is worse, and much hooked fiber exists, the extended parallelization of fiber should be improved as much as possible during drawing to reduce its weight irregularity.

8 slivers in each of two lines are adopted in doubling and drafting. Since the mass specific resistance of milk protein fiber is large, the static electrical phenomenon is serious, so speed should be reduced properly to avoid fiber winds, rubber-covered rolls and rollers. In order to improve strands and reduce hairiness, the drafting in the rear zone for first drawing should be large and the drafting for second drawing should be small - in this way, the extended parallelization of fiber is improved. Pressure should be larger, and enough gripping force should be proportional to drafting force to be sure to make change speed point of fiber concentrated during drafting and the strands standard is improved. In actual production, the technological principle of "more doubling, weight pressure, medium quantum and large gauge" is adopted. Its main technological parameters are shown in Table 3.

Table 3: Main technological parameters of drawing

Item	Technological parameters		Item	Technological parameters	
	First	Second		First	Second
Linear weight (g/5 m)	15.6	15.57	Sliver delivery speed (m/min)	200	200
Center-to-center distance	45×55	45×55	Draft ratio in rear zone (Time	1.820	1.284
Roll pressure (Kg)	30×32×30×6	30×32×30×6	Draft ratio in front zone (Time	4.592	6.243

). Roving

With long fiber length, the mass specific resistance of milk protein fiber is large, and the friction coefficient is small, so, the twisting coefficient of roving should be bigger unless hard head appears in spun yarn. And the elongation rate should be controlled to reduce accidental elongation, which is favorable to improve strands. In the case that roving isn't overlap, the winding density of roving should be bigger to reduce hairiness of resultant yarn. The drafting ratio in the rear zone should be smaller and the ratio in the front zone should be bigger to guarantee the strands standard of roving. Its main technological parameters are shown in Table 4.

Table 4: Main technological parameters in roving

Item	Technological parameters	Item	Technological parameters
Roving quantum (g/10m)	4.12	Spindle speed (r/min)	534
Extension percentage (%)	1.36	Draft ration in rear zone	1.26
Collector in middle zone (mm)	6×4	Twist coefficient for roving	80
Collector in front zone (mm)	8	Pressure weight (kg/spindle)	32×16×28

6). Spinning

Since the fiber is soft, smooth and with weaker cohesion force, the amount of hairiness and thick and thin yarn always appears during spinning.

Therefore, the technological principle of "bigger twisting, smaller drafting ratio in the rear zone, larger roller gauge in rear zone and small nip gauge" should be adopted. Its technological parameters are shown in Table 5.

Table 5: Main technological parameters for spinning

Item	Technological parameters	Item	Technological parameters
Spindle speed (r/min)	15600	Nip gauge (mm)	2.5
Roller gauge (mm)	19×29.5	Twist coefficient of spinning	335
Roller pressure (Kg/double spindles)	18×14×16	Draft ration in rear zone (Times)	1.29

7). Winding

In winding, the electronic clearer is used and the air splicer is adopted to piece. The speed of drum is 1800r/min. Shown in Table 6, the resultant yarn quality reaches the design requirements.

Table 6: The resultant yarn quality

Item	Actual value	Item	Actual value
Fineness (tex)	16.42	2mm hairiness (picks/10m)	178
Weight deviation (%)	+0.76	3mm hairiness (picks/10m)	62
Odd strive (CN/tex)	19.97	Fine end (number/km)	21
CV value of Odd strive(%)	10.9	Slub (number/km)	102
CV value of hundredfold (%)	0.68	Nep (number/km)	132
CV value of strands (%)	13.7		

3. Concluding remarks

The milk protein fiber has good uniformity, less impurity, fullness, easy baling and superior spinning ability, but the friction coefficient between fibers is low, cohesion force is weak, and the mass specific resistance is big, so pretreatment must be done. Meanwhile, the appropriate run-on moisture regain and antistatic agent should be selected to ensure good quality of resultant yarn. Since the milk protein fiber can be developed into knitting and woven fabric, its market viability is strong and it has bright prospects.

Recommended dyeing and after finishing technology of milk protein fiber

1. Resistance to acid and alkali of milk protein fiber:

1). Mix solution PH=1,2,3 (Mix pure water with HCl), treat 30 min in 100C, and test the weight damage rate of fiber.

When PH=1, the damage rate is 3.98%, and there's no change for handling and appearance.
When PH=2, the damage rate is 0.07%, and there's no change for handling and appearance.
When PH=3, the damage rate is 0%, and there's no change for handling and appearance.

2). When PH=10,11,12 (Mix pure water with Na_2CO_3), 70C, treat 40 min in constant temperature, and test the weight damage rate of fiber.

When PH=10, the damage rate is 0.7%, and the fiber is rather yellow.
When PH=11, the damage rate is 0.5%, and the fiber is yellow and feels hard.
When PH=12, the damage rate is 1.3%, and the fiber is yellow and beginning to feel hard.
The after treatment of fiber should be done when the medium is with 10>PH>2.

2. Heat endurance of milk protein fiber

The test is completed with pure milk protein fiber, which contains 40% dyed milk protein fiber and 60% natural colored milk protein fiber to spin 30^S yarn and to conduct oven-test.

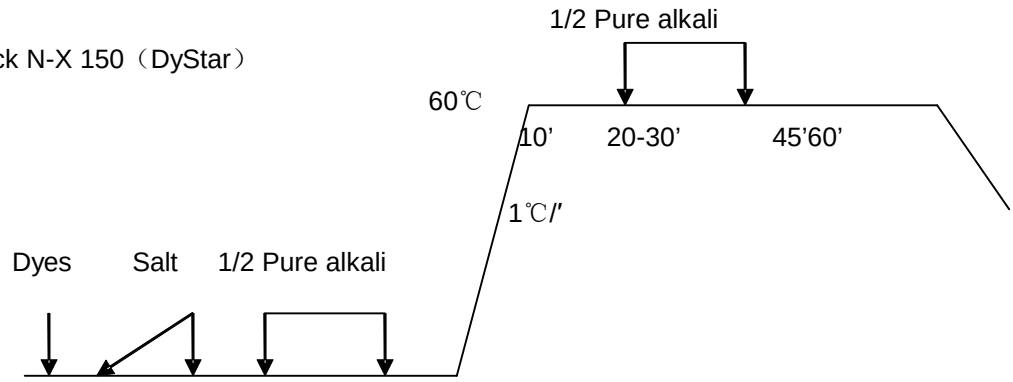
Material		40% dyed milk protein fiber and 60% natural colored milk protein fiber	40% dyed milk protein fiber and 60% natural colored milk protein fiber	40% dyed milk protein fiber and 60% natural colored milk protein fiber
Dyeing temperature		Dyed milk protein fiber:40C	Dyed milk protein fiber:50C	Dyed milk protein fiber:60C
Heating fastness (grade)	Color change(120℃×15SE	4—5	4—5	4—5
	Color change(130℃×15SE	4—5	4—5	4—5
	Color change(140℃×15SE	4—5	4—5	4—5
	Color change(150℃×15SE	4—5	4—5	4—5
	Color change(170℃×15SE	4	4	4
	Color change(190℃×15SE	3	3	3
Heating modular fastness (grade)	Color	4—5	4—5	4—5
	Color	4—5	4—5	4—5
	Color	4—5	4—5	4—5
	Color	4—5	4—5	4—5
	Color	3—4	3—4	3—4
	Color	1	1	1

3. Suggested dyeing technology

Because of its bicomponent, most protein fiber is dyed for protein; it is easy to be stained and tinted. But its technology should be worked out in accordance with heat resistance, resistance to acid and alkali, and the final effect of dyeing to choose dyes and to lay down dyeing technology.Combined with our natural conditions, we suggest using reactive dyes for cotton in medium and low temperature. The specific technology is as follows(only for reference, you are suggested to select one after test during production and implementation):

Dyeing technology 1:

Dyes：Remazol jet black N-X 150（DyStar）

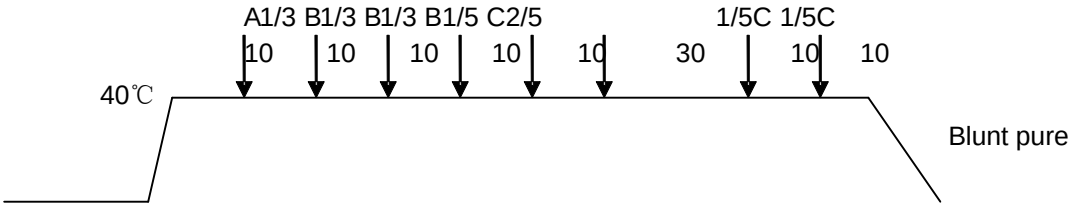


Salt and soda consumption

Dyes	%	＜1	1—3	3—5	＞5
Salt	g/l	30	40	50	60-80
Soda	g/l	1	2	2	2

After treatment:
·Wash in cold water
·Rinse with water in 60C
·Boil 10 min with 2 g/l Hostapon T in 85℃
·Rinse with water in 60C
·Wash in cold water
·Neutralize with 1-2g/l cellulose(60%)
(If needed)
·3% Sirius ^{R}A, adjust acid-base value by cellulose to 5-6 in 40C and circulate 20 min, and then clean it.

Dyeing technology 2
1). Recipe Penetrating
agent: Leveling agent:
Reactive dyes: reactive dyes for cotton (Shanghai Wande Company) Sodium sulfate:
Soda:
2). Dyeing technology
Treat animal protein fiber for 20min in 45C with penetrating agent and leveling agent, and the liquor ratio is 1:25. And then dye in constant temperature.



A: Reactive dyes
B: Sodium sulfate
C: Soda

After dyeing, wash it in 80C with 1% soda and scavenging agent for 20 min, and neutralize for 10 min with 1% formol in 40C, and then treat it with 6# aids in 40C for
20 min. (6# aids can be cashmere-typed softening agent or silicone softening agent
202B by national textile department, its concentration is 7%, dry it in 80-90C after dehydrating and the temperature shouldn't be too high and too much time is not needed.)
3). Fiber condition after dyeing

Table 1:Crabbing fastness of dyeing

Dyes (o, w, f)	Change of original sample	Staining of white cotton cloth	Staining of white wool cloth
Reactive red	4	4-5	4-5
Reactive yellow	4	4-5	4-5
Reactive blue	4	4-5	3-4

Conclusion:
(1). The milk protein fiber can be dyed with reactive dyes for cotton in constant temperature.
(2). Pretreatment for milk protein fiber with penetrating agent in constant temperature and leveling agent is beneficial for dyes to penetrate into fiber to reach the uniform dyeing effect.

4. After treatment of milk protein fiber fabric

Milk protein fiber products should be after treated, such as crease-resist finishing and softening, to keep it soft and delicate.
1). Crease resistant finishing
The crease resistant finishing agent has more choices and the environmental finishing with good crease resist effect should be selected.
2). Softening
During dyeing and producing, the milk protein fiber fabric feels hard after crease resistant finishing in high temperature and tension. In order to make fabric full and soft, softening is needed and softening with a suitable softening agent is an effective method.
You can choose a silicone softening agent, aliphatic amide softening agent, cationic softening agent, etc.
3). Temperature of stabilized finishing
When the linear velocity is under 15m/min, the temperature should be not more than 105C. If the linear velocity is increased, the temperature can be correspondingly higher and it is suggested to be no more than 150C. Please decide the specific technology after trial production.
4). Singeing of milk protein fiber fabric
It can be executed according to the normal singeing technology.

5. Scouring ways for ready-made garments made of milk protein fiber:

1). Wash by hand or washing machine (in bag and weak force)under 35C.
2). Dry-cleaning
3). Ironing in medium temperature (or with steam).
4). Air-dry (or drying below 75C.).
5). Don't use chlorine bleach (wash with chlorinated washing powder is not recommended).
6). Don't wring out or hang dry when the moisture content is over 50%.

The above is only for reference, you can determine your process according to the actual specific conditions after your test

MILVET BLEACHING, DYEING AND FINISHING

By ABrand (Beijing) Technology

MILVET comes from animal protein in milk. The protein is refined and linked to polymers, producing wet-formed fiber. It is a renovated milk protein fiber. MILVET has good strength, softness, brilliance, moisture-conductivity and absorption. As its physical and chemical structure is quite different from natural protein fiber, suitable scouring, bleaching, dyeing and finishing process shall be applied to embody the style and property of MILVET.

1. For treatments

1.1 Desizing

For treat process simply remove oil, anti-static agents, lubricant and coloring matters by desizing and bleaching.

1.2 Different MILVET fabric shall apply different process:

For fabric with starching, destarching shall be done first, either by enzyme, or by alkali or oxidant. MILVET cannot accept mercerizing as it does not resist dense caustic soda.

1.3 Enzyme Destarching Process:

BF7658 amylase 2-6g/L
Salt (Sodium Sulphate) 2-3g/L
Dispersing agent 1g/L
Temperature: 55-66 ℃
Time: 60 minutes

1.4 Different MILVET fabric needs different destarching process; the process shall be subject to other fiber’s property, just like wool/silk blends, the process shall be suitable to 2 fibers.

2. Destarching and Bleaching

The color of MILVET is curcuma, so bleaching is needed. Different white color needs different bleaching.

2.1 Bleaching by Hydrogen Peroxide
2.2 Reduction bleaching
2.3 Hydrogen Peroxide bleaching plus reduction bleaching
2.4 White dyeing
2.5 No absolute white color is available

3. Bleaching Process

3.1 Hydrogen Bleaching,

- For medium color and dark color
- For reference only

Hydrogen Peroxide: 20-40g/L

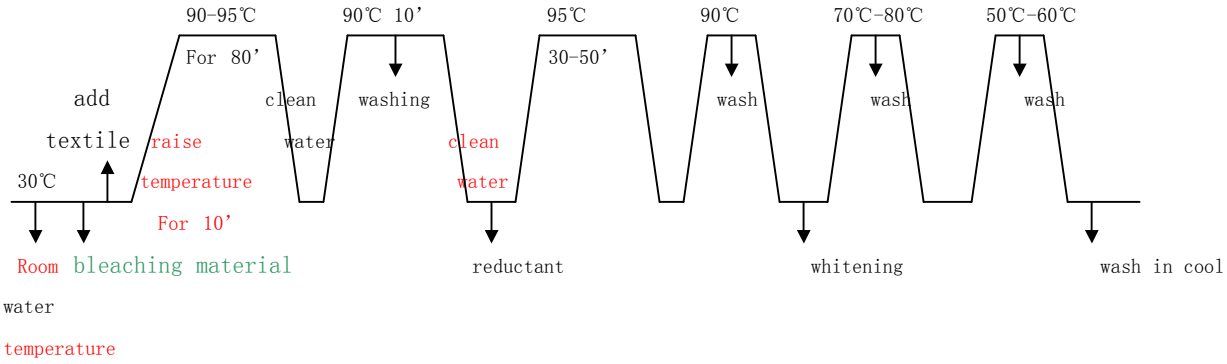
Sodium carbonate: 3-5g/L
Scouring agent: 2-3g/L
Foaming agents: 3-8g/L
PH value: 11
Temperature: 92-95 ℃
Duration: 60-80minutes

3.2 Reduction Bleaching
- For reference only
Hydro Sulphate: 3-8g/L
Sodium carbonate: 2-4g/L
Scouring agent: 1-2g/L
PH value: 11
Temperature: 92-95 ℃
Duration: 60-80 minutes

3.3 Hydrogen Peroxide bleaching + Reduction bleaching
- The products shall be washed after hydrogen bleaching for reduction bleaching

4 Whitening
- For dyeing light color, whitening shall be applied
- Ratio (for reference)
Whitening agent: 0.3-0.8g/L
Salt (Sodium Sulphate): 5-15g/L
Temperature: 70-80 ℃
Duration: 30 minutes minimum

5 PROCESS FLOW (for reference)



5.1 Whitening Agents (for reference)
The following whitening agents have good bleaching effect after tests:
Korea 4BK, China Guangdong CBN-20, Shanghai Daxiang PAB, DM are good,
BW-O2A, CPD, PA2B, Shanghai Daxiang BYB, BY are applicable
VBL, DT cannot be applied for bleaching milvet.

6 Bleaching Method
Fiber bleaching, top bleaching, yarn bleaching (in skein and on cone); fabric bleaching can be applied according to different production equipments.

Fiber bleaching and top bleaching are easy to handle, yarn bleaching is also good. All these 3 methods have good bleaching effects.

- During yarn bleaching process, fluffy or hairiness is easy to rise and yarns are easy to twist together.
- For cone yarn bleaching these 2 problems won't raise but the looseness is very important. Being too tight, bleach liquid cannot penetrate well; bleaching color will be not even. Being too loose, penetration and evenness are good but the yarn will get smooth and go down they will be mingled together and injured.
- If the bleaching temperature is high, the yarn's elongation will be greatly affected. When it is over 95 ℃ the retraction will be big an d handle is hardened.

7. FORE-TREATMENT FOR MILVET/WOOL, MILVET/CASHMERE BLENDS OR INTERLOCK

- The wool fiber shall be taken good care to avoid damage and its fiber's dry elasticity can be reserved.
- The soft and puffy handle and elegant brilliance can be reserved.
- The anti-alkali of milvet is better than wool. Wool fiber will become yellowish when pH>8 and 80 ℃ and its strength is lowered.
- The color of milvet can be diminished when bleaching at pH = 9.5 - 10.5 and 90 - 95 ℃. In order to obtain good result, the suggesti on are as below:

7.1 Fore-treated and bleaching or dyeing process are applied concerning fiber or top or yarn products and then blending, weaving or knitting are processed.
7.2 Considering not damaging wool fiber and making good use of the advantages of milvet and wool, usually scouring is applied with temperature below 45 ℃ and time 30 minutes, cooking is applied with temperature 85 ℃, pH 6.5 and bigger pressure.
7.3 Bleaching is mainly for milvet's de-coloring. It is sugested to use low temperature Hydrogen peroxide to bleach, eg.using TAED made in England at 70-75 ℃ light alkali condition.

8. Fore-treatment for milvet/silk fabric

1) To take out the glue of silk fiber
2) To raise the white grade of milvet
3) To avoid puffiness and hairiness of silk/milvet fabric.
4) Alkali protein dissolvable enzyme can be applied

PROCESS:
Tinogym WSL (CIBA) 0.5-1g/L
Ph value: 9-9.5
Temperature: 55 ℃
Time: 45 minutes

After protein enzyme is degumed, scouring and bleaching are to process:
PROCESS:
H2OS: 5-6g/L
Stabilizer (BAC) 2g/L
Wet penetrating agent (LUN) 1g/L

(By soda ash) pH=8-9
Temperature: 90 ℃
Time: 45-60 minutes

PROCESS FLOWS:
A. Milvet/wool GREY FABRIC→ fore-treatment, alkali protein enzyme deguming→ scouring and bleaching → whitening → sqeezing → dyeing → softening
B. Milvet/silk GREY FABRIC → deguming and bleaching → washing → reduction bleaching → whitening → squeezing → finishing
If the fabric needs gassing process, light gassing and fast speed are applied.