

1

2

3,452,129

PROCESS FOR THE HIGH-SPEED SPINNING OF VISCOSE FILAMENTS

Akihiro Isobe, Yutaka Fujinawa, Kogi Iwasaki, Takeshi Ikeda, Eizo Nakajima, and Takashi Kobatake, Nobeoka-shi, Japan, assignors to Asahi Kasei Kogyo Kabushiki Kaisha, Osaka, Japan, a corporation of Japan

Filed Oct. 19, 1967, Ser. No. 676,526

Claims priority, application Japan, Oct. 21, 1966, 41/97,483; May 30, 1967, 42/34,048, 42/34,049

Int. Cl. D01f 3/10, 5/06

U.S. Cl. 264—180

3 Claims

ABSTRACT OF THE DISCLOSURE

A funnel viscose spinning process wherein the spinning velocity is as high as 140–300 m./min. and the flow velocity as measured at the straight funnel zone is selected to be lower by 35–80 m./min. than that of the extruded viscose filaments.

This invention relates to improvements in the process for the spinning of viscose filaments in accordance with the recently developed funnel spinning technique.

In the aforementioned funnel spinning process, the coagulation bath liquid is led to flow through a vertically extending elongated funnel or fluid bath tube and the viscose extruded from a conventional spinneret is guided to move through the same tube in a parallel flow with the bath liquid and in an enclosed and contacting manner with the latter. In this conventional art, the flow speed of the bath liquid is selected to be substantially equal to or more than that of the downwardly traveling speed of the extruded viscose filaments so as to be in coagulating contact with said filament.

When it is desired to improve the spinning efficiency by increasing the spinning velocity to, for instance, as high as 130 m./min. or still higher, it would be supposed that the flow speed of the bath liquid through the funnel should be correspondingly increased. This leads however to a considerable difficulty in the deflection separation of the spun filaments from the strongly downwardly flowing stream of the bath liquid. Indeed, at the lower end of the funnel, where there is a considerable fluidic resistance upon the spun filaments, this tendency naturally increases with increases of the flowing speed of the liquid.

If one tries to deflect and separate the spun filaments at the funnel end from the main stream of the bath liquid, the speed of which should have been considerably increased for the above purpose, so as to subject the filament bundle to further steps of stretching and winding, frequent breakages of the bundle and disadvantageous nap formation on the filaments will occur, even when one neglects the uneven quality of the spun goods caused thereby, this represents a considerable inherent drawback for this type of spinning process.

When the spinning speed is increased, as above mentioned, to as high as 130 meters per minute or even higher the velocity of the funnel bath liquid is also considerably increased, and another grave disadvantage will be encountered by the turbulent flow of the coagulation bath liquid in the neighbouring zone to the spinneret which is normally dipped therein. The turbulent flow, if formed, will strongly physically attack the extruded viscose before its entrance into the fluid bath tube proper at the very moment at which the viscose is still in a substantially non-coagulated state. The possible breakage of the filaments and the formation of naps thereon will be again encountered.

In order to overcome the last mentioned drawback, it

has already been proposed to provide rectifier means, preferably in the form of metallic gaze, parallel vanes or the like, between the spinneret, the inlet opening of the funnel proper and within the enlarged head chamber, preferably in the form of a closed hopper, formed on top of the funnel for mounting therein said spinneret in a dipped manner. The rectifier is intended to suppress the formation of turbulence in the coagulation bath flow, which provision however leads to a considerable complexity in the design and manufacture of the assembly and resulting in considerable loss in the initial investment.

The main object of the present invention is to provide an improved process for viscose spinning which relies upon the funnel spinning principle, yet which is capable of obviating the aforementioned conventional drawbacks.

A further object of the invention is to provide the viscose spinning process of the above kind, which is capable of providing superior spun goods at a highly increased spinning velocity and with improved operating efficiency.

In order to realize the above objects, the spinning velocity is increased to 140–300 meters per min. The characterizing feature of the present invention, in its broadest aspect, resides in that the flow velocity of the bath liquid as measured at the straight funnel proper is selected to be lower by 35–80 meters per minute than that of the viscose filaments as measured at the same place in the tube.

The inventive high speed viscose spinning process may preferably be carried into effect so as to perfectly suppress the possible occurrence of turbulent bath liquid flow in such a way that the mean flow velocity as measured from the outlet extremity of the extrusion orifices of the spinneret, amounts to 15–60 centimeters per minute plus 0.8–3.0 meters per minute for each increment of 1 millimeter in downward distance from said level within the enlarged head zone above the straight and elongated funnel zone and the dipped length of the extruded, regenerated and coagulating viscose filaments in the overall funnel zone consisting of said both zones is defined by the following formula:

$$Y \geq 1.94X - 133$$

wherein Y in centimeters stands for said dipped length of the extruded viscose; X represents in meters per minute the mean spinning velocity of the extruded regenerating viscose.

In the process according to this invention, the fluid bath velocity is selected to be lower by 35–80 meters per minute than that of the spinning speed as measured within the elongated straight portion of the funnel. As aforementioned, the selection is indeed based upon our experimental observation such that for a fluid velocity difference less than the lower limit of the above specified range there is considerable difficulty in the separation of the spun viscose from the strongly flowing-down bath liquid at the lower end of the funnel due to the intense fluid resistance provided by the bath liquid upon the coagulated filaments, which leads to frequently encountered filament breakage as well as undesirable nap formation, although the fluid resistance of the bath liquid to the gradually coagulating filaments is lesser and the nap formation can be reduced within the said funnel. On the other hand, when the velocity difference is increased beyond 80 meters per minute which is the upper limit of the aforementioned range of the velocity difference, the fluid resistance of the bath liquid to the coagulating filaments within the funnel would be increased beyond a permissible limit, thereby causing disadvantageous filament breakage and nap formation, although the aforementioned separation of the filaments from the flowing bath liquid is easier.

The reason for selecting the velocity of the bath liquid at the level of the outlet ends of the extrusion orifices

to be 15-60 centimeters per minute is such that for a lower velocity than the above-specified lower limit, a considerable difficulty will be encountered in the spinning process caused by failure of the accompanying function of the bath liquid with the extruded viscose on account of its buoyancy within the mass of the bath liquid, because the viscose, having a specific gravity of about 1.10, is lighter in its weight than the latter, the specific gravity of which amounts to ca. 1.20-1.45, depending upon its concentration.

If the flow velocity of the fluid bath liquid is increased beyond the above-specified upper limit of 60 centimeters, the viscose as extruded and thus in its almost non-coagulated soft state will be subjected to considerable tension under the influence of the increased liquid flow, thus inviting frequent breakages of the coagulating viscose filaments in their forming stage. This presents considerable spinning difficulty in adopting such higher operating speed.

If the velocity increment of the fluid bath liquid per each millimeter distance from the delivery ends of the extrusion orifices is reduced in the initial coagulating bath zone formed within the enlarged funnel head, substantially and preferably shaped into a truncated cone, beyond the above-specified lower limit or 0.8 meter per minute, the extruded viscose could not be accompanied by the flow of the bath liquid, because in this case the flow energy cannot overcome the buoyancy of the viscose. On the other hand, if the velocity increment in the above sense is increased to that higher than the above-specified upper limit or 3.0 meters per minute, turbulent flow will take place in the fluid bath, in addition to an excessive tension in the coagulating filaments which may thus be subjected to frequent breakage thereof. These difficulties will make the scheduled viscose spinning very difficult to realize.

According to our practical experiments, it was found that if the dipped length of the extruded, regenerated and coagulating viscose filaments in the overall fluid bath zone be controlled so as to satisfy a formula:

$$Y \geq 1.94X - 133$$

the meaning of X and Y having been given hereinbefore, the extruded filaments in their not so fully coagulated state will emerge from the lower end of the funnel and therefore the disadvantageous formation of naps may generally be encountered in the course of the deflecting separation of the filaments from the fluid flow.

It would be conceivable to speed-up the coagulation of the viscose for avoiding the above drawback by adopting a higher concentration of the sulfuric acid, sodium sulfate and the like contained in the coagulation bath liquid, which leads however to a deterioration of the spun filaments and hence be avoided. Any other counter measure to obviate the aforementioned inferior spinning results caused by the adoption of the extreme operating conditions standing outside the framework defined by the above formula: $Y \geq 1.94X - 133$ has been found ineffective according to our practical experiments.

According to a further aspect of the present invention, the fluid bath liquid is led to flow through a spirally guided passage provided at the lower extreme zone of the funnel, thereby the bath liquid being subjected within this zone to a longitudinally elongated swirling motion and thus the spun filaments, upon properly coagulated, being highly accelerated to physically concentrate along the longitudinal axis of said funnel, so as effectively to form a filament bundle. Thanks to this swirling motion of the bath liquid, the latter will diffuse or spread itself abroad as soon as it emerges from the lower end of the funnel and under the influence of the centrifugal force caused by the swirling. In this way, the longitudinal or vertical component of the flow energy of the bath liquid is considerably reduced and the deflecting separation of the filament bundle after removal from the lower-

most extremity of said funnel will become more easy, because otherwise strongly acting fluid pull upon the bundle may be considerably reduced automatically.

These and other objects features and advantages of the invention will become more clear when read the following detailed description of the invention by reference to the accompanying drawing and several preferred numerical examples of the invention.

In the drawing:

FIG. 1 is a longitudinally sectional schematic view of a viscose spinning assembly adapted for carrying out the process according to this invention.

FIG. 2 is an enlarged elevational view of a part of FIG. 1, illustrative of the lower end portion of the funnel employed therein.

FIG. 3 is a longitudinally sectional view substantially of the funnel head employed in the assembly shown in FIG. 1, wherein, however, some details have been slightly modified.

Now referring to the drawing, especially FIGS. 1 and 2 thereof, the numeral 1 denotes a vertically extending tube forming a fluid coagulation bath, said funnel, preferably ca. 130-450 cm. long, having an outside diameter ranging from ca. 3 to 7 mm. The tube or funnel proper 1 is formed along a certain distance at its lower end portion 2 into a threaded or spiral tube part, constituting a swirling zone, the bore size of said funnel naturally depending upon the spinning velocity of the viscose. With increase of this velocity, the tube bore must correspondingly be larger. On the other hand, the spiral angle and the number of spiral pitch must preferably be reduced with increase of the strength of each filament to be spun, as determined by our practical experiments, assuring easier separation thereof from the coagulation bath liquid to be described.

On the top of the funnel proper 1, there is provided an enlarged head chamber, generally denoted 3, which consists of an upper cylindrical part 4 and a cone-shaped part 5, said chamber being rigidly united at its bottom end with said tube 1, so as to establish a rigid mechanical connection, as well as an intimate fluid communication therebetween. From upper, a conventional spinneret 6 projects through the top wall 7 of said chamber 3 into the interior space thereof. Although not shown, said spinneret 6 is formed therein with a number of, say 30, extrusion orifices vertically arranged in parallel to each other. The spinneret 6 is connected through a feed piping 8, only schematically shown by a chain-dotted line, with a proper viscose supply source, such as a metering pump 9, preferably of the gear type, which is further connected with a viscose solution reservoir, preferably a stationary tank, although not shown.

Below the lower end of the funnel proper 1, there is provided a liquid collecting tray 10, in the neighbourhood of which and at a proper distance therefrom, there is further provided a deflector guide 11 which is preferably formed into a rotatable roll, as schematically shown, of the free-rotating type or of the positively driven type, as the case may be.

Near the top wall 7 of the chamber 3, an inlet socket 12 is provided rigidly with the side wall of said chamber, said socket being connected through a supply piping 13 with a coagulation bath liquid source 14 which is preferably in the form of a metering pump, as schematically shown, advantageously of the gear type, the latter being connected further with a reservoir tank, not shown, maintaining therein a mass of said liquid. The piping 13 is shown again only schematically by a chain-dotted line.

The threaded tube part 2 is shown in its appearance in FIG. 2 in an enlarged scale for better understanding.

In the modified funnel head shown in FIG. 3, there is provided a perforated baffle ring 15 within the chamber 3a for avoidance of possible formation of tubulent inlet flow of the bath liquid to be described. In this drawing, however, the mounting means for said baffle 15 being

omitted from the drawing only for the purpose of simplification. Additionally, the lower end of the funnel at 1a is formed into a straight one, thus without formation of threads. Other constituents of the spinning assembly are substantially similar as before and therefore denoted by same reference numerals as employed in FIGS. 1 and 2, yet affixed each with a suffix "a," for better identification and easy comparison.

The operation of the spinning assembly so far shown and described will be described in the following by numerical examples.

Example

With use of spinning assembly shown in FIGS. 1 and 2 or 3, the spinning was carried out. At first, the pump 14 (or 14a) is operated to feed the coagulation bath liquid (the composition thereof may be varied as shown in the following Tables I and II) through the piping 13 (or 13a) and socket 12 (or 12a) into the funnel head chamber 3 (or 3a). Next, the viscose pump 9 (or 9a) was actuated so as to feed a viscose solution, having a such composition:

Cellulose	wt. percent	8.0
Alkali concentration	percent	5.5
Hottenroth number		11

through feed piping 8 (or 8a) to the spinneret 6 (or 6a), thereby to initiate the spinning. The spinning conditions were varied to a considerable degree as shown in the Tables I and II. The bath temperature was kept always at 62° C.

TABLE I

Spinning conditions														
(1)	(2)	(3)		(6)	(7)	(8)	(9)	(10)			Properties of spun filaments			
		(4)	(5)					H ₂ SO ₄ (g./l.)	Na ₂ SO ₄ (g./l.)	ZnSO ₄ (g./l.)	(11)	(12)	(13)	
75-----	140	3	90	140	26.8	50	1.2	128	260	15	1.80	18.0	1.0	
120-----	260	4	160	200	42.1	40	1.	150	280	15	1.70	18.0	1.2	
150-----	335	4	175	240	39.6	65	2.3	150	280	15	1.65	16.0	0.8	
250-----	375	5	190	260	47.5	70	2.2	175	320	18	1.55	16.5	2.0	
300-----	295	6	165	222	49.1	57	2.1	180	330	18	1.65	17.5	0	
300-----	415	7	205	280	40.8	75	2.6	185	330	18	1.65	15.0	3.5	

- (1) Denier.
 (2) Dipped length (cm.).
 (3) Straight part of funnel.
 (4) Bore of tube (mm.).
 (5) Flow velocity (m./min.).
 (6) Spinning velocity (m./min.).
 (7) Mean fluid bath flow speed at the level of spinneret outlet (cm./min.).

- (8) Difference between spinning speed and bath liquid flow (m./min.).
 (9) Mean flow speed increment (m./min.).
 (10) Bath composition.
 (11) Filament strength, dry (g./d.).
 (12) Filament elongation, dry (percent).
 (13) Number of developed naps per 10⁴ m.

As an example of the conventional centrifugal spinning process, even when operating at a considerably lower spinning speed of 100 m./min., properties of spun filaments, 120 denier, may be as follows:

Filaments strength, dry	g./d.	1.7
Filaments elongation, dry	percent	20

which means that similar results can be obtained only at a considerably lower spinning speed than that employable in the inventive process.

extrusion orifices of said spinneret is between 15 and 60 centimeters per minute plus 0.8 to 3.0 meters per minute for each one millimeter of length of said elongated head zone as measured from said orifices to the top of said elongated tube and wherein the overall length of said bath is defined by the following formula:

$$Y = 1.94X - 133$$

wherein Y is centimeters of dipped length of the extruded viscose and X is the mean spinning velocity of extruded viscose and meters per minute.

TABLE II

Spinning conditions						(10)			Properties of spun filaments			
(1)	(2)	(4)	(6)	(5)	(8)	H ₂ SO ₄ (g./l.)	Na ₂ SO ₄ (g./l.)	ZnSO ₄ (g./l.)	(11)	(12)	(13)	(14)
120----	260	4	200	170	30	150	280	15	1.65	17.0	8.6	0.23
120----	260	4	200	160	40	150	280	15	1.70	18.0	1.2	0.02
75-----	140	3	149	90	50	128	260	15	1.80	18.0	1.0	0.09
300----	295	6	222	165	57	180	330	18	1.65	17.5	0	0.01
150----	335	4	240	175	65	150	280	15	1.65	16.0	0.8	0.03
250----	375	5	260	190	70	175	320	18	1.55	16.0	2.0	0.05
300----	415	7	280	205	75	185	330	18	1.65	15.0	3.5	0.10
150----	335	4	240	155	85	150	280	15	1.60	15.0	7.2	0.25

(14) Number of breakages of filament bundle per spindle per 24 hrs. Remarks: In this Table, (1)-(13) denote same meanings as before.

From the above tables, any person skilled in the art will easily understand that superior spinning results are obtained when operating within the specific range as proposed by the present invention.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present examples are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What we claim is:

1. In a funnel viscose spinning process wherein viscose is extruded into filaments from a spinneret into a coagulating bath comprising an elongated head zone and an attached elongated fluid bath tube having an outlet for said filaments and wherein said filaments are removed from said coagulating bath through said outlet, the improvement comprising:

passing said filaments through said elongated fluid tube at a velocity of between 140 meters per minute and 300 meters per minute and at the same time passing a liquid coagulating bath through said elongated liquid bath tube at a velocity of between 35 meters per minute to 80 meters per minute lower than the velocity of said extruded filaments, said velocity being measured within said elongated tube.

2. The process of claim 1 wherein the mean flow of velocity of the fluid bath as measured at the outlet of the

3. The viscose spinning process of claim 2 wherein the filament outlet of said elongated tube is formed into a spiral fluid passage such that the bath liquid is caused to longitudinally swirl thereby facilitating the removal of said filament from said bath.

References Cited

UNITED STATES PATENTS

1,596,086	8/1926	Elsaessen et al. -----	264—180
2,027,419	1/1936	Dreyfus -----	264—181
3,049,755	8/1962	Aizawa et al. -----	264—181

5

JULIUS FROME, *Primary Examiner.*J. H. WOO, *Assistant Examiner.*

U.C. Cl. X.R.

18—8; 264—103, 181, 188

FOREIGN PATENTS

158,948	9/1954	Australia.
455,534	10/1936	Great Britain.
651,171	9/1937	Germany.

5

Staple
Here
Only!

PRINTER'S TRIM LINE

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,452,129 Dated June 24, 1969

Inventor(s) AKIHIRO ISOBE ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

IN THE CLAIMS:

Claim 2, column 6, line 57, please delete " $Y=1.94X$."
and substitute therefor $--Y \geq 1.94X-133--$.

SIGNED AND
SEALED
MAY 26 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER,
Commissioner of Patents