Title: A SYSTEM FOR INDUSTRIAL POLYESTER YARN PRODUCTION

Abstract: The present invention relates to a system for industrial polyester yarn production in order to be used in industrial fabric production wherein polyethylene terephthalate (PET) material is used mixing with liquid crystal polymer material and thus the drawing strength, elastic modulus of the obtained material is improved.
DESCRIPTION

A SYSTEM FOR INDUSTRIAL POLYESTER YARN PRODUCTION

Field of the Invention
The present invention relates a system for industrial polyester yarn production the elastic modulus of which is improved with additive in order to be used in industrial fabric production.

Background of the Invention
High mechanical properties and a strong structure are required in conveyor band chafer, membrane and coating fabrics. For such embodiments, processes should be improved without increasing the cost much, but providing high modulus and dimensional stability. For this reason studies have been made in field of producing extrinsic PET yarns.

Liquid Crystal Polymers (LCP) which can be used as additive in different materials are in family of high performance resin which has a unique structure comprising long, hard, rod like high oriented molecules. Rod-like molecules are directed to the flow direction during injection or extrusion molding.

The parts molded in LCP exhibit very high dimensional stability even if they are heated up to 200-250 °C. Thermal bending temperature of some LCP classes can reach up to 300 °C. LCP can generally be used as additive in many fields depending on its basic properties. Electronic and electrical components, fuel and gas barrier structures and sensors can be given as example for these fields. United States Patent Document no US201 1083781 discloses the use of LCP material in bicycle tire.

Summary of the Invention
The objective of the present invention is to provide a system for liquid crystal polymer added industrial polyester yarn production.
Another objective of the present invention is to provide a system for industrial polyester yarn production wherein polyethylene terephthalate is used as polymer.

A further objective of the present invention is to provide a system for industrial polyester yarn production whose tensile strength and elastic modulus is high.

**Detailed Description of the Invention**

A system for industrial polyester yarn production developed to fulfill the objectives of the present invention is illustrated in the accompanying figure, wherein

Figure 1 is the schematic view of the inventive system for yarn production.

The components shown in Figure 1 are each given reference numerals as follows:

1. System for polyester yarn production
2. Raw mixture forming unit
   21. Primary particle loading unit
   22. Raw molten extruder
   23. Raw molten cooling unit
3. Primary mixture forming unit
   31. Secondary particle loading unit
   32. Primary molten extruder
   33. Primary molten cooling unit
4. Primary particle loading unit
5. Extruder
6. Cooling unit
7. Roller
   71. Primary roller
   72. Secondary roller
73. Tertiary roller
74. Quaternary roller
8. Hot chamber
8.1. First hot chamber
8.2. Second hot chamber
9. Winding unit

The inventive industrial polyester yarn production system (1) essentially comprises:
- at least one raw mixture forming unit (2) wherein the raw polymer mixture is prepared,
- at least one primary mixture forming unit (3) wherein primary polymer mixture is obtained by using raw polymer,
- at least one primary particle loading unit (4) wherein the polymer particles forming the primary mixture are filled and heated,
- at least one extruder (5) wherein the primary polymer mixture obtained in primary particle loading unit (4) is melted and spun as filaments with the help of the spinneret located at the exit
- at least one cooling unit (6) wherein the material coming from the extruder (5) is cooled,
- at least one roller (7) wherein the material is moved in flow direction,
- at least one hot chamber (8) wherein the material is heated,
- at least one winding unit (9) wherein the material drawn via the rollers (7) by cooling and heating is wound as yarn.

The raw mixture forming unit (1) present in the inventive system (1) comprises:
- at least one primary particle loading unit (21) wherein the polyethylene terephthalate (PET) and liquid crystal polymer (LCP) are loaded and mixed,
- at least one raw molten extruder (22) wherein the raw molten mixture is melted and extruded,
- at least one raw molten cooling unit (23) wherein the material going out of the raw molten extruder (22) is cooled.
In the preferred embodiment of the inventive system (1), PET:LCP ratio of the mixture prepared in the primary particle loading unit (21) is 60:40 by weight. The material which is prepared in this ratio and cooled in cooling unit (23) by being passed through the twin screw extruder (22) is then become as particles.

Primary mixture forming unit (3) comprises
- at least one secondary particle loading unit (31) wherein the polymer particles coming from the raw mixture forming unit (2) are diluted by blending with PET,
- at least one primary molten extruder (32) wherein the primary raw molten mixture is melted and extruded,
- at least one primary molten cooling unit (33) wherein the material coming out of the main molten extruder (32) is cooled.

The raw mixture particles prepared in raw mixture forming unit (2) are sent to the primary molten forming unit (3), and the polymer particles diluted with pure PET are produced here. The PET-LCP raw mixture is heated in the secondary particle loading unit (31), the PET is added until the ratio of LCP in the mixture becomes 1-3% by weight. This process is preferably performed at 260-300 °C.

In one embodiment of the invention, the molecule weights of the particle that are obtained at the outlet of the primary mixture forming unit (3), and their internal viscosity (IV) is increased above 1 dL/g for 12-24 hours at 210-220 °C with solid state polymerization. The purpose here is to increase molecular weight to obtain a polymer suitable for yarn drawing by decreasing the degradation and chain movement during extrusion. Crystallinity increase is above 100% with solid state polymerization.

In one embodiment of the invention, the particles obtained at primary mixture forming unit (3) with increased IV via solid state polymerization are dried in vacuum furnace for at least 24 hours at 120-140 °C, and loaded to the primary
particle loading unit (4) under nitrogen atmosphere at 120 °C. In order to prevent hydrolytic degradation, the humidity value of the primary molten should be under 60 ppm before loading to the extruder (32).

The primary polymer mixture coming out of the primary mixture forming unit (3) are become as particles and transferred to the particle loading unit (4), and dried here at 100-120 °C and sent to the extruder (5) which is heated to 260-290 °C. PET-LCP polymer mixture comprising 1-3% LCP by weight is spun as filaments via spinneret in the extruder (5). In the preferred embodiment of the invention, the length/diameter ratio of the spinneret used at the end of the extruder (5) is 2-5, the hole diameter is 1 mm. The jet velocity of the material from the extruder (5) is 6-7 m/min, the residence lime of the material in the extruder is 11-12 minutes. The throughput here is adjusted as 6-7 g/min.

The PET-LCP filament coming out of the extruder (5) is transferred to the cooling unit (6) preferably treated with cooling water. In one embodiment of the invention, the length of the cooling unit is 70 cm and its temperature is 50-80 °C. In the same embodiment of the invention, the distance between the extruder (5) and the cooling unit (6) is adjusted as maximum 10 cm. The monofilament coming out of the cooling unit (6) first comes to the primary roller (71) and it is sent to the secondary roller (72) from here. In the preferred embodiment of the invention the temperature of the primary roller (71) is between 80-90 °C, and the temperature of the secondary roller (72) is between 90-100 °C. Cool drawing process is applied on the monofilament between these rollers (7).

The monofilament coming out of the secondary roller (72) is transferred to the first hot chamber (81) and heated with hot air to 170-220 °C here and then transferred to the tertiary roller (73). The temperature of the tertiary roller (73) may vary between 170-220 °C. Therefore, hot drawing is performed between the secondary roller (72) and the tertiary roller (73).
The monofilament coming out of the tertian roller (73) enters into the second hot chamber (82) at temperature of 120-180°C. It comes to the quaternary roller (74) which is the last roller without heating, at room temperature; here it is relaxed in ratio of 1-2% and sent to the winding unit (9) in order to be wound.

In the inventive system (1), it was observed that the drawability of PET-LCP yarns produced by adding 1-3% LCP has increased in ratio of 9-13% relative to pure PET yarns, and their elastic modulus has improved in ratio of 20-60%.

When the PET/LCP 99/1 monofilament is twisted with 50 twists as double layer, the conversion percentage is higher than 90%.
CLAIMS

1. A system for industrial polyester yarn production comprising
   - at least one raw mixture forming unit (2) wherein the raw polymer mixture is prepared,
   - at least one primary mixture forming unit (3) wherein primary polymer mixture is obtained by using raw polymer,
   - at least one primary particle loading unit (4) wherein the polymer particles forming the primary mixture are filled and heated,
   - at least one extruder (5) wherein the primary polymer mixture obtained in primary particle loading unit (4) is melted and spun as filaments with the help of the spinneret located at the exit
   - at least one cooling unit (6) wherein the material coming from the extruder (5) is cooled,
   - at least one roller (7) wherein the material is moved in flow direction,
   - at least one hot chamber (8) wherein the material is heated,
   - at least one winding unit (9) wherein the material drawn via the rollers (7) by cooling and heating is wound as yarn, and characterized in that
   - polyethylene terephthalate (PET) and the liquid crystal polymer (LCP) are mixed in ratio of 60:40 in raw mixture forming unit (2),
   - the LPC ratio in the mixture is decreased to 1-3% by weight by diluting the raw mixture with PET in primary mixture forming unit (3).

2. A system (1) for industrial polyester yarn production according to claim 1, characterized by raw mixture forming unit (2) which has at least one primary particle loading unit (21) wherein polyethylene terephthalate (PET) and the liquid crystal polymer (LCP) is mixed by loading in ratio of 60:40 by weight respectively, at least one raw molten extruder (22) wherein raw mixture is melted and extruded; at least one raw molten cooling unit (23) wherein the material coming out of the raw molten extruder (22) is cooled.
3. A system (1) for industrial polyester yam production according to any one of the preceding claims, characterized by primary mixture forming unit (2) which has at least one secondary particle loading unit (31) wherein the polymer particles coming from the raw mixture forming unit (2) are diluted with PET such that the LCP ratio will be 1-3% by weight; at least one primary molten extruder (32) wherein the primary raw molten mixture is melted and extruded, at least one primary molten cooling unit (33) wherein the material coming out of the main molten extruder (32) is cooled.

4. A system (1) for industrial polyester yam production according to any one of the preceding claims, characterized by secondary particle loading unit (31) wherein diluting process with PET is realized at 260-300°C.

5. A system (1) for industrial polyester yarn according to any one of the preceding claims, characterized by extruder (5) wherein the primary polymer mixture is become filament, and which has a spinneret the length/diameter ratio of which is 2-5 and the hole diameter is 1 mm at its end part.

6. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by extruder (5) wherein the exit speed of the polymer mixture as filament is 6-7 m/min.

7. A system (1) for industrial polyester yam production according to any one of the preceding claims, characterized by extruder (5) wherein the throughput of the polymer mixture as filament is adjusted as 6-7 g/min.

8. A system (1) for industrial polyester yam production according to any one of the preceding claims, characterized by cooling unit (6) wherein the filament coming out of the extruder (5) is cooled with cooling water at 50-80 °C.
9. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by primary roller (71) to which the filament coming out of the cooling unit (6) is transferred at temperature of 80-140 °C.

10. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by the secondary roller (72) at temperature of 90-160 °C to which the filament coming out of the primary roller (71) is transferred and wherein cool drawing is applied on the filament.

11. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by first hot chamber (81) to which the filament coming out of the secondary roller (72) is transferred and wherein it is heated with hot air at temperature of 170-220 °C.

12. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by the tertiary roller (73) at temperature of 170-250 °C to which the filament coming out of the first hot chamber (81) is transferred and wherein hot drawing is applied on the filament.

13. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by second hot chamber (82) at temperature of 120-180 °C to which the filament coming out of the tertiary roller (73) is transferred.

14. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by the quaternary roller (74) without heating to which the filament coming out of the second hot
chamber (82) is transferred and wherein hot drawing is applied on the filament.

15. A system (1) for industrial polyester yarn production according to any one of the preceding claims, characterized by winding unit (9) wherein the filament coming out of the quaternary cylinder (74) is wound as yarn by-relaxing 1-2%.
### INTERNATIONAL SEARCH REPORT

**International application No**
PCT/TR2015/000124

#### A. CLASSIFICATION OF SUBJECT MATTER

- **INV.** D01F6/92 D01D10/02 D01F6/62
- **ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

#### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- D01F C08L D01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

- EPO-Internal, WPI Data

#### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C.  
[X] See patent family annex.

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Name and mailing address of the ISA:
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Authorized officer: Van Beurden-Hopkins
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### International Search Report

**Information on patent family members**

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