A method and an apparatus for melt-spinning and cooling a plurality of filaments which are processed to form a non-woven fabric or web. The filaments are guided after extrusion in the form of a filament curtain through a cooling zone and are cooled by a cooling air stream blown transversely to the filament curtain. In order to prevent the flow effects created by air swirls in the side edge zones of the filament curtain, an additional quenching air stream acts inside the cooling zone on each side edge of the filament curtain. For this purpose, the inventive apparatus comprises a quenching member positioned below each longitudinal end of the spinneret.
Fig. 3
METHOD AND APPARATUS FOR MELT-SPINNING AND COOLING A PLURALITY OF FILAMENTS

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method for melt spinning and cooling a plurality of filaments used in the production of a non-woven fabric or web, and also an apparatus for carrying out the method.

[0002] It is known when manufacturing spun-bonded fabric that a plurality of filaments are extruded in a spinning apparatus, cooled collectively as a filament curtain and are deposited to form a non-woven fabric. For this purpose, draw-off nozzles are used, which draw off the filament curtain from the spinning apparatus and guide it to a delivery belt arranged below the draw-off nozzle. For cooling the freshly extruded filaments, the filaments are quenched with a cooling air stream which moves transversely to the filament curtain, so that the filaments are strengthened before entering into the draw-off nozzle. Such a method and/or apparatus are known, e.g., from U.S. Pat. No. 6,183,684.

[0003] In order to be able to meet the requirements of uniformity of characteristics of the individual filaments and also the requirements of greater production speeds, the filaments have to be cooled after extrusion uniformly and evenly to the maximum extent possible. In the known apparatus, a cross-flow quench system is used for this purpose, which is positioned on both of the longitudinal sides of the spinneret and which instantaneously blows a cooling air stream transversely to the filament curtain on the filaments. The immediate concurrence of the cooling air streams outside the filament curtain leads to air swirls, which act especially on those filaments, which are guided directly in the side edge zones of the filament curtain.

[0004] In order to eliminate such negative effects, DE 33 18 096 discloses a apparatus, in which guide plates are arranged which can be displaced parallel to the front sides of the filament curtain. However, this helps achieve only certain flow guidances of the cooling air in relation to the atmosphere. The cooling of the filaments in the side edge zones and also the side edge flow effects can be little influenced by this.

[0005] It is therefore the object of the invention to create a method and a apparatus of the above-mentioned type, in which all the filaments of a filament curtain, especially those in the side edge zones of the filament curtain, can be cooled intensively and uniformly.

SUMMARY OF THE INVENTION

[0006] The above and other objects and advantages of the invention are achieved by a method and apparatus of the above described type and wherein the filaments guided in the side edge zones of the filament curtain are guided in a predetermined atmosphere using defined flow ratios. For this purpose an additional quenching air stream created at least at the front end of the spinneret by a quenching member acts directly on the filaments at the side edge of the filament curtain. Air swirls caused by a transversely directed cooling air stream on the side edge of the filament curtain can thus be prevented advantageously. A balancing of the quenching ratios, in particular, can be achieved using the quenching air stream.

[0007] In order to obtain equal effects on each side edge of the filament curtain, a separate quenching air stream, preferably on each side edge of the filament curtain, acts on the filaments, wherein said quenching air stream is oriented transversely to the cooling air stream. For this purpose, separate quenching members are provided at each end of the spinneret.

[0008] In order to bring about the cooling of the filaments of the filament curtain essentially using the transversely oriented cooling air stream, the improved configuration of the inventive method is particularly advantageous in which the quenching air stream is generated next to the side edge of the filament curtain in a quenching direction that has a component oriented in the running direction of the filaments, and wherein a quenching angle in the range of 0° to 45° is provided between the filaments and the quenching stream. Thus in the extreme case, a parallel flow relative to the filament curtain can be provided, wherein said parallel flow essentially influences only the side edge air layers of the filament curtain. In order to be able to use additional cooling effects of the quenching air stream, the quenching angle is advantageously increased, wherein quenching angles in the range of up to 45° have turned out to be suitable for the purpose of preventing any unreliable differences between the cooling conditions in the center of the filament curtain and those at the side edges of the filament curtain.

[0009] The quenching air streams at both of the side edges of the filament curtain preferably impinge on the filaments at a quenching angle in the range of 0° to 20°. For this purpose, the inventive apparatus comprises a quench opening and a pressure chamber connected to the quench opening, wherein the quench opening has an inclination for forming a quenching angle in the range of 0° to 45° between the filaments and the quenching stream.

[0010] The use of the variant of the method in which the quenching air stream and the filaments operate in an entry region of the cooling zone enables all the filaments to be spun out uniformly. The filaments are confronted with the quenching air stream only after they pass through a short spinning zone.

[0011] In order to achieve the most effectual impact over the entire cooling length in the side edges of the filament curtain, the quenching air stream is created according to an advantageous variant of the method at a quenching speed, which is greater than that of the cooling air stream. It is thus possible to create a turbulence free flow in the border region of the filament curtain up to the outlet of the cooling unit.

[0012] The quenching air stream and the cooling air stream are thereby preferably formed by conditioned air, which essentially has the same temperature. Basically, however it is also possible to supply the filament curtain with a quenching air stream and a cooling air stream having different temperatures. Thus the quenching air stream can also be formed advantageously using ambient air.

[0013] In order to achieve a sufficient cooling even in case of a high filament density inside the filament curtain, preferably a second cooling air stream acts on the filaments inside the cooling zone, said second cooling air stream being blown transversely to the filament curtain opposite to the first cooling air stream. The filament curtain can thus be cooled intensively and uniformly on both of its longitudinal
sides. In the inventive apparatus, the quenching member is preferably formed by a quench opening oriented towards the side edge of the filament curtain and a pressure chamber connected to said quench opening. The quench opening preferably has a rectangular outlet cross-section, which extends essentially parallel to the front end of the spinneret over the entire thickness of the filament curtain.

[0014] In order to achieve a turbulence free flow inside the quenching air stream to the maximum extent possible, a flow straightener is arranged inside the quench opening.

[0015] The inventive apparatus is operated according to a preferred improved configuration using a cooling unit, which contains a cooling wall with a cooling chamber, on both longitudinal sides of the spinneret. Two separate cooling air streams can thus be created, each of which is oriented towards the filaments transversely to the filament curtain. Such cooling units enable an intensive cooling, as a result of which high process speeds are possible even in case of high filament densities inside the filament curtain.

[0016] For influencing the flow configured parallel to the side edges of the curtain, it is further suggested that one or more cover plates be attached to each of the quenching members, wherein said cover plates extend at a distance from and parallel to the side edges of the curtain and are configured to be displaceable. Additional flow effects for ensuring an even side edge flow can thus be created. In this manner it is also possible to utilize the entrained ambient air in case of a partial cover.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] Several embodiments of the inventive method and apparatus are described below in more detail, with reference to the enclosed drawings, of which:

[0018] FIG. 1 schematically illustrates a first embodiment of the inventive apparatus for carrying out the inventive method;

[0019] FIG. 2 schematically illustrates a cross-section of the embodiment shown in FIG. 1;

[0020] FIG. 3 schematically illustrates a top view of another embodiment of the inventive apparatus; and

[0021] FIG. 4 illustrates a cross-section of another embodiment of the inventive apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0022] FIG. 1 and FIG. 2 illustrate a first embodiment of the inventive apparatus for carrying out the inventive method for melt-spinning and cooling a plurality of filaments. FIG. 1 schematically illustrates a perspective view of the embodiment and FIG. 2 schematically illustrates a cross-section thereof. The following description applies to both figures unless explicit reference is made to either of the figures.

[0023] The embodiment comprises a spinneret 1, which has on its bottom side a plurality of nozzle bores arranged preferably in one or more longitudinally extending rows. The spinneret 1 is connected to a melt source (not illustrated here) using a melt inlet 2.

[0024] A cooling unit 3 is arranged below the spinneret 1. Between the spinneret 1 and the cooling unit 3 a short spinning zone is provided, in which the filaments are guided without an active cooling. The cooling unit 3 comprises a cooling wall 4.1 extending parallel to a longitudinal side of the spinneret 1, said cooling wall being connected to a cooling chamber 5.1. The cooling chamber 5.1 is connected to a cooling air source (not illustrated here) using an air inlet 17. A fan or an air-conditioner can be provided as the cooling air source.

[0025] The cooling unit 3 further comprises separate quenching members 8.1 and 8.2, below the ends of the spinneret 1. FIG. 2 illustrates the cross-section of each of the quenching members 8.1 and 8.2, wherein the quenching member 8.1 is assigned to the left end of the spinneret 1 and the quenching member 8.2 is assigned to the right end of the spinneret 1. The quenching member 8.1 is formed by a quench opening 9.1 and a pressure chamber 10.1 connected to the quench opening 9.1. The pressure chamber 10.1 is connected to a pressure source (not illustrated here). Likewise, the quenching member 8.2 arranged at the opposite end is formed by a quench opening 9.2 and a pressure chamber 10.2 connected to the quench opening 9.2. The pressure chamber 10.2 is also connected to a pressure source.

[0026] The quench openings 9.1 and 9.2 each have an essentially rectangular outlet cross-section, in which a flow straightener 11 is arranged. The quench opening 9.1 on the left end of the spinneret has an inclination relative to a plumb line, so that the quenching stream discharged from the outlet cross-section of the quench opening 9.1 impinges on the filaments 6 extruded from the spinneret 1 at a quenching angle. In FIG. 2, the quenching angle is indicated by the reference symbol β.

[0027] The quench opening 9.2 on the opposite end of the spinneret 1 is embodied essentially laterally reversed to the quench opening 9.1. The quench opening 9.2 has an opposite inclination so that the quenching air stream discharged from the outlet cross-section of the quench opening 9.2 impinges on the filaments 6 extruded from the spinneret 1 at a quenching angle. The quenching angle here also is indicated by the reference symbol β. The quenching angles and thus the arrangement of the quench openings 9.1 and 9.2 are configured preferably identically in mirror image relationship at both ends of the spinneret 1.

[0028] As illustrated in FIG. 1, a draw-off nozzle 12 is arranged below the cooling unit 3 in order to draw-off the filaments 6 from the spinneret 1 and to deposit them in the form of a spun-bonded non-woven fabric 18 on a delivery belt 13 arranged below the draw-off nozzle 12. The delivery belt 13 is constructed to be air-permeable and is driven transversely to the draw-off nozzle 12 in the direction of the arrow, using a drive system which is not illustrated here in more detail.

[0029] In the inventive apparatus illustrated in FIGS. 1 and 2, a polymer melt is supplied to the spinneret 1 and is extruded under pressure from nozzle bores arranged on the bottom side of the spinneret 1. The filaments 6 discharged from the nozzle bores of the spinneret 1 are guided in a row-shaped arrangement as a so-called filament curtain 7. The filament curtain 7 is thereby drawn off by the draw-off nozzle 12 from the spinneret 1. For this purpose, the filament
curtain 7 is guided through a guide channel 14 of the draw-off nozzle 12, wherein a conveying fluid is fed to the guide channel 14.

[0030] Before the filaments 6 of the filament curtain 7 enter into the guide channel 14 of the draw nozzle 12, they are cooled by a cooling air stream oriented transversely to the filament curtain 7 in the cooling zone formed by the cooling unit 3. For this purpose, the cooling air stream is generated by the cooling chamber 5.1 and the cooling wall 4.1 and is blown uniformly over the entire width and length of the cooling wall 4.1 onto the filaments 6 of the filament curtain 7. In order to prevent air turbulences on the side edges of the filament curtain 7, the side edges being formed at the longitudinal ends of the spinneret 1, the quenching members 8.1 and 8.2 create additional quenching air streams, which impinge on the filaments 6 guided in the side edges of the filament curtain at a quenching angle α of approx. 20°. The quenching air streams created by the quenching members 8.1 and 8.2 are blown in the running direction of the filaments 6 so as to prevent the occurrence of any substantial air friction on the filaments.

[0031] The transversely oriented cooling air stream and also the quenching air streams configured on the side edges of the filament curtain 7 are coordinated to one another in such a way that the filaments inside the filament curtain 7 are cooled essentially uniformly independent of the location at which the filaments 6 are guided. The quenching air streams are configured to have a slightly higher quenching speed as compared to the transversely oriented cooling air stream so as to prevent the occurrence of air swirls over the entire cooling length and so as to ensure a uniform guidance of the filaments up to the draw-off nozzle 12. The filament curtain 7 is received by the draw-off nozzle 12 and deposited in the form of a spun-bonded fabric 18 on the delivery belt 13.

[0032] For the purpose of not influencing the spin out of the filaments in the spinning zone, the quenching air streams engage the filaments in the inlet region of the cooling zone. The cooling air stream is thus superimposed over the entire length of the cooling zone with the quenching air streams.

[0033] In the embodiment illustrated in FIGS. 1 and 2, the quench openings 9.1 and 9.2 are aligned in such a manner that each quenching air stream impinges on the filaments 6 of the filament curtain 7 at a quenching angle of approx. 20°. Basically, quenching angles lying in the range of 0° to 45° could be configured in order to achieve an advantageous guidance and cooling of the filaments at the side edges of the filament curtain 7. However, the quenching angle on both of the side edges is configured identically in a range of 0° to 20°. The quench openings 9.1 and 9.2 could each be embodied on movable quench lugs whereby a variation of the quenching angle is possible. Furthermore, it is also possible to create the quenching air streams without the help of flow straighteners in the quench openings 9.1 and 9.2.

[0034] Another embodiment of the inventive apparatus for carrying out the inventive method is illustrated in FIG. 3. The embodiment shown in FIG. 3 being essentially identical to the previous embodiment, a top view thereof is schematically illustrated here. Essentially only the differences between the two embodiments are explained below.

[0035] In the embodiment illustrated in FIG. 3, the cooling unit 3 comprises on both of the longitudinal sides of the spinneret 1 a cooling wall 4.1 and 4.2, each of which is connected to a cooling chamber 5.1 and 5.2. The cooling walls 4.1 and 4.2 are arranged essentially parallel to the spinneret 1 on the side of the cooling unit 3 adjacent the curtain 7. The cooling chambers 5.1 and 5.2 are connected to a cooling air source (not illustrated), so that the cooling chambers 5.1 and 5.2 are filled with a cooling medium, preferably cooling air, which is guided under the pressure effect by the cooling walls 4.1 and 4.2 transversely to the filament curtain 7.

[0036] The quenching members 8.1 and 8.2 are arranged on both of the side edges of the filament curtain. Each of the quenching members 8.1 and 8.2 comprises a quench opening 9.1 and 9.2, through which a quenching air stream is generated and blown on the filaments 6 of the filament curtain at a quench angle, as described above. Each quench opening 9.1 and 9.2 can contain a flow straightener, whereby an essentially rectified air flow is generated so as to give rise to a quenching stream that is uniform over the entire thickness of the filament curtain 7. Each of the quench openings 9.1 and 9.2 is connected to a pressure chamber 10.1 and 10.2.

[0037] Especially high filament densities inside the filament curtain 7 can be cooled intensively and uniformly in the embodiment illustrated in FIG. 3. Due to the intensive cooling effect, high draw-off speeds can thereby be advantageously configured using a draw-off nozzle arranged downstream.

[0038] FIG. 4 schematically illustrates a transverse section of another embodiment of the inventive apparatus for carrying out the inventive method. The embodiment being essentially identical to that shown in FIG. 3, only the differences are explained below.

[0039] The cooling unit 3 arranged below the spinneret 1 is formed by the cooling walls 4.1 and 4.2 extending along the longitudinal sides, together with the cooling chambers 5.1 and 5.2. Quenching members 8.1 and 8.2 are provided on each of the side edges, wherein only quenching member 8.2 is illustrated in FIG. 4. Several cover plates are provided at the side edges of the filament curtain 7 in order to be able to shield the filaments 6 from the environment. The cover plates 19.1 and 19.2 assigned to the quenching member 8.2 are illustrated in FIG. 4. The cover plates 19.1 and 19.2 are displaceably held in a top guide 20 and a bottom guide 21. The cover plates 19.1 and 19.2 can thereby be selectively adjusted between a closed position and an open position. A lateral air outlet 22 is formed in the open position. Due to this, additional flow effects can be created on the side edge zones of the filament curtain 7 inside the cooling zone.

[0040] The filament curtain 7 is drawn-off by the draw-off nozzle 12 from the spinneret 1. The filament curtain 7 guided in the guide channel 14 is conveyed by a conveying fluid, which is supplied by the fluid chambers 16.1 and 16.2 and the fluid inlets 15.1 and 15.2 to the guide channel 14.

[0041] The embodiments illustrated in FIGS. 1 to 4 of the inventive apparatus for carrying out the inventive method serve as examples for the design and arrangement of the quenching means. What is important here is that an additional quenching air stream for guiding the filaments on the side edge zones of the filament curtain can be created. It is especially possible to thereby effectively prevent the air
swirls on the side edge zones of the filament curtain, such air swirls being created by cross-flow quenching.

[0042] Many modifications and other embodiments of the invention set forth herein will come to mind to one skilled in the art to which the invention pertains having the benefit of the teachings presented in the foregoing description and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

1. A method for melt spinning and cooling a plurality of filaments comprising the steps of:
   - melt spinning a plurality of downwardly advancing filaments in the form of an elongate curtain which defines opposite side edges and a longitudinal direction extending between the side edges;
   - guiding the downwardly advancing filaments through a cooling zone; and
   - cooling the downwardly advancing filaments inside the cooling zone by directing a cooling air stream transversely toward the filaments along the longitudinal length of the curtain and directing a quenching air stream transversely toward the filaments at least one side edge of the curtain.

2. The method of claim 1, wherein the quenching air stream comprises a separate quenching air stream acting on each side edge of the filament curtain and which are oriented to be transverse to the cooling air stream.

3. The method of claim 2, wherein the separate quenching air streams at the side edges of the filament curtain are each oriented to have a directional component which extends in the advancing direction of the filaments and to form a quench angle of between about 0° and 45° between the advancing filaments and the associated separate quenching air stream.

4. The method of claim 3, wherein each separate quenching air stream forms a quench angle of less than about 20° at the associated side edge of the filament curtain.

5. The method of claim 1 wherein the cooling air stream and the quenching air stream both operate at an inlet region of the cooling zone.

6. The method of claim 1 wherein the quenching air stream has an air speed greater than the air speed of the cooling air stream.

7. The method of claim 1, wherein the cooling air stream and the quenching air stream are each temperature controlled so as to have substantially the same temperature.

8. The method of claim 1, wherein the cooling air stream has a component acting on each of the longitudinal sides of the curtain inside the cooling zone, and so that the components are directed toward each other.

9. The method of claim 1, comprising the further step of positioning a pair of laterally adjustable cover plates adjacent said at least one side edge of the curtain to control the air flow along at least one side edge of the curtain.

10. A method for melt spinning and cooling a plurality of filaments comprising the steps of:
   - melt spinning a plurality of downwardly advancing filaments in the form of an elongate curtain which defines opposite side edges and a longitudinal direction extending between the side edges;
   - guiding the downwardly advancing filaments through a cooling zone; and
   - cooling the downwardly advancing filaments inside the cooling zone by directing a cooling air stream transversely toward the filaments along the longitudinal length on each side of the curtain, and directing a quenching air stream transversely toward the filaments at each side edge of the curtain, and
   - wherein the cooling air streams are directed toward each other and the quenching air streams are directed toward each other and transverse to the cooling air streams.

11. An apparatus for melt spinning and cooling a plurality of filaments comprising:
   - an elongate spinneret for extruding a plurality of downwardly advancing filaments in the form of an elongate curtain which defines opposite side edges and a longitudinal direction extending between the side edges, said spinneret comprising opposite longitudinally extending sides and opposite ends,
   - a cooling unit arranged below the spinneret and including:
     (a) a cooling wall oriented to extend parallel to one of the longitudinally extending sides of the spinneret, with a cooling chamber connected to the cooling wall so that a cooling air stream can be directed transversely toward the downwardly advancing filaments along the longitudinal length of the curtain, and
     (b) at least one quenching member positioned adjacent at least one of the ends of the spinneret for directing a quenching air stream transversely toward the advancing filaments at least one of the side edges of the curtain.

12. The apparatus of claim 11, wherein the at least one quenching member is oriented to generate a quenching air stream which is transverse to the direction of the cooling air stream.

13. The apparatus of claim 12, wherein the at least one quenching member comprises a quench opening oriented towards the side edge of the filament curtain and a pressure chamber connected to the quench opening, and wherein the quench opening has an inclination for forming a quenching angle (α) in a range between about 0° and 45° between the filaments and the quenching air stream.

14. The apparatus of claim 11, wherein a cooling wall and an associated cooling chamber are positioned on each side of the filament curtain, and a quenching member is positioned adjacent each of the ends of the spinneret.

15. The apparatus of claim 14, wherein the quenching member on each end of the spinneret comprises a quench opening which has an inclination for forming a quenching angle (α) in a range less than about 20° between the filaments and the associated quenching air stream.

16. The apparatus of claim 15, wherein each quench opening has a rectangular outlet in cross-section, which extends essentially parallel to the adjacent end of the spinneret and over the depth of the filament curtain.
17. The apparatus of claim 16, wherein a flow straightener is arranged inside each quench opening.

18. The apparatus of claim 11, wherein the at least one quenching member is arranged in an inlet region of the cooling unit.

19. The apparatus of claim 11, wherein the cooling chamber and the at least one quenching member are connected to a common cooling air source.

20. The apparatus of claim 11, wherein the cooling unit comprises a second cooling wall having a second cooling chamber on the opposite longitudinal side of the spinneret, wherein said second cooling chamber directs a second cooling air stream transversely to the filament curtain opposite to the first mentioned cooling air stream.

21. The apparatus of claim 11, wherein a pair of cover plates are positioned adjacent the at least one quenching member, wherein said cover plates extend at a distance from and parallel to one of the side edges of the filament curtain and are constructed to be displaceable.