

SPECIFICATION

Method and apparatus for the thermal treatment of impregnated material webs

The present invention relates to a method and an apparatus for the thermal treatment of impregnated material webs, preferably those impregnated with a settable synthetic resin or plastic material, wherein the impregnated material web is guided in an upward direction through a first heat treatment zone, thereafter about a deflection roll arrangement, and then is guided in a downward direction through a second heat treatment zone. The method and apparatus are particularly suitable for the thermal treatment of fleeces and fabrics formed of organic or inorganic fibres, especially glass fibre fabrics and impregnated with a thermosetting plastic material or resin.

A heretofore known apparatus of this type, wherein the vertically guided material web is deflected during the thermal treatment process, is designed such that the thermal treatment has proceeded as far as possible prior to the deflection, and thus, the synthetic resin accordingly has been brought as extensively as possible into a condition where it has lost its tacky properties. Furthermore, the material web, directly prior to its deflection at its inner side confronting the deflection rolls, has blown thereon cooling air in order to reduce the temperature gradient between the contact surfaces of the material web and the cooled deflection rolls and therefore additionally counteracts the sticking of the synthetic resin at the roll shell. The attempt to achieve an advanced thermal treatment prior to the deflection was decisive for the structural height of such installations, and it was necessary to find a compromise so that the residence time needed for the completion of the thermal treatment was available in conjunction with a satisfactory material web travel speed and a still tolerable structural height.

Embodiments of the present invention proceed along diametrically opposite lines. With the attempt, at the same material web speed to reduce the structural height, or conversely, with the same structural height to increase the material web speed, the success attributable to the invention, from the point of view of the known concept paradoxically, is attributed to the fact that according to embodiments of the invention, prior to the deflection, firstly the thermal treatment is not at all considerably advanced, and secondly, in fact even interrupted by cooling of the material web in a cooling zone. In contrast to the heretofore known concept that the material web, prior to the deflection, should be placed by the thermal treatment as extensively as possible into a condition of non-tackiness of the resin, the heretofore explained measures are predicated upon the recognition that by cooling the material web the tackiness, at the same time however also the polymerization, is so to speak "frozen" or arrested, so that the material web, during the

deflection, does not carry any residual heat which could cause an uncontrolled and uncontrollable progression of the thermal treatment. The material web therefore arrives in the second thermal treatment zone with a temperature distribution which is uniform over its entire width and thickness, so that such in turn can be employed for an exact and therefore optimally controllable thermal treatment. In this manner, even in the presence of a reduced structural height and an increased web speed, as the case may be, sufficient time remains in order to again initiate the thermal treatment following the deflection and to complete the same. It has been surprisingly found that the economies of the system operation and method are not impaired by the loss or expenditure in energy which is caused by cooling of the material web, since the increased productivity and/or reduced construction costs far exceed the foregoing. Additionally, it has been possible to obtain a further increase in the product quality since there is dispensed with the colling of only one side of the material web by the cooling air, particularly however through the action of the cooled rolls. Such apparatus therefore no longer embodies a compromise which is forced upon it; quite to the contrary through appropriate dimensioning of not only the one, rather both thermal treatment zones and the cooling zone, but also the cooling output — which in fact can be designed to produce a shock-like cooling action — it is possible to obtain the optimum under the relevant decisive aspects explained herein.

The present invention is a method of heat treating material webs impregnated with a thermosetting resin, wherein the impregnated material web is guided in an upward direction through a first heat treatment zone, thereafter about a deflection roll arrangement, and then is guided in a downward direction through a second heat treatment zone the method including the step of uniformly cooling the material web, after departing from the first heat treatment zone and before passage through the deflection roll arrangement, in a cooling zone to remove tackiness and to interrupt the polymerisation reaction.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawing, the single figure of which schematically illustrates the upper portion of a vertical installation or plant for the heat or thermal treatment of impregnated material webs.

Describing now the drawing, the plant or installation illustrated by way of example in Fig. 1 will be seen to comprise a first heat or thermal treatment zone 1, where there has only been illustrated the upper portion and which extends from the bottom towards the top of the illustrated arrangement. Neighbouring such first heat treatment zone 1 is a second heat treatment zone 2 which extends from the top towards the bottom and of which likewise there has only been illustrated the upper portion. Above both of the

heat treatment zones 1 and 2 there is arranged a deflection region or zone 3. The construction of both heat treatment zones 1 and 2 extensively corresponds to the construction of both heat treatment zones of known installations and therefore can be assumed to be well known in this technology. At the upper region of the first heat treatment zone 1 there are arranged in superimposed relationship and so as to be situated oppositely of one another the blow chests or casings 4 which are provided with air infeed nozzles 5, through which effluxes a downwardly directed flow of a heated fluid medium, typically for instance a current of heated air, as the same has been illustrated by the arrows. At the lower end of the first heat treatment zone 1, and which lower end of such zone has not been particularly shown in the drawing, there is provided a suction device for sucking-off the medium.

The second heat treatment zone 2 possesses at its lower region, which also has not been shown in the drawing, also blowing chests or casings containing air infeed nozzles, like the structure 4, 5 previously discussed, and through which a current of a hot medium, for instance a current of warm air departs which is then upwardly directed. As clearly illustrated, at the upper end of the second heat treatment zone 2 there is provided an only schematically illustrated suction device 6 which is equipped with inlet openings 7 through which passes the hot air and is conducted away.

In the deflection zone or region 3 there is arranged in conventional manner a deflection roll arrangement which is constituted by four deflection rolls 9, 10, 11 and 12.

The material web 13, which is impregnated in the usual manner with any suitable impregnation agent, passes through the plant in upward direction, i.e. in the direction of the arrow A, and moves initially through the first heat or thermal treatment zone 1 where it is guided between the oppositely located blowing chests or casings 4. The material web 13 which passes over the deflection rolls 9, 10, 11 and 12 is deflected and then subsequently moves in a downward direction, i.e. in the direction of the arrow B and travels through the second heat treatment zone 2. Between the second heat treatment zone 2 and the station where the processed material web is wound-up this material web 13 is cooled in conventional manner.

A cooling zone 14 is arranged between the first heat treatment zone 1 and the deflection region or zone 3. The total length of the first heat treatment zone plus cooling zone approximately corresponds to the length of the second heat treatment zone. In this cooling zone 14 there are provided blowing chests or casings 15 which are arranged above one another with respect to the direction of movement A of the material web 13 and opposite one another with respect to such material web 13. As schematically illustrated, the blowing or blast casings 15 are equipped with upwardly directed outlet nozzles 16, through which effluxes a current of a cooling medium which is directed against the

material web 13, for instance an air flow, and the same has been illustrated by the arrows. Moreover, a suction device 17 is arranged in the cooling zone 14, this suction device being merely schematically illustrated and withdrawing the cooling medium out of the cooling zone 14.

In the deflection or diverting region or zone 3 there are arranged three blowing nozzles 18, 19 and 20 which apply to the material web 13, at the face or side thereof coming into contact with the deflecting rolls 9, 10, 11, 12 a cooling medium, typically air. The blowing nozzle 18 is arranged, viewed with respect to the direction of movement or travel A of the material web 13, forwardly of the first deflection roll 9, whereas both of the remaining blowing or air infeed nozzles 19 and 20 are arranged between the first deflection roll pair 9, 10 and the second deflection roll pair 10, 11. By means of a flue 21 or equivalent removal device it is possible to withdraw the cooling medium out of the deflection region or zone 3.

Having now had the benefit of the foregoing description of a preferred exemplary embodiment of the invention there will now be described the mode of operation of the heretofore discussed installation or plant and the same is as follows; after passing through a conventional impregnation device the impregnated material web 13 is moved upwardly in vertical direction through the first heat treatment zone 1. The material web 13 is then impinged at both faces by the heated fluid medium which flows in counter-current. In this first heat treatment zone 1 there thus initially occurs a slow heating-up of the material web 13, as well as an evaporation of the solvent and a chemical reaction (pre-polymerization, pre-polyaddition, pre-polycondensation). The material web 13 which departs from the first heat treatment zone 1, and which is still in a tacky state, then moves between the blowing casings or chests 15 of the cooling zone 14. Due to the action of the medium which impinges the material web 13 at both of its faces this material web 13 is therefore cooled so that the chemical reaction and the tackiness is frozen.

Now in order to avoid that cooling air from the cooling zone 14 can reach the lower situated first heat or thermal treatment zone 1, the suction device 17 withdraws a greater quantity of cooling medium, due to the applied suction action, than the quantity of cooling medium which is infeed into the cooling zone 14 by means of the blowing chests or casings 15. The pressure in the cooling zone 14 is therefore less than the pressure prevailing in the first heat treatment zone 1.

The three blowing nozzles 18, 19 and 20 within the deflection or diverting region 3, as already explained, therefore impinge the material web 13 at both of its faces with cooling air, without causing a substantial onesided cooling of the material web 13 which has sufficiently been cooled in the cooling zone. The dispensable use of such blowing nozzles 18, 19 and 20 serves to ventilate the space circumvented from the material web.

After deflection of the material web 13 in the

deflection region or zone 3 the material web 13 is guided, in the direction of the arrow B, through the second heat treatment zone 2 where the chemical reaction is continued, i.e. the previously initiated chemical reaction which has started in the first heat treatment zone 1 (post-polymerization, post-polyaddition, post-polycondensation). Due to the fact that the material web enters the second heat treatment zone in the known or definable state in which it left the first heat treatment zone the heat treatment in the second zone can be controlled optimally. Prior to winding-up the material web 13 the latter, as already mentioned, is cooled, in order to rapidly bring the frequently still slightly tacky impregnation agent to room temperature and to stop the chemical process, and thus to ensure the endurance or durability of the impregnated material web 13.

The described installation is particularly suitable for the thermal treatment of fabrics and fleeces formed of organic and inorganic fibres. In particular, it is possible to prepare by means of this installation impregnated glass fibre fabrics.

As the impregnation agent there can be beneficially used, in particular, settable plastics (thermosetting plastics), for instance melamine, phenolic, polyester, epoxy and silicone resins.

The impregnated material webs which have been heat treated in the described installation are preferably further processed into laminates, as the same are used, by way of example and not limitation, in the electrical and electronic industries, for instance for printed circuits.

CLAIMS

1. A method of heat treating material webs impregnated with a thermosetting resin, wherein the impregnated material web is guided in an upward direction through a first heat treatment zone, thereafter about a deflection roll arrangement, and then is guided in a downward direction through a second heat treatment zone, the method including the step of uniformly cooling the material web, after departing from the first heat treatment zone and before passage through the deflection roll arrangement, in a cooling zone to remove tackiness and to interrupt the polymerisation reaction.

2. A method as claimed in claim 1, further including the step of applying to both faces of the material web in said cooling zone a cooling medium.

3. A method as claimed in claim 2, in which air is used as the cooling medium.

4. A method as claimed in any preceding claim, further including the step of selecting as the material web a web constituted by at least any

one of fleeces or fabrics formed of organic or inorganic fibres and impregnated with a thermosetting resin.

5. A method as claimed in any preceding claim, wherein said material web is a glass fibre fabric.

6. Apparatus for heat treating material webs impregnated with a thermosetting resin, comprising means defining a first heat treatment zone for the material web, said first heat treatment zone extending essentially from a lower region towards an upper region thereof, a deflection roll arrangement for deflecting the material web arranged following said first heat treatment zone, a second heat treatment zone arranged following said deflection roll arrangement and extending from a top region towards a bottom thereof, and means defining a uniform cooling zone arranged after said first heat treatment zone and before said deflection roll arrangement, said cooling zone being adapted to remove tackiness and to interrupt the polymerisation process.

7. Apparatus as claimed in claim 6, further including means for applying a cooling medium to both faces of said material web in said cooling zone.

8. Apparatus as claimed in claim 6 or claim 7, wherein said cooling medium-applying means serves to apply air as the cooling medium.

9. Apparatus as claimed in claim 7 or claim 8, wherein said cooling medium-applying means comprises outlet nozzles for the cooling medium arranged within the cooling zone on both sides of the path of movement of the material web and along the path of movement.

10. Apparatus as claimed in any of claims 6 to 9, further including a suction device for the cooling medium arranged in said cooling zone.

11. Apparatus as claimed in claim 10, wherein said suction device serves to maintain the pressure in the cooling zone lower than the pressure prevailing in the first heat treatment zone.

12. Apparatus as claimed in any of claims 6 to 10, wherein said apparatus is used for the heat treatment of material webs constituted by at least any one of fleeces or fabrics formed of organic or inorganic fibres and impregnated with a thermosetting resin.

13. Apparatus as claimed in claim 12, wherein said material web comprises glass fibre fabrics.

14. A method of heat treating impregnated material webs substantially as hereinbefore described with reference to the accompanying drawing.

15. Apparatus for heat treating impregnated material webs substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

deflection region or zone 3 the material web 13 is guided, in the direction of the arrow B, through the second heat treatment zone 2 where the chemical reaction is continued, i.e. the previously initiated chemical reaction which has started in the first heat treatment zone 1 (post-polymerization, post-polyaddition, post-polycondensation). Due to the fact that the material web enters the second heat treatment zone in the known or definable state in which it left the first heat treatment zone the heat treatment in the second zone can be controlled optimally. Prior to winding-up the material web 13 the latter, as already mentioned, is cooled, in order to rapidly bring the frequently still slightly tacky impregnation agent to room temperature and to stop the chemical process, and thus to ensure the endurance or durability of the impregnated material web 13.

The described installation is particularly suitable for the thermal treatment of fabrics and fleeces formed of organic and inorganic fibres. In particular, it is possible to prepare by means of this installation impregnated glass fibre fabrics.

As the impregnation agent there can be beneficially used, in particular, settable plastics (thermosetting plastics), for instance melamine, phenolic, polyester, epoxy and silicone resins.

The impregnated material webs which have been heat treated in the described installation are preferably further processed into laminates, as the same are used, by way of example and not limitation, in the electrical and electronic industries, for instance for printed circuits.

CLAIMS

1. A method of heat treating material webs impregnated with a thermosetting resin, wherein the impregnated material web is guided in an upward direction through a first heat treatment zone, thereafter about a deflection roll arrangement, and then is guided in a downward direction through a second heat treatment zone, the method including the step of uniformly cooling the material web, after departing from the first heat treatment zone and before passage through the deflection roll arrangement, in a cooling zone to remove tackiness and to interrupt the polymerisation reaction.

2. A method as claimed in claim 1, further including the step of applying to both faces of the material web in said cooling zone a cooling medium.

3. A method as claimed in claim 2, in which air is used as the cooling medium.

4. A method as claimed in any preceding claim, further including the step of selecting as the material web a web constituted by at least any

one of fleeces or fabrics formed of organic or inorganic fibres and impregnated with a thermosetting resin.

5. A method as claimed in any preceding claim, wherein said material web is a glass fibre fabric.

6. Apparatus for heat treating material webs impregnated with a thermosetting resin, comprising means defining a first heat treatment zone for the material web, said first heat treatment zone extending essentially from a lower region towards an upper region thereof, a deflection roll arrangement for deflecting the material web arranged following said first heat treatment zone, a second heat treatment zone arranged following said deflection roll arrangement and extending from a top region towards a bottom thereof, and means defining a uniform cooling zone arranged after said first heat treatment zone and before said deflection roll arrangement, said cooling zone being adapted to remove tackiness and to interrupt the polymerisation process.

7. Apparatus as claimed in claim 6, further including means for applying a cooling medium to both faces of said material web in said cooling zone.

8. Apparatus as claimed in claim 6 or claim 7, wherein said cooling medium-applying means serves to apply air as the cooling medium.

9. Apparatus as claimed in claim 7 or claim 8, wherein said cooling medium-applying means comprises outlet nozzles for the cooling medium arranged within the cooling zone on both sides of the path of movement of the material web and along the path of movement.

10. Apparatus as claimed in any of claims 6 to 9, further including a suction device for the cooling medium arranged in said cooling zone.

11. Apparatus as claimed in claim 10, wherein said suction device serves to maintain the pressure in the cooling zone lower than the pressure prevailing in the first heat treatment zone.

12. Apparatus as claimed in any of claims 6 to 10, wherein said apparatus is used for the heat treatment of material webs constituted by at least any one of fleeces or fabrics formed of organic or inorganic fibres and impregnated with a thermosetting resin.

13. Apparatus as claimed in claim 12, wherein said material web comprises glass fibre fabrics.

14. A method of heat treating impregnated material webs substantially as hereinbefore described with reference to the accompanying drawing.

15. Apparatus for heat treating impregnated material webs substantially as hereinbefore described with reference to, and as shown in, the accompanying drawing.

