

Description

The present invention relates to a method of producing remoldable self-supporting thin panels.

Thin panels of this type are known per se and, typically, have a thickness between 1 and 5 mm, preferably between 1.5 and 3 mm. They are "self-supporting" in the sense of maintaining their shape under loads typical of their intended end use, such as when used as furniture components or as shaped panels in automobiles, e.g. as inner door casings; furthermore, they are "re-moldable" in the sense that they can be shaped into most any required three-dimensional shape when heated or reheated to a thermoplastic state and processed in a conventional molding press, e.g. as disclosed in U.S. Patents Nos. 4,243,456 and 4,328,067 with or without concurrent coating by lamination.

Such panels, in addition to their remoldability, must have a substantial mechanical strength combined with low weight while consisting essentially but of low-cost components. These somewhat contradictory requirements can be met by using polymer/filler compositions in which the polymer constituent imparts the required thermoplasticity combined with high mechanical strength (tenacity) while the filler should be capable of being used in substantial proportions, say 30 to 70 % by weight of the total composition, in combination with the polymer without impairing its essential characteristics and without adding much in terms of weight and costs.

Particulate, i.e. comminuted, wood of the type known as "wood flour" or "saw-dust" and other organic substances preferably of the cellulosic type are known to meet these requirements, notably when used with high tenacity polymers, such as typically polypropylene of the homo- or heteropolymeric and frequently isotactic kind. However, molecular structures that yield high tenacity polymers tend to have relatively high "softening temperatures", i.e. the temperature at which they can be processed in their thermoplastic state, and typical processing temperatures of such polymers are in the order of 180 to 220°C. Organic fillers of the cellulosic type, on the other hand, are not stable when exposed to such temperatures in that they tend to decompose at these temperatures and are termed "thermosensitive" herein for short to generally refer to organic fillers that would otherwise be suitable or desirable for use in production of panels because they meet the above aims but are degraded or decomposed at the processing temperatures dictated by the high tenacity polymers.

As is known, e.g. from US-A-4,228,116, thermosensitive cellulosic fillers, such as saw dust, can be used for production of panels by the above described method if, prior to extrusion, an aggregated or agglomerated mixture ("premix") of particulate polymer and particulate filler is formed and if such mixture is

introduced into the extruder. If the step of preparing the premix is omitted, the resulting extrudate tends to have insufficient coherence and/or has an uncontrolled cellular structure caused by voids that are formed due to inclusion of vapor bubbles of gaseous decomposition products including water that is strongly absorbed or chemically bound to the molecular structure of the organic filler within the polymer matrix around the filler particles.

Further, EP-A-0 292 584 discloses co-rotational extruders for processing of polymer compositions including, among others, polypropylene in mixture with organic filler including saw dust. Problems of thermal decomposition are not mentioned and no operational example of processing such a mixture is disclosed.

EP-A-0 172 436 discloses production of webs consisting essentially of polypropylene in admixture with wood filler by first forming a stream of molten polypropylene and then introducing the wood filler downstream. While the extruder is provided with two screws, their configuration is not disclosed; since feeding of the wood constituent requires a separate extruder, it can be concluded that the screws according to EP-A-0 172 436 operate counter-rotational, and that a conventional configuration of the screws without alternating kneading and conveying sections was used.

Accordingly, it is a main object of the present invention to provide for an improved method of the type specified in the preamble of claim 1.

The method according to the invention is characterized by the features defined in the characterizing part of claim 1.

The terms "co-rotating" or "co-rotation" as used herein are intended to refer to rotation of both elongated elements in the same direction of rotation, preferably, but not necessarily, at substantially the same speed, typically in the range of from 50 to 500 rpm and preferably in the range of from about 100 to about 400 rpm depending to some extent upon the length/diameter ratio of the elongated elements. The meaning of "co-rotation" as used herein is the opposite of the rotation in conventional twin-screw extruders that are operated with counter rotating screws.

Each elongated element used according to the invention defines, when in rotation, an essentially cylindrical space having a length/diameter ratio (L/D) in the range of from 15:1 to 45:1, preferably 20:1 to 32:1 with typical diameters in the range of from about 40 mm to about 150 mm.

According to a generally preferred embodiment of the inventive method, the two elongated elements each define, when in rotation, cylindrical spaces of equal diameter; generally, the two rotation-defined cylindrical spaces will have at least some overlap, typically between 10 and 20 % of each diameter, and the integral mixing and extruding space used in the method according to the invention will preferably

have a shape in general correspondence therewith, i.e. one defined by two parallel cylinders of equal diameter that overlap each other in a significant portion, e.g. with an overlap of 5 to 30 % and preferably 10 to 20 % of the diameter for each cylinder. Generally, the distance between the rotation-defined cylindrical spaces of the elongated elements and the integral mixing and extruding space will be small, e.g. in the range of from 0.2 to 2 mm.

The terms "feedingly effective" and "essentially non-feeding" as used herein in connection with the extrusion sections and the kneading sections are intended to indicate that the sections of the elongated elements so identified should cause (feeding), or not cause (non-feeding) significant motion of the mass within the extrusion space towards the extrusion end thereof. Kneader-generated local movement of the mass within the extrusion space in the opposite direction, i.e. toward the feeding end of the extrusion chamber, is not excluded but not preferred while significant and essentially circular turbulent motion caused by the kneader sections of the elongated elements in the kneader zones of the integral mixing and extruding space is believed to be most desirable. It is to be noted immediately that the mass within the integral mixing and extruding space will, of course, be in continuous motion both in the extrusion zones as well as in the kneading zones with a net motion of the mass from the feeding end to the extrusion end thereof.

Yet, while the extrusion sections of the elongated elements and the extrusion zones formed by them upon co-rotation should generate a strong momentum of motion of the mass towards the extrusion end and through the nozzle generally provided there, the kneading sections of the elongated elements and the kneading zones formed by them upon co-rotation should not significantly contribute to the forward momentum of the extruded mass.

"Non-feeding movement", in other words, may have any effect upon the mass processed within the extruder except that of forcing it into the direction towards the extrusion end. Absence or existence of a contribution to the momentum of movement of the extruded mass by a given type of machine element can be easily determined by operating an isolated section (i.e. without adjacent screw-feeding elements) in a test installation and observing the resulting motion of a mass processed therein.

"Feedingly effective", on the other hand, is intended to indicate the result of co-rotating helical elements of the type used for extrusion of plastic, typically the screw-type rotating beams of conventional extruders. It should be noted that co-rotational extruders are known per se so that a detailed discussion of the extrusion section and zones is not required herein.

According to a preferred embodiment the inven-

tive method comprises providing four feedingly effective helical extrusion sections and three interposed non-feeding kneading sections on each elongated element so as to produce a total of four extrusion zones with three kneading zones provided between them. If an additional constituent, e.g. a second filler, of the composition of the extruded panel is to be introduced into the integral mixing and extrusion space, this is done so in the area of an additional (fourth) extrusion zone separated by one (additional) kneading zone from the extrusion zone connected with the venting means.

The invention will be explained in more detail with reference to the annexed drawings illustrating but not limiting the invention and wherein

Figures 1A, 1B and 1C illustrate various views of a typical segment for forming the helical extrusion sections of the elongated elements according to the invention;

Figures 2A, 2B and 2C illustrate various views of a typical segment for forming the non-feeding kneading sections of the elongated elements according to the invention;

Figure 3 is a cross-sectional view of a non-feeding kneading section in an integral mixing and extruding space or chamber according to the invention;

Figures 4A and 4B are diagrammatic illustrations of a preferred embodiment of the integral mixing and extruding space or chamber according to the invention;

Figure 5 is a length diagram.

Fig. 1A is a side-view of a typical monolithic segment 10 for forming helical extrusion sections. Each segment 10 has a bore 11 provided with an elongated recess or groove 12 so that a sufficient number of segments 10 can be arranged on a shaft (not shown). The angle of the helical threads 13 as well as the shape and depth of the helical groove 14 are typical but are not considered to be critical, and proper selection is well within the knowledge of one skilled in the plastics extrusion art. Also, while segments 10 are shown with a double-helical thread, this is a matter of convenience. Generally, it is desirable that adjacently arranged segments 10 will form feedingly effective and, hence, sufficiently continuous extrusion sections of the elongated elements. As is apparent, Fig. 1C is a sectional view along line A-A of Fig. 1A while Fig. 1B is a front view.

Fig. 2A is a side-view of a non-feeding kneading segment 20 that has a bore 21 and groove 22 of the same type as the helical segment 10. Again, a desired number of segments 20 can be arranged on the shaft (not shown) of the elongated element according to the invention. The shape as well as the dimension and displacement of the excenter portions 23 and the shape of the side faces 24 as shown are typical and preferred for many purposes but not believed to be

critical.

Again, the view of the kneader segment 20 shown in Fig. 2C is a sectional view along A-A of the side-view of Fig. 2A while Fig. 2B is a front view.

Fig. 3 is a cross-sectional view of an integral mixing and extruding space or chamber 30 consisting of two joined and mutually overlapping cylindrical portions 301, 302 arranged within a housing 39 that will include conventional heating means (not shown).

Two shafts 37, 38 with an elongated securing ridge 371, 381 each rotate in the same direction as indicated by arrows X, Y and cause the excenters 23 to rotate and effect the essentially non-feeding kneading effect that will be generated by the elongated elements having kneading sections each composed of a predetermined number of segments 20 between adjacent helical extrusion sections each composed of a predetermined number of segments 10.

Figures 4A and 4B are schematic views of an integral mixing and extruding space 40 according to the invention. Fig. 4A is the side-view illustrating a preferred embodiment having four extrusion zones 41, 42, 43, 44 and three intermediate non-feeding kneading zones 45, 46, 47.

The extrusion zones and the kneading zones are formed by the pair of elongated elements 48, 49 extending from the feeding end FE to the extrusion end EE of integral space 40. The elements 48, 49 will co-rotate because of the action of shafts 401, 403 which, in turn, are actuated by a suitable drive means 402.

According to the invention, high tenacity, high melting polypropylene will be introduced into the first feedingly effective helical extrusion section 41 via a first opening 410 near feeding and FE while wood filler will be introduced into the second feedingly effective section 42 via second opening 420 after the polymer has passed through the first non-feeding kneading section 45.

The mixture of polypropylene and wood filler is formed and homogenized in the second helical extrusion section 42 and the subsequent second non-feeding kneading section 46.

A preferred but optional further helical extrusion section 43 follows for optional introduction of a second filler, e.g. short fibers of mineral glass or the like via opening 430. On the other hand, the venting means 440 connected with the last or "third essential" helical extrusion section 44 nearest the extrusion end EE of space or chamber 40 is believed to be essential for most embodiments of the invention.

Fig. 5 is a diagrammatical view of an elongated element 60 extending from the feeding end FE of a space or chamber 61 to the extrusion end EE thereof. Polypropylene is introduced at 62 in the area of a first extrusion zone 601 near the feeding end FE and passes through the first non-feeding kneading zone 605.

At a distance of typically about 10 diameters D,

the wood will be introduced into the second extrusion zone 602 and pass, with the plastified polypropylene, through the next kneading zone 606. If an additional filler is introduced, this should be done at some distance from the opening where the wood is introduced, typically at a distance that is almost as great as that between the entry of the polypropylene and the entry of the wood filler, e.g. 9.5 diameters.

Another non-feeding kneading zone 607 follows before the extruder mass reaches the last extrusion zone 603 nearest the extrusion end EE. Preferably, this last or "third" (i.e. third essential) extrusion zone should have a length that is about equal to the length of the first extrusion zone 601, i.e. about 6 diameters.

Preferably, the length of the second kneading zone 606 is greater than that of any other kneading sections, e.g. 4 to 5 diameters.

Many modifications of the above examples will be apparent to one experienced in the art and the scope of the invention is not to be understood as limited to any specific example given herein for illustration.

Claims

1. A method of producing remoldable self-supporting thin panels consisting essentially of a polymer/filler composition, said method using an apparatus with an integral mixing and extruding space (40) having a feeding end (FE) and an extrusion end (EE) and comprising a pair of co-rotating and mutually co-acting elongated elements (47, 48) arranged essentially in parallel and each having:
 - a length extending essentially between said feeding end and said extrusion end of said space; at least three feedingly effective helical extrusion sections (41, 42, 43) mutually distanced along said length;
 - at least two essentially non-feeding kneading sections (45, 46) each of which is positioned between adjacent extrusion sections;
 - said kneading sections and said extrusion sections of each of said elongated elements being provided substantially at radially adjacent positions along said length to form in said space at least two kneading zones and at least three extrusion zones so as to provide one kneading zone between adjacent extrusion zones;
 - in which said polymer consists, at least in part, of polypropylene having a softening temperature of above 150°C and wherein said filler consists, at least in part, of particulate wood;
 - said method comprising the steps of (a) forming a mixture of said polymer and said filler, (b) extruding said mixture to form a web and (c) calendering said web prior to its solidification;



critical.

Again, the view of the kneader segment 20 shown in Fig. 2C is a sectional view along A-A of the side-view of Fig. 2A while Fig. 2B is a front view.

Fig. 3 is a cross-sectional view of an integral mixing and extruding space or chamber 30 consisting of two joined and mutually overlapping cylindrical portions 301, 302 arranged within a housing 39 that will include conventional heating means (not shown).

Two shafts 37, 38 with an elongated securing ridge 371, 381 each rotate in the same direction as indicated by arrows X, Y and cause the excenters 23 to rotate and effect the essentially non-feeding kneading effect that will be generated by the elongated elements having kneading sections each composed of a predetermined number of segments 20 between adjacent helical extrusion sections each composed of a predetermined number of segments 10.

Figures 4A and 4B are schematic views of an integral mixing and extruding space 40 according to the invention. Fig. 4A is the side-view illustrating a preferred embodiment having four extrusion zones 41, 42, 43, 44 and three intermediate non-feeding kneading zones 45, 46, 47.

The extrusion zones and the kneading zones are formed by the pair of elongated elements 48, 49 extending from the feeding end FE to the extrusion end EE of integral space 40. The elements 48, 49 will co-rotate because of the action of shafts 401, 403 which, in turn, are actuated by a suitable drive means 402.

According to the invention, high tenacity, high melting polypropylene will be introduced into the first feedingly effective helical extrusion section 41 via a first opening 410 near feeding and FE while wood filler will be introduced into the second feedingly effective section 42 via second opening 420 after the polymer has passed through the first non-feeding kneading section 45.

The mixture of polypropylene and wood filler is formed and homogenized in the second helical extrusion section 42 and the subsequent second non-feeding kneading section 46.

A preferred but optional further helical extrusion section 43 follows for optional introduction of a second filler, e.g. short fibers of mineral glass or the like via opening 430. On the other hand, the venting means 440 connected with the last or "third essential" helical extrusion section 44 nearest the extrusion end EE of space or chamber 40 is believed to be essential for most embodiments of the invention.

Fig. 5 is a diagrammatical view of an elongated element 60 extending from the feeding end FE of a space or chamber 61 to the extrusion end EE thereof. Polypropylene is introduced at 62 in the area of a first extrusion zone 601 near the feeding end FE and passes through the first non-feeding kneading zone 605.

At a distance of typically about 10 diameters D,

the wood will be introduced into the second extrusion zone 602 and pass, with the plastified polypropylene, through the next kneading zone 606. If an additional filler is introduced, this should be done at some distance from the opening where the wood is introduced, typically at a distance that is almost as great as that between the entry of the polypropylene and the entry of the wood filler, e.g. 9.5 diameters.

Another non-feeding kneading zone 607 follows before the extruder mass reaches the last extrusion zone 603 nearest the extrusion end EE. Preferably, this last or "third" (i.e. third essential) extrusion zone should have a length that is about equal to the length of the first extrusion zone 601, i.e. about 6 diameters.

Preferably, the length of the second kneading zone 606 is greater than that of any other kneading sections, e.g. 4 to 5 diameters.

Many modifications of the above examples will be apparent to one experienced in the art and the scope of the invention is not to be understood as limited to any specific example given herein for illustration.

Claims

1. A method of producing remoldable self-supporting thin panels consisting essentially of a polymer/filler composition, said method using an apparatus with an integral mixing and extruding space (40) having a feeding end (FE) and an extrusion end (EE) and comprising a pair of co-rotating and mutually co-acting elongated elements (47, 48) arranged essentially in parallel and each having:
 - a length extending essentially between said feeding end and said extrusion end of said space;
 - at least three feedingly effective helical extrusion sections (41, 42, 43) mutually distanced along said length;
 - at least two essentially non-feeding kneading sections (45, 46) each of which is positioned between adjacent extrusion sections;
 - said kneading sections and said extrusion sections of each of said elongated elements being provided substantially at radially adjacent positions along said length to form in said space at least two kneading zones and at least three extrusion zones so as to provide one kneading zone between adjacent extrusion zones;
 - in which said polymer consists, at least in part, of polypropylene having a softening temperature of above 150°C and wherein said filler consists, at least in part, of particulate wood;
 - said method comprising the steps of (a) forming a mixture of said polymer and said filler; (b) extruding said mixture to form a web and (c) calendaring said web prior to its solidification;



wherein said mixture is formed and extruded in a single step by feeding said polypropylene and said wood into said integral mixing and extruding space,

and wherein a part, at least, of said polypropylene is introduced into said space at a portion thereof in the area of a first extrusion zone (41) located near said feeding end, characterized in that a portion, at least, of said wood is introduced into said space at a portion thereof in the area of a second extrusion zone (42) situated closer to said extrusion end than said first extrusion zone.

2. The method according to claim 1 wherein the extrusion zone nearest the extrusion end of said space is connected with a venting means (440) for removing vapors formed within said space (40).
3. The method according to claim 1 or 2 wherein each of said elongated extrusion elements (47,48) comprises four of said extrusion sections and three of said non-feeding kneading sections.
4. The method according to claims 2 and 3 wherein at least one additional constituent is introduced into said integral mixing and extrusion step in an area of an extrusion section situated next to said extrusion zone that is connected with said venting means.
5. The method according to any of the preceding claims 1 to 4 wherein said polypropylene is selected from polymers and copolymers of propylene and wherein said wood filler consists essentially of finely comminuted wood.

Patentansprüche

1. Verfahren zur Herstellung von wiederverformbaren selbsttragenden dünnen Platten, die im wesentlichen aus einer Polymer/Füller-Masse bestehen, bei welchem Verfahren eine Vorrichtung mit einem integralen Misch- und Extrusionsraum (40) verwendet wird, der ein Einspeisungsende (FE) und ein Extrusionsende (EE) hat und ein Paar ko-rotierender und miteinander zusammenwirkender länglicher Elemente (47, 48) umfasst, die im wesentlichen parallel angeordnet sind und jeweils aufweisen:
 - eine Länge, die sich im wesentlichen zwischen dem Einspeisungsende und dem Extrusionsende des Raumes erstreckt;
 - mindestens drei speisungswirksame spiralförmige Extrusionsabschnitte (41, 42, 43), die in Längsrichtung voneinander beabstandet sind;

- mindestens zwei im wesentlichen nicht-speisungswirksame Knetabschnitte (45, 46), die jeweils zwischen benachbarten Extrusionsabschnitten liegen, wobei die Knetabschnitte und die Extrusionsabschnitte jedes der länglichen Elemente sich in Längsrichtung im wesentlichen in radial benachbarten Positionen befinden, um in dem Raum mindestens zwei Knetzonen und mindestens drei Extrusionszonen zu bilden, so dass zwischen benachbarten Extrusionszonen jeweils eine Knetzone liegt; wobei das Polymer mindestens teilweise aus Polypropylen mit einer Erweichungstemperatur von über 150°C und der Füller mindestens zum Teil aus teilchenförmigem Holz besteht; mit folgenden Verfahrensschritten: (a) Bilden einer Mischung aus dem Polymer und dem Füller, (b) Extrudieren der Mischung zur Bildung einer Bahn und (c) Kalandrieren der Bahn vor ihrer Verfestigung; wobei die Mischung in einem einzigen Schritt durch Einspeisen des Polypropylens und des Holzes in den integralen Misch- und Extrusionsraum gebildet wird, und wobei mindestens ein Teil des Polypropylens im Bereich einer ersten Extrusionszone (41) nahe dem Einspeisungsende in den Raum eingespeist wird,

dadurch gekennzeichnet, dass mindestens ein Teil des Holzes in den Raum an einem Teil desselben im Bereich einer zweiten Extrusionszone (42) eingeführt wird, die näher am Extrusionsende angeordnet ist als die erste Extrusionszone.

2. Verfahren nach Anspruch 1, bei welchem die dem Extrusionsende nächste Extrusionszone des Raumes mit einem Belüftungsmittel (440) zur Entfernung von Dämpfen verbunden ist, die sich im Raum (40) bilden.
3. Verfahren nach Anspruch 1 oder 2, bei welchem jedes der länglichen Extrusionselemente (47, 48) vier Extrusionsabschnitte und drei nicht-speisend wirkende Knetabschnitte aufweisen.
4. Verfahren nach Anspruch 2 oder 3, bei welchem in den integralen Misch- und Extrusionsschritt im Bereich eines Extrusionsabschnittes nahe der mit Belüftungsmitteln verbundenen Extrusionszone mindestens eine zusätzliche Komponente eingeführt wird.
5. Verfahren nach einem der vorangehenden Ansprüche 1 bis 4, bei welchem das Polypropylen gewählt ist aus Polymeren und Copolymeren von Propylen und der Füller im wesentlichen aus feinteiltem Holz besteht.



Revendications

1. Procédé de fabrication de panneaux fins redéformables consistant essentiellement d'une composition polymère/matière de remplissage, ladite méthode utilisant un appareil présentant un espace intégral de mélange et d'extrusion 40 ayant une extrémité d'alimentation (FE) et une extrémité d'extrusion (EE) et comprenant une paire d'éléments allongés co-rotationnels et mutuellement co-agissants (47, 48), disposés essentiellement en parallèle et présentant chacun:
 - une longueur s'étendant essentiellement entre ladite extrémité d'alimentation et ladite extrémité d'extrusion dudit espace;
 - au moins trois sections hélicoïdales d'extrusion, d'alimentation effective (41, 42, 43), réparties à distance les unes des autres le long de cette longueur;
 - au moins deux sections (45, 46) essentiellement de malaxage et non d'alimentation, chacune étant disposée entre des sections d'extrusion adjacentes;
 - lesdites sections de malaxage et lesdites sections d'extrusion de chacun desdits éléments allongés étant prévues substantiellement à des questions radialement adjacentes le long de ladite longueur, afin de constituer à l'intérieur dudit espace au moins deux zones de malaxage et au moins trois zones d'extrusion de sorte qu'une zone de malaxage soit située entre des zones d'extrusion adjacentes;
 - [procédé] dans lequel ledit polymère consiste, au moins en partie, de polypropylène ayant une température de ramolissement de plus de 150 °C, et dans lequel ledit matériau de remplissage consiste, au moins en partie, de bois sous forme de particules;
 - ledit procédé comprenant les opérations de (a) formation d'un mélange dudit polymère et de ladite matière de remplissage, (b) extrusion dudit mélange afin de former une feuille, et (c) calendrage de ladite feuille avant sa solidification;
 - dans lequel ledit mélange est formé et extrudé en une seule opération en amenant ledit polypropylène et ledit bois dans ledit espace intégral de mélange et de malaxage; et dans lequel une partie, au moins, dudit polypropylène est introduit dans ledit espace au niveau d'une portion de celui-ci située au niveau de la première zone d'extrusion (41) située près de ladite extrémité d'alimentation, caractérisé en ce qu'une portion, au moins, dudit bois est introduite dans ledit espace au niveau d'une partie de celui-ci située au niveau d'une seconde zone d'extrusion (42) disposée plus près de ladite extrémité d'extrusion que ladite première zone d'extrusion.
2. Procédé selon la revendication 1 dans lequel la zone d'extrusion la plus proche de l'extrémité d'extrusion dudit espace est reliée à un moyen de ventilation (440) afin d'évacuer les vapeurs formées à l'intérieur dudit espace (40).
3. Procédé selon la revendication 1 ou 2 dans lequel chacun desdits éléments allongés d'extrusion (47, 48) comprend quatre desdites sections d'extrusion et trois desdites sections de malaxage et non d'alimentation.
4. Procédé selon les revendications 2 et 3 dans lequel au moins un constituant additionnel est introduit au cours de ladite étape intégrale de mélange et d'extrusion au niveau d'une zone d'une section d'extrusion située à côté de ladite zone d'extrusion qui est reliée audit moyen de ventilation.
5. Procédé selon l'une des revendications 1 à 4 précédentes dans lequel ledit polypropylène est sélectionné parmi les polymères et les copolymères de propylène, et dans lequel ledit bois de remplissage est constitué essentiellement de bois finement broyé.