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(54) **Title:** PROCESS AND PLANT FOR THE PRODUCTION OF COMPOSITE THERMOPLASTICS AND MATERIALS THUS OBTAINED

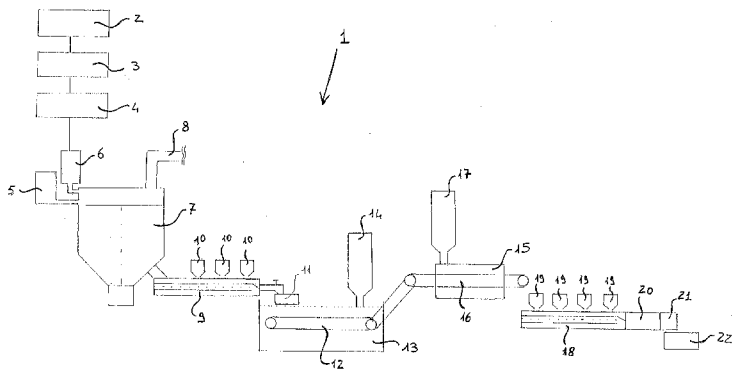


FIG. 1

(57) **Abstract:** The present invention concerns a process and a plant for the production of composite thermoplastic materials with a very high content of filler, starting from materials normally disposed in landfill or sent for incineration, or in any case for uses with a low added value, by preparation of a solution in at least one organic solvent of a polymer selected between polystyrene, ABS, polyvinylidene fluoride and other polymers soluble in organic solvents; blending with the solution of polymers thus obtained at least one filler material; removal of the organic solvent from the blend of filler materials and polymers to obtain a filled thermoplastic material.

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"Process and plant for the production of composite thermoplastics and materials thus obtained"

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Background of the invention

The present invention concerns a process and a plant for the production of thermoplastic composites and materials made therefrom.

More in particular, the present invention concerns a process in which thermoplastic materials and fillers are blended to produce a composite material in which at least one between the thermoplastic material or materials and the filler o fillers are recycled material, at least in part.

In this description, by composite thermoplastic materials we mean materials consisting of an "emulsion" of filler particles of various forms and natures in rigid or flexible thermoplastic polymers. These materials combine the low density, typical of plastic materials, with the rigidity and strength of the fillers, both as particles and as fibrous reinforcements and with acceptable costs; for this reason they are now widely used in sectors such as means of transportation by land, sea and air, in building construction, furnishing and alike.

Composite materials consisting of a resin matrix and a reinforcing component that can be of various kinds, such as powders ($CaCO_3$, etc.) fibers (glass, polymers, graphite), ranging from 30 to 60% by weight, are known; for economic reasons, in the most widely used composites the fibrous component consists of glass fibers (which may be long or short), while for reasons of resistance to high temperatures the polymer matrix often consists of thermosetting materials; thermoplastic composites filled with 30-50% (w/w) of short fibers, particularly in the automotive sector, are known.

The object of the present invention is thermoplastic composite materials. One particular object of the invention is materials in which at least part of the polymers or filler, or both, is recycled materials.

In the list of recycled materials known and usable in this invention we can consider: homogeneous regenerated polymers in the form of PP, PE, PET,

PUR, PA, PS-EPS, ABS, PC, PMMA, PVC, etc. deriving from process waste as well as from selective waste collection from different product sectors such as packaging (films, bottles, drums, shopping bags, etc.), agriculture (films for greenhouses covering, films for silage, irrigation hoses, etc.), textiles (tubes for yarn cones, synthetic fibers, nonwoven fabrics, etc.), motor vehicles (dashboards, tank, bumpers and padding, exhausted batteries, etc.), electrical/electronic appliances (TV cases, refrigerators, computers, etc..), containers for environmental hygiene (waste bins, bells, etc.), building construction and furniture (films, pipes and joints, window frames, fittings, etc.); heterogeneous regenerated polymers consisting of different polymer matrixes mainly coming from selective waste collection.

These recycled materials can be in the form of granules, pellets, flakes, ground materials, micronized materials, semifinished products (such as bars and sheets, etc.).

The fillers known and used for this invention can be in powder form, granules or fibers, and can be of mineral, vegetable or even animal nature. These fillers can perform different functions, from increasing rigidity, thermoregulation, phonoregulation, resistance to abrasion, fire, ultraviolet rays, etc. to mere pigmentation and cost reduction. In general, the most widely used fillers are mineral- or fibrous-based of vegetable origin, but often they are also obtained from other production cycles, after being ground, granulated or treated in other ways, such as inert materials like ash obtained from energy production plants and waste materials from construction activities.

The use, in this invention, of this secondary raw material (recycled), valorized by being compounded with resins, either virgin or also recycled, can represent a strategy capable of giving added value to the material and developing its potential fully. In addition to the fillers based on coal ash from power plants, other types of manufacturing waste or products and by-products of agriculture and industry can be used, such as ash from biomasses with or without pretreatment, sand and quarry dust, metal powders, acetone-insoluble polymers, sawdust, fibrous waste and residues from agriculture, construction

materials, textile scraps, residues from leather tanning and in general anything that normally can be considered as a cost since it must be disposed in landfill and often in special landfill sites. By means of this invention, all these products can be steadly and structurally incorporated in new products.

Highly limiting problems in the production of products from recycled materials are given by the limits imposed by the used technology in combinations with the requisites of the standards that define whether or not a product can be qualified as recycled. For example, to be defined as recycled, a blown product made from HDPE must be produced using at least 50% granules of recycled HDPE (high density polyethylene), in turn containing no less than 95% post-consumption plastics (i.e. materials from selected waste collection) while a product made of PET (Polyethylene Terephthalate) by injection molding must be produced using at least 70% granules or flakes of recycled PET, in turn containing not less than 95% post-consumption plastics.

Another problem is caused by the fact that materials from selected waste collection comprise different types of blended polymers and it is therefore difficult to recycle the above-mentioned blends of heterogeneous polymers as they are often composed of polymers that are incompatible.

The known techniques for processing materials to be recycled normally used require chemical reactions and high cost procedures. The aim of this invention is to obtain materials with a thermoplastic matrix and very high filler content, using simple chemical-physical procedures that do not involve any chemical reactions, preferably starting from materials normally destined to be disposed in landfill, or incinerated, or in any case used for products having a low added value.

A further aim of this invention is to obtain stable materials which can be processed in machines that are normally used for injection molding and with low costs. Still a further aim of the present invention is to provide an industrial process at low energy and economic cost.

Another aim of the invention is to provide a process that will permit recycling of plastics from urban and industrial waste.

Another aim of this invention is to provide a plant for the production of composite thermoplastic materials with very high filler content.

Summary of the invention

These and other aims are achieved by this invention which concerns a process according to claim 1.

Further objects of the present invention are the products obtainable with this process, as characterized according to claim 9, and the treatment plant for production of these composite thermoplastic materials, as characterized according to claim 13.

The thermoplastic composite materials obtained in accordance with this invention comprise preferably more than 60% by weight of filler with respect to the end product (free of organic solvents and dried) and may contain up to about 94-95% by weight of filler with respect to the composite material. The end product effectively consists of an emulsion of fillers in the solubilized polymer matrix and is therefore endowed with a uniform structure as the fillers are uniformly distributed in the thermoplastic. This differentiates it from products with high filler content already known in the art, where the fillers are irregularly distributed in the polymer.

According to the invention, up to about 50% of the filler can be produced with polymers different from and incompatible with the materials used for the base in solution (PS, ABS polyvinylidene fluoride). The polymers used as filler generally (and preferably) have a glass transition temperature lower than that of polystyrene (PS) and make it possible, in addition to or in substitution of ABS, to provide the resulting composite material with characteristics of flexibility and tenacity that PS alone is incapable of. In this connection, it is important to note that the filled composite obtained with the invention is generally extruded or drawn and in any case subjected to a process of plastification and subsequent granulation, a process that leads to better amalgamation of the incompatible polymers with the polymer base.

Thanks to the process used, moreover, the high quantity of filler is dispersed uniformly in the polymer base so as to obtain, in effect, an emulsion of

particles of various size and nature, in rigid or flexible thermoplastic polymers the binder of which ensures their uniformity at the micro and macroscopic level. The filler, which can be composed of various types of materials, contributes to the attainment and maintenance of its technological properties.

According to an advantageous aspect of this invention, the process employed makes it possible to obtain the compatibility of different polymers, that is, to obtain a homogeneous material composed of different polymers, by including polymer materials in the PS and/or ABS base in solution, in the form of "thermoplastic filler", preferably in granular form with dimensions of less than 0.1 mm.

More in general, the fillers (inorganic or not) used have a granulometry in the range between 0.003 mm and 0.5 mm, with preference up to 0.1 mm.

In general, the quantity of "thermoplastic filler" is between 0% and 50% of the total filler of the blend. Polymers suitable for transformation into thermoplastic filler (that is to say a filler of thermoplastic materials, for example HDPE, PP, PET (polyethylene terephthalate), PBT (polybutylene terephthalate), PA6, PA66 (polyamide 6 and 66), POM (polyoximethylene).

In a further version of the invention, the filler consists entirely of the above-mentioned thermoplastic materials (that is, there is only the "thermoplastic filler"), in the desired granulometry. In this embodiment, the process makes it possible to obtain the compatibility of different polymers for a macroscopically heterogeneous end product, whose properties will depend on the composition used.

According to another advantageous aspect of this invention, the process used makes it possible to produce the composite materials processable at low temperatures.

According to another advantageous aspect of this invention, the process employed does not imply significant changes to the traditional systems and machinery used for molding the polymers, other than a different organization of the production line.

According to another advantageous aspect of this invention, the process

employed makes it possible to obtain high quality esthetic effects.

Brief description of the figures

The invention will now be described, by way of example and without limitation, with reference to the enclosed drawing in which:

- Figure 1 shows the layout of the plant according to a preferred embodiment of the invention

Description of the preferred embodiments.

With reference to fig. 1, the plant 1 according to the invention for the production of composite thermoplastic materials with a very high filler content comprises a coarse grinder 2, a metal separator 3; a fine grinder 4; a system 5 for feeding the emulsifying substances; a mechanical feeder 6 for plastic material in granular form or as secondary raw material, after being ground, crushed, flaked, etc.; a silos 7 with vertical mixing auger conveyor in stainless steel equipped with a suction system 8 for the recovery of fumes; a mixing system 9; a dosage system 10 using a system of load cells; a crusher/cuber 11; a conveyor belt 12 with a stainless steel tank 13 equipped with a temperature control system; a suction system 14 for the recovery of fumes; a ventilated furnace 15 with an internal conveyor system 16 and fume recovery 17; a complete extrusion system 18, with a gravimetric dosage system 19 provided with load cells for the addition of additives; a cooling system 20; a cutter 21; and a bagging machine 22.

The materials to be recycled are initially fed into in the coarse grinder 2, then passed into system 3 where they are separated from metals, and finally ground in the fine grinder 4.

The granules of ground plastic material are conveyed, by a mechanical feeder 6, in a stainless steel silos 7 in which the emulsifying substances are also fed by a feeding system 5 so as to achieve the solubilization of the polymers in organic solvent and to obtain an emulsion.

Said stainless steel silos 7 is equipped with a mixing auger conveyor and a suction system 8 for recovery of fumes. As they leave the silos, the solubilized polymers are cold mixed with the inert fillers in powder form in a

mixing system 9 in order to obtain a homogeneous product. The inert materials and additives making up the filler components are added by means of a load-cell dosage system 10.

The product obtained is passed through a cuber/crusher 11 for optimized cutting of the semi-finished materials loaded; however this passage is not strictly necessary since many processing machine will accept even irregular shapes of material. Alternatively, the mixture in acetone can be poured into water with mechanical paddle stirring so as to break the mass into small fragments.

The cubed/crushed material is passed in water into a stainless steel tank 13, equipped with a temperature control system, on a conveyor belt 12 also immersed in water. In this step, there is also a suction system 14 for fume recovery. After the passage in water, the material is conveyed by the belt 16 into a ventilated furnace 15 provided with a fume recovery system 17.

After it has been dried, the material is drawn at a temperature above 200° C by sending it through an extruder 18, preferably equipped with a double counter-rotating screw, where other additives can be added by a gravimetric dosage system 19 provided with load-cells, to characterize the final products, such as pigmentation additives. On exiting the extruder 18 the material is cooled in water by a cooling system 20, then passed through a cutter 21 and finally packaged by a bagging machine 22.

The process according to the invention provides for creating a solution of polymeric thermoplastic base in which one or more filler materials can be dispersed and removing the organic solvent from the blend thus obtained by evaporation or water extraction. The polymers used to prepare the solution are PS (polystyrene), ABS and other polymers, such as polyvinylidene fluoride, which can be solubilized in volatile organic solvents and preferably in the solvents indicated here below. More in particular, suitable solvents are aliphatic ketones, aromatic ketones, amide solvents, aliphatic and aromatic chlorinated solvents. Most preferably, the organic solvent employed is selected between acetone and other water-miscible solvents or mixtures

thereof, in consideration of their low environmental impact, ease of removal and condensability, low cost.

The fillers usable have been discussed in detail above, in particular we indicate the possibility of using a thermoplastic filler of incompatible polymers, ground to a granulometry between 0.003 and 0.1 mm, either in combination with other fillers (minerals, fibers, etc.) or alone.

The process continues then with removal of the organic solvents from the filled blend; said removal can be accomplished by evaporation (necessarily when water-immiscible solvents like chlorinated solvents are used) or by extraction in water of the organic solvent of the filled blend, the process being possible if water-miscible solvents, i.e. water-soluble, are used.

The water temperature is preferably between 40 and 80°C, most preferably 65-70°C, at the latter temperatures obtaining rapid extraction of the acetone from the filled polymer mass. At 40°C extraction is slower and at even lower temperatures, for example at 25°C, part of the acetone remains instead in the filled polymer mass. The solidified mass is dried to remove water and any residue of acetone or other organic solvent.

The organic solvent removal by drying in the furnace occurs at temperatures suitable to cause evaporation of the organic solvent, such as between 35°C and 70°C in the process using acetone.

The dried product is then extruded and reduced, for example, into pellets in the manner known in the art; during extrusion, or drawing, other additives can be added to the polymer mass previously filled.

We list here below few general examples with indication of the ranges of materials usable; these examples should be read taking into account the limitations in ratios between said materials.

More in particular, the weight ratio between said at least one polymer and the above-mentioned at least one organic, volatile solvent, is preferably in the range between 20/80 and 70/30 (w/w); both PS and ABS can be used in a 100% concentration of soluble polymer, that is to say, as the materials composing 100% of the polymeric matrix in which the fillers are dispersed, or

in intermediate blends between these extreme values, depending on the flexibility degree and on the characteristics to give to the final product.

In one embodiment, the blend includes acetone from 10 % to 30%, ABS from 20 to 50% and a filler consisting of polyamide from 10% to 40% and fiberglass from 20% to 70%, all percentages being by weight. Preferably, the acetone is between 10% and 20%, the ABS is between 20% and 40%, the polyamide is between 10% and 30% and the fiberglass is preferably between 30% and 60% by weight of the blend in the presence of organic solvent.

In another embodiment, the blend includes from 10% to 30% of acetone, preferably from 10 to 20%, and from 20% to 50% of PS, preferably from 20 to 40%, to which a filler is added consisting of 50 to 70% of inert material from quarry or other waste, preferably from 60 to 70%, and 20 to 5% of fiberglass, preferably from 10 to 5%. This blend gives a final product having processability, mechanical and impact properties, surface aspect, abrasion resistance higher than similar materials produced in the absence of organic acetone solvent.

In another embodiment, the preparation provides for a blend consisting of 10% to 30% of acetone, preferably from 10 to 20%, and from 20% to 50 % of PS, preferably from 20 to 40%, to which a filler is added consisting of 50 to 70% of inert minerals, preferably from 60 to 70%, from 10 to 5% of limestone, preferably from 7 to 5%, providing a material with processability, mechanical and impact properties, surface aspect, and abrasion resistance higher than similar materials produced without organic acetone solvent.

Another embodiment provides for use of a blend consisting of 10% to 30% of acetone, preferably from 10 to 20%, and from 20% to 50 % of PS, preferably from 20 to 40%, to which a filler is added consisting of 50 to 70% of bottom ash (from power plants), preferably from 60 to 70%, and 20 to 5% of fiberglass, preferably from 10 to 5%. The resulting composite material has processability, mechanical and impact properties, surface aspect, abrasion resistance higher than similar materials produced in the absence of organic acetone solvent.

A further example concerns a blend consisting of 10% to 30% of acetone, preferably from 10 to 20%, and from 20% to 50% of PS, preferably from 20 to 40%, to which a filler is added consisting of 50 to 70% of waste powder from aluminum processing, preferably from 60 to 70%, and 20 to 5% of fiberglass, preferably from 10 to 5%, with processability, mechanical and impact properties, surface aspect, and abrasion resistance higher than similar materials produced without organic acetone solvent.

Another example regards a blend consisting of 10% to 30% of acetone, preferably from 10 to 20%, and from 20% to 50 % of PS, (expanded polystyrene from landfill), preferably from 20 to 40%, to which a filler is added consisting of 20 to 50% of undifferentiated plastic from landfill, preferably from 20 to 30%, and inert minerals from 50 to 70%, preferably from 50 to 60% and from 20 to 5% of fiberglass, preferably from 10 to 5%, with processability, mechanical and impact properties, surface aspect, and abrasion resistance higher than similar materials produced without organic acetone solvent.

The following are illustrative and non limiting examples of the application of said hot process to materials from the recycle chain, and the functional properties obtainable with these materials.

Example 1 – Ash-based materials from power plants using fossil fuel.

According to this example, an acetone emulsion of a series of materials is produced. This emulsion is obtained by dispersing in 1.5 liters of acetone 1 kilo consisting of (on a base of 100) 50 parts fly ash (Enel, Brindisi), 30 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 5 parts PA6 (produced by Rhodia). The product obtained is dried in a ventilated furnace at 70°C, while the acetone in gas phase obtained is condensed using a cooling coil with water or coolant and collected so as to be completely recycled. The dried material is drawn in a drawing machine at T = 220°C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 1.

Example 2 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion is obtained by dispersing in 1,5 liters of acetone 1 kilo consisting of (on a base of 100) 50 parts fly ash (Enel, Brindisi), 30 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 5 parts PA6 (produced by Rhodia). The product obtained is poured in water at 70°C, obtaining immediate extraction of the acetone by the water and thus complete solidification of the product. The mixture of water/acetone obtained is distilled and the condensation products are returned to the production cycle. The dried material is drawn in a drawing machine at T = 220°C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 1.

Example 3 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion is obtained by dispersing in 1,5 liters of acetone 1 kilo consisting of (on a base of 100) 50 parts wollastonite ash, 30 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 5 parts PA6 (produced by Rhodia). The product obtained is dried in a ventilated furnace at 70°C, while the resultant gas phase acetone is condensed using a water or coolant cooling coil and collected so as to be completely recycled. The dried material is drawn in a drawing machine at T = 220°C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 1.

Example 4 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion is obtained by dispersing in 1,5 liters of acetone 1 kilo consisting of (on a base of 100) 50 parts wollastonite ash, 30 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 5 parts PA6 (produced by Rhodia). The product obtained is poured in water at 70°C, obtaining immediate extraction of the acetone by the water and thus complete solidification of the product. The resultant water/acetone mixture is distilled and the condensation products are returned to the

production cycle. The dried material is drawn in a drawing machine at T = 220°C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 1.

The following are other illustrative and non limiting examples of the application of said process to materials from the recycle chain, and the functional properties obtainable with these materials. In particular these examples call for the use of floral ABS, undifferentiated plastics from urban waste and granules of quarry waste or inert construction site waste.

Example 5 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion, on a base of 100, consists of 30 parts of granules from quarry waste or inert construction site waste, 10 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 30 parts of undifferentiated polymers (pulverized) from urban waste (PS PE PP POM PMMA PET) and 15 parts acetone. The product obtained is dried in a ventilated furnace at 70°C, while the resultant gas phase acetone is condensed using a water or coolant cooling coil and collected so as to be completely recycled. The dried material is drawn in a drawing machine at T = 240°C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 2.

Example 6 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion, on a base of 100, consists of 30 parts of granules from quarry waste or inert construction site waste, 10 parts fiberglass (FV, produced by vetrofil) 15 parts ABS (produced by BASF), 30 parts of undifferentiated polymers from urban waste (PS PE PP POM PMMA – polymethylmetacrylate - PA), and 15 parts acetone. The product obtained is poured in water at 70°C, obtaining immediate extraction of the acetone by the water and complete solidification of the product. The resultant water/acetone mixture is distilled and the condensation products are returned to the production cycle. The dried material is drawn in a drawing machine at

T = 180 °C and granulated. The granulate is molded in an injection press for the production of handlebar test specimens and tested in accordance with the internationally accepted standards listed in Table 2.

In another version according to the invention, the process is carried out at lower temperatures than those indicated above, generally around 30-50°C with removal of the organic solvent by evaporation.

The base polymer is solubilized in ketone (acetone) in the ratio of polymer to organic solvent ranging between 1/1 up to 1/1.5 depending on its characteristics.

A filler of various composites is prepared, as listed above, also containing limestone, said limestone being present in an extent of 5% of the total mass (filler+polymer) that is blended.

The filler thus obtained, i.e. the filler containing up to 5% limestone, is blended with the polymer solubilized in ketone. The maximum quantity of filler with respect to the finished composite material (without organic solvent) is 85% by weight.

The material thus obtained (containing the organic solvent) is ready for use in the form of moldable and shapeable paste for the production of tiles, objects, flooring and similar products.

The finished molded or shaped product obtained is dried in a furnace at 40°, while the acetone obtained is condensed using a water or coolant cooling coil and collected so as to be completely recycled.

The following are some illustrative and non limiting examples of the application of said cold process.

Example 7 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion, on a base of 100, consists of 75 parts granules from quarry waste or inert construction site waste, 5 parts limestone, 10 parts expanded polystyrene from urban waste and 10 parts acetone. The product obtained is a shapeable mass with which molded elements are produced. The samples obtained were dried in a furnace at 40° and left wet for 7 days. The tests performed refer to the NORMAL (standard

CNR - Consiglio Nazionale delle Ricerche, Italy) except for the HDT. The results are shown in Table 3.

Example 8 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion, on a base of 100, consists of 50 parts granules from quarry waste or inert construction site waste, 25 parts fiberglass, 5 parts limestone, 10 parts expanded polystyrene from urban waste and 10 parts acetone. The product obtained is a shapeable mass with which molded elements are produced. The samples obtained were dried in a furnace at 40° and left wet for 7 days. The tests performed refer to the NORMAL except for the HDT.

The results are shown in Table 3.

Example 9 - According to this example, an acetone emulsion of a series of materials is produced. This emulsion, on a base of 100, consists of 50 parts granules from quarry waste or inert construction site waste, 25 parts tomato fiber, 5 parts limestone, 10 parts PLA and 10 parts acetone. The product obtained is a shapeable mass with which molded elements are produced. The samples obtained were dried in a furnace at 40° and left wet for 7 days. The tests performed refer to the NORMAL except for the HDT. The results are shown in Table 4.

Table 1:

STANDARD	PROPERTY	UNIT	SAMPLES	
			41615 PA6+ABS+Ash+FV	41616 PA6+ABS+WOLL+ FV
ESP	Impact resistance without cutting. Method IZOD.**T = 23°C** broken test specimens Breaking energy Standard Deviation	% kJ/m^2	100 12.7 3.5	100 11.9 3.4
ASTM D-648	Tensile strength. T=23°C Yielding load Yielding deformation Breaking load Deformation at failure Modulus of elasticity	N/mm^2 % N/mm^2 % N/mm^2	58 0.6 14800	60 1.0 9540
ISO 75	HDT ISO 75Ae 1.80 N/mm^2 ISO 75Be 0.45 N/mm^2	°C °C	195	158
ISO1183	DENSITY	gr/cm^3	2.01	1.68

Table 2

STANDARD	PROPERTY	UNIT	SAMPLES
			Abs+undifferentiated polymers + FV +quarry/construction site waste granules
ESP	Impact resistance without cutting. Method IZOD.**T = 23 °C** broken test specimens Breaking energy Standard Deviation	 % kJ/m^2	 100 11.5 3.5
ASTM D-648	Tensile strength. T=23 °C Yielding load Yielding deformation Breaking load Deformation at failure Modulus of elasticity	N/mm^2 % N/mm^2 % N/mm^2	 58 0.8 12600
ISO 75	HDT ISO 75Ae 1.80 N/mm^2 ISO 75Be 0.45 N/mm^2	°C °C	130
ISO1183	DENSITY	gr/cm^3	1.45

Table 3

STANDARD	PROPERTY	UNIT	SAMPLES	
			Expanded Polystyrene + limestone + inert materials from quarry/construction sites	**Expanded Polystyrene + limestone +FV + inert materials from quarry/construction sites**
Normal	Flexural Strength	MPa	2.0 MPa	?
Normal	Compressive strength	MPa	> 15 MPa	>30 MPa
ISO 75	HDT ISO 75Ae 1.80 N/mm^2 ISO 75Be 0.45 N/mm^2	°C °C	420	>420
ISO1183	DENSITY	gr/cm^3	2.10	2.12

Table 4

STANDARD	PROPERTY	UNIT	SAMPLES
			PLA+ limestone +Tomato fiber + inert materials from quarry/construction sites
Normal	Flexural Strength	MPa	25
Normal	Compressive strength	MPa	>120
ISO 75	HDT ISO 75Ae 1.80 N/mm^2 ISO 75Be 0.45 N/mm^2	°C °C	58
ISO1183	DENSITY	gr/cm^3	2.54

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CLAIMS

1. A process for the production of composite thermoplastic materials, characterized in that it comprises the following steps:

   - preparing a solution in at least one organic solvent of at least one polymer selected from polystyrene, ABS, polyvinylidene fluoride and other polymers soluble in organic solvents;

   - blending with the polymer solution thus obtained at least one filler material;

   - removing the organic solvent from the blend of filler and polymers to obtain a filled thermoplastic material.

2. The process according to claim 1, wherein said at least one organic solvent is selected from among aliphatic and aromatic ketones, amide solvents or mixtures thereof.

3. The process according to claim 2, characterized in that the organic solvent employed is selected from between acetone and other water-miscible solvents or mixtures thereof.

4. The process according to one of the preceding claims wherein the weight ratio of said at least one polymer and said organic solvent is in the range between 20/80 and 70/30 (w/w).

5. The process according to one of the preceding claims wherein said filler material includes thermoplastic materials insoluble in said organic solvent.

6. The process according to one of the preceding claims wherein said organic solvent is an organic solvent according to claim 3 and said organic solvent is removed from said blend of filler and polymers by water.

7. The process according to claim 6, wherein said filled solution is blended with water at a temperature in the range between 40 and 80°C, preferably between 60 and 75°C.

8. The process according to one of the claims from 1 to 5, wherein said organic solvent is removed by evaporation.

9. A thermoplastic material as obtainable with a process according to one of the preceding claims, comprising at least one polymer selected from among PS, ABS and blends thereof in the form of a thermoplastic base wherein one or more filler materials are dispersed, the quantity of the filler being between 60% and 94% by weight of the thermoplastic composite material.

10. The thermoplastic material according to claim 9, wherein said filler includes up to 50% of one or more thermoplastic polymers different from and/or incompatible with said polymers of said polymer base.

11. The thermoplastic material according to one of claims 9 or 10, wherein at least part of said base polymers and said filler materials are materials to be recycled.

12. The thermoplastic material according to one of the claims from 9 to 11 wherein said filler materials include fiberglass.

13. A device for the production of a thermoplastic material according to the process of one or more claims from 1 to 8, characterized in that it comprises: means for blending an organic solvent with one or more polymers and with one or more filler materials to obtain a blend of said materials, means for removing said solvent from said blend and means for extruding the solvent-free product.

14. The device according to claim 13, wherein said means for removal of the solvent include means for treatment of the blend with water and/or at least one drying furnace.

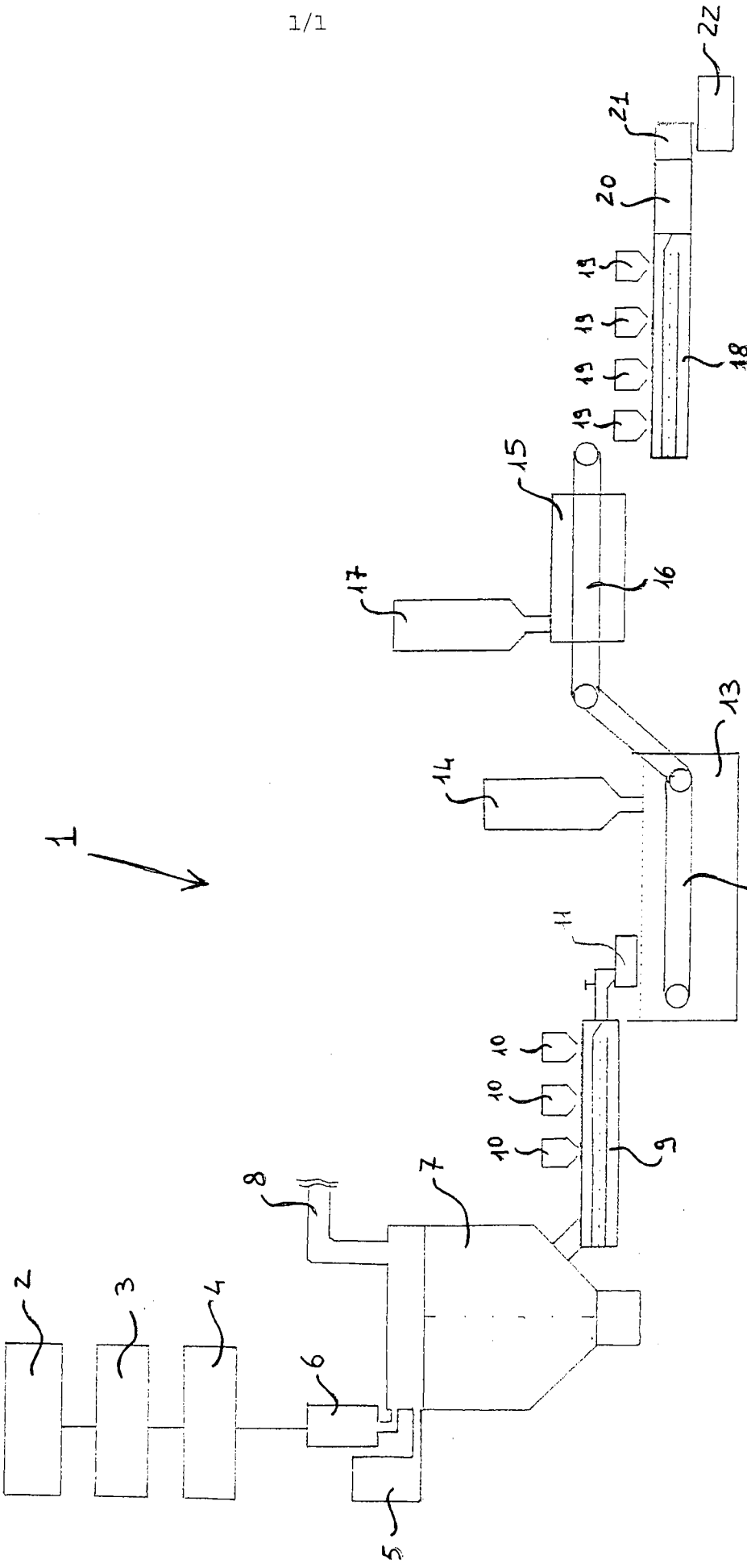


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2007/000841

A. CLASSIFICATION OF SUBJECT MATTER
INV. C08J3/21

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)
C08J C08K C08L

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 practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	HERMAN F. MARK ET AL. EDITORS: "Encyclopedia of Polymer Science and Engineering, Volume 12" 1988, WILEY-INTERSCIENCE , NEW YORK , XP002492460 page 403	1
Y	-----	2-14
X	DATABASE WPI Week 198619 Thomson Scientific, London, GB; AN 1986-122697 XP002492461 & JP 61 062526 A (HUMAN INDUST CORP) 31 March 1986 (1986-03-31) abstract	1,4,5,8, 9,11,13
Y	-----	2,3,6,7, 10,12,14
	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 August 2008	29/08/2008

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	olde Scheper, Bernd

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2007/000841

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 3 628 991 A (THIELE WILLIAM C ET AL) 21 December 1971 (1971-12-21) claim 9	1-14
Y	US 5 229 448 A (COOPER WILLIAM M [US]) 20 July 1993 (1993-07-20) column 2, line 24 - column 3, line 16; claims 1-18; examples I-III	1-14
Y	US 6 395 419 B1 (KUWAHARA TSUNEO [JP] ET AL) 28 May 2002 (2002-05-28) column 4, lines 3-12; claim 1	1-14

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