**Wood plastic composite manufacturing process**

# **wood**

The key technology of WPC manufacturing is how to ensure the high filling capacity of rice husk powder, so that the filling amount of rice husk powder is as high as 80% to 90% to achieve lower production costs and higher performance of products. As for how to ensure that the material has high fluidity and permeability under the premise of high filling capacity, so as to promote thermoplastic melt to fully bond the rice husk powder, to achieve the mechanical properties of co-compound and other aspects of the use of performance, it is mainly necessary to solve the following problems: (1) the choice of raw materials (plastics, rice husk powder types) and how to improve the interface adhesion between plastic and rice husk powder. Because the two-phase composite interface often becomes a stress concentration area, the key to improving the mechanical properties of composite materials is to improve the compatibility of the interface.      (2) Molding equipment and molding process of products - how to improve the ability of rice husk powder to mix and disperse in the system and establish sufficient molding pressure.      (3) Molding mold design and cooling stereotyping technology - the key factor for the improvement of product quality and output.

Some artificial zeolite can be added to the polymer, and this aluminosilicate molecule captures the powder to absorb odors in the material. Through a large number of crystalline cavities in the powder, the adsorbent can capture small organic molecules that produce odors. Molecular trapping adsorbents have been successfully applied to polyolefin extruded pipes, injection and extrusion blow molding vessels, insulating packaging materials, extruded outer packaging and sealing materials. Molecular adsorption powders can also be added to plastics as dehumidifiers to remove moisture from them. Extrusion products of different sizes and shapes increase the diversity of wood-plastic composites When profiles do not require a continuous sheet structure or parts have complex structural designs, wood-plastic profiles can be injection molded or molded. Processors sometimes have to face the problem of how wood-plastic materials are fully molded during processing, and in order to solve this problem, they need to reduce the amount of wood filler used to increase the fluidity of the melt.      Since 200 °C is the upper limit of the operating temperature of wood-plastic composite processing, some resins with a melting point of more than 200 ° C, such as PET, cannot be used for wood-plastic composites. Water vapor degrades the properties of composites and also helps breed microorganisms, so it is important to remove water vapor before using wood fillers. Before processing and molding, the wood filler should be dried, and the water vapor content after treatment is generally required to be less than 1 to 2%.      Today's wood-plastic composite processing machinery requires feeding equipment, drying equipment, extrusion equipment and molding equipment, as well as some necessary downstream equipment such as cooling water tanks, traction equipment and cutting equipment.      The treatment of raw materials requires appropriate additives to modify the surface of the polymer and wood flour to improve the interface affinity between wood powder and resin.      High filling amount wood powder in the molten thermoplastic dispersion effect is poor, making the melt flow poor, extrusion molding processing difficult, can be added surface treatment agent to improve the flowability to facilitate extrusion molding.      Plastic substrates also need to add various additives to improve their processability and the performance of their products.      The feeding process Of the wood powder structure is fluffy, it is not easy to feed the extruder screw, especially the wood flour contains more moisture and often appears "bridge" and "holding rod" phenomenon. Unstable feeding leads to extrusion fluctuations, resulting in reduced extrusion quality and yield. The feeding is interrupted, and the residence time of the material in the barrel is prolonged, resulting in the scorching and discoloration of the material, affecting the internal quality and appearance of the product.      The forced feeding device and reasonable conveying method are adopted to ensure the stability of extrusion.      The small molecules of volatile substances and moisture contained in the processing of exhaust wood powder are very easy to cause defects in the product, and the pretreatment cannot completely remove them. Therefore, the design of the wood-plastic composite extruder exhaust system pays more attention to it than that of the ordinary plastic extruder, and if necessary, it can carry out multi-stage exhaust.      To a large extent, the better the exhaust effect, the better the quality of the extruded product.      Screw configuration design In the extrusion process of wood-plastic composites, the configuration of the screw plays a very important role. Reasonable screw structure can reduce the friction between screw and wood fiber, produce appropriate shear and dispersion mixing, so that the material system containing a large amount of wood powder can be well and uniformly plasticized.      Mold design and cooling stereotyping In addition to ensuring the smooth transition of the runner design and reasonable flow distribution, wood-plastic composite materials have higher requirements for pressure construction capacity and temperature control accuracy.      To obtain good fiber orientation and product quality, it is necessary to ensure that the machine head has sufficient pressure building capacity and long shaping section, and even adopts a double taper structure in the compression section and the shaping section.      The thermal conductivity of wood-plastic composite materials is poor, and most of their products are profiles, which is difficult to cool and set, and water-cooled stereotypes are mostly used. The rational design of the cooling runner ensures efficient cooling. Thermoplastic wood-plastic composite materials (WPC) are modified thermoplastic materials made by filling and reinforcing wood fibers or plant fibers, and being made by different processing methods such as hot pressing composite and melt extrusion. In recent years, with the depletion of global resources and the increasing awareness of social environmental protection, higher requirements have been put forward for the application of wood and petrochemical products. In this context, wood-plastic composite materials can not only play the advantages of each component of the material, overcome the use limitations caused by low wood strength, high variability and low elastic modulus of organic materials, but also make full use of waste wood and plastics to reduce environmental pollution. At present, products that increase the added value of materials are attracting more and more attention.　　At present, the research hotspots mainly focus on thermoplastics such as polyethylene (PE), polypropylene (PP), polyvinyl chloride (PVC), polystyrene (PS) and wood powder, plant straw powder, plant shell and other wood powder as raw materials, and composite materials made by extrusion, injection molding and compression molding. From the perspective of production raw materials, the raw materials of wood-plastic composite materials can be used in various waste plastics, waste wood and crop residues. Therefore, the development and wide application of wood-plastic composite materials help to reduce the pollution of plastic waste, and also help to reduce the pollution caused by agricultural waste incineration to the environment. The production and use of wood-plastic composite materials will not emit volatiles that endanger human health to the surrounding environment, and the material itself can be recycled, which is a new green environmental protection product and an ecological clean composite material. Therefore, the preparation and processing of wood-plastic composites is subject to great economic and environmental benefits.

Effect of coupling agent on the properties of wood-plastic composites:

(1) The manufacture of wood-plastic composite materials by hot pressing composite process, the mixing ratio of wood fiber and plastic is 7:3, and two coupling agents of male acid intoxication and isocyanate vinegar are added under certain process conditions, which can produce wood-plastic composite materials.     (2) With reference to the national standard for medium density fiberboard, the wood-plastic composite material prepared by adding two coupling agents can basically meet the requirements of the performance indicators in the national standard. Comprehensive evaluation, the performance of wood-plastic composites manufactured by adding coupling agent 2 is better than that of wood-plastic composites manufactured by adding coupling agent 1.    (3) Under the same other conditions, different thermoplastic polymers have different effects on the properties of composite materials, and the degree of influence is related to the structure of the polymer itself. Polymer-based wood plastic composites (Wood Plastic Composites, referred to as WPC) refers to a new type of material that has been pretreated with plant fibers or powders (such as wood, bamboo, peanut shells, coconut shells, flax, straw, etc.) as the main component (mass fraction of more than 60%), and polymer resin composite. The material has the advantages of plant fiber and polymer materials, which can replace wood and effectively alleviate the contradiction of poor forest resources and shortage of wood supply in China; Mainly used in building materials, automobile industry, packaging and transportation of goods, warehousing, decorative materials and daily life appliances and so on. Due to the renewable nature of plant fibers and the environmental absorption, WPC is a promising green material, and its production technology is also considered to be a viable and innovative technology.

1 Problems with Polymer-based WPC WPC is widely used and inexpensive, but it is not easy to produce products with excellent comprehensive performance. The main reasons are: 1) Because it contains a large number of hydrophilic groups——— hydroxyl groups, plant fibers have strong polarity, and common resin matrix is usually non-polar and not hydrophilic, so the compatibility between plant fibers and resin matrix is very poor, and the interfacial bonding strength is low, which affects the mechanical properties of WPC; 2) Since hydrogen bonds can be formed between hydroxyl groups, the interaction between plant fibers is very strong, making it extremely poorly dispersed in the resin matrix, and it is difficult to achieve uniform dispersion; 3) When molding processing, plant fillers are easy to degrade and change color, and polymer materials will also be thermally degraded, and unsuitable compounding and processing technology will lead to a decrease in the performance of WPC. Therefore, the key technology in the production of WPC products is to ensure that WPC has good processing fluidity and good compatibility between resin and wood powder under the premise of ensuring a high filling capacity of plant fibers, so as to produce WPC products with higher use performance at a lower production cost. Therefore, the production of polymer-based WPC needs to solve three problems: 1) the processing of raw materials——— the main purpose of improving the interface compatibility between polymer materials and plant fibers; 2) Formula design; 3) The molding equipment and molding process of the product ——— how to maintain stable feeding, effective devocation, improve the mixing and dispersion of wood powder in the system, and ensure the performance of the product The non-polar or weak polarity polymer materials have poor compatibility with strong polarity plant fibers through the molding machinery, molding mold design and setting appropriate process conditions (molding temperature and pressure), so the WPC performance without pretreatment or without any additives is extremely poor. To improve the performance of the WPC, the two components must be modified to make them compatible. For polymer-based WPC, there are three main ways to improve compatibility.

1.1 Treatment of woody parts Chemical method: 1) Surface grafting method, grafting plant fibers before compounding or when re-contracting. For example, maleic anhydride, isocyanate and other grafted plant fibers can be used. 2) Interface coupling is legal, and the coupling agent is used to form a covalent bond with the plant fiber to change the interface adhesion. For example, the use of silane coupling agent, titanate coupling agent, aluminate coupling agent and other treatment fibers to improve the compatibility of fibers and resins. The optimal amount of coupling agent is related to the degree of coverage of the coupling agent on the surface of the wood flour particles. If the amount of coupling agent is too small, it will be difficult to form a good coupling molecular layer because the coating of the filler surface is incomplete, and it will not play the ideal coupling and volume increase effect; Too much, the coupling agent is excessive, the surface of the wood powder will be covered with too many coupling agent molecules, forming a multi-molecular layer, easy to cause the unevenness of the interface structure between the filler and the resin, and the coupling agent in the unreacted other groups will also have adverse effects, thereby reducing the mechanical properties of the composite material. 3) Acetylatation treatment, after the hydroxyl group on the surface of the plant fiber is treated with acetic anhydride or enone, the polar hydroxyl group on the wood is replaced by a non-polar acetyl group to generate an ester. In industry, a mixture of acetic anhydride, glacial acetic acid and sulfuric acid is commonly used for acetylation. 4) Low temperature plasma treatment method, low temperature plasma treatment mainly causes chemical modification, polymerization, free radical generation and plant fiber crystallinity and other physical changes [6] physical methods: 1) physical processing method, through stretching, calendering and heat treatment and other methods of wood fiber or wood powder pretreatment, this method does not change the chemical composition of its surface, but can change the structure and surface properties of the fiber. 2) Alkali treatment method, NaOH, etc. can dissolve some low molecular impurities such as pectin, lignin and hemicellulose in wood, without changing the chemical structure of the main body cellulose, but reducing the rotation angle of microfibers and improving molecular orientation, thereby improving the fracture strength of microfibers. The treatment effect depends mainly on the type of alkali metal solution and the concentration of the solution. 3) Acid treatment method, with low concentration of acid treatment of woody parts, mainly to remove impurities such as pectin that affect the performance of the material. 4) Organic solvent treatment method, mainly used to elute wax in wood, thereby improving the adhesion between the woody part and the polymer matrix. 5) The surface discharge treatment of the raw fiber, mainly using sputter discharge, corona discharge, etc., this treatment mainly causes changes in the physical aspect, which can make the surface of the plant fiber rough to enhance the bonding performance between the interface.

1·2 The resin is partially treated by introducing a polar group into the matrix resin to change its polarity, and the common method of using maleic anhydride (MA) grafts the polymer. For example, MA is modified with linear low-density polyethylene (LLDPE)[3], and the graft reaction is performed on LLDPE with MA under the condition of the presence of free groups, and the polar groups on THE MA are introduced into the non-polar PE molecules to form LLDPE-MA copolymers. After the LLDPE modification, the hydroxyl groups on the macromolecules and the hydroxyl groups in the wood fiber molecules are similar due to the similar polarity, and the intermolecular forces are enhanced, so that the compatibility between the two is enhanced, thereby improving the overall comprehensive performance of the WPC.

1.3 Adding Compatibilizers Currently this is the most used method to improve compatibility. The added compatibilizer is generally a compound containing a polar group at one end and a non-polar group at the other end. According to the principle of similarity compatibility: one end containing a polar group is compatible with the woody part, while the end containing a non-polar group is partially compatible with the resin, which can act as a bridge and combine the two together. The improvement of general compatibility is achieved by reducing the interface energy between the two phases, promoting the dispersion of wood fibers in the resin phase, reducing the cohesion between wood fibers, and improving the capacity of polymer matrix; In addition, by increasing the mechanical entanglement between the polymer chain and the fiber, the adhesion of the interface is improved, and the product with excellent performance is obtained. Such substances mainly include ethylene-acrylate copolymer (EAA), maleic anhydride modified polypropylene (MAPP), phenolic resin and so on.

2 Determination of material formulation 2·1 Selection of polymers Resins used in WPC processing may be thermoset and thermoplastic. Thermosetting resins such as epoxy resins and phenolic resins. Thermoplastic resins such as polyethylene (PE), polypropylene (PP) and polyvinyl chloride (PVC). However, due to the poor thermal stability of wood fibers, only thermoplastic resins with processing temperatures below are widely used as matrix resins for WPC, especially PE. Resins are selected based on their inherent properties, product needs, readiness of raw materials, cost, and familiarity with them. For example, PP is mainly used for automotive products and daily necessities, etc., PVC is mainly used for building doors and windows, covering panels, etc. In addition, the melt mass flow rate (MFR) of the resin also has a certain influence on the properties of the composite material, under the same processing conditions, the MFR of the resin is higher, the overall wettability of the wood powder is better, and the distribution of the wood powder is more uniform. The wettability and distribution of wood powder affect the mechanical properties of composite materials, especially the impact strength. According to statistics, the current market is still dominated by PE wood-plastic composite materials, accounting for about 65%; PVC wood-plastic composites accounted for 16% left and right; PP wood-plastic composites account for about 14%.  
200℃

2·2 Selection of additives Due to the strong polarity of plant fibers, it has strong water absorption; Thermoplastic resins, on the other hand, are mostly non-polar and hydrophobic. Therefore, the compatibility between the two is poor, and the adhesion force of the interface is very small. Appropriate additives are often required to change the surface properties of the resin and plant fibers to improve the interface affinity between plant fibers and resins. Moreover, the high filling amount of plant fibers in the molten thermoplastic resin dispersion effect is poor, often in the aggregation state, making the melt flow poor, extrusion molding processing difficult, the need to add lubricants to improve the flowability to facilitate molding processing; At the same time, the resin matrix also needs to add various additives to improve its processing performance and the use performance of its finished product.

2·2·1 Interface modifier The interface modifier can produce a strong interface bond between the resin and the surface of the plant fiber, reduce the water absorption of the plant fiber, improve the compatibility and dispersion of the plant fiber and the resin, so it can significantly improve the mechanical properties of the composite material. Commonly used interface modifiers are: isocyanate, aluminate, titanate, silane coupling agent (such as γ-aminopropyltrimethoxysilane [11,12]), ethylene- acrylate copolymer (EAA), phenolic resin, maleic anhydride grafted polypropylene wax (Licomont AR504) [13]. The amount of general interface modifier added is 1% to 8% of the amount of plant fiber (mass fraction). It should be noted that maleate interface modifiers and stearate lubricants will have a repulsive reaction, which will lead to a decrease in product quality and yield when used together.

2·2·2 Lubricant WPC often needs to add lubricant to reduce friction and adhesion between the melt and the processing machinery and inside the melt, improve the flowability, promote processing and molding, and improve the surface quality of the product. Lubricants are divided into external lubricants and internal lubricants. The external lubricant adheres to the surface of the melt or processing machinery and mold, forming a lubrication interface and reducing the friction between the melt and the processing machinery; The choice of internal lubricant is related to the matrix resin used, which must have good compatibility with the resin at high temperatures, weaken the interaction between molecular chains, promote the movement of molecular chains, and reduce the cohesion energy between molecules in the resin. The lubricant will have a certain impact on the service life of the mold, barrel and screw, the production capacity of the extruder, the energy consumption in the production process, the finish of the surface of the product and the low temperature impact performance of the profile. Usually a lubricant often has both internal and external lubrication properties. Commonly used lubricants are: zinc stearate, ethylene double fatty acid amide, polyester wax, stearic acid, lead stearate, polyethylene wax, paraffin wax, oxidized polyethylene wax and so on.

2·2·3 Plasticizer When plant fibers are compounded with some resins with high glassing temperature and melt flow viscosity, processing is often difficult, and plasticizers are often needed to improve their processing performance. Plasticizers can increase the plasticity of polymer products, improve flexibility, elongation and processability. For example, in PVC wood powder composites, the addition of plasticizers can reduce the processing temperature, reduce plant fiber decomposition and smoke; However, the addition of plasticizers has an impact on the mechanical properties of WPC, generally with the increase of plasticizer content, the tensile strength of the compound material decreases and the elongation at break increases. Common plasticizer molecules contain polar and non-polar groups. Under the high temperature shear, it can enter the polymer molecular chain and form a uniform and stable system by attracting each other to the polar group on the polymer through the polar group; The insertion of non-polar parts can weaken the mutual attraction of polymer molecules and increase the activity space of polymer segments, so that processing is easy. Commonly used plasticizers are: dibutyl phthalate (DBP), dicaprylyl phthalate (DOP), dicaprylyl sebacate (DOS) and the like.

2·2·4 Ultraviolet stabilizer Polymer materials used outdoors, the photodegradation caused by light can not be ignored. With the improvement of people's requirements for the quality and durability of WPC, the application of UV stabilizers has developed rapidly. It can greatly slow down the degradation of polymers and the decline of mechanical properties in composite materials. Commonly used are hindered amine light stabilizers and ultraviolet absorbers.

2·2·5 Colorants In the process of WPC use, soluble substances in plant fibers are easily migrated to the surface of the product, causing the product to decolorize and eventually turn gray. Sometimes in a certain use environment, dark spots or rust spots will also occur. Colorants can give products color, play a role in beauty, easy identification and improved weather resistance. Therefore, colorants also have a wide range of applications in WPC production. It can make the product have a uniform and stable color, and the decolorization is slow. The American company Americhem has industrially produced a variety of colorants and is constantly improving them.

2·2·6 Antioxidant Polymer material is exposed to air, under the action of oxygen will occur oxidation reaction, such reactions usually occur between room temperature and molding processing temperature, according to the typical chain of free radical mechanism, with automatic catalytic characteristics, so often called automatic oxidation reaction. Therefore, antioxidants are often added to the WPC to inhibit or alleviate the automatic oxidation rate and extend the service life. Commonly used antioxidants are aldehydes and ketamines.

2·2·7 Anti-fungic agent In order to maintain a good appearance and perfect performance of the composite material, it is often necessary to add a fungicide. The selection of the fungicide considers the type of plant fiber, the amount of additives, the fungi in the environment in which the composite material is used, and the moisture content of the product. For example, zinc borate can be antiseptic but not anti-algae.

3 WPC molding equipment 3·1 single screw extruder Conventional single screw extruder is not suitable for WPC molding processing, this is because the material conveying and plasticizing capacity of single screw extruder is weak. The conveying role of the single screw extruder is mainly \* friction, because the wood flour structure is fluffy, so it is not easy to feed; Moreover, the filling of wood powder increases the viscosity of the polymer melt, increases the difficulty of extrusion, and causes the material to stay in the barrel for a long time; At the same time, its exhaust effect is not good, and it is impossible to process plant fibers with high moisture content. Therefore, conventional single screw extruders are more limited in wood-plastic composite extrusion. Single screw extruders for WPC molding processing must use specially designed screws, and the screws should have strong material conveying and mixing plasticization capabilities. And the material is often mixed before extrusion.

3·2 Twin screw extruder At present, the twin screw extruder is the main processing equipment of WPC. This is because the twin screw extruder transports the material according to the principle of positive displacement, there is no pressure return, and the feeding is easy; Good exhaust effect, can fully eliminate volatile components in wood powder; The screws mesh with each other, and the strong shear effect makes the mixing and plasticizing effect of the material better. When the amount of wood flour is relatively low, the material stays in the twin screw for a short time, and there is no wood flour scorching. Therefore, twin screw extruders can produce WPC using powder. Twin screw extruders are divided into homogeneous parallel twin screw extruders and anisotropic conical twin screw extruders.

3·2·1 Co-direction parallel twin screw extruder The co-direction parallel twin screw extruder is often made of a two-stage extrusion unit, and the wood flour drying and resin melting are carried out separately. Wood flour or plant fibers can be processed directly, and after the wood flour is dried, it is mixed with molten resin and continuously extruded, so it is called "wood extruder". Although this two-stage extruder can carry out the drying of wood flour; However, there are certain requirements for the water content of raw wood powder, generally 4% to 8% (mass fraction). Another similar extruder is wood flour is added to the main material mouth of the extruder, the front section of the extruder is a dehydration and destilling device, and then plastic resin and additives are added through the side feeder; Therefore, the extruder is relatively long, and the screw length-to-diameter ratio (L/D) can reach 44~48, of which 2/3 is used for water removal and devocation. The wood plastic material processing industry calls the same-direction parallel twin screw extruder a high-speed, high-energy consumption "compounding" type equipment, generally a combined screw, which can adjust the screw length-to-diameter ratio and configuration (kneading block angle and its number of blocks, different kneading block combination methods), and flexibly set the vent. Famous plastic machinery factories such as Davis-Standard[15] and KruppW&P in the United States produce this kind of co-directional twin screw extruder.

3·2·2 Isotropic cone type twin screw extruder Compared with the high-speed, high-energy consumption "compounding" type of the same direction parallel twin screw extruder, the isotropic cone type twin screw machine is called low-speed, low-energy consumption "profile" type equipment, non-combined screw. Compared with the general cone type twin screw machine ratio, in order to adapt to the requirements of wood flour, small plant fiber density and large filling amount, the volume of the screw feeding area of the heterogeneous cone type twin screw machine used for WPC production should be larger and longer than the conventional model, and the wood fiber is cut off less, and the wood fiber can still be evenly dispersed and the material can be completely melted when the resin is small, and the processing range is wide. If the amount of wood powder and plant fiber is added, the rigidity of the molten resin is large; It is required to resist high back pressure gearbox, strong screw thrust, and adopt screws with fast compression and melting and short metering section to ensure that the wood fiber residence time is short and prevent its fracture and performance deterioration. The production of this equipment is mainly for Cincinatti Milacron, including The Extension TekMilacron in the United States and the Cincinatti branch of SMC in Germany.

4 WPC molding process 4·1 Production process Waste plastics, sawdust, straw and other → crushing and crushing → The treatment of raw materials→ the mixing of wood flour and plastics→ granulation → extrusion → cooling and shaping→ traction → cut → finished products

4·2 Setting of process parameters 4·2·1 Screw speed The speed of the screw is proportional to the production capacity. Therefore, increasing the speed can effectively increase the production capacity; However, the increase in screw speed during WPC extrusion processing is subject to many limitations. For example, for PVC wood powder composites, PVC and wood powder are heat sensitive, and excessive screw speed will lead to degradation and gelatinization of the material; At the same time, the screw speed also affects the residence time and extrusion pressure of the material. Only by meeting the extrusion temperature, shear strength, mixing quality and extruder power limits of the material can the speed be maximized to increase productivity.

4·2·2 Extruder Temperature and Pressure During WPC extrusion, extruder temperature and pressure control is also very important. If the extrusion temperature is too high, the material is easily degraded; At the same time, the excessive temperature makes the viscosity of the melt low, the extrusion pressure is insufficient, resulting in rough surface and poor strength of the product, which affects the extrusion quality. The temperature is too low will make the plastic plastic poor, can not fully wrap the wood powder, will also make the strength of the product affected, at the same time, the melt rupture of the mouth mold temperature is more sensitive, too high and too low mold temperature will cause melt rupture. Appropriately reducing the temperature of the extruder, increasing the pressure of the machine head, and reducing the screw speed can effectively improve the extrusion processing performance of the wood-plastic composite system. The temperature settings of each section in the actual processing process are as follows: I. section: 150~; Paragraph II: 160~; Paragraph III: 170~; Paragraph IV: 180~; Head mouth mold section: 180~. The temperature of each section should be as stable as possible and the total residence time should be less than 15 min.170 ℃190℃195℃195℃205℃

5 WPC application prospects WPC imitation wood material products are widely used in foreign countries, of which North America is currently the largest region in the world WPC market. In 2002, the amount of WPC used in the North American market was about 360kt, and the demand is expected to increase at an average annual rate of more than 10%. In terms of building structural materials, it can be used as indoor and outdoor paving boards, fences, moisture-proof partitions, stair panels, handrails, building formwork, water buildings, door and window frames, platforms, road slabs, etc.; In terms of indoor decoration, it can be used as a variety of decorative strips, decorative panels, curtain rods, curtain rings, frame strips and decorative parts, wall panels, ceiling panels, movable blinds, etc.; It can also be used in the car's door decoration panels, bottom plates, seat backs, seat bases, armrests, roof plates, instrument panels, etc.; In addition, various specifications of transportation pallets and export packaging pallets, warehouse cushioning boards, various types of packaging boxes, transportation glass shelves, etc. used in logistics can use wood-plastic composite panels. In addition, it can also be used for outdoor tables and chairs, courtyard armrests and decorative panels, flower boxes, waste bins, etc. China is a country with poor timber resources, the forest coverage rate is only 12.7 percent, which is only equivalent to 61.3 percent of the world's forest cover, the per capita forest stock is only 12.5 percent of the world's per capita stock, and the per capita wood consumption level is less than 0./a. To this end, china needs to import about 10 million m3 of wood every year. Due to the long-term irrational exploitation of the use, China's forest area is declining at an alarming rate, and under such circumstances, how to make full and effective use of limited timber resources, protect the environment, and serve society has become an urgent problem to be solved. The development of WPC will open up new avenues for the effective and rational use of waste wood and plastics.10 m305m3

Additives for wood-plastic composites Wood-plastic composites often require some additives to be added, such as coupling agents, light stabilizers, pigments, lubricants, fungicides and blowing agents. The following table lists commonly used additives and their role in composites

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| |  |  |  | | --- | --- | --- | | **Additives** | **apply** | **Example** | | **Heat stabilizer** | Prevents polymer degradation during processing | Phenolic resins (primary) and phosphites (secondary) | | **Light stabilizer** | Prevents UV light from damaging the polymer | HALS (amine-blocking light stabilizer); Ultraviolet light absorber | | **Coupling agent** | Improve the combination of wood-plastic interface, increase strength, reduce water absorption, and maintain mechanical properties | Maleic anhydride modified polyolefin | | **lubricant** | Improve flow performance, increase productivity and reduce edge wear | Zinc stearate, vinyl and stearylamide | | **pigment** | Beautify the surface of the product and have a certain degree of ultraviolet protection | Mix the dye | | **insecticide** | Prevents bacterial fungal erosion | Isothiazoles | | **Blowing agent** | Reduce material density and product weight | Exothermic type (azocarbonamine), endothermic type (sodium bicarbonate). | |

For plastic wood composite extrusion molding, the extrusion characteristics are very different from ordinary plastic materials. Due to the presence of wood powder, the extrusion performance of the material is greatly reduced, and the difficulty of molding is increased. Our research on wood-plastic composite extrusion equipment technology mainly focuses on the following aspects.   
1. The selection requirements of the extrusion unit are   
currently available for wood-plastic composite extrusion molding equipment such as single screw extruder, tapered twin screw extruder, isotropic and isotropic rotating parallel twin screw extruder and our newly developed tandem disc extruder. As for which form of extrusion unit to choose, it needs to be determined in combination with the user's own conditions.   
2. The processing technology of the extruder requires   
that the wood-plastic composite material has strict requirements for temperature and material residence time in the barrel. High temperatures or prolonged residence will burn wood powder and destroy the appearance of extruded products. However, if the temperature is too low or the residence time is too short, it will make the plasticization effect bad. In addition, the establishment of the machine head pressure is also an important problem, if the machine head pressure is too low, it will lead to poor molding effect of the product.   
3, extruder head and the requirements of the stereotyping section   
of the head is related to the quality of extrusion products of important components, wood-plastic composite materials due to the particularity of its materials, for the head put forward many special requirements. From the design point of view of the machine head, in addition to ensuring the smooth transition of the runner design and reasonable flow distribution, the pressure construction capacity and temperature control accuracy should also be given special consideration.   
4, the principle of formula design  
 Plastic wood composite wood pallet extrusion molding belongs to environmental protection technology, the raw materials used are waste plastics and a variety of plant fibers. How to choose a suitable adhesive to combine the matrix resin and wood powder well requires the study of the compatibility of the two-phase composite interface. The binder is required to have the following characteristics: it has a certain degree of compatibility with the resin and contains some reactable groups to form covalent bonds with the wood powder. However, the compatibility with the resin should not be too good, otherwise the adhesive may tend to disperse in the resin, and the interface is relatively small, and it will not have a capacitance increase effect. The most ideal adhesive should be preferentially distributed at the phase interface, which itself should be microscopic phase separation and not compatible with other components. In the formulation design, the selection and treatment of matrix resins and the treatment of plant fibers should also be considered.