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Economic model assessment of wood - polymer composites production from agricultural wastes

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ABSTRACT

The purpose of this paper is to provide an overview of wood plastic composite plan and estimating the investment of natural wood-polymer or wood-plastic composites based on natural material, wood and polymers. wood-plastic composite decking has made major advances in material performance, processing and user acceptance. WPCs, also referred to as natural fiber polymer composites, are a mixture of wood, thermoplastic resins, and other additives. Wood can be used in various forms, however, it is commonly used in the form of wood flour (fine particles).. Wood plastics composites are a new type of material that are beginning to find applications in a wide variety of fields.In this report at first, Important aspects of application related then economic investment and required infrastructure facilities estimated. This research adapted basics and indicators for construction of WPC manufacturing with economic conditions in Iran. Product in this plan was provided by wood fiber , polymer and agricultural wastes for example rice husk or straw. With regard to the feasibility and strategic rates and the lower priced product compared to the pure polymer, MDF and other similar products in this plan , used technology and utility equipment are available and cheap. An economic plan of WPC production with 5000 *tone per year and* 60 *occupation estimates about* 68100 *million rials total investment that with rate of return on investment, payback period and break-even point* 2.2 *year* ,46.35 *% and* 34.21% *, respectively. These results suggest that WPC manufacturing Can be economically and good prospects and views for the future are expected.*

Key words*:* Agricultural wastes, Economic, Natural polymer, Wood - Polymer, WPC

INTRODUCTION

Today, for preparation of the cellulose sources in each country It is necessary to capita share of forest at least 0.3 hectare.In Iran with a population of 75 million ,the contribution is Less than 0.06 hectare. So rources of wood products in Iran can provide only 20% The plant needs [7].Wood plastic composites are an important and growing segment of the forest products industry. This industry segment has grown in double digit percentages annually for the past decade.The manufacture of wood filled polymer materials has been an industrial process for about 80 years [1]. The use of natural fibers composites in the construction and automobile industry in many developed and developing countries. These fibers can easily return to the cycle of nature and the production costs are significantly lower. In production of polymer composite such as polypropylene - wood powder with paddy husk, in order to reduce the price of the product by mixing a substance with low price (wood and paddy husk) and a relatively expensive polymer material, it will be possible to recycle waste materials and to produce a lightweight composite with better abrasion and resistance properties. The main materials of multi structures are fiber and matrix and fiber plays a major role and has the highest volume in the production of composites. Based on amount and type of fiber and direction, it has effective roles. Also, matrix role is very significant in stress transfer between fiber and matrix protection in hard environmental situation and protection against mechanical abrasion of the fibers and transverse protection of the fiber and its prevention from buckling under pressure. The important point is to add wood fiber

(solid phase) to polymer matrix which increases the viscosity compared to the polymer raw material. The viscosity increase can be desirable in the process, since it increases the melt strength. On the other hand, strength and physical- mechanical properties of composites changes with respect to the fiber percentage.

Some of the thermoplastic resins include low and high density polyethylenes (LDPE, HDPE), polypropylene (PP), and polyvinylchloride (PVC). Either recycled or virgin plastic materials could be used to produce WPCs. In general, polyethylene based WPCs are more thermally stable and ducticle in nature; and, polypropylene based WPCs have higher stiffness and tend to be more brittle in nature.

Considering the low cost of producing cellulosic material and manufacturer tendency to use it more, to obtain the optimum combination of the composites with desirable mechanical properties and well-behaved process will be necessary. Thus, in the production of composites, the percentage of wood fibers which provide strength and a process that guarantees the part production are of main parameters. In general, in the production of natural fibers and polymer composites, three general objectives are pursued: achieving a material with recyclable and environmental properties and biological degradation compared to polymers, plastics, wood, wooden plates and similar products; Achieving special properties, strength and capability of forming more efficient than polymers, MDF and similar products.Today,in terms of product variety, market changes and economic and costs fluctuations, there are shortages of raw materials and designs for various projects in the field of wood-plastic composites, which is a need for integration, alignment and more feasibility in the capacities and economic infrastructure potentials.

MATERIALS AND METHODS

The basis of this research is feasible study of a production unit of WPC that can assess the economical status of production. The production process in this plan is that first wood and agricultural wastes are milled and converted into fibers. The fibers are dried after preparation in a dryer (industrial oven), and then in the compounding unit, by two crossing extruder at 180 ° C with a flow rate of 110 to 1500 kg /hour and speed of 60rpm with different proportions of wood to polymer and additives takes place in order to modify the properties of the mixing operation[10].

Wood-plastic composite formulations also include additives, such as lubricants, inorganic fillers, colorants, UV stabilizers, biocides and fire retardants. Lubricants aid in processing WPCs, inorganic fillers help in improving the properties and biocides improve decay resistance.WPCs are either extruded, injection molded, or compression molded. Extrusion is the most commonly used processing technology for manufacturing wood-plastic products. WPCs are ideally suited for exterior use. Current applications for WPCs include decking, railing, interior auto parts, cladding and window frames.

The product is a solid and formless material with high molding capability which is available in the consumption market in two forms of raw material and granola for raw materials of polymer and plastic industries and as a molded parts and profiles and raw and laminated sheets.For WPC manufacturing two stages are used , single-stage and twin-stage process . In single-stage process combining raw material and forming are Perfored by twin-screw extruder but in twin-stage process at first raw material are combined by contiuious and batch processes. Then product becomes moulding and forms granules. In twin-stage process are used extrusion , calendring , blowing and injection moulding. Twin-stage process increases density and technical properties and decreases energy , production time , cost and improves degradability ,security and safety. All of this items will create competitive advantages in WPC production.

The extruder is the heart of the WPC processing system, and the primary purpose of the extruder is to melt the polymer and mix the polymer, wood and additives in a process referred to as compounding. In addition, the extruder conveys the compounded wood-polymer mixture through the die. There are four primary types of extrusion systems used to process wpc lumber. These are the single screw, co-rotating twin screw, counter-rotating twin screw, and woodtruder™. Cost for an extruder can vary from 150000 $ for a simple single screw extruder to over one million $ for a complete wood plastic composite lumber extrusion system[3].

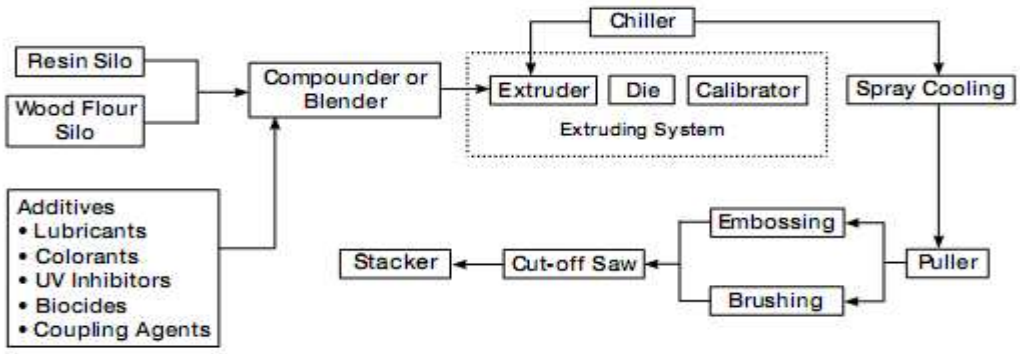

Fig1.The WPC manufacturing process with extrusion forming(source :http://www.wpcinfo.org)

Financial and Marketing Reviews

The feasibility study is the expert studies which are carried out before implementing any financial investment plans. In this study, technical, financial and economic aspects of the project in view of market is considered and analyzed and obtained results are used as a basis for investors' decision making.

This report or the objectives of this study is the preliminary feasibility study of wood-plastic composites which has been prepared in the form of a simple methodology of feasibility studies. In this study, first the studied product is introduced accurately and then the necessary considerations would be accomplished in the market. In continue, the technical studies regarding how to produce and the required hardware facilities are also identified and finally the economical capacities and the required investment volumes to implement the plan is estimated and would be presented, so that investors and those who are interested could obtain all the required information to accomplish their economical investment with the open eyes and clear path of action.

Introduction of the product

This product is part of the composites to be named wood polymer composite(WPC),wood fiber composite (WFC), poly wood and pall wood , poly board, wood flex ,stock wood and wood plastic.

Generally composition of two or more substances together is called the composite materials; the composite materials of fillers or reinforcing materials or polymer are considered as the most important composites. WPC or wood-plastic composite is a material made of wood powder or cellulose products such as cellulose fibers, lignin, and etc.; and also polyolefin, especially polypropylene which for different usage they have found different application.

Due to the main problems in providing forest resources and petrochemical raw materials, and high share of procurement costs and purchasing raw materials in production of lingo-cellulose and plastic materials, especially the environmental problems of polymer, various approaches in the production of wood-polymer nano-composites has been created. Moreover, natural fibers and resins are appropriate replacement for synthetic petrochemical resins and fibers, and also they would provide products with better productive capabilities and more efficiency. According to the existing sources, natural fibers used in composites are classified as two groups of lingo-cellulosic fibers made of agricultural wastes and wooden cellulosic fibers [9].

Product Benefits

Production of natural fiber composite materials and parts (wood) + polymer with regard to environmental regulations concerning the replacement of 90% of exterior and interior components of airplanes, cars, furniture, home and office appliances with these composites up to 2014, and 50% growth of global market of construction products and profiles and home-office supplies and 35% percent growth of the composite components would assure the profitability and future of this industry[2].

Adding wood to unfilled plastic can greatly stiffen the plastic but often makes it more brittle. Most commercial WPC products are considerably less stiff than solid wood. Adding fibers rather than flour increases mechanical properties such as strength and elongation (Table1). However, processing difficulties, such as feeding and metering low bulk density fibers, have limited the use of fibers in WPCs.

Table1 .Mechanical properties of wood-polymer composites

composite	Tensile				Flexural		Heat deflection temperature(ºC)
	Density(g/cm3)	Strength(Mpa)	Modulus(Gpa)	Elongattion(%)	Strength(Mpa)	Modulus(Gpa)	
PP	0.9	28.5	1.53	5.9	38.3	1.19	57
PP + 40% wood flour	1.05	25.4	3.87	1.9	44.2	3.03	89
PP + 40% hardwood	1.03	28.2	4.2	2.0	47.9	3.25	100
PP + 40% hardwood fiber + 3% coupling agent	1.03	52.3	4.23	3.2	72.4	3.22	105

Source: properties measured according to ASTM standards for plastics

The main relative benefits of this material are including reduction of environmental problems and consumption of plastic and natural polymers which are environmental contaminants through production of a material with the properties of biological degradation in nature and avoiding environmental pollution, failure to wear machines, high molding and modeling capabilities, specific properties and high strength, higher share of domestic sources, high profits from sales in the global market, vastness and diversity of the target market, proper capital investment, excellent added value, higher growth in domestic and world markets, waterproof, heat resistant, anti-bacterial, anti-scratch, resistant to environmental factors, moisture, mold and a capacity to recycle, resistant to insects, lack of formaldehyde gas or volatile organic compounds unlike MDF and other similar products, durability, hardness and proper linear expansion, light and portable, resistant to wear and corrosion, dimensional stability (minimal deformation under pressure load), long life and low maintenance cost even under unfavorable weather conditions, ability to work easily with a good set of woodworking tools and lower depreciation. Standards are being identified, modified, or developed to determine WPC performance appropriately and consistently. Depending on the formulation, product, or research objectives, various standards have been used to test these composites, e.g, plastics, plastic lumber, wood, and WPC standards.

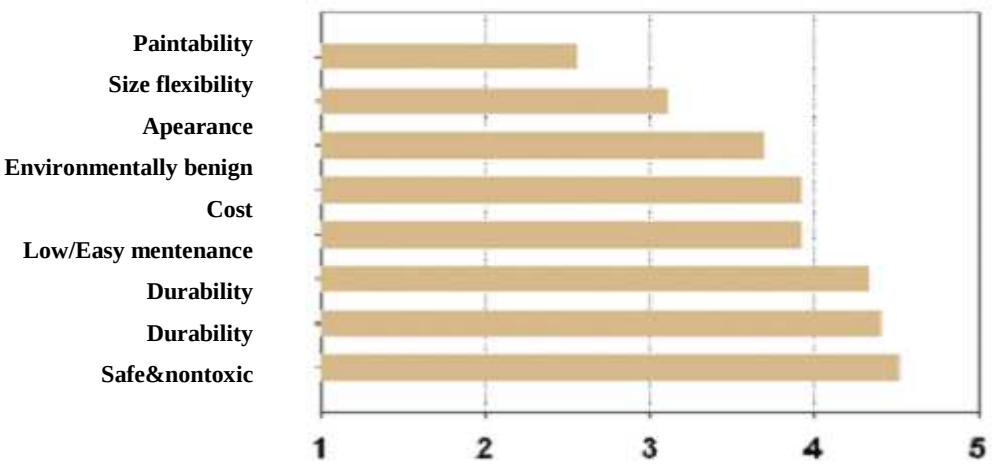

Figure1: Degree of importance(source :http://www.wpcinfo.org)

Economically the plastics' prices are over 40000 rials per kilogram on average, but the price of WPC is about 30000 rials in my view. In 70% of cases, replacement of wood- plastic instead of MDF has economic benefits MDF Investment per cubic meter is 250-300 dollars and wood-plastic is 100-120 dollars[6].

Furthermore, lower cost of maintenance is required during consumption. In terms of quality and mechanical properties, this material due to its inherent is better than all the best properties of both plastic and wood components.Its mechanical strength is two to three times more than MDF; it is more than plastics as well. The flexibility properties of the wood-plastic are better than plastic. It has thermoforming capabilities and convertibility to the original product which has the same or better quality.

Markets, customers, competitors

The major purchasers are of automotive industry, aircraft industry, construction industry: for the pre-built constructions, door and window and other components used in buildings such as knobs, switches and sockets, and so on, sports equipment and goods industries, and companies manufacturing plastic pipes and fittings, cabinet construction and decoration industries and plate products, office furniture and appliances industries and cheaper alternative to the plastic, wooden and other sheets, and plastic products industry, railway, wagons, bridges, etc.[6].

Product Costing

One of the most important benefits is its lower-priced products and higher economy than polymers, MDF and other similar products through mixing an inexpensive material such as wood and wood waste with a rather expensive material like polymer. One of the main purposes and concerns of major industry owners and investors is to achieve a cheaper product and competitive with similar products and accompany with good profits and economy. Meanwhile, one of the most important management and market strategies is supply of fiberglass and plastic products with lower price which is insured the profitable return of investment and profitability of market.

Financial costs and sources

Generally, in pricing the products, two strategies are followed which are usually based on obtaining and paying good dividends approximately 20% of the cost price or selling price per kilogram of raw material or granular composite and per square meter of composite sheet are significantly below market prices for polymers, plastics, MDF sheet, fiberglass, and other similar products [4]. Therefore by considering the above principles and cost price for production and the rate of investment return of selling price is calculated as the table below.

The "Budget Cost" method is the quick method for estimating costs but can give remarkably accurate results if used with care. It not only gives a cost but allows an assessment of the operational efficiency of the factory. For extrusions or injection mouldings a rough allocation of the manufacturing costs can be made as follows.For extrusions or injection mouldings a rough allocation of the manufacturing costs can be made as follows:

Table2 . manufacturing costs of WPC plant

Manufacturing Costs	Mass produced product	Technical product
Materials	70%	55%
Machine (see below)	15%	20%
Tool	5%	13%
Labour	7%	12%
General (packing and transport)	3%	5%
Total	100%	100%

Source: the report results

The machine element can be further sub-divided into:

Table3 . Machine costs of WPC plant

Machine Costs	Mass produced product	Technical product
Electrical	35%	15%
Water	20%	5%
Auxiliary and factory	1%	2%
Fixed plant	44%	78%
Total	100%	100%

Source: the report results

These charts are important because they show that for a mass produced part 80% of the cost is locked up in material at the design stage. Machine costs are less because of higher speeds, lower specification machinery and tooling and generally lower investment[5]. For technical parts i.e.. tighter tolerances, you have higher machinery costs because of slower speeds, higher specification machinery and tooling and generally higher investment. The above method does not take into account production speed except by inference i.e.. small profiles produced faster than large profiles. In fact the influence of production speed is often over-estimated (in my view).

Assuming all other conditions remain the same then a 10% increase in production speed will reduce the component price by approximately 2.7%. A 40% increase in speed gives a price reduction of 8.5%[7].This calculation ignores any effect of increased scrap or increased tooling cost which can often negate these price reductions. There are gains to be made by increasing production speed but they are often not as significant as those to be made from material reduction.

Table 4. Technical Study Abstract details

Technical Study Abstract : 5000 tone per year	Index	Unit
Land Purchase(6000m^2)	3300	Million rials
Site plan(2000m^2)	10500	Million rials
Utility Equipment	2100	Million rials
Machines & Equipment	31000	Million rials
Logistic Equipment	1200	Million rials
Unforcasting	5100	Million rials
Fixed Investment	53100	Million rials
Working Capital	15000	Million rials
Man Power & Personal	60	person
Break-even Point	34.21	%
Payback Period	2.2	year
Rate Of Return On Investment	46.35	%

Source: the report results

CONCLUSION

Strategies used by manufacturers to lower costs include maximizing the amount of wood used in the composite, the production of hollow profiles, and the use of recycled plastics, if readily available Due to environmental concerns and the need to replace substances that has the environment and biological damage and has special properties and more efficient resistance, Polymers and plastics composites can be used. With regard to the feasibility and strategic scores and the lower priced product compared to the pure polymer, MDF and other similar products, there is possible to reach the market and good profits as well as investment return with low risk and high maneuverability in the market.

REFERENCES

[1] Adhikary, S. Pang, M.P. Staiger, University of Canterbur," Engineering: Part B. **2001** : 807–815
[2] Bondeson, D. etc. *Journal of Biobased Materials and Bioenergy* **2007,** 40(4): 367-371.
[3] Bengtsson, M, and Oksman, K.. Polymer Handbook of Engineering Biopolymers , Amazon , **2007** ,21(1): 184-194.
[4]Eder, A. Wood plastic composite – An European market overview. In: Proceedings,1st international symposium of wood-plastic composite in China: Development and prospect; **2007** November; 14(3)121-132
[5]Green, E. Time to re-focus. In: Proceedings, WPC Viable Opportunities in Europe; Vienna, Austria. Applied Market Information Ltd. ; **2003** September
[6]Han, Y., Gardner, D.J., etc. Technical project report 08-16, Advanced Engineered Wood Composite Center, University of Maine. **2007,** 425 p
[7]Javadzadeh Moghtader,G . Master's Thesis,Tehran University, **1995**, 350p
[8]Matuana, L., etc. *Proceedings* of the 51st International Convention of *Society* of Wood Science , **1995** July. *Chicago, Illinois, USA.*
[9]Park, C. Handbook of polymeric foams and foam technology Ch.14 Wood flour composite foams, Cincinnati, OH, USA : Hanser Gardner Publications.**2004** , 24(5) Paper WS-5-6
[10]Rowell, R. M. Lange S. E., and Jacobson .R. e.. In Progress in Woodfibre -Plastic Composites Conference, Toronto, Canada **2007**, 201p