Feasibility Study of Industrial Unit for Preparation and Recycling of Marble and Granite Wastes

Hebatalrahman, A

Consultant in materials sciences and materials applications, Egypt
hebatalrahman11@yahoo.com hebatalrahman@naseej.com

Abstract: In these work, Industrial unit for treatment of marble and granite wastes by physical methods was designed. It treats both wet and dry wastes. After treatment, wastes are used as filler or reinforcement for composite materials industries. Metal molds are used in manufacturing for good surface finish and dimension stability. The molds have heaters and gas cooling system. Heating and cooling rates depends on the properties required in the final products. Final products have different shapes, properties, dimensions, thicknesses, lengths and colors. The unit treats the wastes of the natural marble and granite with all of their types and preparing them in a physical way in order to preserve their characteristics and keep them valid as products. The general characteristics of the product were tested, the objectives of recycling process of marble and granite were established, market analysis and competition factors were studied, the manpower and expected job opportunities were evaluated. The economical feasibility study for the case study in Egypt was done, capital cost, working costs, operation costs, direct and indirect costs were calculated. Expected risks and crisis are evaluated. Results depends on the case study were taken into account. General conclusions and recommendations are mentioned.
[Hebatalrahman, A. **Feasibility Study of Industrial Unit for Preparation and Recycling of Marble and Granite Wastes.** Report and Opinion 2011;3(12):59-67]. (ISSN: 1553-9873). http://www.sciencepub.net/report

Key words: feasibility study, wastes, marble, granite , recycling, preparation

Introduction:

Mining wastes include waste generated during the extraction, beneficiation, and processing of minerals. Most extraction and beneficiation wastes from hardrock mining (the mining of metallic ores and rocks) and 20 specific mineral processing wastes are categorized as "special wastes" and have been exempted by the Mining Waste Exclusion from federal hazardous waste regulations under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The mining industries based on cutting and forming marble and granite leads to environmental pollution problem, which is the greatest problem of the 20th century. The inhabitants of the industrial cities are suffering from the pollution resulting from the factories which causes huge amount of dust in the air of the surrounding areas specially the housing area [1,2].

The remains of these products are not possible to get rid of them in the drains. Pollution is not only limited to the manufacturing area of marble and granite but the owners of the factories decided to export pollution to their neighbors, the owners of the factories get rid of the industry remains in the area down the slope of the mountain. The rest of cutting and sawing marble are mixed with the refrigerating water which forms a sticky liquid (alsahala), it does not have any significant use all over the world. Many workers have confirmed that factories owners insist to throw these remains behind in the direction of the housing area for a very important reason, (alsahala) after getting dry it becomes a solid ground, which permits the expansion of the factory space at the expense of the housing area [3,4]. There is no drain neither sewage nor industrial that helps the drainage of the remains caused by the industry of marble in a safe way. (Sahala) has no economic value at all, carrying it far from the factories area is a big economic wastage because the percentage of water in it reaches 70%, it has a high density and leaving it in the open air for a long time exposed to the air turns it into fine dust. it has harmful effect on health, it affects the reserve of ground water and threaten their competitive edge [5,6].

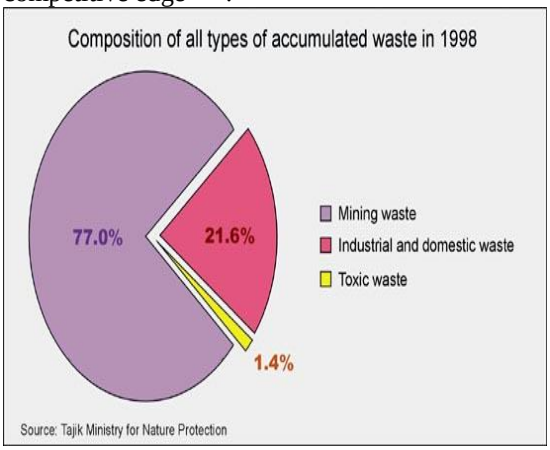

Fig (1) Percentages of mining wastes relative to industrial wastes

The industrial uses and applications

The project services more than 20 different industries; on top of them is the marble and granite industry[7,8]. Egypt consumes annually about 20 million tons of the similar materials, like the materials used in the internal, external finishing processes and insulation and others, according to the lasts statistics of the Central Auditing Agency [9,10]. **Fig (2) waste distribution in mining sites. T**he industry of the building materials is considered a feeding industry for several engineering industries, as follows:-

1. Manufacturing the tiles and the proof-sliding sheets of the insulating materials [11].
2. Finding a replacement from environment friendly materials for the combined additives, especially the fabricated fibers and the harmful asbestos.
3. Getting plastic based or metal matrix composite [12,13]
4. Manufacturing insulating materials with distinctive characteristics, It can be used in the internal and external coverings due to the possibility of getting it in several forms and sizes[14,15].
5. The new composite is considered a type of the industrial marble with high quality and several industrial uses.
6. The industrial unit can be used in different forms and sizes, like using one unit for an industrial estate or small units for each set of factories.
7. The unit can be used for other industrial purposes like drying, grinding of other wastes [16,17].
8. It also can be used for dealing with industrial refuse of the building industry with all of its types and forms.
9. Finding an alternative of the metal coverings that can be used in office furniture, some furniture parts, like tables chairs, sofa stands, the internal tiles and linings segment [18,19].
10. Providing the building and construction sector with its needs of the building materials, fire resistance materials , chemical resistance materials and environmental resistance materials [20,21].
11. Containers, used for keeping gases and chemical materials, the project provides perfect products, like partitions of the operation rooms, and hanging ceilings.
12. Pipes, the organic liquids utensils, agriculture equipments, pipe links of gas, waterpipes especially the hard water pipes or that which saturated with liquids [22,23].

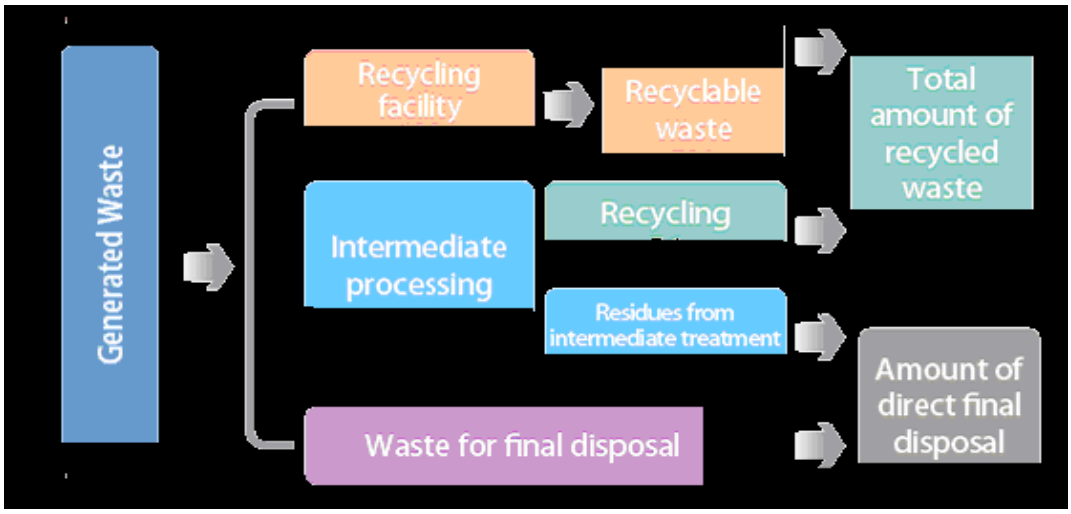

Fig (2). Waste distribution in mining sites

Objectives

1-Building a strong name for the project and the product.

2- Reaching the zero perfect product by the end of the year.

3-Reaching the achievement of sale volume of 300,000 L.E. during the first year.

4-Providing job opportunities for a big number of youth and poor classes (80) persons, 40% of them are from women at least.

5-Achieveing the goals of recycling the refuse of the marble and granite industry.

Fig (3) shows a chart of the objectives of recycling the marble and granite refuse

Unit description and main parts

The invention, subject matter of the project consists of a full automatic industrial unit that is operated to treat the natural marble and granite refuse, in all of their types. That is besides equipping it in a physical method to maintain its characteristics and making it suitable as a filling and strengthening material in the industry of the compound materials with a basis of metals or alloys. **Fig (4) shows the marble and granite wastes recycling unit** [(24)]. The re-use of the natural marble and granite refuse industry is divided into four main sections:

The first section (dry wastes):

Dry refuse which results from the cutting and shaping processes of the marble and granite. It is known with marble fraction. It is of various shapes and sizes. This type of refuse is sometimes added to the mortar mixtures or the bricks industry, a substitution of pebbles or sand. This is considered as a waste of the economic value and the distinctive characteristics of the natural marble or granite. The second phase is the phase of preparing the dry refuse (marble fraction) as the refuse is put in the automatic hammer phase where it is broken into suitable sizes.

The second section (wet wastes):

It is a type of the wet refuse where its percentage of water reaches about 70%. It is sticky and it is produced from the processes of leveling and polishing. Commercially is is known as (Al Sohala) or Al Sahla. The sticky refuse is heavy in weight and big in size. This is due to the existence of water in it. Thus, it is difficult to transport it or store it; besides that they are very soft granules. Therefore they are left on the floors of the surrounding areas in the factory and it does not have an economic value or commercial use at all.

The wet refuse preparation unit, in turn consists of three consecutive phases.

A. They start with the ventilation and turning over (A) as a current of air is pushed together with the continuous turning over for decreasing the percentage of water in the sticky material. This stage can be substituted by increasing the time of turning over.
B. The next phase is the drying phase, as the mixture is automatically pushed by a conveyor belt to the drying room which is fitted with heaters. The heaters are adjusted at 120°C centigrade degrees for a period from three to four hours, for guaranteeing the drying process.
C. Sahal is got out of the dryer in the form of fragile masses which are transferred by a conveyor to the automatic turning over room as it is turned over and made in the form of powder suitable for sivieing and mixing.

The third section (mixing & sieving)

The outcome of the two phases is collected in the automatic sieve. The mixture moves to the final drying and mixing phase. This phase is fitted with heaters at 120°C for a period from 3 to 4 hours. This is for guaranteeing the final drying of the two mixtures.

The fourth section (manufacturing process):

The joining material is added by the upper hopper. The joining material consists of metal and plastic powders of the solid. The surface of the mould is leveled by the weight of the stumps and by using the automatic compression of the hydraulic pressure. The mixture is heated at the required temperature, according to its components. The heating rate depends on the type of the joining material, the stumps are fitted with upper and lower heaters, movable in a horizontal position in order to allow the movement of heaters to compress the mixture according to the required thickness and mixture type. It is also fitted with a tuber that allows passing the cooling gases upon desire for cooling the stumps. The new product is distinguished with the light weight and the ability to endure scratch and damping capacity comparing with the natural marble. It is also liable for the easy formation and is distinctive with different colors and shapes. The unit consists of several main parts **Fig (5) shows float chart of the manufacturing process**

1.The wet refuse preparation unit.
2.The dry refuse preparation unit.
3.The bunker of the collection, final drying and mixture.
4.The metal molds.
5.The upper hammers.
6.The dual hydraulic compressors.
7.The horizontal upper and lower heaters.
8.The cooling gases tube and valves.

Operation & maintenance strategy

It is suggested to establish ten units in Shak Al Teaban district for absorbing the volume of refuse and facilitating the transport and circulation processes due to the difficulty of transporting the refuse to one place. Besides, the small size of the units facilitates the operation and maintenance processes, as it is planned in the periodic maintenance program the existence of a unit in the periodic maintenance, a unit the contingency maintenance and the existence of 8 continuous units at least in the work. Thus, the total of job opportunities is 80 persons for the project, as a whole.

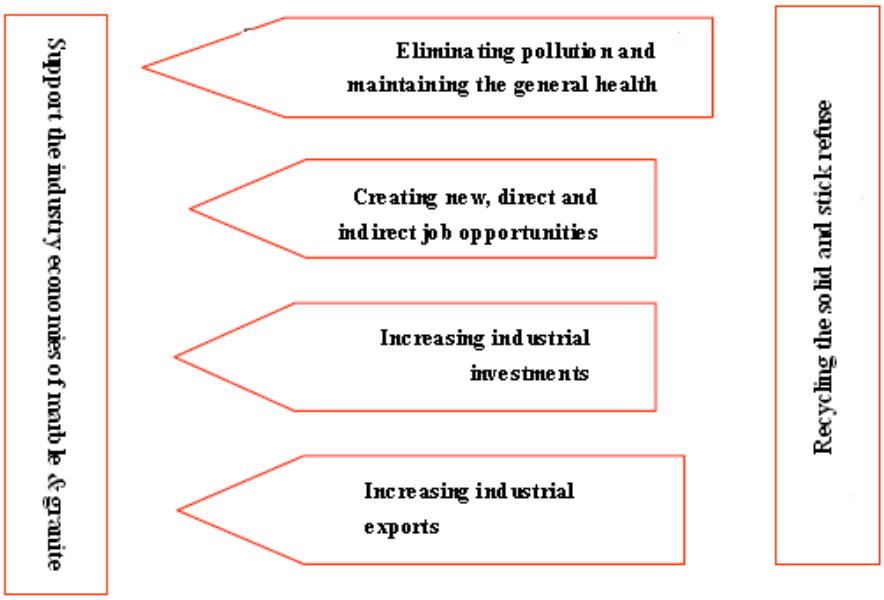

Fig (3) . A chart of the objectives of recycling the marble and granite refuse

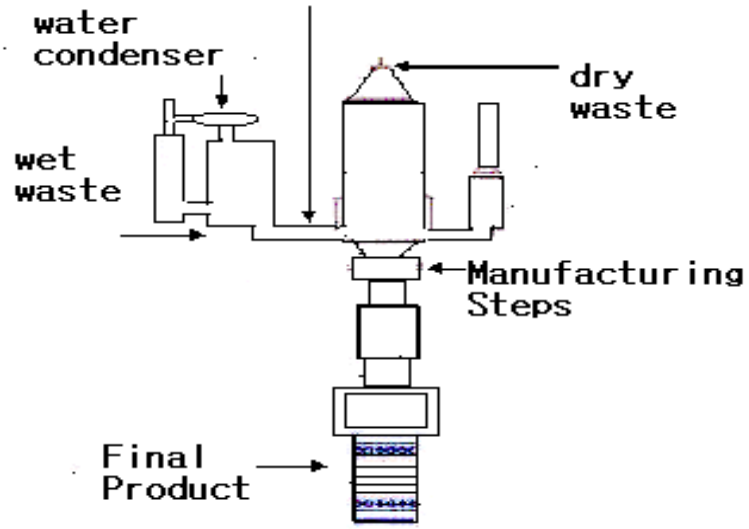

Fig (4). The marble and granite wastes recycling unit

Market Analysis:

A. Quality:

Attention is given to the product quality together with focusing on the accuracy, dimensions stability, quality of design, strength, environmental resistance, conformity of colors, easy installation and the dismantling.

B- The Price:

The low price, together with the quality factors are desirable.

C- The Competition:

Competition with the Local Product:

No other similar product, except products made of plastic or metals that are less regarding the quality.

Competition with the Imported Product:

There is a very expensive imported product and it is less regarding the characteristics as shown in table (1) the general characteristics of the product.

The beneficiaries from the Project

1. Customers who buy the production lines and machines.
2. The youths who have small enterprises.
3. The manufacturers of marble and granite who are interested to expand their products and improve the economical value of their enterprises
4. Direct and indirect employment opportunities. **Table (2) shows the manpower and employments in the project**

Table (1) The General Characteristics of the Products

Characteristic	Hardness Shore D	Resistance of the organic dissolvers	Water absorption and the atmospheric factors resistance	Resistance of acids and alkaline
Value	60	Petrol resistor	Hot water and atmospheric factors resistor	Acids ad light alkaline resistor

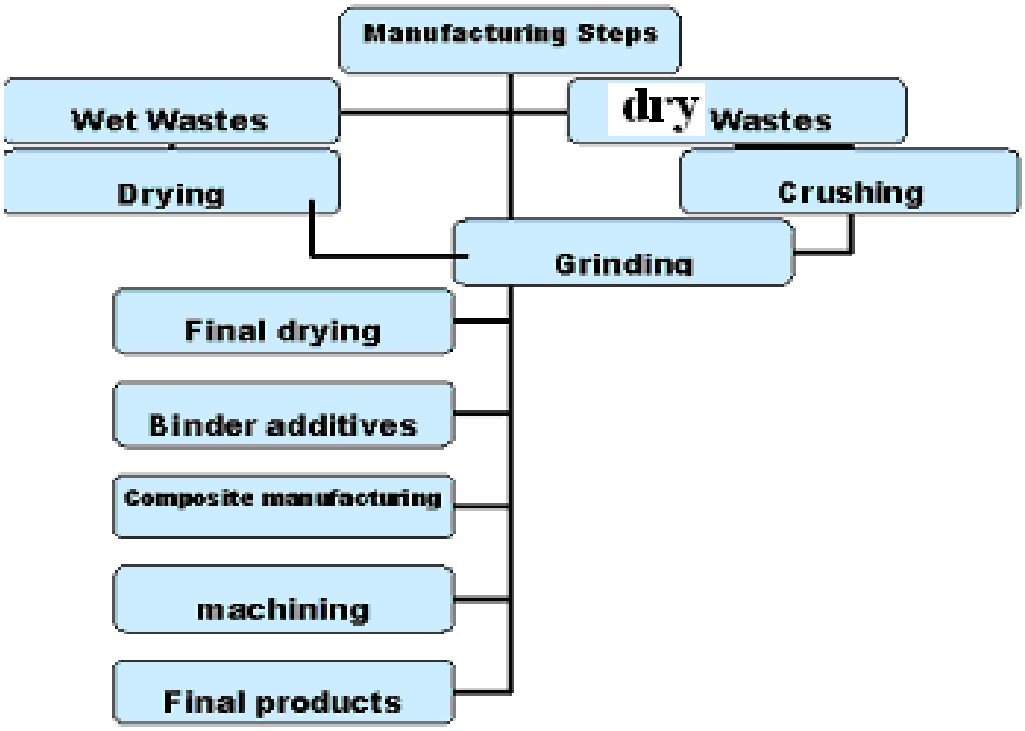

Fig (5) Float chart of the manufacturing process

Table (2) the manpower and employments in the project

Job title	No. of employer	Gender	Monthly salary (L.E.)	Total (L.E.)	Nature of work
Engineer	1	Men/women	1000	1000	**Production and quality supervisor**
Technician	2	Men/women	600	1300	**Operating the units**
Maintenance technician	1	Men	400	400	**Maintenance of the unit**
Laborer	1	Men	300	300	**Assistant works**
Sale representatives	2	Men/women	250	500	**Field**
Accountant	1	Men/women	700	700	**Accounting and administrative affairs**
Total per unit	8			4200	**Each unit provides 8 job opportunities**
Project Total (10 units)	80			42000	**The project provides 80 job opportunities**

The Expenses and the Budget

The economical feasibility study for the unit for recycling of marble and granite wastes are calculated, The calculations are consider case study in Shak Elsoban area in Tora, Egypt. The fixed cost, working cost, total investment costs and their distribution were shown in table (3),(4),(5) and (6) respectively. Operation Cost of a stereotyped Year (Annual Depreciations) are shown in table (7) according to the prices recorded in 2009. Table (8) shows Direct and indirect costs. Table (9) shows the Budget (Revenues and Expenses) according to the social fund for development roles and logistics. The total costs for the project is shown in table(10).

Table (3) Fixed Capital

Investment Factors	Investment Value	Total distribution of expenses
Land	**0**	
Buildings and constructions	**0**	
Machines. Equipment , installations	60400	
Equipment and furnishing	2000	
Means of transport	0	
Foundation expenses	1000	
Emergency reserve (10%)		
Total		63700

Table (4) Working Capital

Capital cycle (one month		
Raw materials – mediating raw materials	17445	
Wages and salaries	4200	
Power (electricity – fuel – utilities)	200	
Maintenance and spare parts	252	
Marketing expenses	100	
Building rents	400	
Insurance	15	
Emergency reserve (10%)	200	
Total		22812

Table (5) Investment Costs Total

Fixed assets	63700	
Working capital	22818	
Investment costs total		86512

Table (6) Distribution of Investments

Investment factors	Investment Value	Investment Distribution Total
Invested capital	17302	
Loan	69209	
		86209

Table (7) Operation Cost of a Stereotyped Year (Annual Depreciations)

Investment Factors	Investment Value	Percentage of Depreciation	Depreciation Value
Buildings and constructions	0	5%	0
Machinery and Equipment	60400	10%	6040
Requirements and furniture	2000	10%	200
Means of transport	0	20%	0
Foundation expenses	1000	10%	100
Emergency reserve	300	10%	30
Total			6370

Table (8) Direct and indirect costs

Investment Factors	Annual Investment	Total
Raw materials – mediating raw materials	209340	
Wages and salaries	50900	
Energy and utilities	2400	
Maintenance and spare parts	3020	
Marketing expenses	1200	
Building rents	4800	
Insurance	181	
Annual depreciations	6370	
Raw materials depreciations 2%	4178	
Loan interests 9%	6229	
Reserve	2400	
Operation costs total per a stereotype year		290527

Table (9) The Budget (Revenues ad Expenses)

Investment Factors	First year	Second year	Third year	Fourth year	Fifth year
Revenues	298200	340800	383400	404700	426000
Cash expenses total	224483	251074	277201	292882	309179
Net profits without the loan	73717	89726	106199	11818	116821
Loan installments	0	17302	17302	17302	17302
Net profit	73717	72424	88897	94516	99519
Cash flow	73717	146141	235038	329554	249072

Table (10) Total Investment Expenses for 10 Units:

Fixed assets	**63700**	
Working capital	**22812**	
Investment expenses total per unit		**86512**
Investment expenses total of the project		**865120**

The Competitive Privileges

The competitive privilege of the products not only from the price, but also it depends on the characteristics of the products as follows:

1. Small weight regarding the solidity.
2. Big hypothesized age.
3. Easy shaping and relative operation with various colors and shapes.
4. Resistance to environmental conditions.

Sustainability

The sustainability is considered the prevailing characteristic of the project. On the part of the financial aspect, establishing a group of small industrial projects for manufacturing the refuse of marble and granite depends at its beginning on a loan with an interest of 9% from the authorities responsible for financing the youth projects and paying attention to the small enterprises. Within a few months the project will be transferred to a project aiming at gaining profit. This is because the products obtained from it are economic and required commodities. It is expected that each project can cover all of its costs of equipment, machinery and raw materials, including the substitution and renewal, within a period from 5-10 years. This is besides

achieving the economic feasibility and providing job opportunities. This is the first factor of the sustainability. The project provided the opportunity in an even way to all the girls and youths to start small enterprises. The second factor of the sustainability is the need of the society to replace a lot of the imported necessary commodities and replacing them with local ones. The dependency of the project on the available wealth sources in the surrounding environment is considered one of the sustainability factors. This is in addition that the project exploits the sources of the wealth in the best way than what actually exists. The most important factor of sustainability is that the project, originally, is based on scientific researches, developed technology and detailed economic feasibility study

Risks and Probable Crises

(a) The high price of the imported raw materials.

Raw materials that should be imported from abroad, this leads to raising the prices of the products, this can be overcome by using local raw materials and technology in industrializing the unit.

(b) Problems connected with the truancy of the trained manpower.

It can be overcome by establishing a main training center connected with the project research center for training staffs with high efficiency and also training them on the improvements which will be inserted on the production line.

In addition to the administrative difficulties, the lack of financing sources and the lack of the statistical data about the quantities and types of the marble and granite refuse.

(c) Crises Regarding the Pollution Resulting from the industry risks and the environmental laws, it can be overcome by achieving the following environmental and health conditions:

Public Conditions:

-The required natural ventilation sources.

- Providing the required fire fighting equipment.

-Providing a permanent water source from the public net.

-The existence of a public net of the health/ industrial sewerage

-The Ministry of Environment should be communicated in order to assess the environmental effect of the project according to the suitable environmental classification model and the requirements of the environment laws. The project is considered one of the new projects in the Egyptian industry. Initially, it could be classified in the grey list [7,13].

Special Conditions:

-Providing the ventilation system and the automatic drawing for reducing the concentration of the emissions and maintaining the temperature in comfortable ranges.

-Safe disposal of the liquid refuse after treating it.

-Using the gloves, masks, protective glasses and ear plugs.

-Collecting the refuse, recycling and pressing it in the same project for producing other items.

Conclusions

The project produce significant contribution to the marble and granite industry can be summarized as follow:-

1. The first automatic industrial unit that deals with all types of the wastes, wet and dry marble and granite industrial refuse, and recycling them in order to get a final product in the same unit.
2. Using a physical method to treat the marble and granite refuse in order to maintain their natural characteristics.
3. Using the marble and granite refuse as a filling, strengthening and improving fillers in composite materials, as substitutions of the expensive additives.
4. Production of new composite materials in different shapes and colors which resisting scratch and environmental conditions
5. Production of composite materials that are suitable for insulation, lining and tiles.
6. Designing a complete production line (an industrial unit that performs the process of the physical treating of the marble and granite) and manufacturing new products.
7. using the environmental pollutants in serving the environment itself to maintain the general health of the citizen and improve economics of the industry.
8. The new unit does not need skillful laborers and it can be established in the industrial zone of mining marble and granite. No module is used in the packing and covering.
9. Production composite materials with electro-static features, resistance to bacteria and possibility of adding new distinctive features.

Recommendations

1. The continuous training for all the specializations by the accrued training centers.
2. Due to the importance of the data about the targeted markets, there is a great need for establishing an effective data base with continuous modernization.

3. The continuous coordination with the governmental and non-governmental boards and organizations.
4. Attempting to enroll in the supply records of the targeted places of the big and governmental companies and the decorations offices.
5. Working with the spirit of the team and the participation of workers in the material and spiritual successes. Securing the policy of satisfying the customers, the quickness of response for any remark and removing its causes, as a first priority for all the workers in the project, the continuous communication with the complaining and non-complaining customers.

Corresponding author
Hebatalrahman, A
Consultant in materials sciences and materials applications, Egypt
hebatalrahman11@yahoo.com
hebatalrahman@naseej.com

References

1. Ghosh, P. and A. K. Samanta(1997). *J. Text, Inst., Part 188 (3),* 209 12.
2. Kwasnick, J. et al. (1997). J *Text. Inst., Part 1, 88 (3):*167.
3. Schmidt, A. X. and C. A. Marlies(1948). *Principles of High Polymer- Theory and Practice,* McGraw-Hill, New York, 1948 Chapter 11.
4. Ghosh, *P.(2002)., Polymer Science and Technology: Plastics, Rubbers, Blends and Composites,* Second Edition, Chapter 1 and 7, Tata McGraw-Hill, New Delhi, 2002.
5. Sett, S.K. and D. Sur(1993). *J. Indian Fibre Text Res., 18(3):113…*
6. Lewin, M.(1984). 'Chemical Processing of Fibres and Fabrics, Fundamentals and Preparation, Part B,' in *Handbook of Fibre Science & Technology,* Vol.1, M. Lewin and S.B. Sello (Eds), Marcel Dekker, New York, 1984, Chapter 2.
7. Partridge, LK. (1989). *Advanced Composites,* Elsevier, Applied Science, London,
8. Mallick, P.K.(1988). *Fibre Reinforced Composites* Marcel Dekker, New York, 1988.
9. Shah, A.N. and S.C. Lakkad (1981). *Fibre Sc. & Tech.,* **15:…17.**
10. Clark, B.A. and M.P. Ansell(1986). *J. Mater. Sci.,* 21:269.
11. McLaughlin, E.C. (1980). *J. Mater. Sci.,* **15**: 886. 7.
12. White, N.M. and M.P. Ansell(1983). J. *Mater. Sci.,* **18**:1549.
13. Holmes M. and D.J. Dust (1983). *GRP in Structural Engineering* Applied Science, London, 1983. Ghosh, P. and P.K. Ganguli, *Jute, Encyclopedia of polymeric Materials,* J.C. Salamone Ed., CRC Inc., New York, 5 (1996) 3504.
14. Kundu, B.C., K.C. Basak and P.B. Sarkar(1959). *Jute in India,* Indian Central Jute Committee, Kolkata, 1959.
15. . Nevell, T.P. and S.H. Zeronian(1985). *Cellulose Chemistry and Its Application,* Ellis Horwood, Chichester, 22-26.
16. Sarkar, P.B., A.K. Majumder and K.B. Pal(1948)……, *J. Text. Inst., 39*:T-44. 11. McGregor, E.A. and C.T. Greenwood(1982). *Polymers in Nature,* John Wiley, Chichester, 1982, Chapter 7.
17. Sarkar, P.B., *J. Indian Chem. Soc.,* (1931) 397; 10 (1933) 263; 11 (1934) 5, 8, 407, *12* (1935) 168, 470, 542, 547.
18. Sarkar, P.B., *Sci. & Culture, 1* (1935) 60, 3 (1937) 411, 485, 551.
19. Gravitis, J. and P. Erins. *J. Appl. Polym. Sci.,* Appl. Polym Symp., *37* (1983) 421.
20. Staudinger, H., Ber 53B (1920) 1073.
21. Carothers, W. H. and J. W. Hill(1932). J *Am. Chem. Soc.,* 54:1559.
22. Ghosh, P. and N.R. Bose(1995). *J. Appl. Polym. Sci.,* **58**:2177.
10. Ghosh, P. and P.K. Ganguli(1994). *J. AppL Polym. Sci.,* 52:77.
23. Kesser, T.D.J.(1960). *Polypropylene,* Reinhold, New York (1960).
24. Lewin, M. and J. Preston, *High Technology Fibres, Part A,* Marcel Dekker, New York (1985) 357.
25. Datye, K. V. and A. A. Vaidya(1984). *Chemical Processing of Synthetic Fibres and Blends,* John Wiley & Sons., New York, 1984.
26. Hebatalrahman Patent 745/2008, Egyptian patent office, 2008.

11/12/2011