MINISTRY OF ENERGY AND ENERGY AFFAIRS
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Securing Energy for Tomorrow

PROFILES FOR DERIVATIVE MELAMINE MANUFACTURING BUSINESS OPPORTUNITIES

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DEVELOPED FOR

The Ministry of Energy and Energy Affairs
Government of the Republic of Trinidad and Tobago

PREPARED BY

National Energy Corporation of Trinidad and Tobago Limited

Contents

List of Selected Abbreviations

BRIC	Brazil, Russia, India, China
CA	Central America
CapEx	Capital Expenditure
EU	European Union
GDP	Gross Domestic Product
GORTT	Government of the Republic of Trinidad and Tobago
HPL	High Pressure Laminates
LPL	Low Pressure Laminates
MF	Melamine Formaldehyde
MSDS	Material Safety Data Sheet
MUF	Melamine Urea Formaldehyde
SA	South America
T&T	Trinidad and Tobago
UF	Urea Formaldehyde
US	United States

In May 2010, Methanol Holdings Trinidad Limited (MHTL) began producing melamine from its 60,000 tpy production facility, which forms part of its AUM I Complex. The production of this commodity, downstream of ammonia, provides an opportunity to leverage the strengths of the energy sector in order to develop linkages with the manufacturing sector. As such, the Government of the Republic of Trinidad and Tobago (GORTT) initiated the development of melamine manufacturing profiles, which could be used as a tool by manufacturers and potential investors in developing business opportunities and further adding value to the country's natural gas resource.

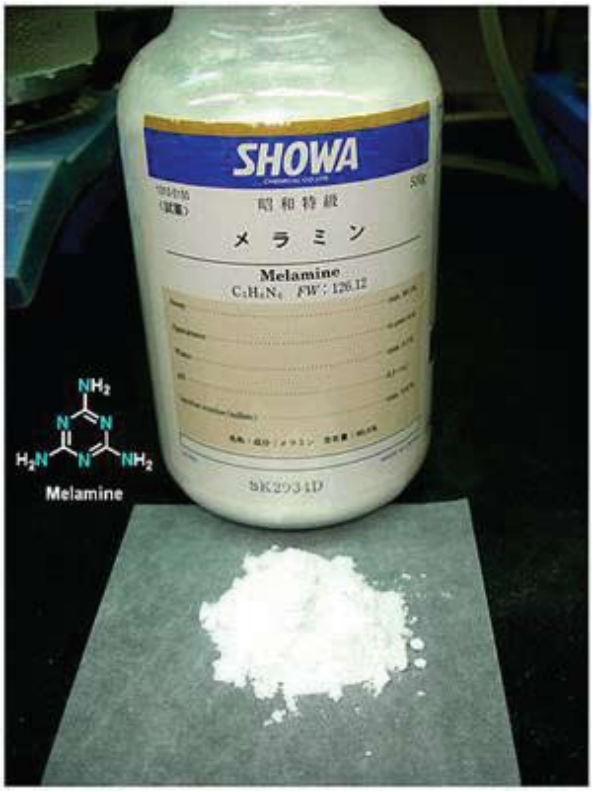
Applications of melamine are vast and plays a vital role in improving the quality, safety, durability and aesthetic appearance of products such as laminated surfaces, adhesives and resins for wood-based panels, just to name a few. For the purpose of developing downstream manufacturing opportunities in Trinidad and Tobago, efforts will focus on industries suitable for the existing markets, infrastructure and logistics such as melamine moulding compounds, dinnerware, laminates, adhesives, coatings and plasticizers.

The use of melamine in manufacturing applications is diverse. The table below illustrates the wide range of end products which contain or use melamine.

Table 1: List of Melamine End User Applications

End Market	Application	Quality/Characteristic
Automotive	• Coating for vehicle body paints • Flame-resistant foam • Interior panels and dash	• Coating, color retention, wear resistance, scratch resistance • Low weight • Low-temperature flexibility • High sound absorption capacity • Good thermal insulation properties • Constant physical properties over a wide temperature range • Application temperature up to 240°C [465°F] • Flame resistance • Abrasiveness
Agriculture	• Rubber vulcanizing agents	
Building & Construction	• Adhesive resins for ceiling tiles • Beams • Carbonitriding of steel • Oriented Strand Board (OSB) • Concrete plasticizers • Concrete shuttering • Construction panels Gypsum • Medium Density Fiberboard (MDF) • Parallel strand Lumber • Particle board • Plywood • Structural foams • Laminated Veneer Lumber (LVL) • Iron on Veneer	• Strength, moisture-resistance, efficient utilization of wood, flow characteristics (concrete), thermal isolation, sound absorption
Electrical & Electronics	• Wind power blades • Computer cases • Switch plates • Junction boxes • Raceways • Domestic appliances • Printed circuit boards • Television casings • Switch plates	• Flame-retardant, sound absorption, acoustic properties, thermal isolation

End Market	Application	Quality/Characteristic
Fibers, Textiles & Coatings	• Banknotes • Drink cans • Fluorescent paints • Intumescent paints • Leather tanning agents • Maps • Matting agents • Printed textiles • Symphase Technology • Special glossy papers • Wallpaper • Wrinkle-free clothing	• Wear-resistance, wet-strength properties, printability, color performance, color retention
Furniture	• Bathroom fittings • Bedroom furniture and fitments • Cabinets desks • Furniture tops • Kitchen and bathroom counter-tops • Nursery and children's furniture	• Lamination, durability, scratch-resistance, heatproof, chemical-resistance, moisture-resistance, printability, richness of design, efficient utilization, antibacterial
Packaging	• Packaging	• Packing
Sports, Leisure and Consumer goods	• Durable dinnerware • Basketball goals • Bowling balls • Hockey pucks • Ice hockey sticks • Lawn bowls • Melamine cleaning sponge • Outdoor table tennis tables • Picture and mirror frames • Skis • Surfboards • Slideboards • Snowboards • Table football tables • Toys	• Strength, durability, attractiveness, performance
Other	• Anti-punking agents in binders for glass fibre insulation • Ion-exchange resins • Nitrification agent (nitrogen force) • Printing ink • Raw material for cyanuric acid (swimming pools disinfectant) • Starting material for melamine derivates and salts for a variety of applications	



Notwithstanding these numerous applications of melamine, there are several issues related to the manufacturing of the final products which should be considered. These include:

- Seeking and obtaining committed product buyers.
- Obtaining proprietary technology and standardized work processes where necessary. (Licences to use the intellectual property of sellers, including machinery, equipment, software, etc).
- Obtaining ISO9000 certification as it relates to quality and management systems.

- Melamine has been used in consumer applications without incidents since it was commercialized. Examples include kitchen worktops, laminate floors, work-surfaces, furniture, dinnerware, banknotes and automotive coatings. These applications contain bonded melamine-based polymer. Even direct or indirect oral contact with any of these products is completely safe.
- Melamine has been used as a flame retardant material for furniture and mattresses for decades, and complies with all the health and safety requirements in this industry. Any melamine that may be present in the bedding foams will be locked in the foam matrix and therefore cannot enter your digestive system while sleeping on flame retardant mattresses.
- No personal injuries are likely in the event of spillage. Melamine has a very low acute toxicity. If it is inhaled or gets in the eyes, it is only mildly irritating, and the irritation quickly subsides when exposure ceases.
- Melamine is absolutely not intended to be used as an ingredient in food and feed applications and therefore should never be used as such. Melamine in bonded form is widely and regularly used in dinnerware, meeting the most stringent requirements of the US Food and Drug Administration (FDA).
- Most melamine-based products require additional materials or inputs to create a finished product. Examples of these are illustrated on Figure 3.

Some of the major markets for melamine derived products are highlighted in Table 2.

Table 2: Major Markets and Potential Markets for Melamine Products

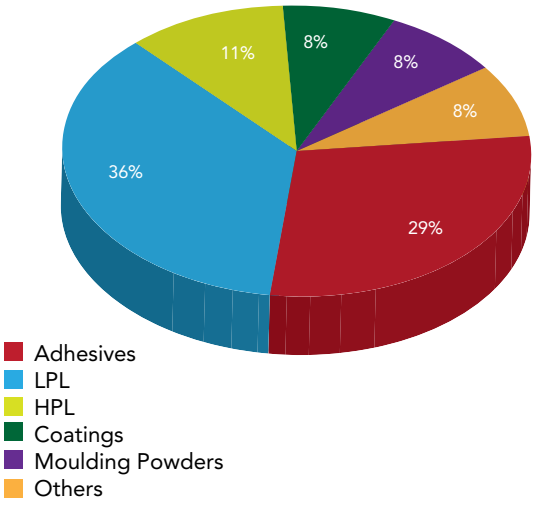
Product	Major Markets
Moulding Compounds	Regional, South America (SA), Central America (CA), Africa, United States (US)
Tableware, Dinnerware and Utensils	Regional, SA, CA, Africa, US
Toys	Regional, SA, CA, Africa, US
Toilet Seats	Regional
Laminates	Regional, SA, CA, Africa, US
Adhesives	To Multinational buyers – Special needs Regional, SA, CA, Africa
Coatings (Special)	Niche Market Potential
Melamine Phosphates – Flame Retardants	Multiple Potential – Worldwide
Symphase Technology (New low cost high tech vacuum package coating)	Regional Packaging companies
Plasticizers	Multiple Potential Worldwide

It should be noted that a lot of market potential resides in the BRIC (Brazil, Russia, India, China) countries as well. Due to the growing GDP and increasing population in those countries, drivers such as increased consumerism and an expanding middle class would create added potential for consumer products. Goldman Sachs has estimated that by the year 2050 the BRIC countries will be among the six top economies of the world[1]. Therefore, the market potential for melamine-based products such as toys, tableware, adhesives and laminates would continue to be favourable in these economies. This is especially significant with respect to Brazil which presents a substantial market potential for manufacturing industries from Trinidad and Tobago due to its relative proximity.

[1] *www.wikipedia.org, 01st April 2011.*

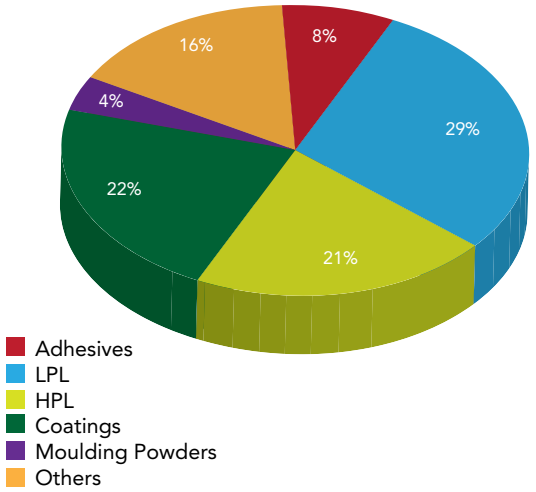
The world market for melamine applications is shown in Figure 1.

Fig 1: Worldwide Melamine Market Segments



In the Americas 72% of melamine produced is used in applications for high pressure laminates (HPL), low pressure laminates (LPL) and coatings as shown in Figure 2.

Fig 2: Melamine Market in the Americas



Consumption of melamine in 2010 was estimated to be 1.264 million tonnes increasing slightly from 2007 when consumption was at 1.225 million tonnes. Worldwide capacity has increased by 400,000 tonnes or 9% from 2007 to 2010 while consumption only increased by 1%. This has resulted in decrease in the utilization of melamine facilities from 87% in 2007 to 70% in 2010. Even so, it is projected that the market size for melamine in 2015 would be 1.663 million tonnes globally due to increase consumer demand. South and Central America will see growth of 4.8% with increased demand for melamine use in wood adhesives and laminates. Therefore it is expected that additional melamine capacity would be required in the near to medium term.

Most of the consumption gains have been in Asia and more specifically China. China is the single largest consumer of melamine at 39% global consumption, 53% of capacity and 46% of global production. Europe is the second largest market, consuming 32% of the melamine produced globally.

Approximately 50% of the melamine produced worldwide is used in the production of laminates. The next major uses of melamine are in the production of wood adhesives (29%), surface coatings and moulding compounds.

Over the past twelve to eighteen months, there has been a steady increase in the price of melamine, from US$1,862 per tonne in January 2010 to US$2,435 per tonne in February 2011 on the US bulk domestic market. This price has been fairly constant since October 2010. Currently, there are no indications that this may trend downwards in the near term.

In order to develop melamine manufacturing industries and business opportunities, it is necessary to have a conceptual plan that will allow for proper material flow and logistical arrangements. Figure 3 provides a diagrammatic overview for integrated melamine manufacturing industries, while Figure 4 illustrates a conceptual estate plan for derivatives of melamine and related manufacturing industries.

Figure 3: Diagrammatic Overview of Integrated Melamine Derivative Industries

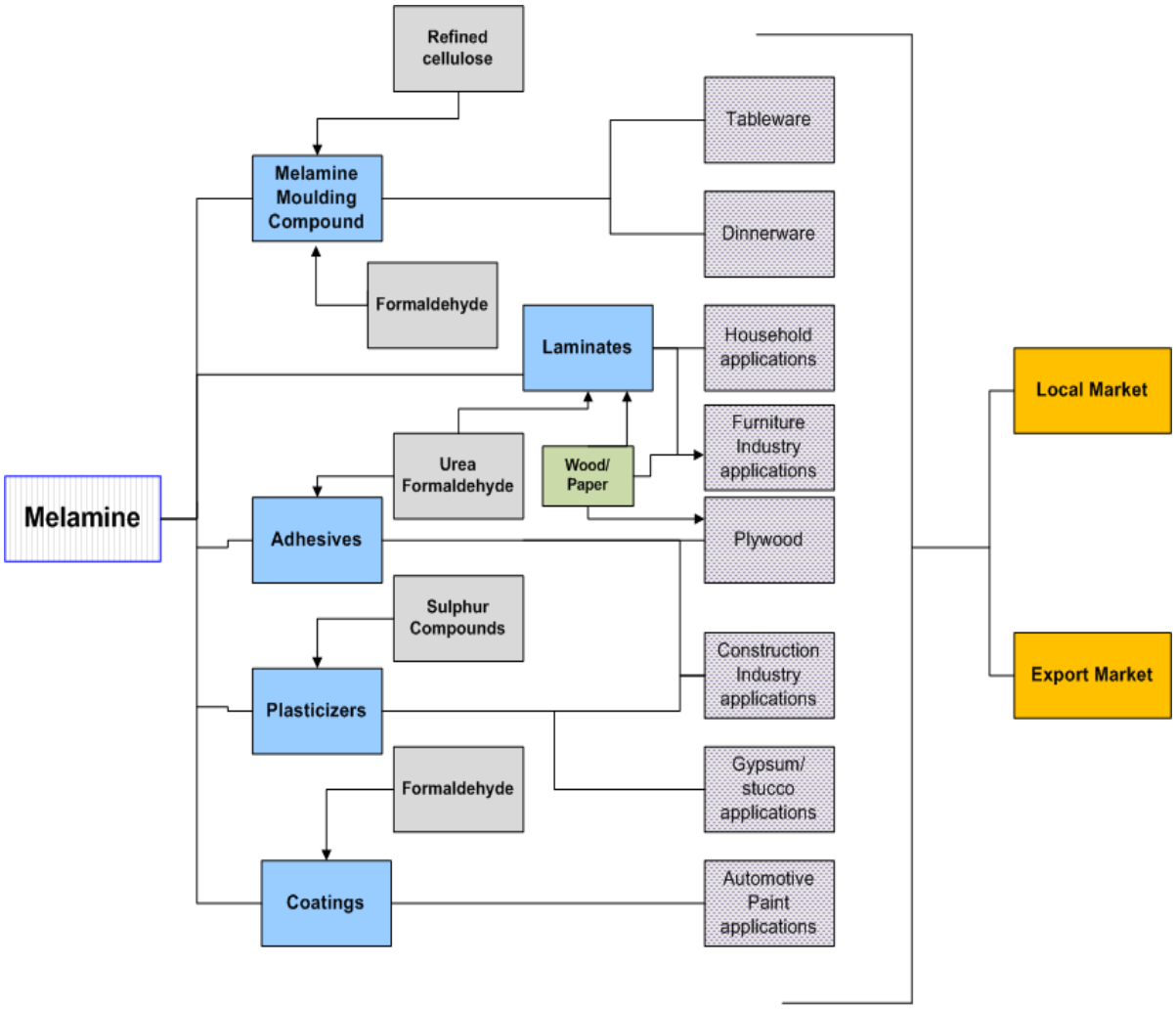
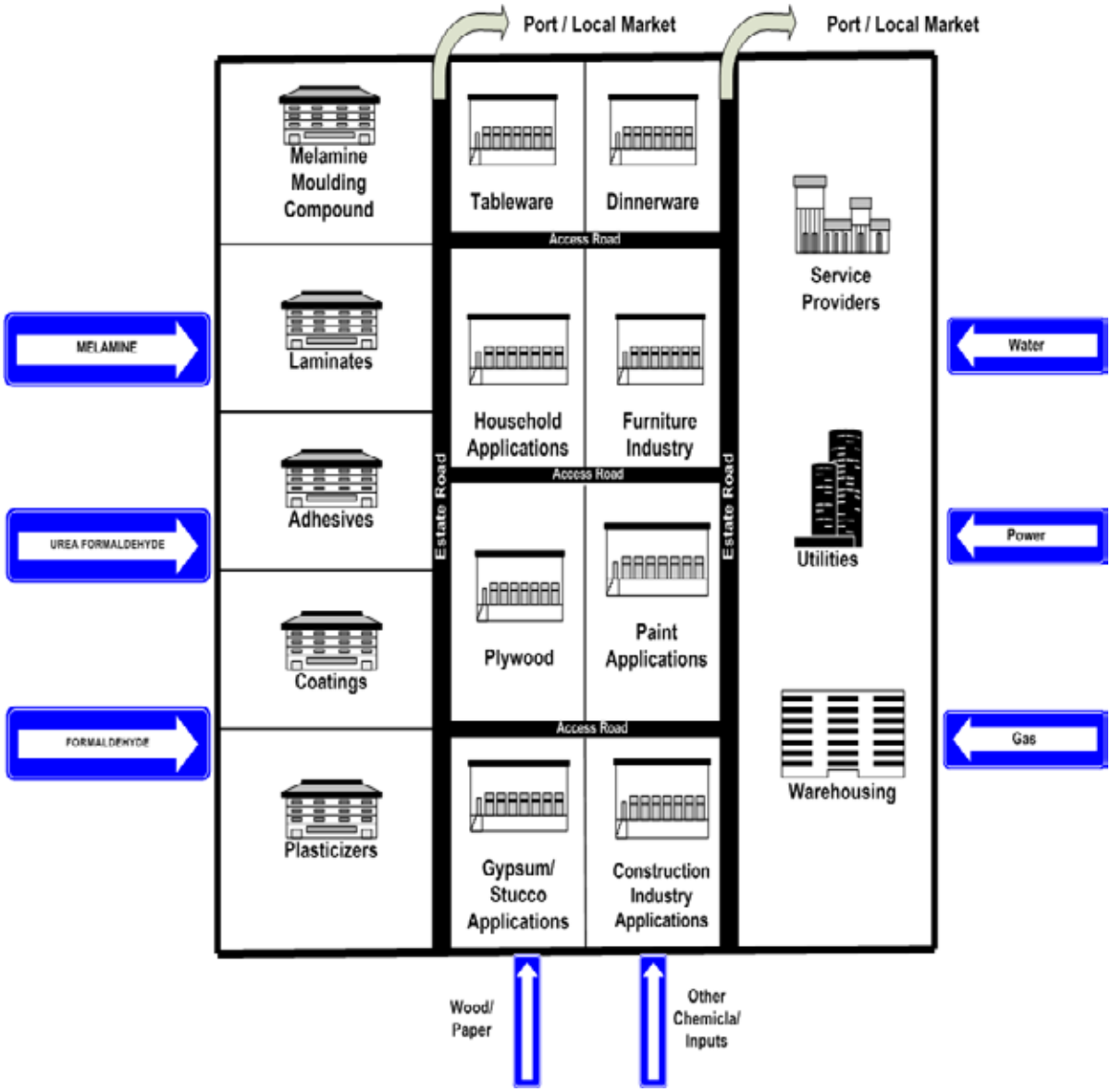


Figure 4: Conceptual Estate Plan for Downstream Melamine Manufacturing Industries



5.1 Product Characteristics

Melamine Moulding Compound (MMC) is an alpha-cellulose filled melamine formaldehyde material, which is available in an unlimited range of colours. It produces mouldings with surface hardness unsurpassed by any other plastics. Moulded parts have excellent resistance to abrasion, boiling water, detergents, weak acids and weak alkalis as well as acidic foods and extracts.

Compared to thermoplastics, Melamine Moulding Compound exhibits:

- Superior surface hardness that cannot be duplicated by thermoplastic materials.
- Superior heat resistance exceeding 99°C with continuous use index of 130°C.
- Environmentally friendly raw material components that do not contain halogens or organic solvents.
- Superior chemical resistance.
- Excellent scratch resistance that cannot be duplicated by engineered thermoplastic materials.
- Unparalleled UV stability and colour retention.

Melamine Moulding Compound is particularly well-suited for moulding food contact products, including quality dinnerware for domestic and commercial food service.

5.2 Market Assessment and Current Situation

- With new demand for melamine-based automobile parts, the overall global production of Melamine Moulding Compound appears to be under supplied at present.
- Overall outlook for global market demand is good with increasing demand in South and Central America, as well as the African markets.
- Forecast for projected growth for the next 10 years is about 3% per annum.
- The future market will be driven by creative internet or e-marketing, innovations in the industry and economics. The current retail price for Melamine Moulding Compound ranges from US$2.00 to $3.00 per lb for coloured product and US$1.25 to 1.75 per lb for non-coloured product.
- The historical demand for the product had an average growth rate of about 3% over the last ten years.
- Specific markets for production from Trinidad and Tobago are Regional, South and Central America, Africa and the US.
- There are no major potential barriers to accessing these markets.
- Some of the major manufacturers of Melamine Moulding Compound include:
  - Amity Thermosets PVT Ltd (India)
  - Kaihua County Hao Teng Melamine Products Factory (China)
  - Shijiazhuang Golden Color Chemical Co., Ltd. (China)
  - Henan Premtec Enterprise Corporation (China)
  - Jiashan Luyuan Chemical Co., Ltd. (China)
- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US and India.

5.3 Capital, Input and Infrastructure Requirements

Table 3: Requirements for Melamine Moulding Compound Facility

Item	Estimated Requirement*
Floor Space	1000 sq m
CapEx	US$250,000 – 500,000
Working Capital	US$50,000 – 100,000
Capacity range	3 – 5 tonnes per day
Manpower requirement	30 – 40
Utility Requirements	500 kW power supply 20 tonnes per day water
Other Input Materials	Refined cellulose, formaldehyde

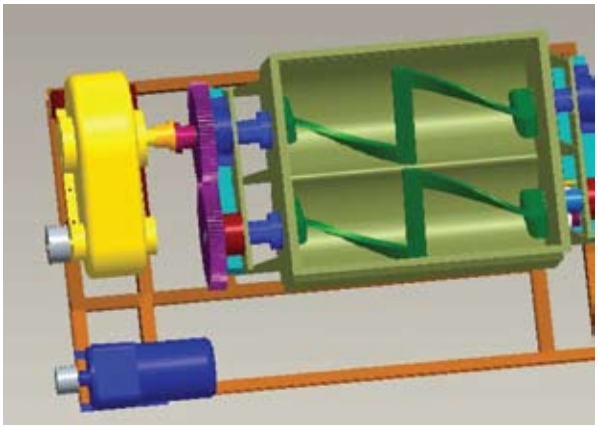
** depending on plant capacity and level of automation.*

The major pieces of equipment used for processing melamine formaldehyde moulding compound (MF powder) include:

- Chemical Reactor Vessel
- Kneading Machines (kneading mixers)
- Belt Dryers
- Crushers
- Ball Mills,
- Dust Separators
- Dust Collectors
- Powder Sieve

Figure 5 shows a cross-section of a kneading (mixing) machine, which is specially designed for mixing and kneading of the chemical constituents that exit the reactor during the production process.

Figure 5: Melamine Moulding Compound Mixing Equipment (cross-section)



Technical parameters:
Vat volume: 1500 litres, 2000 litres, 2500 litres
Rotations: 30 – 50 per minute
Power: 18.5kW, 26kW

6.1 Product Characteristics

Melamine dinnerware is constructed with the use of melamine moulding compound, and comes in bright and lively colours. The current trend for eating outdoors has resulted in a ready-market for melamine based dinnerware. Presently melamine dinnerware is favoured for casual outdoor dining rather than formal dinner parties. Vintage melamine is sought after and is regularly sold on Internet auction sites, while modern manufacturers are making melamine dinnerware in retro designs for that authentic 1950s look.

Adding decorative overlays during the moulding cycle can enhance the appearance of the moulded articles. This important added value would allow Trinidad and Tobago to insert a unique local brand of art-form that is skewed to worldwide end users' cultural preferences.

Melamine's resilience made it the dishware of choice on some U.S. Navy ships in the past. The current desire for products to be modern and new, led to melamine getting a makeover. American melamine manufacturers such as American Cyanamid, Bracknell, and Northern Plastic worked with designers, including Russel Wright, Joan Luntz and Kaye LaMoyne, to create elegant dinnerware designs.

Melamine bowls and plates, presents a cheerful and versatile alternative to traditional china. The colourful and contemporary designs are symbolic, stylish and desirable. One particular brand, Melaware is considered to be very stylish. An added advantage of this product is its strength and durability, in that it can be dropped without being damaged.

Melamine dinnerware is easy to clean and as such requires normal hand washing with liquid dish detergent. However, it is not microwavable, and could melt if subjected to such heating conditions for extended periods.

6.2 Market Assessment and Current Situation

- Overall global production of uniquely designed high-end Melamine Dinnerware is currently in good demand.
- Overall global market demand is favourable with increasing demand from Regional, South and Central America and Africa markets. This global market requirement is currently about 6 million units per year.
- Forecast projected growth for the next 10 years is approximately 3% per annum.
- The future market will be driven by creative internet or e-marketing, innovations in the industry and economics.
- The current retail price for a melamine dinner plate ranges from US$0.80 to US$2.85.
- The historical demand for the product had an average growth rate of about 4% over the last ten years.
- Specific markets are Regional, South and Central America, Africa and the US.
- No major potential barriers to accessing these markets are foreseen.
- There are several hundred current manufacturers and suppliers of melamine dinnerware worldwide. Major manufacturers include:

- Henan Hylink Imp. & Exp. Co., Ltd. (China)
- Quanzhou Jieli Trade Company Limited (China)
- Liyang Xinrong Melamine Products Co., Ltd. (China)
- Fuzhou Fortune Homeware Co., Ltd. (China)
- Zhejiang Lesheros Houseware Manufacturing Co., Ltd. (China)

- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US and India.

6.3 Capital, Input and Infrastructure Requirements

Table 4: Requirements for Dinnerware Manufacturing Facility

Item	Estimated Requirement*
Floor Space	600 sq m
CapEx	US$300,000 – 500,000
Working Capital	US$60,000 – 100,000
Capacity range	600 to 1,200 pieces per day
Manpower requirement*	15 – 40
Utility Requirements	60kW electricity 5 tonnes per day water
Other Input Materials	Melamine moulding compounds

** depending on plant capacity and level of automation.*

A typical process flow and factory layout for a dinnerware manufacturing facility is illustrated in Figures 6 and 7 below respectively.

Figure 6: Flowchart for the production of Melamine Dinnerware

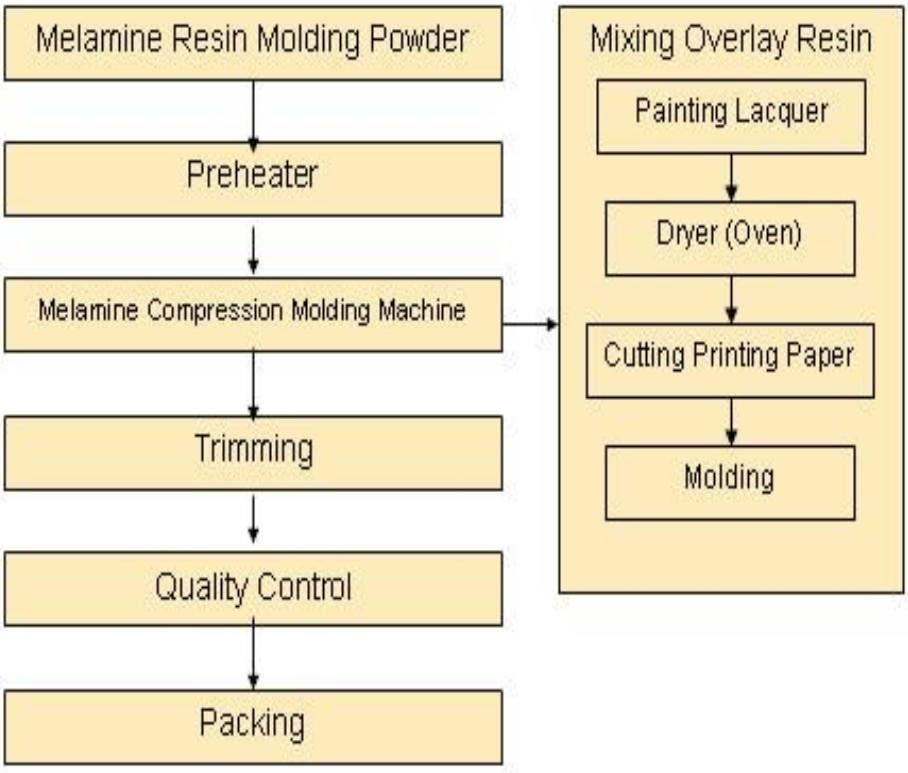
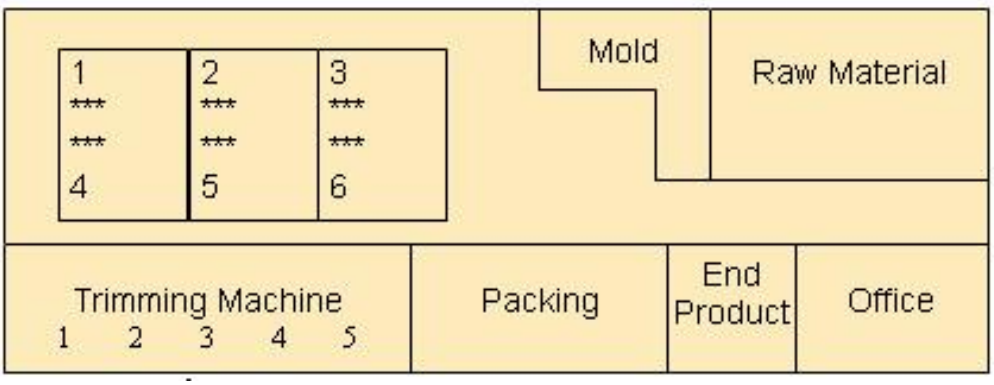


Figure 7: Layout for Dinnerware Manufacturing Facility



The manpower requirement for a turnkey dinnerware manufacturing facility as shown in Figure 7 is presented on Table 5.

Table 5: Manpower requirement for typical Dinnerware Manufacturing Facility

Section	Manpower (person)
Plant Manager	1
Production Technician	1
Foreman	2
Operator	10
General Worker	1
Total	15

Various configurations of process equipment can be used for the production of melamine dinnerware. The tables below include a typical combination of major pieces of equipment. However, it should be noted that ultimately, the selection of the respective equipment would be dependent on the desired output and space available.

Table 6: Typical Machines to be used in the manufacture of Dinnerware

1.	100 MT Hydraultic Moulding Machine	3 SETS
2.	5 kW Pre-heater	3 SETS
3.	Trimming Machine	5 SETS

Table 7: Other Equipment to be used in the manufacture of Dinnerware

1.	2HP Air Compressor	2 SETS
2.	Scale 0-2 kg	7 SETS
3.	4 kW Heater	1 SET
4.	Chiller Tower (5 tonne)	1 SET

Table 8 provides useful information related to the manufacture of plain plates. The production capacities are based on an 8-hour work day and a 25-day month. The rate of good products is 80%.

Table 8: Production Capacities for various Dinnerware (plate) dimensions

DIA.	Thickness	Weight	Monthly Output	Raw Material
7″	2.5mm	110g	32,000PCS	4.95 tonnes/month
8″	2.5mm	150g	32,000PCS	6.7
9″	2.5mm	180g	32,000PCS	8
10″	3.0mm	270g	24,000PCS	9
12″	3.0mm	370g	16,000PCS	8.3
14″	3.0mm	520g	16,000PCS	11.6

The following provides selected technical details of various machines used in the manufacture of melamine dinnerware.

Figure 8: Dense Two Color Melamine Tableware Moulding Machine (good for producing 2-colour tableware)

Technical parameters:

Pressure	200 tonnes
Plate size	600 x 600 mm
Cylinder diameter	360 mm
Maximum stroke	400 mm
Motor	10 HP
Heater capacity	10.8 kW
Oil reservoir capacity	120 gallons
Machine size	2530 x 1500 x 2150 mm
Kind	Twin-Screw
Processing	Extruder
Type	Plastic Product Hydraulic Press
Company	Fujian Hongan Machinery Co. Limited

Figure 9: Pre-heater for Melamine Powder

Technical parameters:

Output	7kW
Power source	415V (adjustable)
Power input	13KVA
Voltage switching	3-stage
Arrangement of hood	MOTOR type
Dimension (W*D*H)	600 x 850 x 1540 mm
Supplied by	Fujian Hongan Machinery Co. Limited

7.1 Product Characteristics

- Adhesives are high quality glues specifically designed to bond a wide array of decorative laminates, melamine board, wood and wood-based panel products.

- Each adhesive has been developed and selected to suit most applications required by cabinet makers, joiners, furniture manufacturers, post-formers and builders. Melamine adhesives are among the many adhesives in use. Due to the availability of petrochemical feedstock, Trinidad and Tobago may be considered as a preferred location for adhesive manufacturing facilities.

- Melamine adhesive is widely used in cabinet making for assembly of laminated board with traditional fittings such as dowels, cams, staples and screws. It is a versatile adhesive that will also bond a variety of porous materials such as timber, particleboard, MDF board and Craftwood® to non-porous substrates such as rigid foam, melamine surfaces and cultured marble.

The table below provides some of the properties of melamine adhesives.

Table 9: Properties of Melamine Adhesives

Product Properties	
Colour	White liquid, dries clear
Solids	High (approx. 50%)
Viscosity	3,500 cps
Open Assembly Time	5 minutes maximum at 20°C
Closed Assembly Time	10 minutes maximum at 20°C
Clamp Time	4 hours minimum

7.2 Market Assessment and Current Situation

- There has been an increase in demand for multiple speciality high performance and nano-formula adhesives. This is as a result of requirements of the automobile, aircraft, construction and other industries. As such, overall global production for specialty adhesives at present appears to be highly favourable.

- Overall global market demand is excellent with increasing demand from this Region, the US, South and Central America, Africa and EU markets.

- Forecast projected growth for the next 10 years is expected to be about 5% per annum.

- Due to the hundreds of different formulae of adhesives, current retail prices for adhesives could vary from regular store pricing to NASA and other space travel speciality needs. The future is promising because of the many new innovative extreme performance adhesives, creative internet or e-marketing, innovations in industry and the current global economies' desire to cut costs.

- The historical demand for adhesives has increased by 5% annually over the last ten years.

- Major potential barriers to accessing these markets are: product shelf life, trade restrictions, MSDS restrictions, obtaining contract manufacturing agreements, stringent quality control and potential environmental impact concerns.

- Major Manufacturers include:

  - Astra Chemtech Private Limited (India)
  - Wilsonart (USA)
  - 3M (USA)
  - Conpro Chemicals Private Limited (India)
  - IPS (USA)

- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US, India and EU.

- Manufacturing adhesives are a relatively competitive business. There are several hundred small and a few mega manufacturers and suppliers. Manufacturers' technologies for specific products are proprietary.

Table 10 provides an overview of the applications of melamine in the adhesives sector.

Table 10: Applications of Adhesives

Adhesive Products & Selection Guide	Substrates												Applications					
	Particleboard	MDF Board	High Pressure Laminate	Wet Area Panelling	Melamine	Timber	Metals (1)	Plaster Board	Cement Sheet	Masonry	Plastic (2)	Rubber (3)	Laminating	Post Forming	Edge Gluing	Wall Panels	Flooring	Assembly
Contact Adhesives																		
Brushable Contact Adhesive	•	•	•	•		•	•	•	•	•	•	•	•	•	•			
Sprayable Contact Adhesive	•	•	•			•	•	•	•	•	•	•	•	•	•			
Gel Contact Adhesive	•	•	•			•	•	•	•	•	•	•	•		•	•		•
Cleaners & Solvents																		
ABS Edge Strip Cleaner															•			
Contact Adhesive Thinner													•	•		•		
Adhesive Cleaner													•	•		•		
Construction Adhesives																		
Wet Area Panelling Adhesive	•	•		•	•	•	•	•	•	•	•					•		
Particleboard Flooring Adhesive	•	•			•	•	•	•	•	•	•						•	
PVA Adhesives																		
Cross-Linking PVA Adhesive	•	•	•			•		•	•				•	•	•	•	•	•
General Purpose PVA Adhesive	•	•				•		•	•				•					•
Craftwood PVA Adhesive	•	•				•		•	•				•	•		•	•	•
Melamine Adhesive	•	•			•	•												•

(1) Except copper and its alloys (2) Except polyethylene, polypropylene, Teflon etc. (3) Except silicone

7.3 Capital, Input and Infrastructure Requirements

Table 11: Requirements for Adhesives Manufacturing Facility

Item	Estimated Requirement*
Floor Space	1,000 – 3,000 sq m
CapEx	US$800,000 – 4,000,000
Working Capital	US$200,000 – 1,000,000
Capacity range	3,000 gallons per week
Manpower requirement	40 – 60
Utility requirements	400kW electricity 40 tonnes per day water
Other Input Materials	Urea formaldehyde

** depending on plant capacity and level of automation.*

Examples of various types of equipment and machinery that can be used for the production of melamine adhesives are contained in the section that follows. However, it should be noted that ultimately, the selection of the respective equipment would be dependent on the desired output and space available.

Figure 10: Hot Melt Glue Machine

Technical parameters:

Packing	Polywood Suitable Delivery
Unit Price/Payment	FOB Qingdao US$17000-33000
Origin	China (Mainland)
Min. Order	1
Transportation	by Vessel
Type	Complete Set of Chemical Equipment
Product Type	Hot Melt Glue Stick
Hot Melt Granules:	Hot Melt

This unit could be used in the production of variety of hot melt granules, hot melt stick, hot melt adhesive film including melamine products.

Figure 11: Resin Production Equipment (YD-FS-005)

Technical parameters:

Packing	Packaged as Per Customer Request
Model No.	YD-FS-005
Origin	China
Min. Order	1 Unit
Transportation Request	as per Customer
Type	Complete Set of Chemical Equipment
Product Type	Alkyd Resin, Acrylic Resin, Epoxy
Machine Material	Stainless Steel/Carbon Steel
Application	Alkyd Resin, Phenolic Resin, Hotmelt Glue, melamine resin
Function	Heat, React, Dilute

Figure 12: Hot Melt Glue Stick Machine

The above unit could be used in the production of a variety of hot melt granules, hot melt stick and hot melt adhesive film. It uses an extrusion method, without the reactor, and extruder screw specially designed to achieve a plasticizing and mixing effect. It is an energy-saving piece of equipment and is highly automated. The products are bright and uniform. This machine is manufactured by Yantai Yuanda Machinery Factory, China.

8.1 Product Characteristics

Melamine-formaldehyde resins are used in specially formulated resin systems to produce highly durable coatings.

Typical melamine-modified coatings applications include:
- Vehicle body panels
- Household appliances
- Drink cans
- Coils of metal sheeting

The benefits of melamine-moulded coatings include:
- Good colour retention
- Wear resistance
- Scratch resistance
- Glossy finish

Melamine and its derivatives are suitable to enhance the flame-retardant properties of polyurethane foams, intumescent (flame-retardart) paints and other coatings, textiles and plastics.

Melamine-based flame retardants are considered to be more environmentally benign than conventional halogen-based flame-retardants.

The benefits of melamine based flame retardants include:
- Environmentally friendly, halogen-free flame-retardant formulations
- Cost effective across a wide range of applications
- Safe storage and handling
- Low smoke evolution and density
- Low corrosion

Typical flame-retardant applications include:
- Domestic appliances
- Television sets
- Soft furnishings
- Hospital and hotel mattresses
- Public seating (e.g. theatres and public transport)
- Furniture
- Fire doors
- Intumescent paints
- Ventilation ducts and shutters
- Floor coverings

When melamine is exposed to heat and flames it decomposes. It absorbs heat and creates a cooling effect. The time to ignition is delayed significantly as nitrogen, which is liberated by melamine during its decomposition, dilutes the oxygen. This inhibits the spread of flames and the generation of smoke.

When melamine-based flame-retardant coatings are exposed to fire they are degraded. As melamine also acts as a blowing agent, a stable insulating charred foam layer is formed. Consequently, the substrate material beneath the charred foam layer is protected from damaging heat.

Melamine-formaldehyde (MF) resins increase wear resistance, thus extending the life of paper & textile. MF resins also provide wet-strength properties to specialty papers. Melamine-based banknotes (e.g. the euro) can be wrinkled and folded endlessly and still retain a good appearance. Typical MF-resin coated paper and textile applications include:
- Banknotes
- Wallpaper
- Maps
- Wrinkle-free clothing

8.2 Market Assessment and Current Situation

- An increased demand for multiple speciality and fire-retardant high performance and nano-formula coatings in the automobile, aircraft, construction, household and other industrial uses has resulted in an increase in overall global production for speciality coatings.

- Overall global market demand is good with increasing demand expected from this Region, the US, South and Central America, Africa and EU markets.

- Forecast projected growth for the next 10 years is about 5% per annum.

- Market drivers in the future will include creative use of the internet or e-marketing, innovations in the industry and good economics. Due to the many different formulas for speciality coatings, current retail prices for coatings could vary from the average store pricing to that used by NASA for space travel requirements.

- The historical demand for coatings has increased considerably over the last ten years.

- Specific target markets are worldwide with emphasis on the Region, South and Central America, Africa and the US markets.

- Major potential barriers to accessing these markets are: product shelf life, trade restrictions, MSDS restrictions, obtaining contract manufacturing agreements, quality control and potential environmental impact concerns.

- Manufacturing coatings, with multi-national dominance in the industry, is a relatively competitive business. There are several hundred small and some mega manufacturers and suppliers. Manufacturers' technologies for specific products are proprietary.

- Major manufacturers include:
  - Akzo Nobel (Netherlands)
  - Sherwin-Williams (USA)
  - PPG (USA)
  - Materis (France)
  - Benjamin Moore (USA)

- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US, India and EU.

8.3 Capital, Input and Infrastructure Requirements

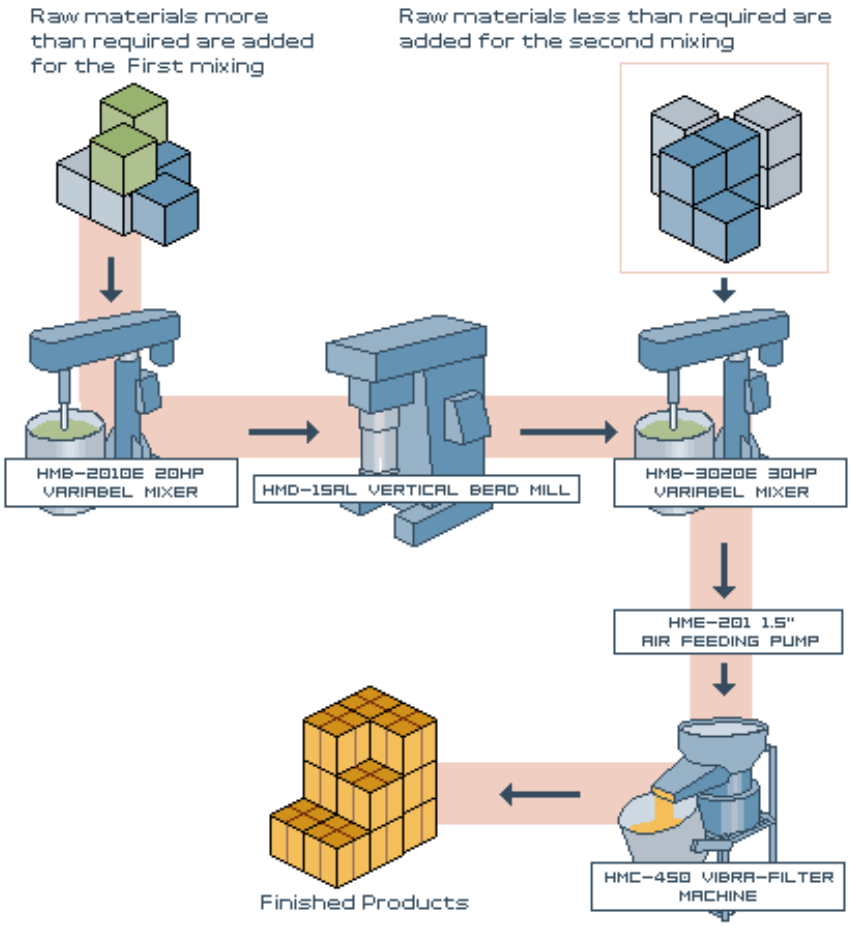
Table 12: Requirements for a Coating Manufacturing Facility

Item	Estimated Requirement*
Floor Space	1,000 sq m
CapEx	US$300,000 – 1,500,000
Working Capital	US$75,000 – 375,000
Capacity range	4,000 gallons per week
Manpower requirement	30 – 50
Utility requirements	300kW electricity 40 tonnes per day water
Other Input Materials	formaldehyde

** depending on plant capacity and level of automation.*

A turnkey Melamine Coating Manufacturing Plant is illustrated in Figure 13.

Figure 13: Flow diagram of a Melamine Coating Manufacturing Plant



As discussed in previous sections, one of the applications of melamine is in the production of melamine formaldehyde (MF) resins. This is one of the main ingredients in the production of car baking enamel, a widely used paint coating.

Some of the other inputs required in the production of car baking enamel include:

- acrylic resin
- short oil alkyd resin
- epoxy resin
- solvent
- pigment

An estimate of the human resource requirement for a car baking enamel manufacturing facility is captured in Table 13. The staffing requirements for other facilities that can produce ready-mixed paint, red iron oxide anti-corrosion primer, lacquer or polyurethane paint would be similar.

Table 13: Manpower Requirements for Paint Manufacturing Facility

Position	Staffing requirement
Plant Manager	1
Chemical Engineer	1
Formula Technician	6
Product Testing Operator	2
Assistant Worker	10
Packaging Worker	10

Examples of typical equipment that can be used for the production of paints adhesives are illustrated in Table 14 below. However, it should be noted that ultimately, the selection of the respective equipment would be dependent on the desired output and space available.

Table 14: Example of Equipment Requirement

Paint Name	Typical Equipment	Qty	Electricity
Ready Mixed Paint,	1. HMB-3020E 30HP Mixer.	3	
Red Iron Oxide Anti-Corrosion Primer,	2. HMD-30AL Vertical Type Bead Mill.	3	
Lacquer Paint, Enamel,	3. HMC-405 Vibra-Filter Machine.	6	
Car Baking Enamel,	4. HME-101 1" Air Feeding Pump.	6	320HP
Polyurethane Paint.	5. HMK-800 (800 litre) Mixing Tank.	8	(240kW)

9.1 Product Characteristics

Melamine is the binding force that makes laminates strong and resistant to heat, scratching, impact, water and chemicals. The attractive surfaces are hygienic, stylish and enhance the richness of any design.

The main application for melamine in laminates is as a raw material for MF (melamine formaldehyde) and MUF (melamine urea formaldehyde) resins that give laminated panels and floors their unique surface properties and attractive finishes. These resins are also heat and chemical resistant, and suitable for hygienic anti-bacterial surfaces.

Typical applications include:

- Laminate flooring
- Furniture tops
- Kitchen and bathroom counter-tops
- Wall cladding
- Cabinets
- Self-assembly furniture

Laminates are made in two types:

- High Pressure Laminates (HPL)
- Low Pressure Laminates (LPL)

High pressure laminates are made of several layers of Kraft paper impregnated with phenolic resin and topped with one or more layers of decorative paper. The decorative paper is treated with melamine formaldehyde or melamine-urea formaldehyde resin. The hard laminate sheets are then bonded to a fiberboard substrate. High pressure laminates are preferred where durability, impact strength and resistance to heat, moisture and chemicals are required.

Typical applications include:

- Kitchen and bathroom counter-tops
- Heavy-duty furniture tops and laminate floors
- Exterior wall cladding
- Street and playground furniture

Low pressure laminates are commonly referred to by builders as melamine-faced chipboard (MFC) or 'melamine' for short. In the laminate flooring industry, most producers call this technique Direct Press lamination.

Low pressure laminates are manufactured by pressing paper impregnated with melamine urea formaldehyde (MUF) resin directly onto a particleboard or fibreboard substrate. No adhesive is needed for this as the resin literally "fuses" the paper onto the board.

- The manufacturing process typically utilizes:
  - Low press pressure (20-30 bar)
  - High temperature (170-190°C)
- Low pressure laminates are preferred when cost is an important factor.
- Typical uses include kitchen cabinets, laminate flooring and self-assembly furniture.
- Melamine impregnating resins and adhesives are also used in in wood-based panels.
- Melamine is the binding force behind the furniture, flooring and construction industries.
- Glue based on melamine gives laminates, plywood, MDF, OSB or any other wood-based matrices optimal moisture resistance and integrity.
- Waterproof melamine adhesives are either used to glue pieces of wood together to form boards and beams, or are mixed with woodchips or sawdust and compressed to form wood-based panels.

- Wood-based application areas include:
  - Laminates
  - Plywood
  - Particle Board (PB)
  - Medium Density Fibreboard (MDF)
  - Oriented Strand Board (OSB)
  - Laminated Veneer Lumber (LVL)

- Benefits of melamine in wood-based panels include:
  - Versatile – available in an unlimited variety of dimensions
  - Cost effective – competing materials like solid wood, plastics and metal are more expensive
  - Easy to use – can be shaped easily
  - Forest friendly – helps forest conservation by making efficient use of waste wood
  - Moisture resistant

9.2 Market Assessment and Current Situation

- Trinidad and Tobago is not a timber rich country, and would need to import wood for large scale manufacturing of laminates. The laminated board business is still flourishing worldwide, especially in the US and in timber rich Brazil and Southern Africa.

- Overall global market demand is positive with increasing demand expected from this Region, the US, South and Central America, Africa and EU markets.

- Forecast projected growth for the next 10 years is approximately 1.5% per annum.

- The future market will be driven by creative internet or e-marketing, innovations in the industry and economics. Local experience and the nurtured creative ingenuity could be used to create local unique laminate patterns. However, it should be noted that laminate production is a very competitive business.

- The historical demand for laminates has been relatively flat over the last ten years.

- Specific target markets are worldwide with emphasis on the Region, South and Central America, Africa and the US markets.

- There are no major potential barriers to accessing these markets.

- Manufacturing laminates with multi-national dominance in the industry will be very competitive. Most manufacturers' technologies for specific products are proprietary.

- Major manufacturers include:

  - Golden Laminates Ltd, India Ltd. (India)
  - Ampco Products (USA)
  - Fuzhou Yilida Wood Industry Co., Ltd. (China)
  - Xiamen Nan Hua Wen Co., Ltd. (China)
  - Changzhou Chaomei Wood Co., Ltd. (China)

- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US, India and EU.

9.3 Capital, Input and Infrastructure Requirements

Table 15: Requirements for Laminates Manufacturing Facility

Item	Estimated Requirement*
Floor Space	2,000 sq m
CapEx	US$300,000 – 1,500,000
Working Capital	US$75,000 – 375,000
Capacity range	3,000 to 10,000 sq m per day
Manpower requirement	40 – 100
Utility requirements	700 kW electricity 60 tonnes per day
Other Input Materials	Urea formaldehyde

** depending on plant capacity and level of automation.*

The following section provides examples of laminating machinery and their technical parameters.

Figure 14: Paper Laminating Machine

Paper Laminating Machine

1. TMB-C Paper Sticking Machine film is suitable for large specialized manufacturers. It has such advantages as high quality and sticking paper without wrinkle or bubbles.
2. The production line has such advantages as advanced index, high precision, reasonable layout, novel structure and handy operation, and is an excellent option for sticking paper or PVC on timber.
3. Equipment configuration includes: dust collection and absorption equipment, single spread glue equipment, paper holding and sticking equipment, automatic cut paper equipment, hot press equipment and repress equipment, automatically trimming and automatically put on and off mat.

Technical parameters

Mode Specification	0320 x 1350 mm
Minimum Board Length	600 mm
Board Width	1220 mm
Board Thickness	2 – 30 mm
Feeding Speed	1 – 18 m per minute
Motivity Power	15kW
Heating Power	36 kW
Paper Width	1280 mm
Overall Dimensions	2100 x 235 x 4200 mm
Machine Weight	10 tonnes

Figure 15: MDF board facing Paper Machine

- Melamine coating machine used in secondary processing industry of wood-based panel, deco paper on furniture, balance paper, MDF.
- Estimated Range of Cost - US$100,000-500,000.

Figure 16: Automatic Laminating Machine

This machine has two working tables and two independent heating systems, specially designed to allow the laminating of two sides of the work piece at the same time. It is also capable of laminating the melamine membrane at one side. Features include high efficiency, fast finishing and stable laminating. The machine is the ideal working equipment for furniture, cabinets, decorative materials, artworks and advertisements.

Technical Parameters

Model	XRFM2511-C
Working Table Size	2360 x 1120 x 60 mm (x2)
Overall Size	5350 x 1400 x 1400 mm
Total Power	14.5 kW
Actual Electricity Use	5 kW
Total Weight	1200 kg

10.1 Product Characteristics

Plasticizers or dispersants are additives that increase the plasticity or fluidity of the material to which they are added. These include plastics, cement, concrete, wallboard, and clay. Although the same compounds are often used for both plastics and concrete, the desired effects and results are different.

Plasticizers for concrete increase the workability of the wet mix, or reduce the water required to achieve the desired workability, and are usually not intended to affect the properties of the final product after it hardens. Plasticizers for wallboard increase fluidity of the mix, allowing lower use of water and thus reducing energy to dry the board. Plasticizers for plastics soften the final product increasing its flexibility.

Plasticizers or water reducers, and super plasticizers or high range water reducers, are chemical admixtures that can be added to concrete mixtures to improve workability. Unless the mix is "starved" of water, the strength of concrete is inversely proportional to the amount of water added or water-cement (w/c) ratio. In order to produce stronger concrete, less water is added (without "starving" the mix), which makes the concrete mixture less workable and difficult to mix, necessitating the use of plasticizers, water reducers, super plasticizers or dispersants.

Plasticizers are also often used when volcanic ash is added to concrete to improve strength. This method of mix proportioning is especially popular when producing high-strength con-crete and fiber-reinforced concrete.

Adding 1-2% plasticizer per unit weight of cement is usually sufficient. Adding an excessive amount of plasticizer will result in excessive segregation of concrete and is not advisable. Depending on the particular chemical used, too much plasticizer may result in a retarding effect.

Plasticizers are commonly manufactured from lignosulfonates, a by-product from the paper industry. Super plasticizers have generally been manufactured from sulfonated naphthalene condensate or sulfonated melamine formaldehyde, although newer products based on polycarboxylic ethers are now available. Traditional lignosulfonate-based plasticizers, naphthalene and melamine sulfonate-based superplasticizers disperse the flocculated cement particles through a mechanism of electrostatic repulsion. In normal plasticizers, the active substances are adsorbed on to the cement particles, giving them a negative charge, which leads to repulsion between particles. Lignin, naphthalene and melamine sulfonate superplasticisers are organic polymers. The long molecules wrap themselves around the cement particles, giving them a highly negative charge so that they repel each other.

10.2 Market Assessment and Current Situation

- While newly engineered plasticizers are frequently emerging in almost every industry, many plasticizer users usually stick to traditional formulas. Countries like Trinidad and Tobago could encourage local bulk buyers to contract traditional plasticizer blends from a local manufacturer.

- Due to the overall global market downturn, the use of concrete plasticizers has declined to a great extent as a result of the decrease in construction activity throughout the world.

- Forecast for projected growth for the next 15 years appears to be somewhat flat. Developing economies like India and China are major producers of plasticizers. Due to the low labour costs in these countries, inexpensive traditional plasticizers are being exported from those markets.

- The future market would be driven by product quality, adequate delivery mechanisms, creative internet or e-marketing, innovations in the industry and world economics.

- The historical demand for concrete plasticizers has dropped considerably over the last ten years due to a decline in construction activities.

- Specific target markets are worldwide with emphasis on the Region, South and Central America, Africa and the US and EU markets.

- Major potential barriers to accessing these markets are: product shelf life, trade restrictions, MSDS restrictions, obtaining contract manufacturing agreements and quality control.

- Manufacturing plasticizers, with Asian dominance in the industry makes it a very competitive business. There are several hundred small and some mega manufacturers and suppliers. Manufacturers' technologies for specific products are proprietary.

- Major manufacturers include:
  - Beijing Hengan Admixture Co., Ltd. (China)
  - Hunan Pioneer Building Material Co., Ltd. (China)
  - Shandong Tongsheng Building Materials Co., Ltd. (China)
  - Suzhou Sunbo Chemical Building Materials Co., Ltd. (China)

- Major sources for supplying turnkey operations and equipment are from China, Taiwan, US, India and EU.

10.3 Capital, Input and Infrastructure Requirements

Table 17: Requirements for Plasticizer Manufacturing Facility

Item	Estimated Requirement*
Floor Space	1,000 sq m
CapEx	US$300,000 – 1,500,000
Working Capital	US$60,000 – 300,000
Capacity range	2,000 gallons per day
Manpower requirement	30 – 50
Utility requirements	250 kW electricity 20 tonnes per day water
Other Input Materials	Sulphur compounds

** depending on plant capacity and level of automation.*

These profiles are intended to provide basic information for potential investors, entrepreneurs and manufacturers who may be interested in developing businesses using melamine as an input material.

It is anticipated that the information presented in this booklet could assist in the development of a business plan for such enterprises. The GORTT would expect the Business Chambers, financial institutions and other related stakeholders to cooperate for the realization of these opportunities. In this regard, appropriate sites would be identified for the establishment of integrated melamine processing industries with access to utilities, raw materials and infrastructure for distribution of products. Consideration would also be given to other interventions and forms of assistance which may be required for establishing these industries.

There would be a concerted effort to develop joint venture projects with established manufacturers, as well as expand and develop local businesses to access the available opportunities. It is imperative that a framework be established for creating sustainable linkages between the energy sector and the manufacturing sector in Trinidad and Tobago. It is only by developing manufacturing industries using the output from the energy sector that we would be able to extract optimal value from the country's hydrocarbon resources, and create a truly diversified industrial sector.

Melamine Moulding Compound

Name of Company	Address	Phone	Email	Website
Amity Thermosets PVT Ltd	204/205 Kharade Apartment, Station Road, OPP. Leela Mumbai, Maharashtra, India, 400063	91-22-26865530 91-22-26865534 (Fax)	info@amityindia.com sales@amityindia.com purchase@amityindia.com	www.amityindia.com
Kaihua County Hao Teng Melamine Products Factory	Xincun, Tongcun Town, Kihua County, Quzhou/Zhejiang, China	0086-570-6045206 0086-570-6045272 (Fax)		
Shijiazhuang Golden Color Chemical Co., Ltd.	No. 9 Shuixiehuadu Luancheng Town, Shijiazhuang, Hebei, China, 050000	86-311-66697780		www.sjzjincai.com
Henan Premtec Enterprise Corporation	No. 101 Nanyang Road, Zhengzhou, China, 450053	86-371-69067080 86-371-69067193 (Fax)		www.premtec.com.cn/
Jiashan Luyuan Chemical Co., Ltd	Fanjing Road, Ganyao Town, Jiashan Zhejiang, China	0086-573-84822568 0086-136-16158469	yxwzx@hotmail.com yxwzx@yahoo.com	www.jslychem.com

Dinnerware

Name of Company	Address	Phone	Website
Henan Hylink Imp. & Emp. Co., Ltd	Ziyou Road, Xinxiang, Henan, China, 453000	0086-373-2713663 0086-373-2713660 (Fax)	www.hnhylink.com
Quanzhou Jieli Trade Company Limited	Number 174, Gaoshan Road, China, 362000	86-595-13799560763 0086-595-86310177 (Fax)	
Liyang Xinrong Melamine Products Co., Ltd	6 Laoming Road, Shangxing Industrial Area, Liyang City, Jiangsu Province, China, 213363	86-25-52184105	www.green-ware.cn
Fuzhou Fortune Homeware Co., Ltd	4/F Xiyingli Tea Market, 18 Bayiqui Central Road, Fuzhou, Fujian, China, 350001	86-591-83010888-263 86-591-83010999 (Fax)	www.fortunehw.com
Zhejiang Lesheros Houseware Manufacturing Co., Ltd	Houjie Village, Hongjia Street, Jiaojiang District, Taizhou City, Zhejiang Province, China, 318050	86-576-88033202 86-576-88038000 (Fax)	www.xjkcnj.com

Adhesives

Name of Company	Address	Phone	Email	Website
Astra Chemtech Private Limited	306 Nav-Vivek Industrial Estate, Mogul Lane, Mahim, West Mumbai, 400016, Maharashtra, India	9122-24442379/24472469 9122-24442696 (Fax)	sales@astra1.org	
Wilsonart International Inc	2400 Wilson Place, P.O. Box 6110, Temple, Texas 76503-6110, USA			www.wilsonart.com
3M Global Headquarters	3M Corporate Headquarters, 3M Center, St. Paul, MN 55144-1000, USA	1-888-364-3577		
Conpro Chemicals Private Limited	E-8, Site 4, Industrial Area, Sahibabad, Uttar Pradesh 201010, India	91-120-6517232 91-120-4278836 (Fax)	conprochemicals@yahoo.co.in info@conprochemicals.com	www.conprochemicals.com
IPS Corporation	455 W. Victoria Street, Compton, CA 90220, USA	800-888-8312 877-477-8327 310-898-3304 310-898-3300	edi@ipscorp.com tncustserv@ipscorp.com international@ipscorp.com	

Coatings

Name of Company	Address	Phone	Website
Azko Nobel	Zutphenseweg 10, 7418 A J Deventer, Postbus 10, 7400 AA Deventer, Netherlands	31-570-679222 31-570-608814 (Fax)	www.akzonobel.com
Sherwin-Williams	101 W. Prospect Avenue, Cleveland, OH, 44115, USA	216-566-2000 216-566-2947 (Fax) 800-474-3794	
PPG Industries Inc	One PPG Place, Pittsburgh,	412-434-3131	
Materis	Pennsylvania 15272, USA 19 Place de la Resistance, Issy-Les-Moulineaux, Ile-de-France, 92446, France	33-1-41-17-45-45 33-1-41-17-18-65	
Benjamin Moore & Co.	Paint Headquarters Inc 712Kentucky Pkwy, Owensboro, KY, 42301, USA	502-685-1333 502-683-3297 (Fax)	www.paintheadquarters.com

Laminates

Name of Company	Address	Phone	Email	Website
Golden Laminates Ltd (Mr. Deepesh)	SCO 14 , Sector 7-C, Madhya Marg, Chandigarh – 160019, Punjab, India	91-172-2795930/ 2795821/2795293 91-172-2795478 (Fax)		
Ampco Products	11400 NW 36 Avenue, Miami, FL, 33167, USA	305-821-5700 866-642-5300	info@ampco.com	
Fuzhou Yilida Wood Industry Co., Ltd	No. 108, Xiaoqiao, Houyu Village, Jingxi Town, Fuzhou, Fujian, China, 350100	86-591-22183279 86-591-22183269 (Fax)		www.haogefloor.com
Xiamen Nan Hua Wen Imp. & Exp. Co. Ltd (Mr. Lesley)	B1203, No. 25, Luling Road, Xiamen, China, Xiamen, Fujian, China, 361009	86-592-5559-951 86-592-5559-971 (Fax)		www.nanhuawen.com
Changzhou Chaomei Wood Co., Ltd	Qiangfeng Industrial Zone, Cuiqiao, Henglin Town, Wujin District, Changzhou, Jiangsu, China, 213022	86-519-89662667 86-519-89662665 (Fax)		www.baibofloor.com

Plasticizers

Name of Company	Address	Phone	Website
Beijing Hengan Admixture Co., Ltd	Industrial Park 36, Tongzhou District, Beijing, China, 101109	86-10-69593119 86-10-69563077 (Fax)	www.henganadmixture.com
Hunan Pioneer Building Material Co., Ltd	No. 95 of Gaoling, Laodao River Town, Kaifu District, Changsha, Hunan, China, 410152		
Shandong Tongsheng Building Materials Co., Ltd	No 4666 Zhaode Road, Weifang Shandong, China	86-536-2139156	
Suzhou Sunbo Chemical Building Materials Co., Ltd	No. 4666, South Dongfang Road, Wangfu Office Industrial Zone, Qingzhou, Chandong, China, 262500	86-0536-2139516 86-0536-2139517 (Fax)	www.sdtongsheng.ent

It should be noted that turnkey plant designs for small chemical related plants require very specialized small plant design and equipment sourcing expertise. The turnkey design basis will provide input for equipment specifications as well as other plant parameters. The turnkey plant provider should be verifiably experienced, reliable, cost effective, motivated and innovative.

Taiwan, Mainland China and India (Asia) have been leading suppliers of small plant turnkey designs and related equipment.

Melamine Moulding Compounds

Zhejiang WanAn Plastic Co. Ltd
Tongcun Country, Kaihua Town,
Kaihua County, Quzhou,
China, 324305
Tel: 86-570-6045206

QuZhou LiLi plastics Co. Ltd.
Tel: 86-570-6045272

Dinnerware

Han Chang Machinery Industrial Co. Ltd
No.5 Lane 360 Chung Cheng S. Rd Yung Kang City, Tainan, Taiwan
Tel: 886-6-253-6106 / 886-6-253-5358
Email: Han.chang99@msa.hinet.net

Han Chang Machinery Industrial Co. Ltd
Foreign Department
5F No. 45 Chung Shan North Road, Sec. 3, Taipei, Taiwan
Tel: 886-2-2597-5301/ 886-2-2593-0672
Email: paitechf@ms5.hinet.net

Doug guan Han Chang Machinery
Industrial Co. Ltd
Qiaotou Cun Industrial Area (Zone)
Huancheng RD.
Qiaotou Town, Dongguan City,
Guanggdong Province China
Tel: 86-769-8345-6555/ 86-769-8345-8555

Adhesives

Taiwan Turnkey Project Association
Tel: 886-2-2383-1832/ 886-2-2311-9090 (Fax)
Email: public@tpcc.org.tw
Website: www.tpcc.org.tw/EN/

Coatings

Zhejiang WanAn Plastic Co. Ltd
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QuZhou LiLi plastics Co. Ltd.
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Laminates

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NATIONAL ENERGY CORPORATION OF TRINIDAD AND TOBAGO LIMITED

Corner Rivulet and Factory Roads,
Brechin Castle, Couva,
Republic of Trinidad and Tobago,
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Tel: (868) 679-1156; 1061; 1138; 2453
Fax: (868) 636-2905