UNIVERSITY OF COCHIN

B.TECH DEGREE COURSE

IN

POLYMER SCIENCE AND RUBBER TECHNOLOGY

PROJECT REPORT

ON

A SMALL SCALE UNIT

TO

MANUFACTURE LATEX FOAM IN KERALA

DISSERTATION REPORT SUBMITTED BY,

A.O. MATHEW, B.Sc.

REGISTER NUMBER:

IN PARTIAL FULFILMENT OF B.TECH DEGREE.

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ACKNOWLEDGEMENT

This project report has been prepared and submitted in the form of dissertation unlike project reports to procure loans to start industries. The primary mission of this is the partial fulfilment of B.Tech Degree. From the point of view of a dessertation work I believes that extra details given on technical aspects are justifiable. However, I do not claim the report to be exhaustive and complete in all respects. But I hope this will serve as guide line to start and operate the project.

I take this opportunity to express my thanks to all a all persons who helped in my endeavour and particularly Dr.D.Joseph Francis, Prof. and Head of the Department of Polymer Science and Rubber Technology, E.V. Thomas, Deputy Director, Chemistry and Rubber Technology Division, R.R.I.I. and Philip Kurian, Lecturer, Department of Polymer Science and Rubber Technology, for their guidance in preparing this report. I would like to extend my thanks to V.Thomas, Majestic Foam Rubbers, Ettumanoor for his valuable suggestions.

Cochin - 22,
16-12-1980. A.O. MATHEW.

C O N T E N T S

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SECTION - A

INTRODUCTION:

A.1 History and main object of the Project:

Although Poizot had used latex in a process for making foam rubber as early as 1910, manufacture directly from latex was first suggested by Schidrowitz and Goldsborough in 1914. Their process consists in the formation of a porous or cellular coagulum which is then valcanised. Gas forming substance may be added during coagulation and the mass is valcanised by heating in steam.

It was not until 1931 that production of latex foam was begun on a commercial basis. In that year the Dunlop Co. is reported to have manufactured at the rate of one tonne of latex foam per week. The industry gained rapidly until the beginning of World War - II.

The growth of latex foam industry in recent years may be traced not only to the generally excellent and uniform qualities of the product but the basic simplicity of the process used and relatively light equipment required.

Although a number of methods have been developed for making foam rubber from latex, the one has attained the most important commercial development to date comprises of whipping a suitable latex compound to produce foam which is poured into moulds, gelled and valcanised under conditions which prevent evaparation of water contained in the gelled latex foam.

The main object of this project is to manufacture 34.5 metric tonnes of latex foam products per annum.

A.2 Product Description:

Cellular rubber is defined as a mass of cells in which the matrix is rubber. The three main classes of cellular rubber are foam, sponge and expanded rubber. Foam rubber is particularly defined as a product made from liquid starting materials. Latex foam rubber consisting of a network of open or inter connecting cells which may be subjected to large, repeated deformations without damage. It has a porous surface skin, allowing it to breathe readily. Consequently latex foam is used widely in applications requiring a cool and comfortable cushioning material. As with other types of rubber sponge, the product is charactoristic of special process used; the distinguishing property of the latex foam is its fine reticulate or interconnecting cell structure made up of continous phases of both air and rubber. The air may account for 85 - 90% of the total volume of the foam. The various types of end products made from foamed latex is given in the Appendix - VI.

A.3 Evaluation Prospectus:-

The demand for the latex foam is steadly increasing and units producing this are working hard to meet the demand. Though specific information on the capacity, production and demand for various products are not available, based on the performance of the existing units, it is clear that there is a

good demand for this product. Ever increasing growth of hotels, hospitals and automobile industry presents a good demand for latex foam products.

The per capita consumption of rubber in India is about 0.27 kg. whereas in U.S.A. it is 14 kg. In an economy gradually moving from a rural to urban style it is imperative that the per capita consumption should go up at a faster rate.

Latex foam products find main demand as mattresses and cushioning material. These are light, resilient and comfortable. Light weight, everlasting spring action and impact resistance make this product aceptable for following application.

1) Cushions for home, hotel, hospital and automobiles.
2) Carpet backing.

As the population and standard of living increases more and more, good demand for latex foam products.

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SECTION-B

MARKET SURVEY

B. 1. User's/Customer's analysis:-

There are 40 foam rubber products manufacturing units in India of which seven units are in Kerala. In India for manufacturing foam rubber products only natural rubber latex concentrate being used. The total natural rubber used as latex for variety of latex foam products is 3543 MT in 1978-79. The consumption of latex in between 1970-71 to 1978-79 registered an increase, indicating the high demand for latex products. The following tables corroborate this fact.

Latex consumption and its percentage to total consumption:-

Year	Total consumption (MT)	Latex consumption DRC MT	Percentage
1970-71	87237	6206	7.11
71-72	96454	7020	7.28
72-73	104028	6829	6.56
73-74	130302	7846	6.02
74-75	132604	7453	5.62
75-76	125692	6352	5.05
76-77	137623	8497	6.17
77-78	144969	9033	6.23
78-79	164524	10960	6.66

Source:- Indian Rubber Statistics. Vol.16,1980.

Consumption of latex for foam production

Year	Total latex Consumption DRC (MT)	Latex consumption for foam DRC (MT)	Percentage consumption
1970-71	6206	3598	57.98
71-72	7020	3676	52.36
72-73	6829	3513	51.44
73-74	7846	3457	44.06
74-75	7453	2796	37.51
75-76	6352	2033	32.00
76-77	8497	2238	26.33
77-78	9033	2653	29.37
78-79	10960	3543	32.32

Source:- Indian Rubber Statistics. Vol.16, 1980.

To meet the demand for latex foam we are now importing latex foam. This shows that the production of the latex foam products not enough. The following table shows the quantity of import and its value.

Quantity and value of foam products imported.

Year	Quantity (Kgm.)	Value '000 Rs.
1970-71	119080	339
71-72	25326	73
72-73	788	16
73-74	--	--
74-75	21545	309
75-76	27000	738
76-77	25000	319
77-78	31616	290

Source:- Indian Rubber Statistics. Vol.16, 1980.

In India the consumption of rubber for latex foam production is only 1.6% of the total consumption while dipped goods consume, 2% of the total consumption according to the 1978-79 statistics. The following table will confirm these facts:-

Consumption of all kinds of rubber according to endproducts in 1978-'79

Products	Consumption (MT)				Percentage Consumptio
	Natural rubber	Synthetic rubber	Reclaimed rubber	Total	
Automobile tyres and tubes	83212	20060	5863	109135	48.2
Cycle tyres and tubes	19972	3832	7489	31293	13.8
Camal Back	8771	1840	1152	11763	5.2
Footwear	16884	4508	2978	24370	10.8
Belts and hose	11138	1526	1832	14496	6.4
Latex foam	3543	--	--	3543	1.6
Dipped Goods	4492	--	--	4492	2.0
Cables & Wires	705	414	19	1138	12.0
Battery Boxes	391	706	2494	3591	
Others	15416	4714	2503	22633	
Total	164524	37600	24330	226454	100

Source:- Indian Rubber Statistics. Vol. 16, 1980.

As mentioned earlier the major fields of application of latex foam products are houses, hospitals, hotels, automobile industry and theatres.

a) Houses, Hospitals and Hotels:-

They consume mainly as mattresses and pillows. Almost all hotels are using latex foam as the cushioning material. Availability of health services in India is very poor. The following table gives this fact. Since the standard of living and increasing health services will certainly increase the demand for foam header beds.

Availability of health services in India per 1,00,000 population

Year	1960-61	70-71	73-74	74-75	78-79
Beds	42.4	49.4	49.6	49.0	49.6

Source:- The Times of India Directory & Year Book. 1979.

b) Automobile industry:-

Consumes latex foam products in large quantities for cushioning. The anticipated demand for commercial vehicles for the year 1982-83 is estimated at 61,000 numbers. The estimated production of various types of vehicles by 1982-83 as worked out by automobile working group is given below.

Type of vehicle	1978-79	79-80	80-81	81-82	82-83
		in '000 numbers			
Commercial	50	52.5	54.5	58	61
Jeeps	10	11	12	13	13
Cars/Station wagon	39.5	42	44	46.5	48.5
Motor cycle	82	90	100	115	125
Scooter two wheelers	225	265	300	345	400
Scooter three wheelers	25	27.5	30	33	36
Tractor	40	42	44	46	48

Source:- Indian Rubber Directory- 1979.

c) Theatres:-

Most of the theatres in towns and cities are using latex foam cushion. As more and more of them coming up, a very good demand for latex foam as theatre seats and back rests can be expected.

B. 2 Assessment of future demand:-

India has registered rapid economic progress in the context of her sixth five year plan and with rubber industry too. Rubber industry has tremenous potential for growth. There are obious indications of steep increase in demand for rubber by latex goods. The following tables gives the estimates of future demand for various latex products.

Estimates of demand for various latex goods:-

Items	1978-79	83-84	89-90	2000 AD
Latex foam (Tonnes)	9000	11700	15200	27000
Condoms (Mil.Nos.)	600	1200	2400	11000
Dipped goods (Tonnes)	6000	9000	13500	33000

And the requirement of elastromer for the estimated demand of latex goods is given below:-

Items	1989-90		2000 AD	
	Quantity	Consumption (Tonnes)	Quantity	Consumption (Tonnes)
Latex foam	15200 (T)	12000	27000 (T)	22000
Condoms	2400 Mil. pieces	2000	11000 Mil. pieces	10000
Dipped Goods	13500 (T)	14000	33000 (T)	33000

Source:- Indian Rubber Directory, 1979.

SECTION- C

PRODUCTION REQUIREMENTS

C. 1 Location:- The main factors to be considered in selection of location for a factory are following:-

a) A factory is relatively immobile.

b) The impact of location on operating costs and profits are considerable and it varies between 25 to 50%.

c) Building cost, maintenance, taxes on land and building are large and fixed.

Further points to be considered are:-

a) Availability of raw material.

b) Availability of skilled and unskilled labour.

c) Availability of Power and Water.

d) Facilities for transportation by rail and road.

Considering all these factors, any of the industrial estates in Kerala can be selected. The major and bulk raw material is natural rubber latex which is easily available.

Following are the advantages for locating a factory in an under industrial estate:-

i) Built up areas available at cheaper rates.

ii) Undue delay in getting electric connection, water supply, transport facilities etc. can be avoided.

iii) Reduced overhead expenses.

iv) The nearness of various type of industries will facilitate interservicing.

v) Availability of cheap labour.

C.2 Plant and layout:-

In order to keep the operating costs at the minimum, the following points should be considered in determining the layout for plant.

i) Material handling is to the minimum.

ii) Room for further expansion.

iii) Ensure an easy flow of material.

A layout is given in the Appendix II.

C.3 Land and Building:-

The total land required may be finalised according to the future expansion programme.

Buildings:-

Before finalising the requirement of built up area for the factory the following factors to be considered:-

1) The minimum built up area required for each machinery.
2) Expansion programmes.
3) Space for keeping maximum amount of raw materials and finished goods.
4) Space for keeping maximum amount of inprocess inventories.

Thus the total built up area is 3000 sq.ft. and details are given below:-

i)	Raw material storage	-	500 sq.ft.
ii)	Foaming	-	400 "
iii)	Vulcaniser	-	300 "
iv)	Boiler	-	100 "
v)	Squeezing machine	-	100 "
vi)	Drying chamber	-	500 "
vii)	Inspection and packing	-	350 "
viii)	Finished good storage	-	500 "
ix)	Office	-	150 "
x)	Toilet	-	100 "
	Total	-	3000 Sq.Ft.

C.4. Requirement of Main raw material:-

The total estimated production per annum is 34.5 tonnes.

The important raw material required for the project are:-

1) 60% centrifuged natural rubber latex.
2) sulfur.
3) Zinc mercaptobenzothiazole (Z.M.B.T.)
4) Zinc diethyldithiocarbamate (Z.D.C.)
5) Zinc oxide.
6) Sodium silicofluoride.
7) Belloid T.D.
8) Oleic acid.
9) Caustic potash.
10) Starch.

11) Cetyltrimethylammoniumbromide. (Foam stabiliser)

12) Nonox sp. and mould releasing agent.

Requirement of all items, are duscussed hereunder in detail.

1. 60% Centrifuged natural rubber latex:

Generally for foam rubber articles, the chief raw material used is 60% centrifuged natural rubber latex which is preserved with 0.7% ammonia. The annual requirement of the latex for this project would be 27 tonne D.R.C.

2. Sulfur:-

Raw material sulfur is used as the valcanising agent in the manufacture of foam rubber. The requirement for this project is 690 kg annually.

3. Zinc mercaptobenzothiazole (Z.M.B.T.)

It is used as an accelarator in the foam rubber manufacturing. The annual requirement of M.B.T. for the project would be 300 kg.

4. Zinc diethyldithiocarbamate (Z.D.C.)

Z.D.C. is also used as an accelerator. It imparts good ageing properties and is non-staining and is extremely useful as a booster. The annual requirement of this would be 300 kg.

5. Zinc Oxide:-

Zinc oxide is an activator of valcanisation and as an auxiliary gelling agent. The grade used is white seal. The annual requirement of zinc oxide would be 1350 kg.

6. Sodium silicofluoride:

This is the gelling agent used in the manufacture of foam rubber. The annual requirement of this would be 420 kg.

7. Belloid T.D.:

It is a dispersing agent, used in foam rubber manufacture. This is used in making a dispersion of sulfur, Z.M.B.T. and Z.D.C. in water for adding to the latex before valcanisation. The annual requirement of Belloid T.D. is 100 kg.

8. Oleic acid:-

It is used in making the soap solution. The annual requirement of this would be 300 kg.

9. Caustic potash:-

It is also used in making the soap soultion alongwith oleic acid. The annual requirement would be 60 kg.

10. Starch:-

Starch is used as a filler in foam rubber manufacture, to increase the hardness and to reduce the cost. The annual requirement of this would be 4500 kg.

11. Cetyltrimethylammoniumbromide:-

It is used as a stabiliser of the foamed latex. The annual requirement of this would be 390 kg.

The annual consumption and cost of all raw materials are listed in Annexure - II..1.2. The list of suppliers of raw materials is given in Appendix - IV.

Terms of purchase of Raw Materials:-

All negotiations related to purchase of raw material are done through banks on a margin money of 25%, the Bank will advance 75% for the purchase of materials. The amount has to be paid back from sales with interest. The purchased materials will be kept in the bank's godown in the factory and materials withdrawn on payment of cash whenever required.

C.5. Machinery and Equipments:-

The selection of machinery is most important since maximum utilization of machinery gives better return for the money spent. The selection of each machinery is based on the following considerations.

i) The estimated capacity.
ii) The accepted standard dimensions.of the product.
iii) The type of production.
iv) Its effect on utilization of all machinery.

Based on these considerations the following machineries are selected for production of 115 kg foam per day.

C.5.1. Planetary Mixer:-

For foaming of the compound per day this unit requires one 200 litre planetary mixer. It is equipped with a 3 HP Motor and speed of the planetory and beater is 25 and 75 rpm at slow speed and 50 and 150 rpm at high speed respectively.

C.5.2. Deammoniation tank::-

A deammoniation table fitted with disc mild steel compartments of capacity 400 litre with 1 HP Motor.

C.5.3. Vulcaniser:-

A vulcaniser with rails and trolley of size 170" x 70" x 20" for vulcanising the gelled foam.

C.5.4. Squeezing machine:-

Squeezing machine with rubber rollers of size 6" diameter and 50" length with reduction gear assembly and screw adjustable device equipped with 3 HP motor.

C.5.5. Boiler:-

Vertical, cross tube boiler of 120 to 200 kg/hr. Capacity and a working pressure of 50 psi with a motor of 3 H.P. for pumping water.

C.5.6. Drying chamber:-

Drying chamber with steam heated pipe fittings and trays of capacity of 300 kg.

C.5.7. Moulds:-

Moulds of different sizes for different end products are used.

C.5.8. Ball mill and high speed stirrer:-

Ball mill of 5 jars of capacity each jar being 10 kg. balls of 3" diameter equipped with 1 HP motor and high speed stirrer of capacity 5 litre with 1 HP motor.

C.5.9. Platform Balance:-

Platform balance of 200 kg. capacity selected.

C.5.10. Compounding tank:-

A compounding tank of 300 litre capacity made of mildsteel is selected.

The details of machinery and equipment is given in Annexure - I.1.

The list of suppliers of machinery is given in Appendix - V.

Terms of purchase of machinery:-

i) Quotations are made and satisfactory quotations are confirmed.

ii) Prices quoted are exclusive of packing, transportion costs, sales tax etc.

iii) 50% of the price should be paid in advance and remaining at the time of despatch.

C.6. MANPOWER REQUIREMENT:-

The total manpower requirement is classified under the following heads:

1) Administrative staff.

2) Factory staff.

The details of manpower required is given in Annexure-II.2.2.

C.6.1. Administrative staff:-

The head of the administrative staff is the manager who handles the over all management of the factory. The other staff members are one accountant cum-clerk and two watchmen-cum peon.

C.6.2. Factory Staff:-

These are the people involved in actual production

operation. According to the skill and experience requirement they are classified into four classes, supervisor, skilled, semiskilled and unskilled. Details of manpower requirement is given below:-

Job Description	Number of staff/workers.
Manager	1
Accountant cum Clerk	1
Watchmen cum Peon	2
Chemist	1
Supervisor	2
Skilled labour	4
Semiskilled labour	2
unskilled labour	6

C.7. UTILITIES:-

The utilities required are water, electricity and steam. The requirement of these are given below:-

C.7.1. Power requirement:

Machine		H.P.
1. Planetary mixer	-	3
2. Deammoniation tank and ball mill.	-	1
3. Squeezing machine	-	3
4. Water pump	-	3
5. High speed stirrer.	-	1
6. Fan, light etc.	-	1
Total	-	12 HP or 9 KW

Power is available in the Industrial Estate from K.S.E.B. On the basis of following operational data, power charges are worked out as follows:-

No. of working days	-	300
No. of working hours/day	-	16
Utilization factor	-	60%
Tariff	-	20 paise.
Power cost per annum	-	$\frac{9 \times 300 \times 16 \times 60 \times 20}{100 \times 100}$
	=	Rs.5184/=

Rounded off Rs.5200/=

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C.7. 2. Fuel:-

Proposed fuel for boiler is fire wood. The capacity of the boiler required will be of the order of 120 to 200 kg/hr. For which fire wood requirement is estimated as 25 tonne per month and 300 tonne per annum, which is easily available locally at the prevailing price of Rs.150/tonne.

Fuel cost per annum = Rs.45000/=

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C.7.3. Water:-

This unit requires water for boiler, for washing the valcanisied foam and for personal uses.

1. Water consumed by boiler	-	1000 litre
2. Water for valcanised foam	-	460 litre
3. Personal use	-	200 litre
Total	-	1660 litre

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The above quantity of water is available from Industrial Estate water supply.

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SECTION - D

DESCRIPTION OF PROCESS OF MANUFACTURE

The process described is based widely used Dunlop (silicofluoride) process in which foaming is accomplished by the machincal incorporation of air into a suitable latex compound, followed by the addition of a delayed action gelling agent which allows time for the fluid foam to be shaped before it gels. The wet gelled foam is then valcanised, washed, dried and finished.

D.1. General principles:-

The compounded latex is allowed to mature before adding further valcanising ingradients. In some cases fillers as aqous dispersion added and after which compound is frothed to a foam. The foaming operation is carried out by agitating the compound with revolving wire whisk. After foaming gelling agents are added and foam is transferred to moulds and is valcanised. The order of procedure is given below:-

1. Deammoniation of latex.
2. Preparation of dispersions, emulsions or solutions of compounding ingredients.

3. Initial compounding with valcanising agents, frothing agents and antioxidants.
4. Maturation.
5. Further compounding with valcanising agents, frothing agents, secondary gelling agents and fillers.
6. Foaming, addition of zinc oxide, gelling agent and foam refining.
7. Moulding and gelation.
8. Valcanising.
9. Washing and drying.
10. Finishing.

Flow diagram for the process is given in Appendix -I

D.1.1. Deammoniation:-

The purpose of deammoniation is to improve the processing charactorstics (eg. strength of the gelled wet foam) and the structure of the finished product. The alkalinity should be determined both on the de-ammoniated latex before compounding and on latex fully compounded except for zincoxide and gelling agent. The ammonia content of latex is reduced to 0.22% for batch foaming.

D.1.2. Preparation of compounding ingredients:-

Since most of compounding ingradients are insoluble in water, it is necessary for these to be prepared as aqous dispersions or emulsions for addition of latex. Dispersions are prepared by grinding with water in presence of a dispersing agent using a ball mill. For efficient working ball mills

should be half filled with stone pebbles and charged with water and chemicals. The volume of water and chemicals should correspond to approximately one quarter of the volume of the mill. Vessels should be well scoured between charges of different materials.

Emulsions of liquids are prepared using high speed stirrers. Water soluble ingradients are added as solutions.

Typical formulations are as follows:-

Foaming agent:-

Potassium oleate is obtainable as a 50% solution which is diluted to 20% with distilled or soft water. Alternatively 20% potassium oleate can be prepared from potassium hydroxide and oleic acid as follows:-

	Parts by weight	
Oleic acid	100	A
Water	402	
Potassiumhydroxide	23.3	B
Water	43	

A is warmed to 75°C and B is added to A with efficient stirring.

Accelerators:-

Zinc diethyldithiocarbamate and zinc mercaptobenzthiazole are the accelerators normally used for foam, as 50% dispersions:

	Parts by weight
Accelerator	50
Dispersing agent (Belloid T.D.)	1
Soft water	49

Ball milled for 16 hrs.

Vulcanising agent:

Sulphur is used as a 50% dispersion:

	Parts by weight
Sulfur	50
Dispersing agent	1
Soft water	49

Ball milled for 48 hrs.

Antioxidants:-

Non staining types are normally used. Nonox sp, a liquid used as 50% emulsion.

	Parts by weight	
Nonox Sp.	100	A
Oleic acid	5	
Ammonia (0.880 sp.gr.)	5	B
Distilled water	90	

A is warmed to 75° C and B is added using high speed stirrer.

Fillers:-

The incorporation of cheap fillers into foam compounds in order to reduce compound cost is common practice. The filler used is starch.

To meet current latex foam specification relating to moulded foam products it is usually found that upto 30 parts by weight of filler can be incorporated per 100 parts of natural rubber.

Fillers are added as aqous slurries by stirring the following mixture until a smooth paste is obtained.

	Parts by weight
Filler	100
Dispersing agent	2
soft water	35 - 45

Secondary gelling Agents:-

The most commonly used secondary gelling agent is cetyltrimethylammoniumbromide. Addition of this raises gelling P^H of the latex thus reducing the risk of foam collapse before gelation occurs.

The liquid concentrates ~~mr~~ are diluted to 50% with distilled or soft water for use.

Activator and Gelling Agent:-

Zinc oxide functions as an activetor of valcanisation and as an auxiliary gelling agent. It is used as a 50% dispersion.

	Parts of weight
Zinc oxide	50
Dispersing agent	1
Soft water	49

Ball milled for 16 hrs.

Gelling Agents:-

Sodium silicofluoride is prepared and stored as a 50% dispersion and is diluted to 20% before use.

	Parts by weight
Sodium Silicofluoride	50
Soft water	50

Ball milled for 24 hrs.

D.1.3. Compounding and Processing:-

The latex compound given in Appendix - III is typical of those for latex foam. Compounding is carried out jacketted mixing tank fitted with a stirrer to operate at speeds of about 50, 150, 300 rev./min. The low speed is used during maturation and faster speeds for mixing process.

Initial compound:-

Potassium oleate solution is added to the latex, followed by sulfur, accelerators and finally antioxidant. When all ingradients are incorporated stirring should continue for approximately 10 minutes to ensure thorough mixing.

D.1.4. Maturation:-

When mixing is complete, warm water is pumped into and circulated through the jacket of the mixing vessel to bring the compound temperature of 30°C which is maintained for a period of 16 hours with continuous stirring at slow speed. After this the compound is cooled using cold water and is ready for next operation.

D.1.5. Further compounding:-

To the matured and cooled compound the following ingradients are added with stirring. The proportion of potassium oleate added will depend upon the density of the foam required for the particular endproduct. Filler, starch is to be added in this stage.

D.1.6. Batch Foaming:-

Batch foaming is suitable for small production units or when miscellaneous products of varying density and/or colour are required. It is carried out in a foam mixer consisting of a metal bowl and wire whisk stirrer which can be rotate at three different speeds. The rotating wire whisk whips the latex to a froth. Control of the volume to which the latex is foamed is essential and is achieved by marking the frothing bowl or by using a measure to check the distance of the foam from the top of the bowl when the whisk is stopped. The initial foaming is carried out at high speed; when the foam is approaching final volume the speed is reduced to medium rate. Just before the required volume is reached zinc oxide dispersion is added. Stirring is continued for 45-60 seconds and the speed of mixer is again reduced to slowest rate and the sodium silicofluoride dispersion is slowly added.

D.1.7. Moulding and Gelation:-

When the foaming operation is completed the foam is immediately transferred into two-piece moulds (warmed to 30-40°C) designed to produce the desired size and shape of the finished product. The majority of commercially produced mattresses,

Cushions and pillows have cored structure. This structure is formed by using moulds with regularly spaced pins which project (usually from the top mould plate) into the cavity of the base part of the mould, thereby giving a honey comb structure to one side of the finished product. The load-bearing properties of a unit for a given weight of rubber are improved by such a design. Further more the large surface area of the product allows for shorter cure and drying times.

Cast aluminum alloy moulds combine the desired properties of a good heat transfer, resistance to corrosion, lightness and a smooth surface to facilitate stripping. To allow for the shrinkage which takes place during drying of the foam products, moulds should be made over size (normally about 8 percent linear). Trials should be made with the type of compound to be used to assertain the actual shrinkage before deciding final mould measurement.

The tensile and tear properties of the wet latex foam immediately after valcanisation are appreciably lower than those of dried product and it is therefore essential to ensure that stripping from the mould is made as easy as possible. Core pins are usually tapered and the interior of the mould should be lubricated with a mould release agent before filling with foam. Release agents are usually applied to the mould by spray and care should be taken to ensure that these are dry before the foam is introduced, as incomplete drying can cause surface collapse or surface shrinkage of the foamunit.

Gelation of the foam, enclosed in the mould, takes place after a time intervel (the gelling time) dependent on the temperature, the amount of gelling agent and zinc oxide present, the amount and nature of stabilisers and the properties of the latex itself. Gelation should normally be complete in few minutes and can be readily judged by observing the condition of mould overflow.

D.1.8. Valcanisation:-

After gelation, the foam is valcanised by heating for 30 minuts at 100°C. The time will depend upon the thickness of the product. Valcanisation usually carried out in steam chamber.

Valcanisation should follow gelation as soon as possible to minimize shrinkage.

D.1.9. Washing:-

After valcanisation the mould is opened and the wet cured foam is removed and washed in running water. This is effected by passing the foam articles through a series of water-spray and squeege rolls, with a final pass through dry rolls to remove excess of water.

Drying:-

After excess water has been removed, drying may be completed batchwise in an oven which is heated by steam. During drying, foam products should be laid flat without distortion to avoid permanent deformation. Products drying in contact with each other are often difficult to separate. This practice

can result in rejects due to tears or severe surface blemishes.

D.1.10. Finishing and Inspection:-

After drying, the products are trimmed and examined. Defects such as tears and small surface blemishes can be repaired using latex as an adhesive. Products are then tested against the specification to which they are being produced.

D.2. QUALITY CONTROL AND SPECIFICATION:

The specification tests are carried out according to ISI 1741 - (1960). The following paragraphs summarize some of the tests involved.

Hardness:-

The hardness expressed as the indentation index is determined by the load required to compress the foam to specified indentation depth.

Indentation Set:-

This is determined periodically by measuring the change in thickness which a static load is imposed on the product for a specified time at a specified temperature.

Pounding Test:-

This test involves submitting a sample to a continued pounding with an indentor for a given number of cycles (e.g. 250,000 cycles at rate of 4 per second) The loss in hardness and any permanent deformation is measured.

D.3. Faults and Remedies:-

Different degrees of foam collapse in which the small cells break down to form fewer but larger cells, resulting in coarse

structure, loose surface skin and the presence of 'rat holes' (large isolated holes) can be due to insufficient gelling agent or gelation taking place at too low a pH value. Loose skin can also be caused by the moulds being too cold, whilst moulds which are too hot can result in a thick skin or flow marks on the surface. Shallow depressions on the surface (known as 'lakes') can be due to misuse of mould release agents and, if gelation is too rapid, the resultant foam is liable to split in the centre.

A fault can be due to more than one cause, but the following table may be helpful as a guide to remedies:

Fault	Possible Cause	Suggested Remedy
Coarse structure	Gelation at too low a pH	Increase secondary gelling agent.
Rat holes	Gelation at too low a pH	Increase secondary gelling agent.
Loose surface skin	Insufficient gelling agent	Increase SSF and/or secondary gelling agent.
	Mould too cold	Use warmer mould.
Thick skin	Mould too hot	Use cooler mould.
Flow marks on surface	Mould too hot Gelation too fast	Use cooler mould Reduce SSF
Surface lakes	Excess mould release agent	Reduce mould release agent
	Mould release agent not dry.	Ensure that mould release agent is dry.
Splitting in centre	Gelation too fast	Reduce SSF Use cooler mould.

D.4. Process loss:-

Perfect elimination of the process losses costs more than what is lost by it. So the aim is to reduce the

losses to economic level. By carefully adjusting the batch weight, the losses can be reduced to negligible amount.

D.5. Waste Disposal:-

The main losses are occured due to mould overflow and product rejects. These waste cannot be reworked since they are valcanised. But for this waste there is a good demand by small parties for making pillows and as a filling material for sofa-cum-beds.

D.6. Product Diversification:-

Product diversification is possible further as number of foam products coming under this catagory and can be manufactured by the same equipments and raw materials by changing the mould where necessary. The various foam products other than mattresses and pillows are bus seats, theatre seats and back rests, chair seats, cycle seats, scooter and motor cycle seats etc. All these can be manufactured by the same process.

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SECTION- E

SELLING AND DISTRIBUTION ARRANGEMENTS

The most commonly adopted method for selling are direct sales by opening sales depot and sales through commission basis. Foam products can be sold through agents & dealers on a commission basis of 15 to 20%. Distribution of foam products outside states will be done through train on F.O.R. basis.

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SECTION- F.

CAPITAL REQUIREMENTS

The financial aspects of the firm can be given in the following heads:-

1. Fixed capital requirement.
2. Working capital requirement.
3. Gross capital requirement.
4. Total Manufacturing cost.

F.1. Fixed capital requirement:-

It is the sum of the expenses incurred for plant, machinery, land and building. The estimated fixed capital requirement in the above head are as follows:-

Land	-	Rented
Building	-	Rented
Plant & Machinery	-	2.70 lakh.
Miscellaneous	-	0.06 lakh.
Total fixed capital	-	2.76 lakh.

Details of Fixed Capital is given in Annexure - I.

F.2. Working capital requirement:-

The working capital requirement depends on:-

(i) The duration for which raw material inventory has to kept optimum so as to ensure uninterrupted production.

(ii) The duration in which finished goods should be stored to ensure uninterrupted supply.

(iii) The duration involved in purchasing, manufacturing and selling.

(iv) The duration between selling of the goods and the payment to be received.

It also depends to a great extent on credit facilities available from bank, from raw material suppliers and the credit terms between firm and the customer.

The costs involved during this period is called working capital. In the present case since all materials are available indeginiously one month raw material inventory is enough. The duration involved in manufacturing, storying, selling and cash payment is usually two months for latex foam

products so working capital may be taken as the total variable expenditure involved during the period of three months and are classified in the following heads:-

1.	Raw material cost	-	5,89,800.00
2.	Manufacturing cost	-	1,30,100.00
3.	Other overheads	-	17,100.00
	Total working capital (annual)	-	7,37,000.00
	Working capital for 3 months.	-	1,84,250.00

Details of working capital are given in Annexure-II.

F.3. Gross capital requirement:-

It is the sum of fixed capital requirement and working capital requirement and is the total investment on the project. Gross capital requirement is given in Annexure - III.

F.4. Total manufacturing cost:-

It is the sum of all direct and indirect costs involved in the manufacturing operation. Annual manufacturing costs can be classified in the following heads:-

1. Raw material cost.
2. Personnel cost - Salaries.
3. Utilities - It involves total cost incurred in power, water & steam.
4. Overhead expenses and
5. Other fixed costs and interest on loan.

The annual costs involved in these sections are as follows:-

1. Raw material cost	-	Rs.5,89,800.00
2. Manufacturing cost	-	Rs.1,30,100.00
3. Overhead expenses	-	Rs. 17,100.00
4. Other fixed cost and interest on loan	-	Rs. 80,900.00
Total cost	-	Rs.8,17,900.00

Details of the total costs are given in Annexure-IV.

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SECTION - G

FINANCING PLAN

Before starting the project sufficient planning should be done to raise the money. One can get financial assistance from the following sources.

G. 1.1. State Small Industries Corporation:

Offers machinery on hire purchase on a margin money of 20%. Repayment starts after two years and should be complete within 7 years. It offers special considerations to technically qualified persons.

G.1.2. State financial corporation:-

Offers financial assistance as cash to small and

medium scale industries. Provide 100% machinery cost, 70% building cost and 40% working capital at 11.85% interest. Repayment starts after 2 years and should be complete on by 10 years.

G.1.3. State Bank of India and Subsidiaries:-

They sanction medium investment credit for purchase of machine and construction of factory building. Also provide working capital for purchase of raw material at 16% interest.

G.1.4. Commercial Banks:-

Commercial banks provide cash loans for machinery, loans are provided at 25% margin money. Pay back period is 3 years. For working capital any amount can be drawn.

a. Keyloan facility:-

For purchase of raw material bank will advance money on 25% margin money and 15% interest. The material will be under banks lock and key. Small amounts can be drawn according to requirement.

G.2. Financing of the Project:-

Gross capital of Rs.4,50,410.00 is proposed to be raised with following manner.

G.2.1. Borrowings:-

The whole machinery cost, Rs.2.76 lakh is obtained from the KFC at the interest of 11.85%.

About 75% of working capital, Rs.1,34,250.00 is supposed to be taken from a commercial bank at a 15% interest.

6.2.2. Own fund:-

The balance of the total capital is contributed by the entrepreneur. This is Rs.50,000.00.

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1. Borrowing:-

a. Loan from KFC	- Rs.2,76,160.00
b. Working capital from Bank.	- Rs.1,34,250.00
2. Own fund	- Rs. 50,000.00
Total	- Rs.4,60,410.00

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SECTION - H

PRODUCT PRICING

The three main strategies of pricing are cost oriented pricing, demand oriented pricing and competition oriented pricing. For latex foam products cost oriented pricing is more relevent. The price of the latex foam is fixed as Rs.60/- per kg. The details of sales turnover and net profit given in Annexure-V.

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SECTION - I

PROFITABILITY

Financial viability of the project can be assessed through profitability. The following factors are assessed and which shows that the project is financially viable.

I.1. Rate of return on own capital:-

Own Capital	-	Rs. 50,000.00
Net profit	-	Rs. 44,160.00
Rate of return on own capital	-	88.32%.

I.2. Rate of return on capital employed:

Gross capital	-	Rs. 4,60,410.00
Net profit	-	Rs. 44,160.00
Rate of return on capital employed.	-	9.59%

I.3. Profit on net sales turnover:-

Net sales turnover	-	Rs. 9,32,400.00
Net profit		Rs. 44,160.00
Profit on net sales turnover.		Rs. 4.74%

I.4. Break even analysis:-

Break even point is that quantum of sales at which the unit is just able to recover all expenses. In other words, it is the point at which neither profit nor any loss incurred.

Break Even Point = $\frac{F}{P-V}$

Where F = Annual fixed cost.

P = Selling price per kilogramme.

V = Variable price per kilogramme.

Total variable cost:

i) Raw material cost	- Rs.5,89,800.00
ii) Utilities	- Rs. 50,200.00
iii) Direct labour	- Rs. 49,800.00
iv) sales expense	- Rs. 40,900.00
v) Duty	- Rs.1139,600.00
Total variable cost	Rs.18,70,300.00
Variable price	Rs.54.2

Annual fixed cost:-

(Cost of production + Sales Expenses + duty)- variable cost

= Rs.1,28,100.00

B.E.P. = $\frac{128100}{60-54.2}$ = 22086 Kg.

I.5. Sales turn over:-

Total quantity produced	- 34,500 Kg.
Selling price	- Rs.60/=
Total sales turn over	- Rs.20,70,000.00
Waste foam	- 400 kg.
Selling price	- Rs.5/=
Total	- Rs.2000.00
Grand total sales	- Rs. 20,72,000.00

SECTION - J

ECONOMIC VIABILITY

J.1. Interest commitments:-

1.	Interest on working capital @ 15%	- Rs. 20,138.00
2.	Interest on term loan from KFC @ 12%	- Rs. 33,140.00
	Total	Rs.53,278.00

J.2. Ability to payback borrowed funds:-

The term loan has to be paid back within the prescribed time. It is kept minimum time to save interest.

Pay back period:-

	Annual net profit	- Rs. 44,160.00
	Depreciation	- Rs. 27,616.00
	Available surplus	- Rs. 71,776.00
Less:	Drawings	- Rs. 15,000.00
	Amount used for repayment	- Rs. 56,776.00
	Term loan to be paid	- Rs. 276160.00
	Pay back period	- 5 years.

SECTION - K

CONCLUSION

The present scheme for manufacture latex foam comes under the small scale sector since value of plant and machinery is below 15 lakh. The small unit gives the entreprenseur the following benefits:-

1) Profit.
2) Independence and satisfaction.
3) Opportunity to use his ideas.
4) Opportunity for growth.

To the nation it provides following benefits.

1) Provides employment to good number of people, since latex industry is labour intensive, large employment with less investment.
2) Develops entrepreneurship and entrepreneurskills.

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ANNEXURES

ANNEXURE - I

FIXED ASSETS

1.	Land	- Rented
2.	Building	- Rented.
3.	Plant and machinery	- Rs. 2.70 lakh.
4.	Miscellaneous	- Rs. 0.06 lakh.
	Total	- Rs. 2.76 lakh.

ANNEXURE - I-1

Plant and Machinery		Rs.
1.	Compounding tank	- 4,000.00
2.	Planetary Mixer 200 lit.capacity	- 40,000.00
3.	Valcaniser with rails and trolleys- 2 Nos.	24,000.00
4.	Squeezing machine	13,000.00
5.	Ball mill and high speed stirrer - (one each)	5,000.00
6.	Plat foam balance	- 3,500.00
7.	Drying chamber of 300 kg. capacity.	- 30,000.00
8.	Moulds of different size	- 65,000.00
9.	Boiler	- 60,000.00
10.	Deammoniation tank	- 6,500.00
11.	Miscellaneous tools	- 3,000.00
	Total	- 2,54,000.00
	Freight and sale tax @ 4%	- 10,160.00
	Errection charges	6,000.00
	Furniture & Equipment	- 6,000.00
	Total	- 2,76,160.00

ANNEXURE - II

WORKING CAPITAL(ANNUAL)

		Rs.
1.	Total raw material cost	- 5,89,800.00
2.	Manufacturing cost	- 1,30,100.00
3.	Other over heads	- 17,100.00
	Total (Annual)	- 7,37,000.00
	For 3 months	- 1,84,250.00

ANNEXURE-II-1-1

Raw material cost - For 150 kg. latex per day operating two shifts

	Item		Rs.
1.	Latex 150 kg. DRC 90 kg @ Rs.17.50		1575.00
2.	Z.D.C. 1.0 kg @ Rs.42/=		42.00
3.	Z.M.B.T. 1.0 kg @ Rs.50/=		50.00
4.	Sulfur 2.3 kg @ Rs.3.50		8.00
5.	Zinc oxide 4.5 kg @ Rs.18/=		81.00
6.	Sodium silico fluoride 1.4 kg @ Rs.6/=		8.40
7.	Caustic potash 0.2 kg @ Rs.17/=		3.40
8.	Oleic acid 1 Kg. @ Rs.18.50		18.50
9.	Foam stabiliser 1.3 kg @ Rs.49/=		63.70
10.	Nonox SP. .9 kg @ Rs.40/=		36.00
11.	Belloid TD & Mould Release agent		20.00
12.	Starch 15 kg @ Rs.4/=		60.00
	Total	118.6 kg.	1966.00
	For one month (25 days)		49150.00

ANNEXURE - II-1

Raw material requirement for one year

	Item	Rs.
1.	60% latex 45000 kg DRC 27000 Kg @ Rs.17.50	4,72,500.00
2.	Z.D.C. 300 kg. @ Rs.42/=	12,600.00
3.	Z.M.B.T. 300 kg. @ Rs.50/=	15,000.00
4.	Sulfur 690 kg @ Rs.3.50	2,415.00
5.	Zinc oxide 1350 kg @ Rs.18/=	24,300.00
6.	S.S.F. 420 kg @ Rs.6.00	2,520.00
7.	Caustic potash 60 kg @ Rs.17/=	1,020.00
8.	Oleic acid 300 kg @ Rs.18.50	5,550.00
9.	Foam stabiliser SR 390 kg @ Rs.49/=	19,110.00
10.	Nonox sp.	10,800.00
11.	Belloid T.D. & Mould release agent	6,000.00
12.	Starch 4500 kg @ Rs.4/=	18,000.00
	Total	5,89,815.00
	Rounded off	5,89,800.00

ANNEXURE - II-2

MANUFACTURING COST (ANNUAL)

		Rs.
1.	Cost of Utilities	50,200.00
2.	Salaries	73,920.00
3.	Rent (land & building)	6,000.00
	Total	1,30,120.00
	Rounded of	1,30,100.00

ANNEXURE - II-2.1

COST OF UTILITIES

	Rs.
Cost of power	5,184.00
Cost of fuel	45,000 .00
Total	50,184. 00
Rounded off	50,200. 00

ANNEXURE -II.2.2.

SALARIES

A. Administrative staff		Monthly salary Rs.	Total salary Rs.
1. Manager	- 1 -	650.00	650.00
2. Accountant-cum-clerk	- 1 -	400.00	400.00
3. Watchmen-cum-peon	- 2 -	200.00	400.00
			1450.00
Salary per annum			Rs. 17400/=

B. Factory Staff:-			
1. Chemist	- 1 -	800.00	800.00
2. Supervisor	- 2 -	350.00	700.00
3. Skilled labour	- 4 -	Rs.10/= per day 25 days	1000.00
4. Semi-skilled	- 2 -	Rs.9/= per day 25 days	450.00
5. Unskilled labour	- 6 -	Rs.8/= per day 25 days	1200.00
			4150.00
Salary per annum			Rs.49,800.00
Total salary			Rs.67,200.00
Benefit @ 10%			Rs. 6,720.00
Total			Rs.73,920.00

ANNEXURE -II.2.3.

Rent - Land and Building

Rent per month	Rs.500.00
Rent per annum	Rs.6000.00

ANNEXURE - II.3

Other Over heads

		Rs.
1.	Repairs and Maintenance of machinery 2% @ 2%	- 5,080.00
2.	Insurance @ 1½%	- 4,000.00
3.	Stationery, printing, postage etc.	- 8,000.00
	Total	17,080.00
	Rounded off	17,100.00

ANNEXURE - III

Gross Capital Requirement

		Rs.
1.	Total fixed capital	- 2,76,160.00
2.	Total working capital	- 1,84,250.00
	Total capital requirement	- 4,60,410.00

ANNEXURE - IV

Total cost of Productions:-

		Rs.
1.	Raw material cost	- 5,89,800.00
2.	Manufacturing cost	- 1,30,100.00
3.	Over heads	- 17,100.00
4.	Other fixed cost and interests on loan (Annexure IV-1)	- 80,900.00
	Total cost of production	- 8,17,900.00

ANNEXURE - IV-1

Other fixed costs and interest

		Rs.
1.	Depreciation on machinery @ 10% -	27,616.00
2.	Interest on working capital @ 15% -	20,138.00
3.	Interest on term loan from KFC @ 12%	33,140.00
	Total	80,894.00
	Rounded off	80,900.00

ANNEXURE - V

Gross Expected sales

	Rs.
34500 kg @ Rs.60/-	20,70,000.00
400 kg waste foam @ Rs.5/-	2,000.00
Total sales turn over	20,72,000.00
Less:- Excise duty @ 55%	11,39,600.00
Net sales	9,32,400.00
Less:- sales expense @ 5% on cost of production	40,900.00
	891500.00
Less:- Cost of production	817900.00
	73600.00
Less:- tax, @ 40%	29440.00
Profit after tax	44160.00

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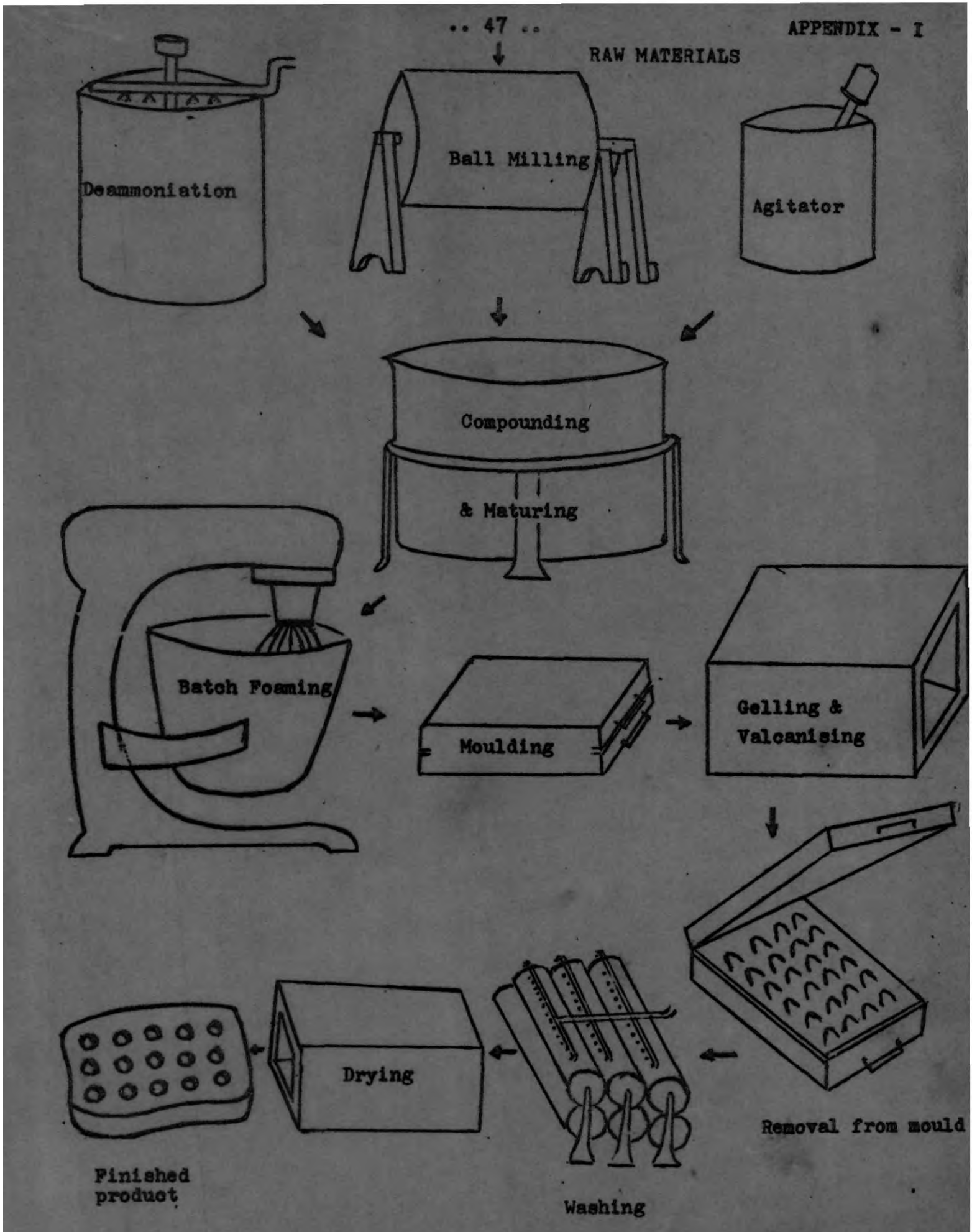
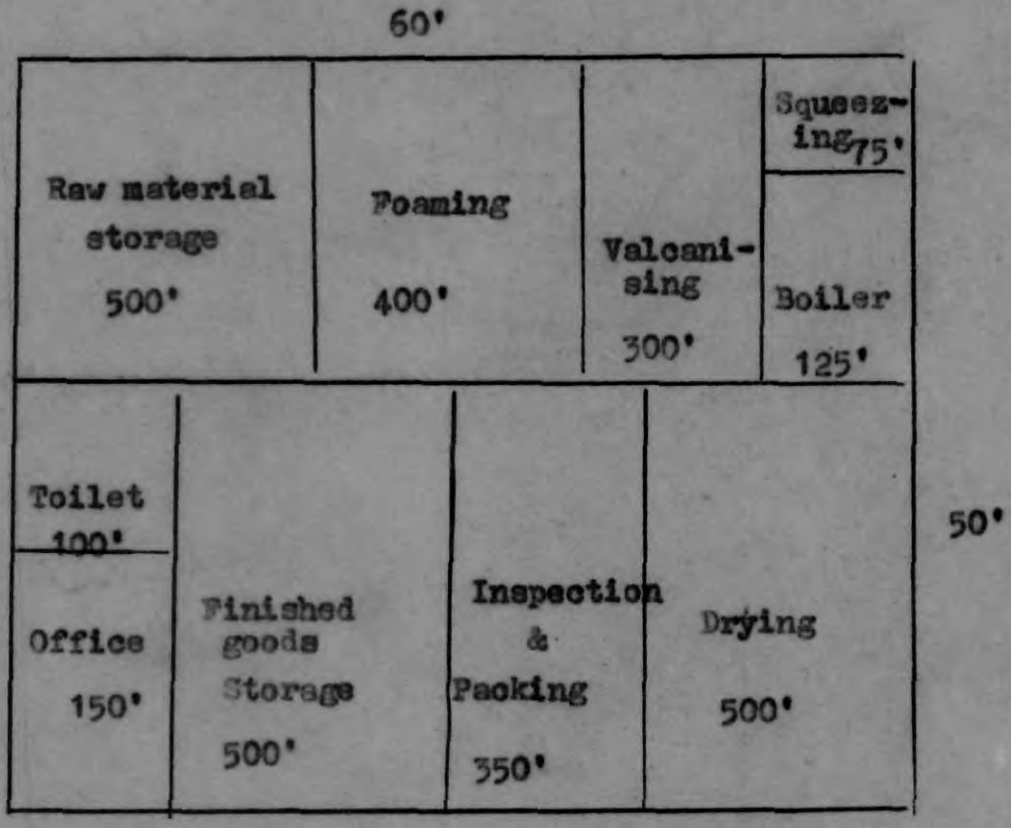
APPENDIX - I



FLOW DIAGRAM - LATEX FOAM MANUFACTURE

APPENDIX -II

PLANT AND LAYOUT



APPENDIX - III

COMPOUNDING FORMULATION

Item	Wet weight Kg.	Dry weigh Kg.
60% natural rubber latex	167.00	100.00
20% Potassium oleate dispersion	2.50	0.50
50% Znic diethyl dithio carbamate dispersion	1.50	0.75
50% Znic mercaptobenzothiazole dispersion	1.50	0.75
50% Sulfur dispersion	3.00	1.50
50% Nonox sp emulsion	2.00	1.00
Mature for 16 hours at 30°C, cool and add		
20% potassium oleate	5.00	1.00
50% Z.D.C.	0.70	0.35
50% Z.M.B.T.	0.70	0.35
50% sulfur	2.00	1.00
50% starch slurry	32.00	16.00
Before foaming add		
50% foam stubeliser solution	3.00	1.50
When foaming complete add.		
50% Zinc oxide dispersion	10.00	5.00
20% Sodium silicofluoride dispersion	7.5	1.50
		131.20

Cure at 100°C - 30 minutes.

APPENDIX - IV

LIST OF RAW MATERIAL SUPPLIERS

1.	Padijarekara Agencies, Kottayam.	60% NR latex
2.	Plantation Corporation of Kerala, Kottayam.	"
3.	Bayar India Ltd. (Rubber Division) Express tower, Nariman point, P.B. No. 1436, Bombay-21.	Accelerators, Antioxidants, Sulfur and Zinc oxide.
4.	Mindia Chemicals Ltd., Wakefield House, 11, Sprott Rd., Bombay - 38.	"
5.	A.C.C.I. Ltd., Chemical Dept., P.B.No.909334, Chowringhee Road, Calcutta-1.	"
6.	Suhrid Geigy Ltd., Baroda.	Belloid T.D.
7.	Goderj Soaps Ltd., 249, Mowbrays Road, Alwarpet, Madras - 18.	Oleic acid
8.	M/s Bansal Chemicals, P.B. No. 2854, Raghunayakula Street, Madras - 3.	Potassium hydroxide.
9.	A.V. Thomason & Co. (India)Ltd., 22, Marshalls Road, P.B. 763, Egmore, Madras - 8.	Foam stabeliser & Mould lubricant.
10.	Gopal kammath Kaloor road, Cochin - 18.	Sodium silico fluoride
11.	Laxmi Starch Ltd., Kundara, Kerala	Starch.

APPENDIX - V

LIST OF MACHINERY SUPPLIERS

1.	Gransons Ltd., 207, Kakad chambers, Dr. Annie Beasant Road, Bombay - 18.	Planetary mixer.
2.	Sam sons enterprises, 353, west of chord Road, Bangalore - 10.	Moulds.
3.	Wanson India (P) Ltd., Brown Boveri House, 264-265 Dr.Annie Beasant Road, Bombay - 25.	Boiler.
4.	Batlibai & Co. Private Ltd., V.B. Gandhi marg, Fort, Bombay - 23.	Boiler.

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APPENDIX - VI

SIZES OF VARIOUS FOAM RUBBER PRODUCTS

1. 75 x 36 x ½" Plain slab.

Mattresses - single.

1. i) 75 x 36 x 1" Cavity sheet
   ii) 75 x 36 x 2" "
   iii) 75 x 36 x 3" "
   iv) 75 x 36 x 4" "

2. i) 75 x 30 x 2" "
   ii) 75 x 30 x 3" "
   iii) 75 x 30 x 4" "

Mattresses - double

3. i) 75 x 42 x 2" "
   ii) 75 x 42 x 3" "
   iii) 75 x 42 x 4" "

4. i) 75 x 48 x 2" "
   ii) 75 x 48 x 3" "
   iii) 75 x 48 x 4" "

5. Bus seats (Flat)
   i) 45 x 15 x 3" "
   ii) 30 x 15 x 3" "
   iii) 15 x 15 x 3" "
   iv) 45 x 15 x 2½/3½ (tapered)

6. Theatre seats
   17 x 17 x 1½/2½

7. Back rest
   21½ x 17 x 1½/2½

8. Chair seat
   i) 15 x 15 x 2"
   ii) 15 x 15x 1½"

9. **Pillows:-**

i) 15 x 12 x 3½"
ii) 18 x 12 x 4"
iii) 24 x 16 x 4½"
iv) 24 x 16 x 5"
v) 26 x 16 x 5".

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