UNIVERSITY OF COCHIN

B.TECH COURSE

IN RUBBER PROCESSING AND TECHNOLOGY :

PROJECT REPORT
ON
A SMALL SCALE RUBBER LINING UNIT
IN KERALA.

DISSERTATION

SUBMITTED BY

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F O R E W O R D

This project report has been prepared and submitted as a dissertation unlike project reports prepared for procuring loans to start new industries. The chief objective of this is the partial fulfilment of my technical degree. Viewing from the wider perspective of a dissertation of a technical course, I think, the delibrate inclusion of some technical aspects in section D is justifiable.

However, I do not claim this report to be perfect and exhaustive in all respects.

I gratefully acknowledge the assistance and co-operation extended by all those who have helped me in this endeavour. My special thanks are due to Shri.E.V.Thomas, Deputy Director; Shri.C.M.George; Project Officer; Shri. M.K.Balagopalan Nair, Chemical Engineer and Shri.P.U.George, Cost Accountant of Rubber Board and Rubber Research Institute of India.

15th March, 1977. M.M.JOSE.

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SECTION A

INTRODUCTION

With the growth of heavy chemical industries in our country chemical corrosion is becoming an aspect of increasing importance. The equipments and storage tanks are normally lined with rubber, ebonite, PVC FRP, Glass etc. to avoid the corrosion of the metal due to contact with various chemicals used in the process. In this project lining of vessels with rubber is dealt with.

A.1. MAIN OBJECT OF THE PROJECT.

Vulcanised natural rubber in the form of soft rubber and ebonite linings has, for many years been successfully used as a corrosion resistant material in chemical plant lining application. Early use of rubber as a corrosion resistant material include ebonite stop - cocks, pistons and valves, rubber gloves, aprons etc. However the general use of rubber as a corrosive resistant lining appears to have developed significantly since the early 1920's.

The chief object of the project is to meet the widely increasing demands for chemical plant lining. The scheme under consideration envisages to undertake job orders for rubber lining of chemical tanks and vessels according to users demand and specification at the factory premises. The target of the project is to line an area of 15,000 square meters per annum.

A.2. PRODUCT DESCRIPTION

Rubber lining, popularly called 'Tank lining' is a sheet of rubber bonded to the inside of a rigid metal vessel usually made of mild steel and subsequently vulcanised. A bond is developed between the applied lining and the metal and any attempt to pull them apart will normally result in the lining tearing before the bond yields. The main purpose of rubber

lining is to provide resistance to chemical action and abrasion and to prevent the contamination of contents of a vessel. The lining is not designed to contribute anything to the mechanical strength of the metal structure. The lined vessels are quite suitable for use either under vacuum conditions or under pressure conditions.

The hardness of the rubber compounds used for lining of the vessels varies from 50 - 100° shore A. In the case of ebonite linings the hardness ranges from 60 - 80 shore D and that of butyl linings 65 ± 5° shore A.

The minimum temperatures normally recommended for linings are, soft rubber - 80° F, hard rubber + 35° F, and Neoprene - 20° F.

A.3. PROSPECTS AND TARGETS.

The major areas of application of rubber lining are the various industries like fertiliser, metallurgical, Textile, chemical and allied industries. The prospects of the proposed project is therefore directly correlated with the following:

1. Total number of chemical and allied industries.
2. The annual growth rate of these industries.
3. Annual increase in production.

The annual growth rate and annual increase in production of these industries can be ascertained from table 1 and table 2 given below:

TABLE - I

INDEX NUMBERS OF INDUSTRIAL PRODUCTION

Base 1960 = 100

	1951	1961	1966	1971	1972	1973	Percent change 1973 over 1972
1. Chemicals & chemical products	42.4	113.4	168.4	252.4	293.8	301.9	+ 2.7
2. Textiles	79.7	102.8	108.9	106	114.4	113.3	- 0.9
3. Basic metal industries	46.5	118.7	191.5	208.6	225.3	215.8	- 4.4
4. Petroleum refinary products.	11	106	195.9	316.9	317.2	332.8	+ 5.0
5. General industrial growth index.	54.8	109.2	153.2	186.1	199.4	200.7	+ 0.5

Ref. INDIA - 1976 PAGE 267

TABLE 2

PROGRESS OF INDUSTRIAL PRODUCTION

Industry	1950-51	'60-61	'65-66	'69-70	'72-73	'73-74	'74-75 Provisic
CHEMICAL & ALLIED INDUSTRIES.							
1. Nitrogeneous fertilisers ('000 tonnes)	9	98	233	716	1059	1060	1184
2. Phosphatic fertilisers	9	52	111	222	326	373	311
3. Sulphuric acid ('000 tonnes)	101	368	662	1197	1226	1353	1292
4. Rayon Industry ('000 tonnes)	2.1	43.8	75.6	98.8	113.1	101.8	186.4
METALLURGICAL							
1. Steel(lakh tonnes)	14.7	34.2	65.3	64.3	62.8	57.6	62.7
2.Finished steel(")	10.4	23.9	45.1	48	50.2	44.8	48
3. Steel castings('000 tn.)	..	34	57	46	70	55	60

Ref. INDIA - 1976 PAGE 265

From the table it can be seen that the growth rate of various chemical and allied industries is increasing steadily at a faster rate. A survey conducted among the fertiliser and chemical factory in Kerala reveals that the area to be rubber lined increases 15-20° in every year.

The annual requirements of rubber lining for various plants of a tippical fertiliser factory is reproduced below in table 3.

TABLE 3

Year	Requirement
1969-70	1500 Square metres
1972-73	1500 " "
1974-75	3300 " "
1975-76	4500 " "
1976-77	7000 " "

Despite the large demand, the total number of units undertaking this job is very little and most of the existing units are working additional shifts to meet the huge demand.

In addition to the great scope for starting a new unit for rubber lining in the country an entreprenuer in Kerala is bestowed with the following advantages also.

1. Power is cheap and is available in plenty.
2. All raw materials are locally available.

A.4. COMPETITIVE SITUATION.

The maine competitors in this field are plastic (FRP), glass and lead. However rubber occupies the monoply in the field of lining because of the following advantages.

1. Adaptability: Rubber is adaptable to any size or design bf construction, more so than most linings.

2. Uniformity: The material can be applied uniformly both as a lining and as a covering with equal effectiveness.

3. Leak proof: Unlike wood or lead, rubber is free from leakage.

4. Non-conductivity: In plating and electrolysis industries this is a plus point as it means constant current density is maintained.

5. Increased capacity: The equipment has a larger capacity due to thinness and lightness of the rubber lining.

6. Economy: Rubber lining is generally cheaper than other types of anticorrosive materials.

Therefore, in view of the increasing demand and favourable conditions a unit targetted to undertake 15,000 square metres of rubber lining per annum is quite feasible.

SECTION B

MARKET SURVEY

B.I. USERS AND CUSTOMERS ANALYSIS

B.I.1 MAJOR FIELDS OF APPLICATION

(a) Rubber lining in Steel Industry

In the continuous steel strip pickling industry rubber lined steel tanks with brick sheeth are used almost exclusively. Normally a $\frac{1}{4}$" thick lining is used.

In addition to the tank lining, the tank covers, sewer lines, fume exhaust system and the waste disposal pits require rubber lining in the sulphuric acid pickling of mild steel.

(b) Transportation of corrosive liquids.

Corrosive liquids are moved in bulk by tanks car, tankstruck, barge etc. all of which are rubber lined. A soft rubber lining is recommended since hard rubber tends to crack under the stresses and vibrations to which the tank cars are subjected. The most common acid carried is hydrochloric acid. Soft rubber behaves satisfactorily with HCl and phosphoric acid. The formation of a hydrochloride film on the surface retards diffusion and prevents blistering.

(c) Rubber lining in Rayon industry

In the Viscose process for the manufacture of rayon, rubber lined pipings, storage tanks, regeneration and purification of the spin bath tanks etc. are used.

(d) Phosphoric acid and Acid phosphates industry.

The most common items lined are absorption towers, tanks cars, storage tanks, pipes and vessels. The type of rubber lining is determined

by the end use to which the acid is put. When acids or phosphates are used for fertiliser manufacture special lining qualities are not necessary. In cases where an oil floatation process is used, neoprene lining is recommended.

(e) Rubber lining in plating industry

Rubber is a natural choice for lining plating tanks. The vessels and tanks used in electrolytic tin plating for the various operations like cleaning, pickling, rinsing etc. are all rubber lined.

(f) Rubber lining for miscellaneous equipments.

In the chlorine manufacture industry a hard rubber lining is usually used in electrolytic cells.

Rubber has also played a prominent part in the development of a novel type of squeeze or press roller used on wool washing and scouring machines. Rubber is also exclusively used in spinning machines, in theinstallation for the production of silica sols, in hydrocyclones etc. Thus the use of rubber in various industries are many and varied.

B.2. MARKET SURVEY

The following information were obtained from the market survey.

1. The thickness and number of plies varies as per requirements the material handled, pressure and temperature. However the preferred thickness of lining varies from 3 - 6 mm.

2. Usually three types of linings are done 5 mm thick (single ply) 5 mm thick (double ply)., 2.5 mm + 2.5 mm.
10 mm thick 5 mm + 5 mm

3. For most of the application NR based compounds are used for lining.

4. The hardness of the compounds used for lining various from 50 - 100 Shore A.

5. The service life of the lining is generally between 5 - 10 years unless otherwise premature failure accurs.

6. For butyl lining the hardness is 65 ± 5°A.

7. Service requirements include phosphoric acid, ammonium sulphate, nitrophosphates, brine, sulphuric acid and sulpher dioxide (along with brick lining) sodium silicofluride, synthetic cryolite, ammonium carbonate and ammonium chloride.

8. There are only two units undertaking this work in Kerala.

9. The charge is usually quoted per unit area lined ie, on square metere, subject to various factors like thickness of lining, nature of polymer, hazards and difficulties involved in lining the vessel etc.

B.3. PROSPECTS OF THE PROJECT.

Rubber lining industries are growing satisfactorily all these years. Though the proposed project is specialy concerned with tank lining with soft natural rubber of 5 mm thick, any type of rubber lining work can be undertaken with the existing mechinery.

The work is of the job order type and where ttanks and vessels are lined according to customer specifications, Though the project intends to undertake lining work at the factory premises, special orders can also be undertaken provided they user meets all the additional expenses involved

in the transportation of equipments, personnel etc to the site.

B.4. SPECIFIC MARKET.

The main market areas are states like Bihar, Orissa, West Bengal Maharashtra and Thamilnadu where most of the chemical and allied industries are clustered. Local orders are also obtained. The market in Kerala is mostly in the Alwaye region where most of the chemical and fertiliser industries are situated.

B.5.MARKETING CHANNELS.

Orders will have to be collected from various concerns involved in the production and handling of chemicals. These concerns will send the vesslls to factory premises at their own cost if no insuperable transportation difficulties are involved. These tanks and vessels are cleaned and lined with rubber according to their specification and returned to the customer within the agreed period. If it is not possible to fetch the vessels to the factory or if the customer isvery particular to emcute the work under his direct supervision. Such orders can also ~~can~~ be undertaken at the site. Quotations are submitted staking the minimum acceptable rate, guarantees that can be given, duration of time within which the work can be completed, terms of payments etc. After entering into contract, the work will be executed as per agreement.

SECTION - C.

PROFUCTION REQUIREMENTS.

C.1.LOCATION.

The selection of location of a factory is very important and it is more or less influenced by the following basic facors.

1. A factory is meletively immobile and when once established, it is difficult to abandon the site.

2. The plant location has a considerable influence on operating costs and profits. The former may very upto 25% or even 50% from one location to another.

3. Building costs, maintenance costs and taxes on land and building are large and fixed.

However, the specific factors relating to the rubber lining factory according to order of importance are given below.

1. Availability of power and its cheapness.
2. Availability of labour, both skilled and unskilled.
3. Availability of water.
4. Facilities for transport and communication.
5. Proximity to raw materials.
6. Proximity to customers.

Since most of the fertiliser, chemical and allied industries are clustered in the Alwaye region, a suitable place in Ernakulam District offers almost all the aforesaid advantages.

A small scale concern for rubberlining work can be advantageously located in an industrial estate because of the following advantages.

1. Facilities like transport, water, elect-ricity are available without delay.

2. Comparatively lower capital investment on land and building. Building available at very reasonable rent.

3. Availability of labour - both skilled and unskilled.

4. Adequate facilities for testing and training for labour.

5. It reduces overhead costs to a minimum.

6. Collective purchase of raw materials possible.

7. Industrial estates provides accomodation for banks, dispensaries recreation faciiities etc.

The proposed unit can therefore be located in an Industrial Estate.

C.2.RAW MATERIAL REQUIREMENTS.

The firm intends to undertake job orders for lining 15,000 square metres per annum. For this estimated capacity, the total annual requirement of rubber compound based on selected formulations and volume of lining (5 mm thickness) comes to 120 Tonnes including process losseas. The details are given in Annexure 2.1. The important class of raw materials used are given below.

(a) Polymers: Rubber lining can be based on NR, butyl, Neoprene or Hypalon. For the estimated job the firm requires 50.5 tonnes of NR per annum. Natural rubber is available from local market at a consolidated price of Rs.7/kg with an uninterrupted supply.

(b) Curing Agents: Accelerators required are (1) MBT and (2) TMT Zinc - Stearic acid activation system is used.

Annual consumption and price are given below:

Accelerator	Consumption per annum	Price/kg.Rs.
TMT	783 kg.	26.50
MBT	480 ,,	23.90

(c) Fillers : The following fillers are used for rubber lining

Fillers	Annual consumption	Price/kg
China Clay	37,900 kg.	Rs. 0.40
Barium sulphate	15,160 "	Rs. 1.50
Carbon black	10,107 "	Rs. 4.50

Details of suppliers are given in Appendix 6.

Other materials used include Flectol H (Poly - 2, 2, 4 - trimethyl - 1, 2 - dihydroquinoline) sulphur, solvents, bonding agents, sand, trichloro ethylene etc.

Source of Supply

All raw materials are available indegenously. Several agents are available in the country to supply rubber chemicals. Detailed list of suppliers are given in Appendix 6, and most of them have got sales depots or agencies in Kerala.

Terms of purchase.

All negotiations concerning the purchaseof raw material are done through banks. On a margin money of 30% the bank will advance 70% as for the purchase of materials. The amount has to be repaid within 70 days with interest. The purchased materials will be stored in the banks godown and materials are withdrawn with onnpayment of cash whenever required.

C.3. DETAILS OF FIXED ASSETS

1. Land and Building

The land and building are rented from an industrial estate.

The built up area required is calculated to be 3375 sq.ft. The area available is split are follows into different sections.

Raw material storage	300 Sq.ft.
Cab	150 Sq.ft.
Mixing and sheeting	440 "
Building	320 "
Sand blasting room	300 "
Vessel cleaning and lining	440 "
Autoclave and Accessories	420 "
Boiler room	150 "
Administration, stores and Toilet	855 "
T o t a l ..	3375 "

An 'A' type building in the industrial estate which provides a built up area of 3496 sq.ft. is chosen.

Plant Layout.

Theimportant points to be remembered in fixing the lay out are

1. Materials handling costs should be minimum.

2. It should ensure continuous flow of the materials inside the plant.

3. Storage capacities and their location.

4. Expansion at a later date which should dovetail into existing operation.

The proposed layout is shown in Appendix 2.

2. Plant and Machinery

The machinery required can be classified into

1. Mixing and sheeting equipments
2. Vessel cleaning equipments
3. Lining equipments
4. Curing equipments.

Selection of Machinery

The selection of machinery is the most important since maximum utilisation of machinery gives better return for the money spent. However, maximum utilisation is not possible when the size of machine is fixed by the nature of the product. The selection of machinery is based on the following considerations.

1. Estimated capacity
2. Type of production
3. Accepted standard dimensions of the product.
4. Its effect on the utilisation of all other machinery.

The basic machinery for mixing is mixing mill 12" x 30" size,with chilled cast iron rolls, driven by 30 HP motor. The capacity of the mill is 15-20 Kg. per batch. For mixing 200 Kg. of compound per shift this mill is quite adequate.

The equipment used for sheeting is a 2 - bowl sheeter 16" x 42" size driven by 50 HP motor. Uniform sheets of any desired thickness and a maximum width of 100 cm. can be produced using this. Because of the large capacity of this sheeter itneed be worked only in single shift.

Since a small scale concern like this cannot afford the huge expenases involved in the installation of a calander machine of the appropriate size and since the economic utilisation of it is not possible within this production schedule and the sheeter can very well serve the purpose the above selection is justified.

Equipments for cleaning the vessels include a sand blasting equipments and compressor 20 Cft, 100 Psi driven by 30 HP motor.

Lining equipments comprise of racks for mounting the vessels, consolidating equipments, lifting and handling equipments etc.

For vulcanisation an autoclave of size 5' x 12' is installed horizontally. Size permitting open tanks and vessels are vulcanised in this since vulcanisation in autoclave gives maximum bond strength. Normal cure time for autoclave vulcanisation is about 2-3 hours. Vessels which cannot be accommodated in the autoclave and small one which are not open are vulcanised using steam under pressure after covering the vessel with tarpaulin. Hot water is also used for vulcanisation. Rails trolleys and accessories for placing tanks inside the autoclave. A boiler with a capacity of 150 Kg. of steam per hour is installed for steam generation.

The details of machinery requirements are given in Annexure I.

All machinery are manufactured indegenously and the list of suppliers are given in Appendix 6.

Terms and conditions of purchase of machinery.

1. Quotations are made and satisfactory ones are confirmed.

2. Price quoted are exclusive of packing transportation costs, sales tax, excise duty, etc.

3. 30% of the price should be paid in advance and the remaining at the time of purchase. Payment can be done through banks.

4. Purchase has the right for inspecting the machinery.

5. Supplier possess the right for cancellation changing delivery time and prices due to unforseen reasons.

6. Normal delivery period of major machinery varies from 2-5 months.

7. Liabilities passes on to the customer immediately after despatch and shortages should be noted within a week.

8. Warranty against manufacturing defects is assured.

C.4. MAN POWER REQUIREMENTS

The man power requirement may be divided into 3 categories.

1. Managerial and Administration
2. Technical
3. Labourers.

1. Managerial and Administration

The head of this is the Manager cum Technologist. In the present case the owner himself can hold that position.

2. Technical

Technical staff include the works Engineer, Production Supervisors, Mechanic.

The total number of personnel in these two categories is 7. This is shown below.

Managerial	
Manager cum Technologist	1
Accounts Officer	1
Clerk/typist	1
Technical	
Works Engineer	1
Shift in charge	2 (One per shift)
Mechanic	1
T o t a l ..	7

3. Labour Requirement

Labour is the category of people who are directly involved in production. The scheme now envisages a two shift production and it can be increased to 3 after the market has captured and according to increasing orders. The total number of labour force (both skilled and unskilled) required for two shift production is 26. Total wages per annum with 25% fringe benefits come to about Rs. 1,54,500. Details of man power requirements are given in Appendix 4.

Training Programme.

As the rubber lining operation is a skilled job some training programme may be necessary for the workers. For the efficient functioning of thefirm well experienced and trained technologist, supervisors, skilled workers etc. are essential. Being a small unit which cannot afford such an elaborate training this may be arranged in institutions such as common facility service centres. Further training may be given in the factory itself with the one experienced hand available.

C.5. INFRA STRUCTURES AND OTHER FACILITIES.

1. Roads: For the successful functioning of any industry, transport facilities are an a must. To bring the raw materials to the factory and to haul the finished goods into the market transport facilities are unavoidable.

Since this project is established in an Industrial Estate, it is not met with transport problems.

2. Water Supply: Water is required for mixing mills, boiler feed, workers and office staff. The water required for the purpose is supplied by the Industrial Estate at a nominal charge.

3. Power: The driving force behind any industry is electricity. As the factory is located in a state where electricity is surplus, Power is not a problem. Industrial Estate ensures power without expenditure on transormer and other electrical connections. Separate connections are necessary for high tension and low tension lines.

4. Steam: Steam is essential for vulcanisation of the lining.

SECTION D

PROCESS AND TECHNOLOGY OF RUBBER LINING

The flow diagram for the process of rubber lining is given in Appendix 1.

The important steps in the process of rubber lining are the following:

1. Compound design
2. Stock mixing
3. Sheeting and building
4. Surface preparation of vessels
5. Application of bonding agent
6. Lining
7. Vulcanisation
8. Inspection and quality control

1. Design of lining compound

The compound design for rubber lining is based on the following parameters.

1. Service requirements
2. Processibility, and
3. Price

The service performance demanded on the lining by the user determines the vulcanisate properties and is arrived at by a detailed consumer analysis. Full details regarding the exchange of information between the contractor and the user are given in Appendix 5.

The correct choice of a rubber quality which will offer optimum chemical protection is sometimes a difficult task as there are so many factors to be considered. They are -

1. Nature of materials to be handled

1. Full analysis of the materials to be handled shall be taken into consideration including the constituents present in trace quantieies and materials likely to promote photochemical reaction which may have a deleterious effect on the life of the lining.

2. Temperature:

The following temperatures of the materials to be handled are taken into account.

(a) Normal operating temperature

(b) Maximum and minimum temperature

(c) Cycle of temperature variation

3. Degree of vacuum or pressure

(a) Normal operating pressure

(b) Maximum and minimum pressures

(c) Cycle of pressure variation

4. Cycle of operations - whether batch or continuous.

5. Concentration and degree of purity of chemicals to be handled.

6. Mechanical wear and damage

7. Amount and nature of suspended solids.

8. Effect of chemical absorption and swelling

D.2. Mastication and mixing

Natural rubber has to be masticated before mixing. Mastication is required since the thickness of liningis small.

The masticated rubber and other ingredients are weighed and mixed according to the formulation and batch sizes. Mixing is done on 12"x30"

mill the batch size of which is 15-20 Kg. Mixing time ranges from 15-25 minutes. The mixed stock is sheeted out and matured for 24 hours.

D.3. Sheeting and Building

The mixed stock is warmed on the two bowl sheeter. When it is sufficiently plastic and attains homogenity, it is sheeted out to a minimum thickness of about 1.6 mm. The sheets are rolled with inner liner and kept for sometimes to effect dying out of the strains by creep. It is then transferred to another inner liner and rolled before it is getting completely cooled down. This allows the remaining natural shrinkage.

The temperature of the rolls must be maintained in close tolerances If the bowls are too hot, then air bubble, and blisters may occur which is very harmful to the linings.

Building is carried out on building tables or on heated platens. The plies are placed one above the other and hand consolidated care being taken to see that no air is trapped between the plies. For this pressing should be started from the centre of the sheet towards the end. Air entrapment results in porosity, blowholes, defective adhesion etc. causing separation even after vulcanisation of the lining.

Thickness of lining

The thickness of the lining should be generally 3-5 mm. butin cases where there is likelihood of severe chemical reaction, abrasion or mechanical damage the thickness may be increased to 6 to 10 mm. Linings upto 6 mm thickness may be applied as a single layer. The minimum number of plies required tobuild up the thickness are as follows:

Thickness of lining mm	Minimum Numberof plies
upto 3	2
3 to 5	3
6	4

D.4. Surface Preparation of Vessels.

In order to get excellent bonding of the stocks on the metal surfaces, the metal surfaces must be very clean and polished and non-greasy. Grease, oil, scale, rust, chemical, contamination, protective coatings of all kinds and loose dirt must be removed completely.

The surface is first cleaned either by sweating with live steam or solvent. This removes oils and greases. Next the surface is subjected to sand blasting, in which, fine grain sand is forced on the surface under compressed air. Size permitting metal components are best sand-blasted at the contractors works in a special chamber lined with soft rubber. After the surfaces are sand blasted, they are cleaned with trichloro ethylene in liquid form.

D.5. Application of Bonding agent.

After all the solvents being evaporated off leaving a completely dry surface, the bonding agent is applied either by spraying or by brushing. Bonding agents generall used are based on isocynates like Desmodur-R and chlorinated rubbers. Two or three coats are applied depending on bond strength required.

D.6. Lining operation.

The coated surface is allowed to dry for 24-72 hours to remove solvent vapour and entrapped air. The calendered sheet is then cut to

size solutioned and allowed to dry and pressed on to the prepared surface with a hand roller. Each sheet should overlap the adjacent one and care should be taken to prevent air entrapment. The number of joints should be minimum- To minimise blistering it is usual to introduce a length of cotton cord or string between the metal and the lining to allow the gases to escape.

There are three methods of making the joints.

1. Overlaping bevel joints
2. Strapped joints
3. Flush joints

Overlap bevel joints are produced by skiving the edges of sheets. The total contacting surface between two sheets shall be a minimum of 4 times the sheet thickness, butnot exceeding 30 mm. at any one point.

In strapped joints, the sheets are skived and joined, and a chamfered strap, is then centrally alligned over the joint. The contacting length shall not exceed 30 mm. The thickness of the strap may be upto 0.8 mm. less than that of the lining but not less than 1.5 mm.

Flush joints are used for the staggered joints in the double lining method of application.

D.7. Vulcanisation

Before being vulcanised the rubber lined equipment is usually allowed to rest for at least 24 hours to allow the trapped air to diffuse away.

The method of vulcanisation will depend on the nature and size of equipment to be lined. The five methods of vulcanisation usually adopted are -

1. Autoclave cure in open steam
2. Atmospheric steam in which liwe steam is used without pressure
3. Hot water
4. Hot air
5. Room temperature vulcanisation

Vessels which are small enough to go into the autoclave are always vulcanisedin open steam at a maximum pressure of 45 psi since it gives the maximum bond strength. Most of the metal tanks willbe open and can easilybe vulcanised in autoclave.

The time and temperature of vulcanisation are governed by the size and weight of the vessel, the thickness of the lining and the rate of cure of the comp ound. Normally, in rubber lining compounds the cure system is slightly on thefaster side. Steamp pressure is allowed to build up gently to the specified maximum pressure and is maintained there through out the curing cycle. 'Stepped' cure can also be employed. Normally for autoclave vulcanisation the cure time is about 2 hours. At the end of the curing cycle the steam pressure has to be reduced to Zero. Suddên release of pressure - especially when both rubber and adhesive are hot- can lead to separation either between the rubber plies or between rubber and metal. This cane be avoided xt by balancing the reduction of steam pressure by an increase of air pressure, the lined unit being finally allowed to cool in the autoclave under only air pressure. Alternatively towares the end of the cycle, cold water may be sparyed on to the hot vessel while still in the autoclave.

When the lined vessel is too large to be accommodated in an autoclave it may be vulcanised usinghot water. In this method, the tank is

flooded with water, and steam is passed thro gh a pipe upto the bottom. The temperature of wateris raised almost upto the boilding point and the cure is accomplished in a period of 24 - 48 hours. The column of water exerts the required mechanical pressure during vulcanisation. The level of water is always kept above the finished surface.

In order to check curing a few test pieces of the same compound and bonded to a small 2" x 2" metal piece in the same way the lining of the original equipment, are suppended at various levels in the tank. The test pieces are removed from time to time and when the cure at all the levels inside the tank is found to be complete, the heating is stopped and water drained off.

The third method of vulcanisation using steam is mi followed if the vessel has sufficient strength to withstand internally applied pressure. High or low pressure steam may be used. This proceedure can only be adopted if the vessel can be lined and then sealed steam proof.

D.8. Inspection and quality control.

After vulcanisation, visual inspection is carried out over the entire surface using a good source of light. The entire surface shall be free of cracks traces of bubbles, lack of adhesion, hollow spaces etc. Presence of hollow spaces is checked by tapping with a wooden mallet.

D.8. 1. Acceptance tests.

1. Standard of quality of compound

Routine checks for maintaining the quality of the compound.

2. Quanlity of sheet.

The sheet should be examined to ensure that it is free from blisters and other defects.

3. Adhesion test.

The adhesion of the lining to the metal shall be checked when requested by the user.

The adhesion values of the various types of rubber, for a rate of separation of 25 mm/minute are given in Table I.

TABLE .I

Mininum values of adhesion.

Type of rubber	Metals		Concrete and rendered brickwaork.
	Pressure Vulcanisation	Vulcanisation by hot water or steam at atmosphere pressure.	
	Kgf/cm	Kgf/cm.	Kgf./cm.
Natural rubber (soft)	3.6	2.7	0.9
Polycholoro prene	3.6	2.7	0.9
Butyl rubber	3.6	2.7	0.9
Chlro sulphonated Polycthylene	2.7	2.7	0.9

4. Quality of vessel to be lined.

Before lining, the vessels has to be checked for strength.

5. Hardness testing:

Hardness testing, as per IS:3400(Part II) 1965 is carried out at all points. Hardness tolerence ±5°.

6. Tests for Continuity of lining.

(a) High Frequency spark test.

A high voltage high frequency spark discharge should be directed at the lining. Where defect occurs in the lining the discharge is earthed, producing a strong bluish-white continuous spark.

The voltage shall be 5 to 6 KV/mm thickness of the lining unless the lining contains higher amounts of black in which case the voltage shall be 1.5 KV/mm.

7. Thickness of lining. Measured using suitable thickness meter.

8. Hydrolic testing of lined vessels.

When required by the user, a hydrolic test, at an agreed pressure and for an agreed time should be applied to the vessel.

9. Vacuum testing.

The lining shall show no defects after being subjected to a specified vacuum for a specified time, ousually, one hour.

10. Resistance to bleeding by the lining.

When contamination of the liquids by the lining meterial is detrimental check tests should be carried out.

Process loss.

In any type of manufacturing process there occurs somekind of losses. The aim is to feduce these losses to economic level. The process losses various according to nature of product and process. The losses in the case of lining are as ~~flees.~~ follows.

1) Handling losses. This include losses due to fly off during transportation, handling, weighing and compounding. This comes to about 0.5%.

2) Losses during sheeting: These are due to (a) scorched compounds, (b) Crows feet etc. The lower the thickness, higher the losses. This runs upto 3%.

3) Losses during lining: This includes cuttings due to (a) air entrapment

(b) joint pinholes etc. This loss runs upto 2%.

4. Losses during Vulcanisation: This is due to the adhesion failure. If the bond is not strong, the lining may be peeled off immediately after vulcanisation. This amounts to 4.5%.

Hence the losses due to all these comes to about 10%.

Waste disposal:

The main loss occurs after vulcanisation of the lining. It cannot be reworked. So it is sold for reclaiming.

Product Diversification.

With the same installed machinery and without incurring additional expenses subsidiary products like rubber covered rollers, sheetings like industrial and oilresistant etc. can be manufactured. The extra time available with the sheeter and mixing mill can be utilised in this way.

SECTION. E.

UTILITEES.

E.I. WATER.

Water is required in the factory for :-

1) cooling of mixing mills, two bowl sheeter and for boiler feed.

2) Toilet and otherpurposes.

Total water requirement per day.

1) Mixing mills	3500 litres
2) Two bowl sheeter	5000 "
3) Boiler	1000 "
4) Autoclave and Accessaries	500 "
5) Toilet and others	5000 "
TOTAL:	15,000 Litres.

Total water requirement per day, = 15 k.litres.

Therefore the annual water requirement comes about 4500 kilo litres.

Cost of 4500 k.litres of water @ Rs.0.33 =Rs.1485.

E.II POWER.

Main sources of power is electricity.

Assuming 80% consumption of the installled capacity the total power requirement per day can be arrived at as follows.

HP of double shift machinery = 37 .

Therefore power consumption of double shift machinery = 309.1 KWH.

Horse power of single shift machinery = 50

Therefore power consumption of single shift machinery = 208.8.KWH.

Total power consumption of per day = 518 KWH.

Annual consumption of electricity = 1,55,400 KWH

Cost of electricity @ Rs.015/KWH = Rs.23,310

Annual power consumption for fans, lighting etc =450KWH

Cost of this @ Rs.0.35 =Rs.158

Total Cost = Rs.23,470 Per annum.

Rs.3.STEAM.

Boiler of capacity 150 kg of steam per hour is installed and autoclave used is of size 5' x 12'. The autoclave is working for two shift with a maximum pressure of 45 psi. The steam consumption calculated considering all factors including losses comes to about 100 kg /hr. Operating cost of boiler can be calculated from the furnace oil consumption.

The efficiency of boiler is assumed to be 10 kg of steams per litre of furnace oil. Therefore furnace oil requirement per day = 160 litres.

Annual requirement =48,000 litres

Cost of furnace oil @ Rs.1.10 per litre = Rs.52,800

The total cost of utilities can be summed up as follows.

Item	Cost.Rs.
1) Water	1,485
2) Electricity	23,470
3) Steam	52,800
TOTAL:	77,755.
Roundoff:-	77,800

SECTION - F

PRICING POLICY:

The charge in fixed based on the following consideration

1. Current rates existing in the market
2. Cost of production
3. Profit condition
4. Profuction capácity.
5. Nature of polymer and thickness of lining used.
6. Hazards and difficulties invòlved in the job.

Since the work in of the job order type there is no standard rating for rubber lining. The usual practise is to charge the job based on the area of lining ie, charge per squremeter. The contractor and the the user must arive at an agreement regarding charging when the contract is made.

For rubber lining with soft natural rubber of 5 mm thickness the rate per square meter of lining is fixed as Rs.100/-. For specific orders the rates are quoted accordingly.

SECTION - G

FINANCIAL ASPECTS:

The financial aspects of the project can clasified into 5.

1. Fixed capital
2. Working capital
3. Gross capital
4. Manufactureing cost
5. Sales and Administration expenses.

F.1.FIXED CAPITAL

Fixed capital is the sum of the expenses incurred for plant, machenary, Building and pre-operative expenses that can be capitalised.

Since the project is located in an industrial eatate no capital is involved for land, buildings etc. Office machinery, furniture etc are also included in fixed capital. Pre-operative expenses are accounted for the costs incurred during the iddè time of plant and machinery before actual production starts. A period of 6 months is usually taken as the idle time. The estimated fixed capital requirments are given below:-

1.	Land and Buildings	- Rented (Accounted in working capital)
2.	Plant and machnery	- Rs.5,05,700
3.	Pre-operative xepenses	- Rs. 25,000
4.	Miscellaneous fixed assets	- Rs. 23,000
	Total	5,53,700

Details of fixed capital in shown in Annexure 1.4.

F.2.WORKING CAPITAL

The working capital rwquirement depends on

(a) The duration for which raw material inventory has to be kept.

(b) The duration involved in manufacturing marketing and selling.

Usually the working capital is taken as the total variable expenditure involved during a period of 3 months. It includes the following.

		Rs.
1.	Raw material cost	1,66,700
2.	Manufacturing costs	
	a. Utilities	19,500
	b. Salaries and wages	55,000
3.	Other overheads	15,300
	Working capital	2,56,500
	Rounded off	2,57,000

Details of working capital requirements are given in Annexure - 2.

F.3.GROSS CAPITAL

Gross capital is the sum of the fixed capital and working capital. Details are given in Annexure - 3.

F.4.MANUFACTURING COST

Thisincludes all direct and indirect cost involved in the manufactureing operation. Raw material cost, utilities, Personnel cost plant overhead, other fixed costs and interest on working capital etc. are included in this.

		Rs.
1.	Raw materials cost	6,66,900
2..	Personnel cost	2,20,500
3.	Utilities	77,800
4.	Overhead expenses	61,100
5.	Other fixed costs and interest on working capital	1,41,900
	Total	11,68,200

Details of total manufacturing cost are given in Annexure - 4.

F.5.SALES AND SALES ADMINISTRATION EXPENSES.

This can be broken into marketing expenses, general administration expenses and sales commission. Since the proposed project is of the job order type no expense is incurred for sales commission.

1.	Marketting expenses (Freight and Handling)	1,00,000
2.	Administration expenses	10,000
3.	Miscellaneous	5,000
	Total	1,15,000

Details of sales and sales administration expenses are given in Annexure - 5.

SECTION - H

FINANCING PLAN:

The finan e requirements of an industry is very high and an entrepreneur will not be able to afford all the expenses by himself. So he has to plan sufficiently early to rais e the required capital. There are a good number of financial institutions to assist the entrepreneurs. Financial institutions usually provide upto 80% of fixed capital requirements. Centain institutions give it as cash loan and others as machinery on hire purchase.

Some of the financial institutions and the nature of assistance they provide are given below.

1. STATE FINANCIAL CORPORATION.

Theyn provided 100% machinery cost,75% of building cost, 40% of working capital at 7.5% interest upto 10 lakhs. Repayment starts after two years and should be complete within 10 years.

2.NATIONAL SMALL INDUSTRIES CORPORATION

Indegenous and imported machinery can be obtained on hire purchase scheme from those institutions. Repayable in 7 years in instalments.$ Interest

3. KERALA STATE SMALL INDUSTRIES CORPORATION

Machinery worth upto Rs.10 lakhs can be obtained on ahire purchase scheme. Interest 7.5% and repayment period maximum 7 years after the first two years

4. KERALA EMPLOYMENT PROMOTION CORPORATION

Provides 95% of the cost involved in the purchasing, serviceing, taxes, insurance and transportation of all machinery and equipments as a loan at 7% interest.

5.INDUSTRIAL DEVELOPMENT BANK OF INDIA

This institution gives financial assistance directly to industries

Interest ranges from 15 - 16%.

6. COMMERCIAL AND CO-OPERATIVE BANKS

Nationalised Banks provide entire working capital at 16% interest and loans for machinery on 25% margin money and 12% interest

Pay back period for working capital is 3 years. Co-operative banks gives loans to industrial co-operatives.

FINANCING OF THE PROJECT

Gross capital of Rs.8,11,000 is proposed to be realised as follows.

(a) BORROWINGS: The entire machinery cost of Rs.4,12,800 is taken from KFC at 7.5% simple interest.

The whose of the working capital of Rs.2,57,000 is supposed to be taken from a Nationalised Bank.

(b) OWN FUND: The balance of the total capital is contributed by the enterpreneur. This amounts Rs.1,40,900. This amount is used for preliminary and pre-operative expenses.

		Rs.
(a)	BORROWINGS	
	1. From K.F.C.	4,12,800
	2. From Nationalised Bank	2,57,000
(b)	OWN FUND	1,40,900
	Gross capital	8,10,700
	Rounded off	8,11,000

SECTION - I

PROFITABILITY:

The financial viability of the project can assertained through the profitability. The following fa tors are considered in this.

1. Rate of return on own capital.
2. Rate of return on capital employed.
3. Percentage profit on sales turnover.

In the proposed project annual gross profit is Rs.2,16,800 and Net profit Rs.1,30,000.

I.1.RATE OF RETURN OF OWN CAPITAL

Own capital	Rs.1,40,900
Net profit	Rs.1,30,000
Therefore Rate of return on own capital	92.28%

I.2.RATE OF RETURN ON CAPITAL EMPLOYED

Total capital employed	Rs.8,11,000
Annual Net Profit	Rs.1,30,000
Rate of return on capital employed	16.03%

I.3.PERCENTA E PROFIT ON SALES TURNOVER

Annual turn over	Rs.15,00,000
Net Profit	Rs. 1,30,000
Percentage profit on sales turnover	8.67%

SECTION - J

ECONOMIC VIABILITY

J.1.INTEREST COMMITMENTS:

Interest for term loan from K.F.C. @ 7.5%	Rs.31,000
Interest on working capital loans @ 16%	Rs.41,100
Total interest commitments	Rs.72,100

J.2.ABILITY TO PAY BACK BORROWED FUNDS.

The term loan has to be paid back within the purchased period. Savings in interest can be achieved by immediate payback. Of the total profit approximately 25% is retained as drawings and 75% used to pay back term loans. Since part of the money is paid back in first year, the ability to pay back borrowings will be more, due to decrease in interest commitments.

J.3.PAY BACK PERIOD

	Rs.
1. Annual net profit	1,30,000
2. Add depreciation	69,800
3. Available surplus (1+2)	1,99,800
4. Less Drawings (25%)	49,950
5. Amount available for repayment	1,49,850
6. Term loan to be paid back	4,12,800
7. Pay back period	2.75 Years.

SECTION - K

SOCIAL BENEFITS

This small scale unit for rubber lining provides the following benefits to the nation and to the entrepreneur.

1. Benefits to the nation

a. Larger employment with less investment

b. Ensures a more equitable distribution of the national income.

c. Enhances the revenue earning of the nation

d. Facilitates an effective mobilisation of local resources and skills.

2. BENEFITS TO THE ENTREPRENEUR

a. It gives profit

b. Opportunity to put his ideas into practise.

SECTION - L

HIGHLIGHTS OF THE PROJECT:

1.	Fixed capital	Rs.5,53,700
2.	Working capital	Rs.2,57,000
3.	Total capital employed	Rs.8,11,000
4.	Working shift per fay	2
5.	Total labour force	26
6.	Total staff	7
7.	Built up area	3375 sq.ft.
8.	Annual production	15,000 sq.metres
9.	Net profit	1,30,000
10.	Location	An industrial estate in Kerala.

The project is sound and economically feasible.

ANNEXURES

ANNEXURE - 1.
FIXED ASSETS :

ANNEXURE 1.1.

I. Land and Building — Rented (Accounted in working capital)

II. Plant and machinery

	Item	No:	Value Rs.
1.	Mixing mill, 12" x 30" size, 30 HP motor, chilled cast iron rolls & Accessories	1.	80,000
2.	2 Bowl sheeter 16" x 42", 50 HP motor and Accessories	1	1,60,000
3.	Autoclave 5' x 12', 40 psi	1	40,000
4.	Boiler, 150 kg/hr with ion exchanger	1	50,000
5.	Air compressor, 20 cft, 100 psi	1	20,000
6,	Sand blasting equipment	1	4,000
7.	Buildings stable, 30 ft length	1	6,000
8.	Trolleys, rails and accessories	1.	15,000
9.	Weighing scales		
	100 kg dial Balance	1.	5,000
	5 kg dial balance	1	1,500
10.	Materials handling equipment, consolidation rollers, Miscellaneous tools and equipments	1.	15,000
11.	Conveyers and accessories	1.	5,000
12.	Seiving equipment and accessories	1	1,000
13.	Laboratory equipments		
	a. Hardness tester	1	1,500
	b. High frequency spark tester	1	4,500
	c. Thickness gauge	1	800
	d. Miscellaneous lab:equipments		3,500
	Total		4,12,800

	C/O	4,12,800
5% provision for price escalation		20,640
Total		4,33,440
Sales tax @ 7.5%		30,960
Installation, Transportation etc. @ 10%		41,280
Total		5,05,680
Rounded off		5,05,700

ANNEXURE 1.2.

PRE -OPERATIVE EXPENSES

Interest on block loan -- for Rs.4,12,800 @ 7.5% for 6 months	15,480
Taxes	1,500
Travelling Expenses	2,500
Postage, Telegram, Telephone	1,000
Printing and stationary	2,000
Rent and Establishment	1,500
Other miscellaneous Expenses	1,000
Total	24,980
Rounded off	25,000

ANNEXURE 1.3

MISCELLANEOUS FIXED ASSETS

	Rs.
Office machinery and equipments	5,000
Furniture	2,000
Workshop equipments	10,000
Fire fighting equipments	2,000
Miscellaneous tools, spares and equipments	4,000
	23,000

ANNEXURE 1.4.

TOTAL FIXED ASSETS

Land and buildings (Rented)	
Plant and machinery	5,05,700
Pre-operative expenses	25,000
Miscellaneous	23,000
Total	5,53,700

ANNEXURE - 2

WORKING CAPITAL REQUIREMENTS:

Annual working expenses

		Rs.
1.	Total raw materials cost	6,66,900
2.	Manufacturing cost	
	(a) Cost of utilities	77,800
	(b) Salaries and wages	2,20,500
3.	Administrative and other over heads	61,100
	TOTAL	10,26,300
	Working capital (for 3 months)	2,57,000

ANNEXURE - 2-1.

DETAILS OF WORKING EXPENSES ON RAW MATERIALS :

(Annual)

Sl.No.	Material	Annual consumption Kg.	Price/kg. Rs.	Total annual cost. Rs.
1.	Natural rubber	50,534	7.00	3,53,740
2.	Zinc oxide	2,527	17.00	42,960
3.	Stearic acid	631	11.50	7,260
4.	Clay	37,901	0.40	15,160
5.	Barium sulphate	15,160	1.50	22,740
6.	F.E.F. Black	10,107	4.50	45,480
7.	Flectol H	631	31.00	19,560
8.	T M T	783	26.50	20,750
9.	M B T	480	23.90	11,520
10.	Sulpher	1,263	2.30	2,910
11.	Bonding agent	1,500	65.00	97,500
12.	Sèlvent oil S B P	6,000 liters	4.20/lit.	25,200
13.	Tri-chloro ethylene	100	11.00	1,100
			Total	6,65,880
	Others			
	Sand	100 ton	10.00/ton	1,000
			Total	6,66,880
			Rounded off	6,66,900

ANNEXURE 2-2.

MANUFACTURING COST:

(Annual)

		Rs.
1.	Utilities	77,800
2.	Salaries and wages	2,20,500
	Total	2,98,300

ANNEXURE 2 - 2.2 - 1.

UTILITIES

(Annual)

		Rs.
1.	Water	1,485
2.	Power	23,470
3.	Furnace oil	52,800
	Total	77,755
	Rounded off	77,800

ANNEXURE 2-2 : 2.

SALARIES AND WAGES (ANNUAL)

(a) Administration & Technical

Sl.No.	Position	Total staff per day	salary per month	Total Annual Sal
			Rs.	Rs.
1.	Manager cum Technologist	1.	1,200	14,400
2.	Accounts Officer	1	500	6,000
3.	Clerk- Cum - Typist	1	400	4,800
4.	Works Engineer	1	700	8,400
5.	Production Supervisor	2	600	14,400
6.	Mechnic	1	400	4,800
	T o t a l l			52,800

(b) Wages of labourers (Annual)

Wages to be paid to 11 unskilled personnel @ Rs.350 per month	46,200
Wages to be paid to 6 semiskilled personnel @ Rs.400 per month	28,800
Wages to be paid to 9 skilled personnel @ Rs.450 per month	48,600
T o t a l :	1,23,600
Total Salaries and wages (a+b)	1,76,400
Annual fringe benefits (25%)	44,100
T o t a l :	2,20, 500

ANNEXURE 2-3

ADMINISTRATIVE AND OTHER OVERHEADS (ANNUAL)

		Rs.
1.	Repairs and maintanance of machinery (5%)	21,700
2.	Insurance @ 2% of fixed capital	11,000
3.	Stationary, Supplies and Printing	7,500
4.	Taxes	1,000
5.	Audit and legal charges	5,000
6.	Postage and Telephone	2,500
7.	Travelling and Advertisement	5,000
8.	Misdallaneous	2,000
9.	Rent @ Rs.450 per month	5,400
	Total	61,100

ANNEXURE.3

GROSS CAPITAL:

a.	Total fixed capital	5,53,700
b.	Total working capital	2,57,000
	Total	8,10,700
	Rounded off	8,11,000

ANNEXURE - 4.
OF
TOTAL COST/PRODUCTION (ANNUAL)

		Rs.
1.	Cost of raw materials	6,66,900
2.	Utilities	77,800
3.	Sslaries and wages	2,20,500
4.	Administrative and other over ~~drafts~~ heads	61,100
5.	Fixed costs and interest on working capital	1,41,900
	Total:	11,68,200

ANNEXIRE - 4-1.

OTHER FIXED COSTS AND INTEREST ON WORKING CAPITAL

1.	Depreciation	
	a. Depreciation of Machinery (Rs.4,33,400 @ 15%)	65,000
	b. Depreciation on other fixed assets and pre-operative expenses(Rs.48,000 @ 10%)	4,800
2.	Interest on loans	
	a. Interest on block loan @ 7.5% (Rs.4,12,800)	31,000
	b. Interest on working capital loan (Rs.2,57,000 @ 16%)	41,100
	Total fixed costs	1,41,900

A N N E X U R E -5.

. SALES AND SALES ADMINISTRATION EXPENSES :

	Rs.
1. Annual freight and handling charges	1,00,000
2. Sales administration expenses	10,000
3. Miscelaneous	5,000
T o t a l :	1,15,000

A N N E X U R E - 6

A-NNUAL TURN - OVER ;

1. Annaul turn over 15,000 sq.metere @ Rs.100/m^2	15,00,000

A N N E X U R E - 7.

ANNUAL SALES INCOME AND PROFIT :

Annual turnover	15,00,000
Less sales and sales administration expenses	1,15,000
Annual sales income	13,85,000
Less cost of production	11,68,200
Pfofit beforetaxation	2,16,800
Less, provision for tax incidents @ 40%	86,720
Net profit after taxation:	1,30,080
Rounded off	1,30,000

ANNEXURE - 8.

BREAK - EVEN ANALYSIS :

Break even quantity is that quantity which if profuced and sold will give neither a profit nor a loss. It is calculated from the formula

$$n = \frac{F}{P-V}$$

F = total fixed cost

P = Average selling price per sq.metre

V = Variable cost per sq.metre.

VARIABLE COST PER SQUARE METRE:

1.	Annual raw materials cost	6,66,900
2.	Cost of utilities	77,800
3.	Direct labour	1,72,500
4.	Sales and sales distribution cost	1,15,000
	Total	10,32,200

Total profuct sold per annum 15,000 sq.metre

Therefore variable cost per sq.metre 68.8

Total sale of profuct 15,00,000

Therefore selling price per sq.metre 100

Fixed cost:

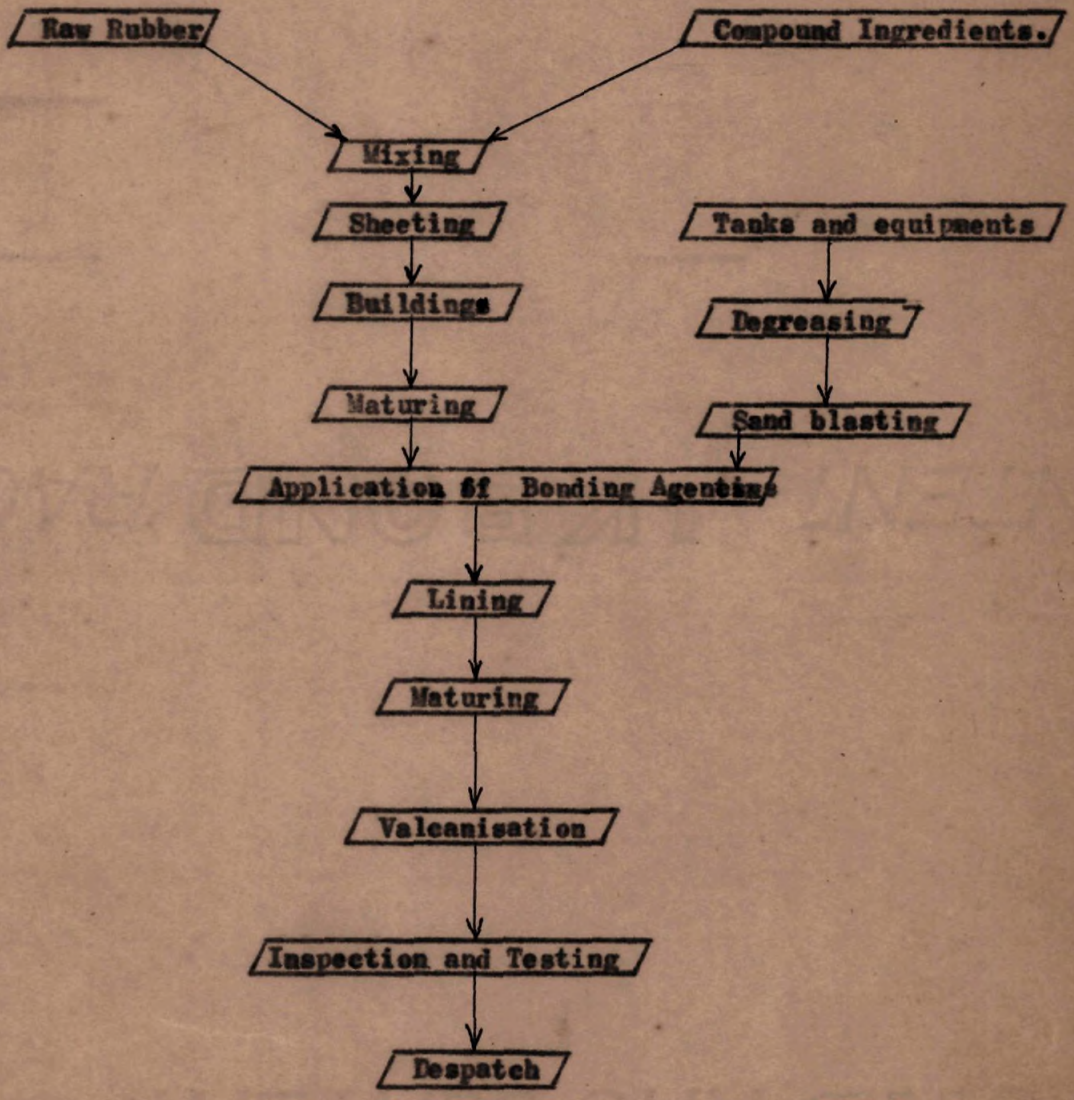
Cost of profuction	11,68,200
Add Sales and sales administration expenses.	1,15,000
Total	12,83,200

Total	C/O		12,83,200
Less Variable cost			10,32,200
Total fixed cost			2,51,000
Break even point		=	$\frac{2,51,000}{100 - 68.8}$
		=	8044 Sq.metre.
	ie.		53.6%

APPENDICES

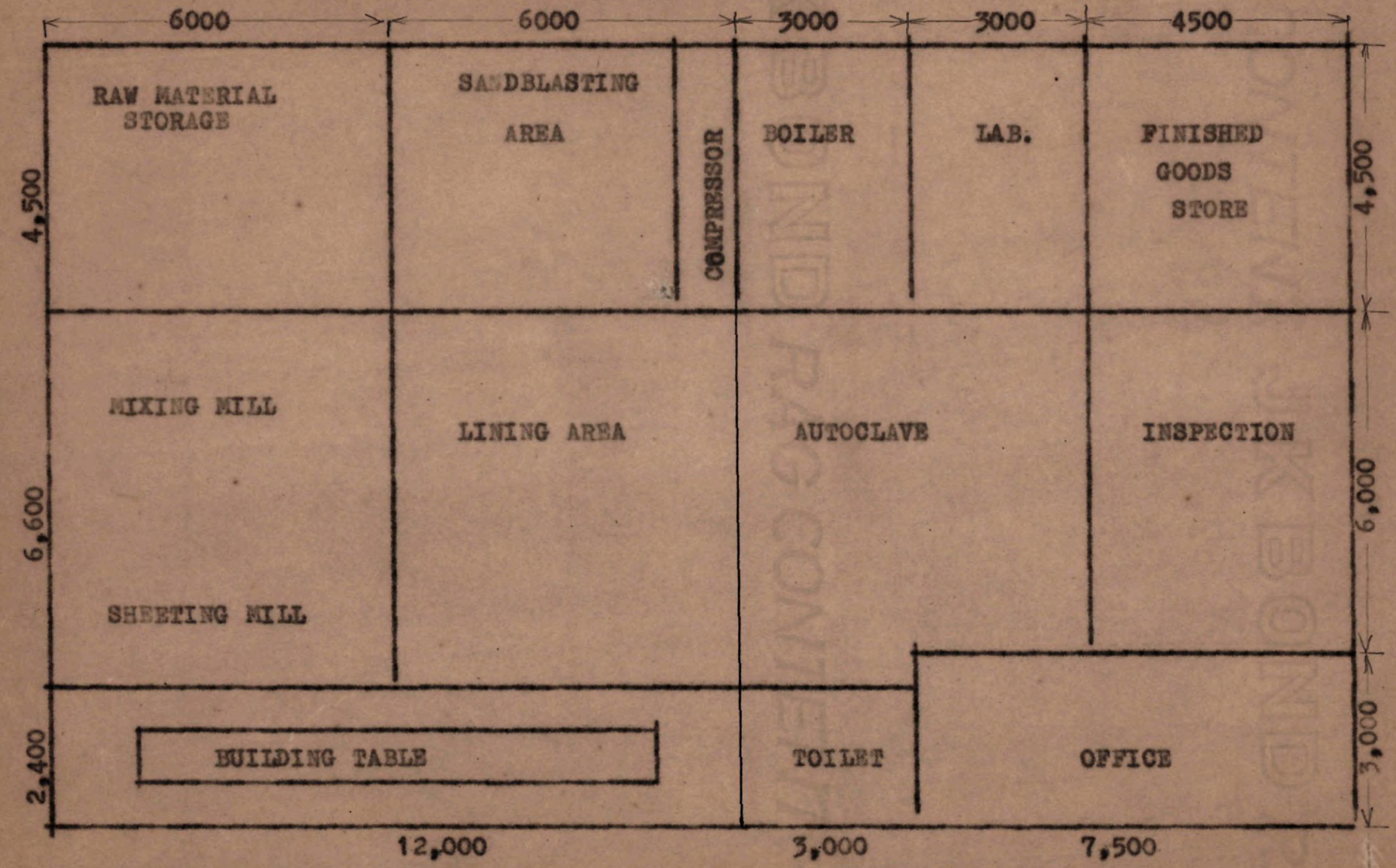
APENDIX -1.

PROCESS FLOW CHART OF RUBBERLINING



APPENDIX - 2

PLANT LAYOUT:



Note:- All dimensions in mm

Scale 1 mm = 100 mm

A P P E N D I X -3.

COMPOUND FORMULATION :

Material	Parts by weight		
	Autoclave		Hot water
Natural rubber	100.00		100.00
Zinc oxide	5.00		5.00
Stearic acid	1.25		1.00
China clay	75.00		----
Barium sulphate	30.00		100.00
P E F Black	20.00		10.00
Flectol H	1.25		1.25
T M T	1.55	M B T S	0.40
M B T	0.95	Z D C	0.30
S	2.50		3.00
Total	237.50		220.95

APPENDIX 4

Total Labour Requirement

Job Description	Total Labour / Shift			No. of shift	Total labours/day
	U.S	S.S	S		
Compounding(Weighing)	1	-	-	2	2
Mixing	1	-	1	2	4
Warming and Sheeting	-	1	1	1	2
Sheet Building	-	1	1	1	2
Metal cleaning	1	-	-	2	2
Sand seiving	1	-	-	1	1
Lining	-	1	2	2	6
Curing	1	-	-	2	2
Inspection and testing	-	-	1	1	1
Watchman	1	-	-	2	2
Boiler attendant	-	1	-	2	2

A P P E N D I X - 5.

Exchange of information

The following consultation may be desirable and arranged between all parties concerned with the design, use, manufacture and erection of the vessels.

1. Constructions of equipment to be bined location of weld joints and finish of surface.

2. Operating temps and pressures.

3. Nature and concentration of media for which vessel or equipment is required.

4. Presence of abrasives in contents.

5. Other factors influencing material stress like expansion, vibration or impacts of contents on lining

6. Internal or external installation and means of access, lifting facilities etc.

7. Site conditon and the availability of services for site vulcanisation.

8. Safty measures to be taken durining lining on site.

A P P E N D I - 6.

SUPPLIERS OF RAW MATERIALS AND MACHINERY

Suppliers	Item
A. Suppliers of Machinery	
1. Sohal Engg. works Tuli Pipe Road off Haines Road Mahalaxmi, Bombay - 13	Mixing mills, Auto claves Calenders.
2. Richardson & cruddan Ltd. Byculla Iron works Bombay - 8.	Mixing mills
3. Indian Expeller works 17 A, Saitafalwadi, Mazgaon, Bombay -10.	Mixing mills
4. Batliboi & Co., Pvt.Ltd., Forbes street, Fort, Bombay - 1.	Boilers and Air Compressers.
5. Versha Boilers Private Ltd., Green House, Bombay -i.	Boilers
6. Electro Medical Apparatus Co., 3 Tandel street, (South) Dongri. Bombay - 9.	Spark Tester.
7. Hiroshima Instruments, Bombay -67	Testing equipments, Hardness tester.

B.Supplers of Raw Materials

1. Natural Rubber -- Available in the local market

2. Corbon Black

(a) United carbon India Ltd., Backbay Reclamation Bombay -20.

(b) Philips carbon Black Ltd., 31, Netaji Subash Road Culcutta - 1.

3. Zinc oxide

(a) .Kamani Mechnic oxides Pvt.Ltd. Kamani Chambers, Nicol Road, Bombay-1.

(b) Muraka Chemicals Manufacting Co., Labo Mansion, Sardar Vallabhai Patel Road. Culcutta-1.

4. Stearic acid

(a) Godreji Soaps Pvt.Ltd., Eastern Express High way, Vikhrali, Bombay - 79.

5. Rubber chemicals

(a) Bayer (India) Ltd., Express Towers, Nariman point, Bombay -1.

(b) Mindia chemicals, Wakefield House, 11 sprott Road, Ballard Estate, Bombay -1.

(c) Alkali and chemical corporation of India Ltd., Calcutta.

6. Solvent oils

Esso Standard Eastern Inc. 17 J.Tata Road, Bombay-1.

7. Sulpher

(a) Sulpher Mills (Pvt.) Ltd., 23, Kailash Darshan, Bombay -7.

(b) IA.IC Private Ltd., I.A.M, 241 Backbay Reedamation, Bombay-1.

8. Mneral Fillers, China Clay, Barytes

(a) Amex Private Ltd., Post Box No.215, National House, 6, Thulloch Road, Appolo Bunder, Bombay-1.

(b) Hindustan China Clay works, Pappinisseri, Cannanore, Kerala.