UNIVERSITY OF COCHIN

B. Tech. Course

In Rubber Processing And Technology

PROJECT REPORT ON A SMALL SCALE SURGICAL AND INDUSTRIAL GLOVES MANUFACTURING UNIT IN KERALA

DISSERTATION REPORT

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Un. Reg: No. 55.

In Partial fulfilment of

B. Tech., Degree.

28th April 1975.

C O N T E N T S

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SURGICAL AND INDUSTRIAL GLOVES

A.1.Introduction:-

Rubber gloves protect our fingers from heat, mechanical injuries, electricity, acids and alkalies etc.

There are various types of gloves like, surgeon's gloves, household gloves, electrician's gloves, industrial gloves, rubberised fabric gloves, rubberward-dressing and porter's gloves, rubber post-mortem gloves, fire-resistant gloves etc.,. The Different types of polymers like Neopreme latx, nitrile latex etc, used depending upon the performance and service requirements of he finished product.

Since, there exists good demand for surgeon's gloves and industrial gloves, production of these two types of gloves will be profitable. The function of the gloves in general, is to give protection to our fingers. Surgeon's glove, protect fingers of Surgeon's hands. Industrial gloves provide safety for hands of million workers working in various types of industries.

Following are the main advantages offered by rubber gloves especially surgeon's gloves and industrial gloves in comparison with the fabric gloves.

(1) Rubber gloves can be used for specific purposes. Surgeon's gloves and electrician gloves are examples for this. Fabric gloves are not suitable for these purposes.

(ii) Rubber gloves are highly flexible and light in weight.

(iii) They offer more service life.

A.2. Evaluation of prospects:-

Though gloves can be manufactuered with very little investment on a small industry basis, some large scale units in this country had almost monopolised the manufacture and marketing of these products. However, recently much progress has been made in the manufacture of these products in the small industry sector, because technical knowhow is no longer a problem and all the raw materials are now indigenously available.

The demand for industrial gloves and surgical gloves is steadily increasing and some of the units producing these gloves are working hard additional shifts to meet the demand. Though specific information on the capacity, production and demand of these items are not available, based on the performance of the existing units, it is clear that there is good demand for these products. Ever increasing growth of hospitals and industries permit good demand for surgical and industrial gloves.

B.Market Survey:-

Only 8% of total NR is used as latex for a wide variety of latex goods. The consumption in foam is as high as 60% of total latex concentrate, makes clear the fact that consumption for the production of a good number of consumer goods like gloves is as low as 3.2% of total NR production.

The production and consumption of latex concentrate in between 1966-'70 registered an increase, indicating the high demand for latex products. The consumption of latex for dipped goods steadily increased in between 1966-'70. The below given tables corroborate this fact.

Table showing Latex production and its percentage to total rubber production

Year	64-65	65-66	66-67	67-68	68-69	69-70	70-71
Total rubber production (metric tonnes	61057	63765	68685	74518	86615	86213	87237
Latex production (metric tonnes)	3547	4002	4181	4717	5148	5499	6209
Percentage of Latex to total production	5.811	6.277	6.082	6.33	5.944	6.378	7.12

(Source: Indian Rubber Statistics Volume 12, 1971)

Table showing consumption of latex concentrate for dipped goods and their percentage to total production

Year	66-67	67-68	68-69	69-70
Consumption for dipped goods (Metric Tonnes)	1253	1624	2160	2291
Percentage of total production	1.22	1.48	1.69	1.75

(Source: Indian Rubber Statistics Volume 12, 1971)

There are 31 units in Indiax producing gloves. (Source:Indian Rubber Directory, 1970) Among them, nine units are producing electrical gloves, Eighteen units producing household gloves; Twentysix units producing industrial gloves and Twenty three units producing Surgical gloves.

Following table gives the demand expectation of dipped goods other than condoms and their existing installed capacity.

Product		Demand 1978 - '79	Existing Capacity
Dipped goods other than Condoms.	Tonnes	6,000	4,000.

Source: From an article entitled "Indian Rubber Industry in the Seventies" by Mr. K.M. Philip.

Following table gives the consumption of latex for dipped goods in organised ~~section~~ sector.

Year	Consumption of latex in metric tonnes.
68-69	1810
69-70	1941
70.71	2157
71-72	2446
72-73	2470
73-74	2854

(Source: Rubber Board Statistics)

From the above mentioned tables it is clear that there is good demand for dipped goods. Since the production of dipped goods in general are increasing year by year, gloves production also is increasing year by year.

The nation is planning for a speedy development and development without industrialisation is not possible. Since Indian Industries are recording remarkable progress every year, there is very good demand for industrial gloves. Many chemical industries are coming up every year. Hence the demand for industrial gloves will go on increasing as yeas go by. The percentage of Industrial growth from 1951 to 1972 is given in the following table. From this it is clear that, there is very good demand for industrial gloves.

Index Numbers of Industtial production

Base 1960= 100

Year	Percentage of growth
1951	54.8
1961	109.2
1966	153.2
1970	180.8
1971	186.1
1972	199.4
Percentage change in 1972 over 1971.	+ 7%

(Source: Ministry of Information and Broadcasting, Delhi)

Since the population of India is marking a considerable growth rat a number of hospitals, number of surgeons and hence number of operatio are increasing steadily. This means that the demand for surgeons gloves will be increasing gradually. Also an enquiry made in the demand position of Industial gloves showed that One unit in Kerala is getting orders from various industriesx for 20,000 pairs of industrial gloves in a week and that unit is not having the capacity to meet the demand.From this, it is clear that there is good scope for starting a small scale unit on the production of gloves with a capacity of 10,000 pairs of srugeon's gloves and 10,000 pairs of household gloves as proposed.

Export potential:-

Previously these items were imported. Good quality surgeons gloves are having very good export ptential. They are exported mainly to the following countries: U.K., U.S.S.R., Iran, Iraq, Nigeria, France, Jordan, Phillippines, Ethiopia etc.,

From the following table it is clear that there is good export potential for surgeon's gloves.

Year	Numbers exported	(Value Rs.)
1969-'70	57,61,849	3840925
1970-'71	14119332	5579079
1971-'72	709272	332542
1972-'73	323971	239871
1973-'74	3477466	1478540

(Source: Journal entitled Monthly statics of the Foreign Trade of India", Exports and reexports)

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C. PRODUCTION REQUIREMENTS

C.I. Plant Location:

When selecting sites for locating the factory, three important considerations should be kept in mind.

(1.) A factory is relatively immobile and when once constructed and/or occupied, it is difficult to abandon the site.

(2) The impact of plant location on operating costs and profits can be considerable. Operating costs may vary upto 25% or even 50% from one location to another. Naturally the choice should be such where costs are not only minimised but also offer such minimised costs continually in the future.

(3) Building occupancy costs are both large and relatively fixed.

Between sites which offer comparable advantages in relation to these considerations, the choice must fall on the one which answers as closely as possible these further essential requirements:

(i) Proximity to markets

(ii) Proximity to raw materials and Venders of spare parts, general stores items etc,

(iii) Facilities for transportation (Rail, Road and air)

(iv) Availability of skilled and unskilled labour.

(v) Availability of power, water and fuel.

(vi) Satisfactory climate.

Kerala state is selected since this state is blessed with ample power, water and large quantity of raw material namely NR latex. So, a suitable place in Kerala, say, an Industrial Estate can be considered since it meets the above mentioned requirements.

Following are the advantages of locating the factory in an Industrial Estate:

(i) Build up areas are 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 to various types of industries will facilitate interservicing.

(v) Availability of cheap labour.

Because of the above advantages, the factory can be located in an Industrial Estate at Kerala.

RAW MATERIAL REQUIREMENTS

C.2. RAW MATERIAL REQUIREMENTS

The raw material requirements are calculated on the basis of the following capacity of production.

	Product	Capacity/month.
(1)	Surgeon's gloves	10,000 pairs per month.
(2)	Industrial gloves.	10,000 pairs per month.

The monthly requirements of each item is calculated and also the respective cost for each item based on the formulation and weight, of gloves. The weight of a pair of surgeon's gloves is worked out to be 30 grams and that of industrial gloves is determined to be 400 grams. Based on the above aspects, the quantity of raw materibak required per months and their cost are calculated separately for such type of glove and these values are given in the following tables.

TABLE I. SURGEON'S GLOVES:-

Materials	Parts per 100 rubber.	Quantity required per month in Kgs.	Unit Price in Rs. per Kgs.	Value Rs. Ps.
NR Latex (Centrifuged 60% drc.)	100	275.7	10.00 (including premium)	2757.00
Vulcastab LW (Stabilise)	1.0	2.757	28.5	78. 6
ZnO	2.0	5.514	18.0	99. 0
TMT	2.0	5.514	30.61	168. 30
Nonox SP (Antioxident)	0.5	1.378	24.21	33. 40
Mineral oil	3.0	8.271	9.0	74. 52
Sulphur	0.25	0.689	2.0	1.38
				3212.20.

TABLE II: INDUSTRIAL GLOVES:

Materials	Parts per 100 rubber.	Quantity per month in Kgs.	Price in Rs. per Kg.	Value in Rs.
NR Latex (Centrifuged 60% drc.)	100	2,826	10.00	28,260
Vulcastab L.W.	1.0	28.26	28.5	806.550
ZnO	1.6	45.216	18.0	813.600
Z.D.C.	1.0	28.26	33.06	933.900
China clay	25.0	706.5	0.30	211.950
Nonox D	1.0	28.26	35.90	1214.534
G.P.F.	10.0	282.6	4.40	1243.44
Sulphur	2.0	56.52	2.0	113.04
				33,397 .01

Cost of coagulant	Rs. 2,000.00
Distilled water (500 litres) Re.0.40 per litre.	Rs. 200.00
Dispersol LN 30 Kgs. Rs.13/Kg.	Rs. 390.00
For talc 150 Kg. per month 53 paise per Kg.	Rs. 80.00
Packing material	Rs. 600.00
Main raw materials cost for surgeon's gloves.	Rs. 3,212.20
Main raw material cost for Industrial gloves.	Rs. 33,397.01
Total	Rs. 39,879.21.

C.3. **LAND AND BUILDING**

C.3.1. The total land required is calculated to be 700 square metres. Land and building is taken for rent since in an Industrial Estate, Built up area come be got for a lower rent.

C.3.2. Building :-

The built up area required is estimated to be 200 sq. metres. Rent is fixed to be Rs.2.50 for 1 metre. And for the rest, 500 sq.metre, the rent is Re.1.00 for 10 metres.

Hence the total rent for Land and building is Rs.550/- per month.

C.4. MACHINERY AND EQUIPMENT REQUIREMENTS

The main items of machinery and equipment required for the production of surgical and industrial gloves is listed in the following table.

Sl.No.	Equipment	Numbers.	Price per item	Total Rs.
1	Mixer 3 spped, 25 lit. capacity 2.H.P.motor.	1 No.	Rs. 4,000	Rs. 4,000
2.	Ball mill-6 pots with 3 H.P.motor.	1 "	Rs. 3,000	Rs. 3,000
3.	Thermostatically controller air oven 6'x3'x3' (3KW)	1 "	Rs.13,000	Rs.13,000
4.	Moulds (Wooden formers)			
	(i) 75 pairs for surgical gloves	150	Rs. 40/- per pair.	Rs 6,000
	(ii) 75 pairs for Industrial gloves.	150	Rs.40/-per pair	Rs. 6,000
5.	Storage tank 700 litres capacity.	One	Rs. 2,500	Rs. 2,500
6.	Coagulant tank 200 litres capacity.	One	Rs.1,000	Rs. 1,000
7.	Dipping Tank 500 liter capacity.	One	Rs.2,000	Rs. 2,000
8.	Erection, electrification & Transport charges			Rs. 2,500
	Office furniture, small balance.			Rs. 7,000
				Rs.47,000

As testing equipment for latex products are very costly it is advisable that surgical products which require quality standards are tested separately in recognised testing laboratories once in a week or so.

Hence the total cost of plant and machinery is worked out to be Rs.47,000/-.

C.5. MANPOWER REQUIREMENTS

Following table given the man-power requirements for production of 10,000 pairs of surgical gloves and 10,000 pairs of industrial gloves per month. Single shift of eight hours is proposed. to be sufficient to meet the above production capacity.

Sl.No.	Occupation of Personnel	Salary in Rs.	Numbers	Total Rs.
1.	Chemist cum Technologist	800	1	800
2.	Clerk/Typist	300	1	300
3.	Skilled worker for compounding section	300	1	300
	For Dipping "	300	1	300
	For drying "	300	1	300
	For Vulcanising "	300	1	300
4.	Storekeeper/Accountant	300	1	300
5.	Watchman	200	1	200
6.	Unskilled workers	225	7	1575.
				4,675.00
	Other Benefits (20%)			935.00
	Hence Total Salary/Wage per month			5,610.00

C.6. Utilities:

The main utility requirements are water and power.

(a) Water is required for washing and cleaning the moulds, leaching the surgeon's gloves and for toilet and bath rooms.

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Hence 100 Kilo litres/months at a rate of 0.55 per kilo litres is required.

Hence the cost is Rs. 55/-

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(b) Electrical requirements:- (Power consumption)

Power is required to run the 2.H.P. motor of the mixer, 3 H.P motor of the ball mill and also the electric air oven.

No.	Item.	KW hour
1.	Mixer	1.492
2.	Pot Mill	2.238
3.	Air Oven	2.00
4.	Lighting, fan, etc.,	4.00
5.	Water pump	2.00
	Total	11.730
	say	12 kwh.

For 8 hours (ie) for one day = 96 kwh
Electrical cost is 0.18 per unit.

Hence for one month (say 25 working days) 2,400 kwh of power is required.

Hence the cost for power consumer is 2,400x0.18 = Rs.432.00
Hence the total cost for utilities is

(1) For water	- - -	Rs. 55/-
(2) For Power	- - -	Rs.432/-
Total		Rs. 487/-

PROCESS DETAILS

The manufacture of dipped or seamless rubber articles is a very old industry. Until the advent of latex, the process consisted broadly of dipping a suitably shaped former in a solution of rubber in an organic solvent, withdrawing it at a very slow rate, drying and vulcanising the deposit and finally removing the finished article from the surface of the former.

A single dip was sufficient for producing very thin articles, but in the case of heavy ones the dipping and drying operations had to be repeated several times. The solution used was of high viscosity, yeat it contained a very small percentage of rubber; consequently the usage of solvent was high, and as the methods available for solvent recovery were extremely inefficient, it was not surprising that when latex became commercially available attempts were made to use it in place of rubber solution.

The speed of manufacture is undoubtedly the most important benefit derived from the use of latex in place of rubber solution. The majority of articles can be dipped, dried, vulcanised and stripped in a small fraction of time required by the old process. This means that the fewer formers are needed and so space and capital expenditure are reduced. The equipment necessary for the manufacture of dipped articles from latex can be very elaborate and costly but reasonably satisfactory results can be obtained with the aid of quite simple apparatus: this is not the case with rubber solution. Finally, latex lends itself to the production of certain articles which would be extremely difficult to manufacture from rubber solution.

Dipping Processes:-

(i) Straight dipping:-

This is the simplest and the earliest of all dipping processes, consisting of immersing a former in the latex compound, withdrawing it, and drying the deposit adhering to the surface. This is dipping without the assistance of any ancillary aids such as coagulants. A deposit forms by virtue of the viscosity of the latex and of its tendency to wet out the former. Straight dipping is usually practised as a multi-dip process, allowing partial or complete drying between the successive dips. The thickness of the composite deposit is aproximately proportional to the number of dips, as is indicated in the Appendix I.

The speed at which the former is immersed in latex is not critical, but it is important for the first contact between the former and the surface of the fluid to be made slowly to avoid trapping air bubbles. The speed of withdrawal, must, however be controlled, so that it does not greatly exceed the rate at which the excess of latex drains from the surface of the former back into the dipping tank.

The thickness of the depsosit produced by a single straight dip depends on many factors, such as the viscosity and solids content of the latex, the surface on which the deposit is produced, the spåed of withdrawal, the temperature of the latex, the temperature of the former, the humidity of the surrounding atmosphere etc., Therefore in spite of its apparent simplicity, this process is not an easy one to control if absolute unifirmity of quality is essential. Further more, with an article of complicated shape such as a gåove, it is almost impossible to obtain an even thickness. Consequently the use of this process is mainly confined to the manufacture of prophylactics and finger cots, articles of simple shape which cannot satisfactorily be produced by anyother method. On completion of dips, tips of formers will carry drips of latex. It is sufficient merely to invert the formers and allow the drop flatten out and spread.

(2) Dipping with the aid of Coagulants:-

Initial immersion in Coacervant:- This method employs materials which have a Coagulating effect on latex, such as acids, mainly accetic and formic, and salts of certain metals, usually calcium nitrate and calcium chloride. In carrying out the process, the former is dipped in a solution which contains one or more of the above-mentioned materials and is then immersed in the latex compound. The action of the Coagulant causes a relatively thick solid depsot to congeal on the surface of the former. The thickness of that deposit builds up very rapidly at first, but Coagulating action slows down progressively as the thickness of the Coagulum increases. Generally the time of immersion in latex does not exceed 30 seconds. In the alternate method, the former can be dipped into the latex compound first and then into the Coagulant bath.

The nature of this variation of thickness with dwell time is explained by the supposition that deposition proceeds by a mechanism which involves the diffusion of the coacervant out from the former together with the simultaneous consumption of coacervant as deposition proceeds.

The figure is given in Appendix II.

The attendant disadvantages encounters in, initial immersion in coacervant method, we non-uniformity of deposit, together with a tendency for the deposit to slip off the former during withdrawal unless the shape of the former precludes this. The tendancy to slippage is due to the presence of a film of liquid between the deposit and the former. This film of liquid derives partly from the layer of coacervant initially present, and partly from serum which is exuded as a result of syneresis.

Initial immersion in latex:- (or) Teague process:-

The disadvantages of the anode process are overcome in this Teague Process. In this process, the former is first immersed in latex, and is then withdrawn, immersed in the Coacervant, withdrawn, then immersed in the latex a second time. The former is allowed to dwell for a time which is determined by the final thickness of the deposit required for industrial and surgical gloves.

The variation of thickness with dwell time is very similar to that observed when the initial immersion is in the coacervant except that the deposits tend to be a little thicken because of the initial film of rubber.

Coagulants:-

A coagulant prepared according to the following formula will be found satisfactory:

Methanol	50
Distilled water...........	27
Calcium nitrate	20
Glacial acetic acid	3

The following may be used either as build-up or final Coagulants:

20% Calcium chloride

Calcium chloride - - - -	20
Ethyl alcohol (denatured) -	80
	100

30% Calcium Nitrate

Calcium Nitrate	30
Ethyl alchol (denatured)	70
	100

Stir until completely dissolved

For improved wetting, add either of the following at ¼ to ½% on total wet basis:

(a) Octyl alcohol (2 - ethyl hexanol)

(b) Igepal Co-630.

Wetting will also be improved if coagulant is stored for 7-10 days in a tightly closed container at room temperature.

It is always difficult to coat sharp edges, but the Anode process is much adapted than the Teague. Ply separation will only occur in the Teague process if the coagulant is not dry before the next latex dip is made. The degree of coagulant dryness is observed as follows:

Glistening appearance	-	Too wet
Dull sheen		O. K
Shiny		Too dry

Slippage will occur when using the Anode Process if the coagulant immersion is deeper than the latex immersion.

(3) Dipping with the aid of Zinc - ammonia complex:-

Under this heading comes all dipping processes utilising the destablising action of the Zinc - ammonia complex. The complex forms when Zinc Oxide or certian Zinc stals come into contact with an aqueous solution of ammonia. Though several compounds are available, the following is particularly an effective one:-

	Parts by weight
Zinc Oxide	20
Ammonium Benzoate	50
28 Be' Ammonia	140

This mixture is added to 1800 parts by weight of normal latex. The latex so compounded does not thicken to any appreciable extent, but becomes heat sensitive, coagulating instantly above the critical tempearture of 78°c. A former dipped in this compound need only be subjected to a temperature of about 80-90°c for a very short time to coagulate the deposit. It can be dipped again and the operation repeated until the desired thickness is build up.

(4) <u>Dipping with heated formers</u>:-

There are substances, both organic and inorganic, which are capable of exerting a coagulating action on latex at elevated tempeartures only. These materials can be incorporated into latex, usually bringing about an appreciable increase in viscosity, the resulting compounds remaining fluid at temperatures upto about 50°c, but coagualating rapidly at 80°c -90°c. By employing heat sensitive compounds in conjunction with heated formers industrial gloves of considerable wall thickness can readily be produced. Ammonimum sulphate, ammonium persulphate, diphenyl guanidine and Zinc-ammonia complex are examples of heat sensitising agents. As the continous dipping of hot formers will bring about an increase in the temperature of the dipping tank, cooling jacket is necessary, so as to maintain the temperature at 14-18°c.

SEQUENCE OF OPERATIONS:-

(i) Compounding of latex:-

All the compounding ingredients are added to the latex, which is then heated to achieve a degree of prevulcanisation. The compounding details are given under the section, namely "Compound design." The level of prevulcanisation will be determined by the balance of quality and economy which is required. After cooling, the compound is matured for a few days under gentle agitation, during which time all air bubbles should be completely eliminated. From this stage onwards it is importent to see that no air is drawn down into the compound, otherwise pinholes and grosser defects will find their way into the finished product. Care must be exercised when stirring, powring deaerated latex. Maturation gives processing advantages such as uniform viscosity, stronger gel, and uniform vulcanisation of product. Matured mixes are cooled to approximately 20°c and prior to filling the dipping tanks, they are strained through a 80--100 mesh nylon or stainless steel gauze.

(ii) Pretreatment of formers:-

The formers are cleaned, washed, heated and then dipped into the coacervant solution. It is important that the layer of coacervant should be uniform over the surface of any one former; this requires attention to the cleanliness of both the former and the bath of solution.

(iii) Immersion of former:-

The immersion rate should be sufficiently slow to prevent air being drawin into the bath with the former, but sufficiently fast to maintain the meniscus surrounding the former in a convex - to-air condition. If the speed of immersion is not uniform, thicker bands tend to form during the periods of slower immersion.

Immersion speeds of the order of 3 to 6 feet per minute are usually found to be acceptable. It is advisable to immerse the former so that the latex level comes above the coacervant level. In this way, slippage of the deposit off the former during subsequent removal may be prevented. Further more, the formation of skin and coagulum by an excess coacervant diffusing away from the top of the former is also prevented.

(iv) Dwell:-

The duration of the dwell period will be determined by the thickness of deposit required in relation to the stability of the latex and the potency and quantity of coacervant held by the former. Dwell times of the order of the order of 1 to 5 minutes are common for production of industrial gloves. Of course, if dipping is being carried out without the aid of a coacervant, then no period of dwell is necessary.

(v) Withdrawal:-

This is commonly carried out in two stages. The former is first withdrawn about one inch after some 10 or 20 second dwell; withdrwal is then completed after the remainder of the dwell time has elaspsed. The reason for this procedure is simply to provide a thin film of rubber at the top of the article from which the bead may be subsequently rolled.

Withdrawal should take place slowly. For coagulant dipping, speeds of about 1 to 2 feet per minute are usually satisfactory.

(vi) Inversion:-

It is desirable to invert the withdrawn former through 180° in order to ensure dispersal of the drops which inevitably form at the lower extremities of the deposit. Rotation is usually continued through a full revolution.

(vii) Drying:-

The order in which these operations take place (namely, drying, leaching, beading etc.,) may vary. Drying may be effected by direct gas heating, by electric heating elements together with forced convection, by hot air, or by live steam. Heating with live steam offers a very satisfactory method of drying, since it fulfils the conditions for the slow but steady evaporation of water. For economic reason hot air oven may be used for this purpose, at a tempearture of 80-100°c so that beads or rings can be made.

(viii) Beading:-

The process of beading involves the rolling down of the thin film of rubber which has been left for this purpose while the article is still on the former. It may be done by hand or automatically be means of small rotating brushes or rollers. Deposits from lightly prevulcanised or unvulcanised latex retain sufficient of their self adhesive tack to enable this operation to be carried out without the aid of an adhesive. This operation is performed when the deposit is still partly moist since it ensures good adhesion, necessary to prevent the bead unrolling after vulcanisation.

(ix) Vulcanisation:-

Unless pre-vulcanised latex is used, the dipped articles must be vulcanised before being stripped from the formers. Vulcanising with hot water offers many advantages and is widely used. The exclusion of air prevents oxidation and the intimate contact with the heating medium produces uniform results. By making a provision for a continuous change of water, extraction of water soluble materials and vulcanisation can be carried out at the same time thus saving the time and effort. Hot air vulcanisation is very popular mainly owing to its simplicity and low cost of equipment. High temperatures can be used for rapid vulcanisation and gradual temperature rise can be arranged to remove any traces of moisture that may still be present in the deposits. The equipment is just an oven used for drying the latex deposits but with higher temperature. Cure time is approximately 25-30 minutes at a temperature of 130°c for industrial gloves. And for surgical gloves, the cure time is 45 minutes at 100°c.

(X) Dusting:-

Dusting is necessary in order to prevent the article sticking to itself after removal from the former. Dusting powders, like clays and talcs may be used for cheapness. Zinc sterate is preferred where appearance is of importance since it dissolves in the rubber and yet at the same time inhibits surface tack in the finished product. Other dusting media include starch and lycopodium powders. Anyhow, talc is most commonly used.

(XI) Stripping:-

Since the production is on a small scale, stripping is done by hand. Gloves are stripped by hand, the operator gripping the edge of the gauntlet and pulling it over the palm and fingers. The pulling operation results in the gloves being turned inside-out, so a reversing operation must follow.

(XII) Leaching or Washing:-

Leaching with water is necessary in order to remove water-soluble serum residues, residual coacervant and surface-active substances. The effect is to improve the feel of the product as well as its resistance to water absorption and to ageing. Leaching is done for surgical gloves either after dipping or after vulcanisation. This is carried out in hot water for 3-30 minutes. Unleached gloves can be tacky and may be difficult to store because the traces of coagulant on the glove surface are capable of absorbing moisture making the glove wet.

(xiii) Surface treatment:- (Roughening and Halogenation)

Untreated latex gloves are difficult to slip on hands and for this reason the glove surface is usually treated with a solution of chelorine or Bromine to obtain a non-grip surface. The glove is made easier to put on and take off. The prodess is carried out by immersing the glove for a few seconds in either chlorine water, bromine water, sodiumhypochloride solution or sodium gypobromite solution. Halogenation may be conveniently combined with roughening processes which make use of shot-blasted formers, for the deposit still on the former may then be dipped into halogenating solution, dried, removed from the former, and turned inside out, whereupon roughened and halogenated surfaces will be in their correct positions.

(xiv) Drying:-

After washing and surface treatment, gloves are dried in tumbler driers though which hot air is circulated. Drying temperatures are normally in the region of 40-60°c, depending on the thickness of the gloves.

(xv) Testing and Inspection:-

Visual inspection followed by an inflation test for pin holes is usually sufficient. 100% inspection is carried out for surgeons gloves and industrial gloves.

PRINCIPLES OF COMPOUND DESIGN

(i) Choice of polymer:-

Most latex dipping is at present carried out with compounds which are based upon Natural rubber latex. Either unvulcanised or prevulcanised latex may be used. The latter is especially attractive for this application, since it is far more convenient to vulcanise latex in bulk than when it is in the form of deposits upon innumerable formers. However, deposits from prevulcanised latices tend to be of lower tensile strength, elongation at break and tear resistance than are films which have been vulcanised after deposition The resistance of prevulcanised films to grease and oil is also inferior to that of post-vulcanised films. Clearly, a balance has to be achieved between economics and performance, (ie) between the cost saved by using prevulcanised latex and the depreciation of properties which accompanies it. The usual procedure is to partialll precure the latex compound to a level determined by the maximum depreciation of quality which can be tolerated. The balance of cure is given after deposition and drying. The thicker the article, the greater is the level of precure which can be tolerated. Hence prevulcanised latex is used for industrial gloves and centrifuged or creamed latex is used for the production of surgical gloves.

Synthetix latices generally have not found much application in dipping processes. The main defect is their inferior wet-gel strength.

(2) Dispersing agents:- All the compounding ingredients are added as emulsions and dispersions. Both high speed colloid mills and slow-running ball mills are suitable for this purpose. Water soluble cascinates and aliginates are also very powerful dispersing agents. Dispersol LN is used, ~~as a stabiliser~~. It is an ICI product.

(3) Fillers and Softeners:-

Small quantities of fillers and Softeners may be added in order to modify the properties of the dried, Vulcanised deposits and to reduce costs. Filler additions should never be large, and a maximum loading of 20 parts per 100 parts of polymer is suffested. China clay is used for industrial gloves. The stiffening effect of the filler is considerable and may have to be offset by the addition of a softener such as mineral oil.

Softeners are prepared as emulsion in water.

A typical formula is as follows:-

		Parts
(a)	Light mineral oil	47
	Oleic acid.	3
(b)	Distilled water	48
	0.888 Ammonia solution	2

(a) is slowly poured into (b) while the latter is agitated with an agitator. An emulsion is obtained.

(4) Stabilizers:-

Very small addition of either proteinous or polyethylene oxide condensate stabilisers are recommended (Vulcastab LW) for the maintenance of latex stability.

Small additions of potasium hydroxide are usually made to dipping compounds which are based upon ammonia preserved unvulcanised natural rubber latex. The main function of this is to maintain the alkalivily and therefore the stability.

(5) Antioxidants:-

Antioxidants should always be includedin dipping formulation, because of the thinness of the rubber films to be produced. Phenyl Beta Naphthyl amine (Nonox D) is used for industrial gloves. For sufgical gloves mixture of styerenated phenols (Nonox SP). Following is the formula for dippersion of China clay and Nonox D.

Nonox D dispersion	20%
	Parts by weight.
Nonox D	50
China clay	50
Dispersol LN	3
Distilled water	147

Ball milled for 24 hours.

(6) Activator:-

Zinc Oxide is used as an activator.

ZnO (40% Dispersion) Formula	
	Parts by weight.
ZnO	100
Dispersol LN	3
Distilled water	147

Ball milled for 24 hours.

(7) Vulcanising agent:-

Sufphur is used as the vulcanising agent. Following formula is used for the preparation of 50% dispersion of sulphur.

Sulphur 50% dispersion	
	Parts by weight.
Sulphur	100
Dispersol LN	4
Distilled water	96

Ball milled for 48 hours.

(8) Accelerators:-

Ultrafast accelerators are used for the purpose. Zinc diethyl dithio Carbamade, (Vulcafor ZDC) or Tetramethyl thiuram disulphide (Vulcafor TMT) can be used.

Vulcafor TMT (50% dispersion)

Vulcafor TMT	100
Dispersol LN	2
Distilled water	98

Ball milled for 24 hours.

(9) Viscosity modifiers:-

It is sometimes necessary to increase the viscosity of the latex bath, especially in the straight dipping process, where the thickness of the deposit depends largely upon the viscosity of the latex, Methyl Cellulose and sodium carboxymetayl cellulose are recommended for this purpose, especially the medium viscosity grades.

(10) Colours:-

Colour is added to the formulation as required. For industrial gloves, carbon Black is added as a pigment. It is added as a dispersion

Based on the consideration discussed above, The following formula is ~~xxxx~~ arrived at for production Surgeons gloves.

	Parts by weight. dry	actual.
Natural Rubber (as 60% latex)	100	167
20% Polyethylene Oxide condensate dispersion (Vulcastab LW)	1	5
50% Sulphur dispersion	0.25	0.5
50% Tetramethyl Thiuram disulphide (Vulcafor TMT)	2.0	4.0
50% ZnO dispersion	2.0	4.0

20% dispersion Nonox SP (misture of styrenated Phenols)	0.5	2.5
50% Mineral oil dispersion	3.0	6.0
Total solids content of bath % 57.7		
Cure: Minutes at 120°C in hot air. 40		

It will be noted that the formulation for a surgeon's glove contains a very low level of sulphur but a high level of tetra -methyl thiuran disulphide. The primary purpose of this combination is to achieve a natural rubber vulcanisate of outstanding heat resistance, for such gloves have to withstand repeated sterilisation at tempe- ratur of 100°C or above. A secondary characteristic of the curing combination used in this surgeon's glove formulation is that it pro- duces a vulcanisate of rather low modulus. The modulus is further reduc by the addition of a small quantity of mineral oil. High-modulus gloves are generally unacceptable to the medical profession, as they impose a considrable strain upon the surgeon's hands.

Following is the formulation proposed for the production of Industrial gloves.

	Parts by weights dry	Wet (actual)
60% Centrifuged NR latex	100	167
20% Stabiliser (VulcastabLW)	1.0	5.0
50% Sulphur dispersion	2.0	4.0
50% ZDC(Vulcafor ZDC)	1.0	2.0
40% ZnO dispersion	1.6	4.0
50% China clay dispersion	25.0	50.0
20% Nonox D dispersion	1.0	5.0

25% Carbon Black dispersion	10.0	40.0

Cure: 30 Minutes at 105° -110°C

Product Diversification:-

Product diversification is possible for this plant as a number of products coming under the category of dipped goods can be manufactured easily by using the same equipments and raw materials but by changing the former whereever necessary. For instance the plant can be used for producing household gloves, electricians gloves, rubber bands, finger tips, etc., by the same dipping process. Since there is very good export market for finger tips and household gloves diversification can be effected to include these itemsalso in the production scheme.

Process Loss:-

The process loss for surgical gloves and industrial gloves is normally found to be about 1%. The process loss can be minimised if proper quality control measures are undertaken. Following is the list of defects commonly met with these defects can be rectified by taking proper control measures.

Defects: Causes and remedies.

(1) Pinholes, craters and blisters:

Probably the largest number of defects encuountered in gloves, come under this heading. The usual cause is air bubbles entrapped in the latex. The remedy is to allow sufficient time for the air bubbles to rise out of the latex, and them to scavenge the suffface of the bath with absorbent paper or a float. Pinholes also may be caused through particles of dirt and dust settling on the former.

(2) Webbing:$

This term is applied to the formation of liquid films or webs between adjacent formers or between adjacent parts of the same former natably between the several fingers of a glove former. The cause is obscene, but is related to the surface free energy of the latex compound. Silicone antifoaming agents or 2-ethylhexanol can be used as antiwebbing agents.

(3) "Mud cracking"-

It occasionally happens that cracking of the deposit occurs during drying out. This appearance is then rather like that if drying mud, hence the origin of the name. The cause of this defect is that the Wet gel strength or cohesive strength of the drying deposit is insufficient to support the forces of contraction which are induced through drying.

(4) Blank spots:-

These are usually caused by traces of grease upon the surface of the former. Attention to the cleaning of the former is required.

(5) Lumpy deposits:-

The usual cause is skin on the surface of the latex bath. Such skin may be formed by evaporation of water from the surface or by incompletely dried coacervant solution running down off the surface of the former. Coacervants which dry down to non-hygroscopic film such as cyclohexyl ammonium acetate one rather easier to manage than those which give hygroscopic films, notably the calcium salts.

Quality control measures

(1) Acceptance sampling tests:-

The creamed or centrifuged latex purchased is tested for its dry rubber content, total solid and Ammonia content. Centrifuged latex will have 61.5% total solids content, 60% dry rubber content and 0.6to 0.8% of ammonia. Quality control measures are taken by controling the quality of latex and also the other compounding ingredients.

(2) Improcess quality control:-

To ensure uniformity of quality, it is essential that the characteristics of the latex compound remain substantially unchanged at all times. The stability of the latex depends to a considerable extent on its ammonia content, and in the dipping tanks which are open to atmosphere, this tends to diminish through evaporation. "Samples of the dipping compound should be tested served times during the day and any reduction in the pH value corrected by an addition of ammonia. If the ammonia content of the latex is accurately maintained, appreciable changes is viscosity are unlikely to take place. Neverthless, at lease one viscosily test should be made every day before the commencement of dipping. Pippette Viscometer is used.

The composition of the coagulant is rigidly controlled. R pH value of acid coagulants should frequently be chècked and if necessary corrected. Even when the compounded latex is stored at a low temperature, and the dipping tamks are efficiently cooled, prevaleamisation proceeds rapidly. Often this does not adversely affect the quality of the finished product but it is necessary to adjust the time or the temperature of Vulcanisation to avoid overcome.

(3) ISI Specification tests:-

Rubber products sectional committee CDC6 of Indian standard Institution, specified tests for surgeon's gloves. This is given in IS:4148-1967. The gloves are produced in such a way that there dimensions should conform to those specified by ISI. Tensile strength Elongation at Break, Heat ageing in autoclause, tension set test, reaction to aqueous extract and accelerated ageing in air oven tests are carried out and the test results are checked to find out whether they fall within the limits of ISI specification. Hence the quality of the product can be controlled by controling the test results to conform with that of ISI standards spedified.

(4) Waste disposal.

In surgeon's gloves, the gloves with pinholes are rejected. These rejected gloves are scraped. These scraped gloves which go as waste, are disposed by cutting them and making them as rubber bands. These rubber bands are used for packing the gloves.

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E. Financial Aspects.

E.1. Fixed capital requirement:-

The Total fixed capital is the sum of the expenses incurred for equipment and machinery, oth er fixed assets and preopesative expenses The estimated capital requirement is calculated as follows.

(1) Equipment and machinery	Rs. 47,000/-
(2) Other fixed assets (Table F.1)	Rs. 7,000/-
(3) Preoperative expenses (Table F.2)	Rs. 4,300/-
Total	Rs. 58,300/-

Hence, the total fixed capital required is Rs. 58,300/-.

E.2. Working capital requirement:-

Working capital is the expenses incurred during a definite period for operating the plant. Working capital includes cost of raw materials, salaries and wages, utilities and other overheads.

(1) Raw material requirement per month	Rs. 39,879.21
(2) Wages and salaries per month.	Rs. 5,610.00
(3) Utilities.	Rs. 487.00
(4) Other overheads (Table F.3)	Rs. 2,150.00
Total	Rs. 48,126.21
Working capital for 3 months	1,44,378.63
(Rounded off)	1,44,000.00

Total Financial requirements:-

(1)	Total fixed capital	Rs. 58,300.00
(2)	Working capital	Rs. 1,44,000.00
	Total	2,02,300.00

Table F.1. Other Fixed assets.

Sl.No.	Items.	No.	Cost in Rs .
1.	Pumps and piping	1	3,000/-
2.	Water tank (4,000 liters capacity)	1	2,000/-
3.	Miscellaneous tools and equipments, tables etc.,	-	2,000/-
		Total	7,000/-

Table F.2. Pre-operative expenses:-(for six months)

(1) Travelling expense	Rs. 500/-
(2) Postage, telegram, telephone	Rs. 400/-
(3) Printing and stationary	Rs. 700/-
(4) Rent and establishment	Rs. 600/-
(5) Miscellaneous expenses	Rs. 500/-
Total	Rs.2700/-
(6) Interest on Block loan(8%)	Rs.1600/-
Total	Rs.4300/-

Table F.3. Other Overheads

(1) Repairs and Maintenance of machinery, building etc.,	Rs. 500/-
(2) Advertisement and Publicity.	Rs. 200/-
(3) Minor Taxes and Insurances etc.	Rs. 500/-
(4) Rent of the building.	Rs. 550/-
(5) Miscellaneous	Rs. 400/-
Total	Rs.2,150/-

G. FINANCING PLAN

Now-a-days, the trend is to receive loan from Financial institutions like, nationalised banks, State Financial Corporations, State Government Institution under the State Aid to Industries Act. Some state governments have entered into an agreement with the State Financial Corporation under which the Corporations act as agents of the State Governments for reuting a portion of the Government funds to small Industries.

The following financial plan can be utilised for starting and running the Project.

Loan fron Nationalised Bank on 10-16% interest Rs	Rs. 1,44,000.00
Own Fund	Rs. 18,300.00
Loan from State Financial Corporation	Rs. 40,000.00
Total	Rs. 2,02,300.00

H. COST OF PRODUCTION
(Manufacturing Cost)

The cost of production per month is calculated as follows: The monthly manufacturing expense involved in the production of 10,000 pairs of Surgeon's gloves and 10,000 pairs of industrial gloves is estimated as follows:

1. Raw material	Rs. 39,880.00
2. Salaries and Wages	Rs. 5,610.00
3. Utilities	Rs. 487.00
4. Other overheads	Rs. 2,150.00
5. Interest on working capital loans (16%)	Rs. 1,920.00
6. Interest on Block loan (8%)	Rs. 266.70
7. Depreciation on:	
(1) Machinery (10%)	Rs. 4,700.00
(2) Other fixed assets and preoperative expenses (10%)	Rs. 970.00
Total	Rs.55,983.70

The cost of production per month Rs. 55,983.70

Rounded off to Rs. 56,000.00

I. MARKETING AND SALES EXPENSES

Marketing is done through distributors in important cities and towns, and commission on sales given to the distributors vary from 15 to 20%

Hence 15% Commission on sales is given to the distributors.

Total Sales	Rs. 70,000.00
Sales Expense (15% Commission)	Rs. 10,500.00
Hence Marketing and Sales Expense per month	Rs. 10,500.00
Cost of production per month	Rs. 56,000.00
Hence totoal cost of production	Rs. 66,500.00

J. PROFITABILITY AND ECONOMIC VIABILITY.

The financial viability of a project can be examined through an analysis of profitability. The following are the factors to be considered.

(1) Annual Gross profit.

(2) Rate of return on own capital

(3) Rate of return on capital employed

(4) Interest committment.

(5) Profit on sales.(Percentage)

J.1. Annual Gross profit:-

Annual gross profit is the difference between net sales and annual cost of production.

The net sales per annum	8,40,000
The annual cost of production	7,98,000

Hence, the annual gross profit.	42,000

J.2. Rate of return on own capital.

This is the ratio of the gross profit to own capital.

Hence rate of return on own capital is 42,000/18,300

(ie.) 230 %

J.3. Rate of return on capital employed:

Pricing Policy:

Even though there is very good demand for this products, They are proposed to be sold at a price, a little lower than the existing current market prices. Hence the price of a pair of surgical gloves is fixed to be Rs. 3/- and that of industrial gloves is fixed

[Rs. 4/-. Since 7" Surgical gloves and 12" industrial gloves are having very good demand in the market, the proposed project is supposed to manufacture these sizes of gloves.

Total sales per months for industrial gloves	10,000 x Rs.4/- per pair Rs. 40,000.00
Surgical gloves.	10,000 x Rs.3/- per pair Rs. 30,000.00
Hence total sales xxxxx per month.	Rs. 70,000.00
Cost of production per month	Rs. 66,500.00
Hence profit per month.	Rs. 3,500.00
Total investment.	Rs.2,00,700.00
Return on investment per annum.	$\frac{3,500 \times 12 \times 100}{2,02,300}$ = 20.4%

J.4 Interest Committment:-

Interest for Banks per year.	Rs. 22,040
Interest for Financial Institution per year	Rs. 3,200
Hence Total Interest per annum.	Rs. 25,240

J.5. Percentage profit on sales:-

Sales per annum.	Rs. 8,40,000
Annual cost of production.	Rs 7,98,000
Percentage profit on sales.	5.0%

]

K. Conclusion (Social Benefits)

The present scheme for the manufacture of gloves comes under the small scale sector since the value of plant and machinery is below ten lakxhs. The small unit gives the entrepreneur the following benefits:

(i) Profit

(ii) Independence and satisfaction.

(iii) Oppomtunity to use his ideas.

(iv) opportunities for grewth.

To the nation it provides the following benefits:

(i) Provides employment to good number of people, since latex industry is labour intensive. In other words, it provides larger employment with less investment.

(ii) Earn foreign exchange through export.

(iii) Develops entrepreneurship and entrepreneur skills.

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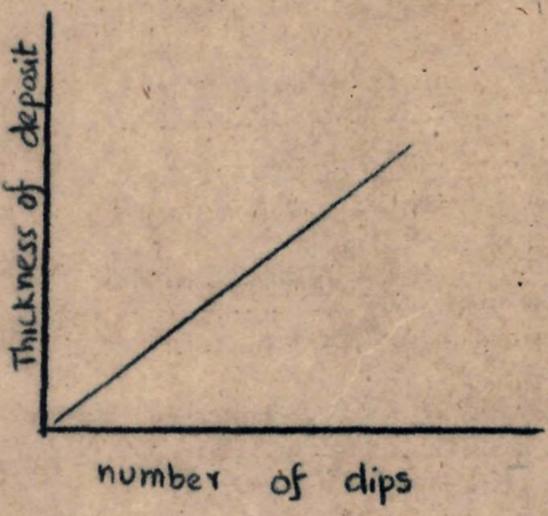
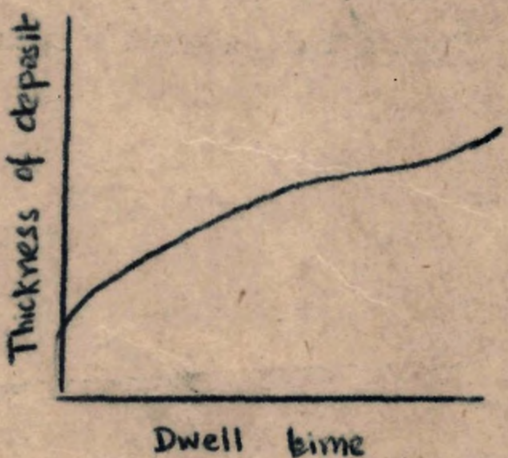
[APPENDIX 1]

1.(i)

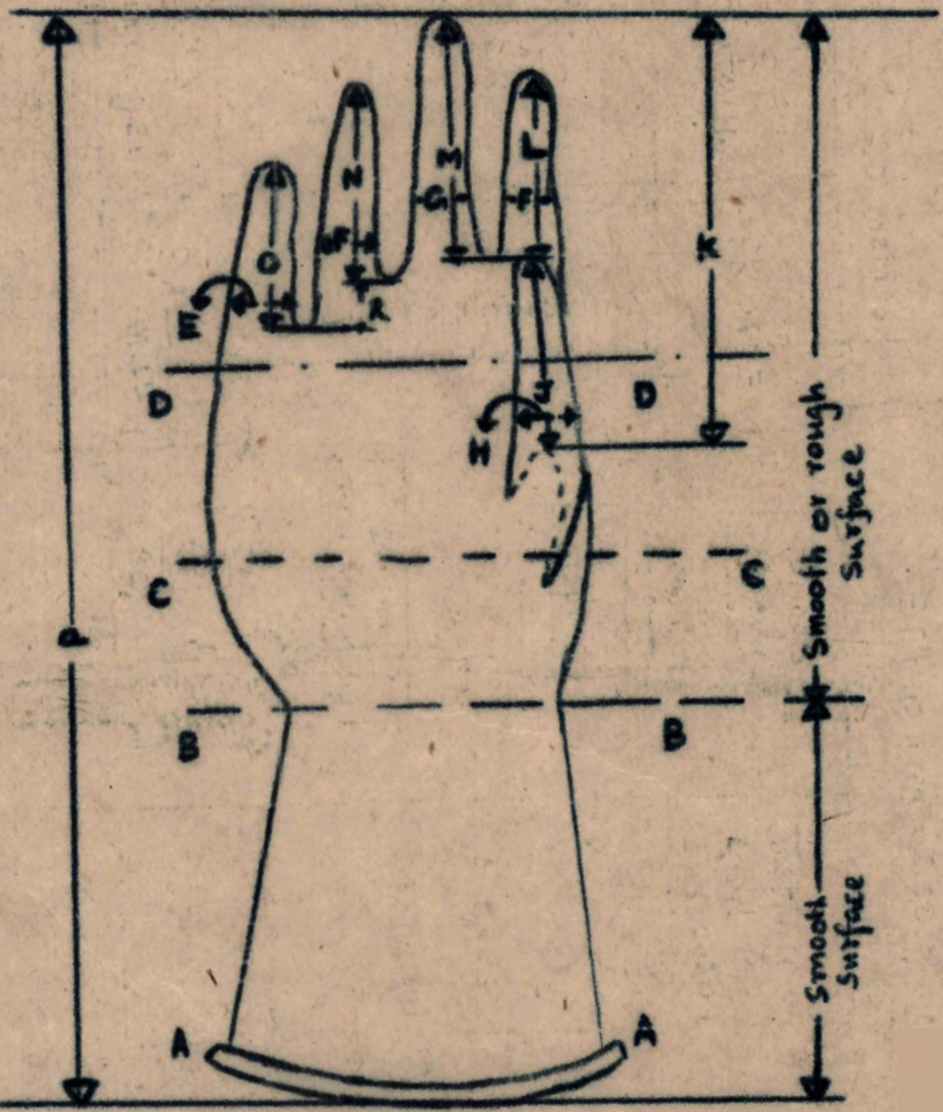


1(ii)



APPENDIX 2

FIGURE SHOWING THE DIMENSIONS OF A SURGICAL GLOVE.



APPENDIX 3.

I.S.I. Specification for dimensions of Surgical Gloves.

ALL DIMENSIONS IN MILLIMETRES

Description	Size			Tolerance.
	6"	7"	8"	
Perimeter at A	180	190	210	± 5
Perimeter at B	132	152	170	± 3
Perimeter at D	160	185	205	± 3
Circumference at E	48	52	58	± 2
Circumference at F	52	56	60	± 2
Circumference at G	52	58	62	± 2
Circumference at H	60	68	69	± 2
Length at J	52	57	62	± 2
Length at K	105	115	120	± 3
" at L	60	65	74	± 2
" at M	74	80	84	± 2
" at N	62	68	74	± 2
" at O	56	60	64	± 2
" at P	275	285	290	± 5
" at R	8	8	9	± 1

(iii) Weight: The weight per pair of gloves for different sizes shall be as follows:

Size	Weight in gram
6	21 to 26
7	25 to 31
8	29 to 33

(iv) The Thickness of rubber shall be 0.24 ± 0.06 millimeter.

APPENDIX-4

Raw materials suppliers/manufacturers.

(1) NR Latex concentrate - Readily available in the market.

(2) Rubber chemicals:-

(Accelerators and antidegradants)

(i) Alkali and Chemical Corporation of India Ltd.,.
34, Chouringhee road,
Calcutta-16

(ii) Bayer (India) Ltd.,
82, Vir Nariman Road,
Bombay -1

(iii) Mindia Chemicals Ltd.,
Wakefield house,
Ballard estate, Bombay-1

(iv) Para Chemicals,
C/o Kerala Paints Pvt. Ltd.,
M.G.Road, Ernakulam,
Cochin, Kerala.

Most of these manufacturers are having their sales Depots in Kerala.

Carbon Black

(i) Phillips Carbon Black Ltd.,
31, Netaji Subhas Road,
Calcutta-1

(ii) United Carbon India Ltd.,
NKM International house,
5th floor, 178, Backbay Rectamakon,
Bombay-20.

APPENDIX 5

PROCESS FLOW CHART FOR INDUSTRIAL

AND

SURGICAL GLOVES

Latex Reception — Lab:Acceptance tests.

Compounding — Dispension of Compounding ingredients.

Maturation

Formers coated with coagulant dipped into Latex

Swelling & Withdrawal

Drying, Coagulant application process repeated to get desired thickness

Drying.

Beading

Valcanisation.

Dusting and stripping

Surface Finishing

TESTING AND INSPECTION — Quality Control Tests.

Packing & Despatch

APPENDIX 6

FACTORY LAYOUT.