UNIVERSITY OF COCHIN

B.TECH DEGREE COURSE

IN

POLYMER SCIENCE AND RUBBER TECHNOLOGY

PROJECT REPORT

ON

A SMALL SCALE UNIT

TO

MANUFACTURE PLASTIC CANES

IN KERALA

REPORT SUBMITTED BY:-

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Cochin - 22,

16-12-1980. D.S. RAJAGOPAL.

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CHAPTER - I

I N T R O D U C T I O N

This project is for the manufacture of plastic canes from poly propylene. It is intended to produce 50,000 kgs of cane/year. At present plastic canes are made in sizes of 2 m.m., 3 m.m. & 4 m.m. width and thickness ranging from 0.6 m.m. to 2 m.m. In the present project it is proposed to manufacture 3 m.m. and 4 m.m. size canes which are in greater demand.

Wooden canes were used for rattening furnitures like cots, sofas, chairs etc. Now these wooden canes are being replaced by plastic canes made of H.D.P.E./L.D.P.E. blend and recently by canes of poly propylene - L.D.P.E. blend.

With the destroyal of reserve forests, the wooden canes have become a scarce and expensive material. Plastic canes are now cheaper than the wooden canes. They can be made available in different attractive colours, giving the furnitures a good aesthetic appearence. Plastic canes have a smoother surface finish; they are washable and has superior mechanical properties.

Wooden canes are available in market at lengths of 2 to 3 meters and they require slicing and finishing before using them for rattening. But plastic canes are available in continuous lengths and require no finishing.

Hence the labour cost required for rattening with plastic canes is much less compared with wooden canes.

Canes made of polyethene and poly propylene are resistant to moisture and air and require no protective coating, but the wooden canes has to be pained with costly enamel paints.

Plastic canes are also used for making ladies hand bags, shoping bags, baskets etc.

Today most of plastic canes are produced from H.D.P.E./L.D.P.E. blend. But the canes produced from poly propylene has several advantages over those produced from H.D.P.E. Firstly P.P. is about Rs.3/= less costlier than H.D.P.E. Canes produced from poly propylene has a better shining appearence, which gives the furnitures, baskets & bags an extra beauty. It is mainly due to these reasons that poly propylene was choosen as the raw material in the present project.

As mentioned before, plastic canes have almost replaced wooden cane in the furniture industry. All most all furnitures (cots, sofas, etc.) manufactured at present are being rattened with plastic canes. Now tea poys and stools rattened with plastic canes are popular.

Plastic canes are also consumed for making basket and hand bags, which do have a potential market.

The demand for plastic canes in 1978 in Kerala was 80,000 Kg. In 1979, the demand was over 1,00,000 Kg. and is likely to increase in coming years.

Though there are about thirteen small scale units in Kerala, manufacturing plastic canes, a larger portion of the demand is met by canes produced outside the state, especially from Bombay.

So it will be advantageous to start a small scale unit for the manufacture of plastic canes in Kerala, both from the consumers point of view as well as the manufacturer's view.

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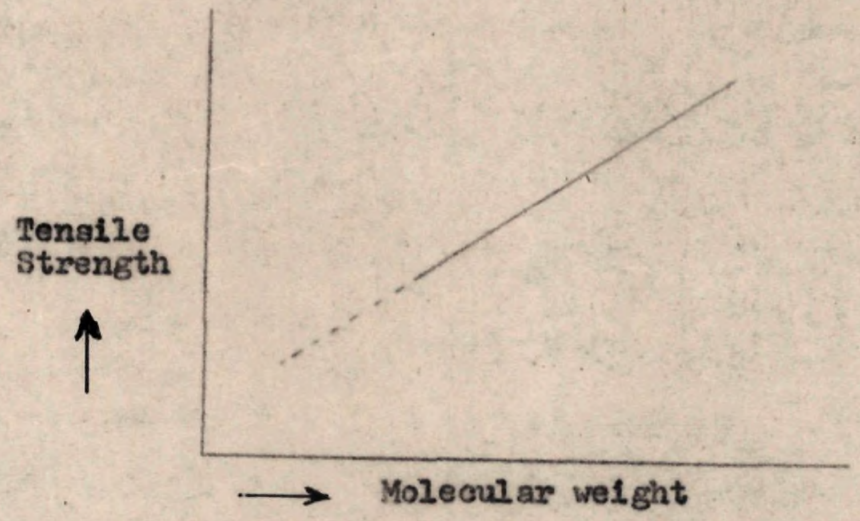
CHAPTER - II

LITERATURE SURVEY

Literature on the manufacture of plastic canes is very meagre. However the extrusion process may be considered similar to that used for other extruded products with minor changes, to impart good strength and finishing properties to the cane.

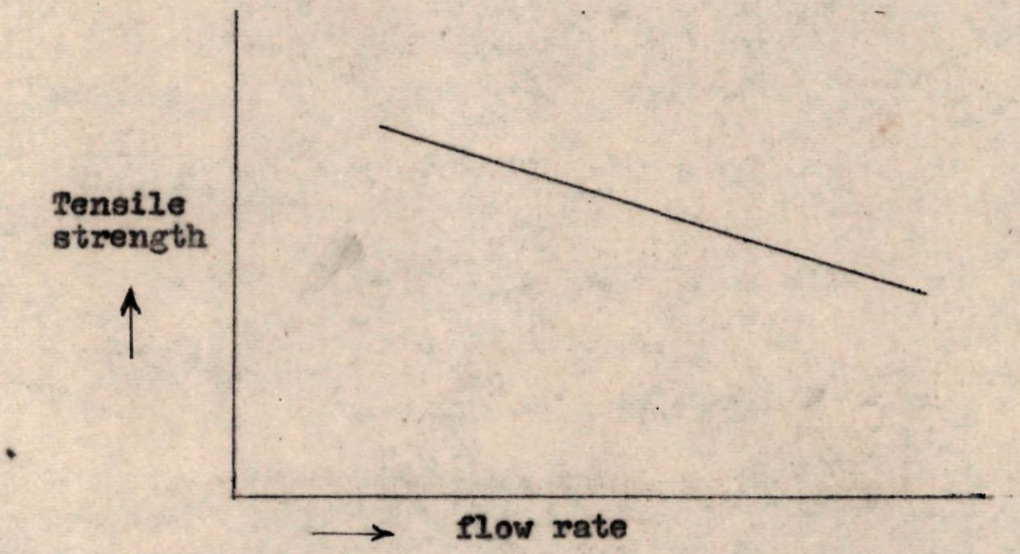
The canes should have high tensile strength and low elongation at break. Tensile strength depends on the molecular weight of the polymer, degree of stretching, the extrusion flowrate etc.

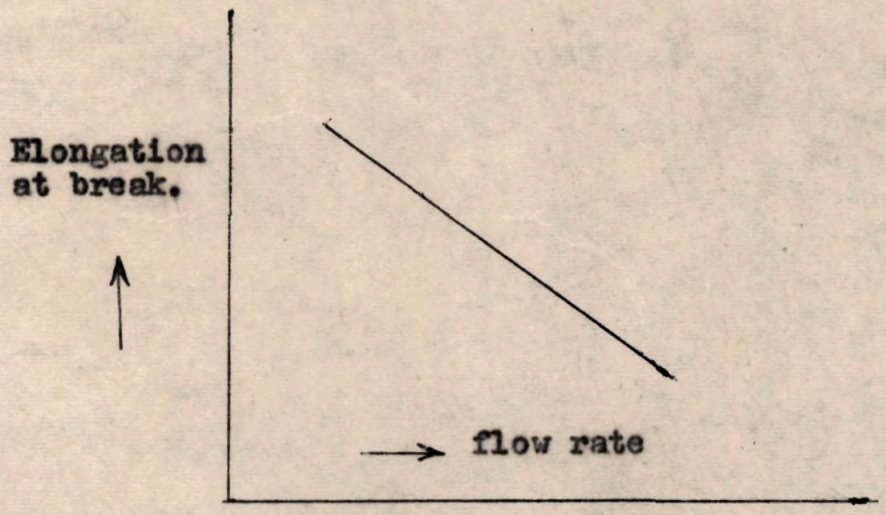
(1) The dependence of tensile strength of poly propylene canes on the molecular weight of the polymer is as shown below:



The tensile strength increases as molecular weight increases with in a practical range of somewhat below 100,000 to about 400,000.

The dependence of Tensile strength and Elongation of the cane on the flow rate can be shown as below:





The flow rate through the die is thus an important parameter affecting the tensile properties of the extruded cane.

(2) The rate of flow through the die is given by the equation:-

$$Q = \frac{P_1}{Kn_1}$$

where Q = flow rate through die (cm^3/Sec.)

P_1 = Pressure drop across the die.

n_1 = Apparent resin viscosity at shear rate in die ($Kgf/cm^2\ Sec^{-1}$)

K = die constant (cm^{-3})

The die profile for cane extrusion is in the form of a slit and its die constant is given by the relation

$$K = \frac{12\ L_1}{Wt_1^3}$$

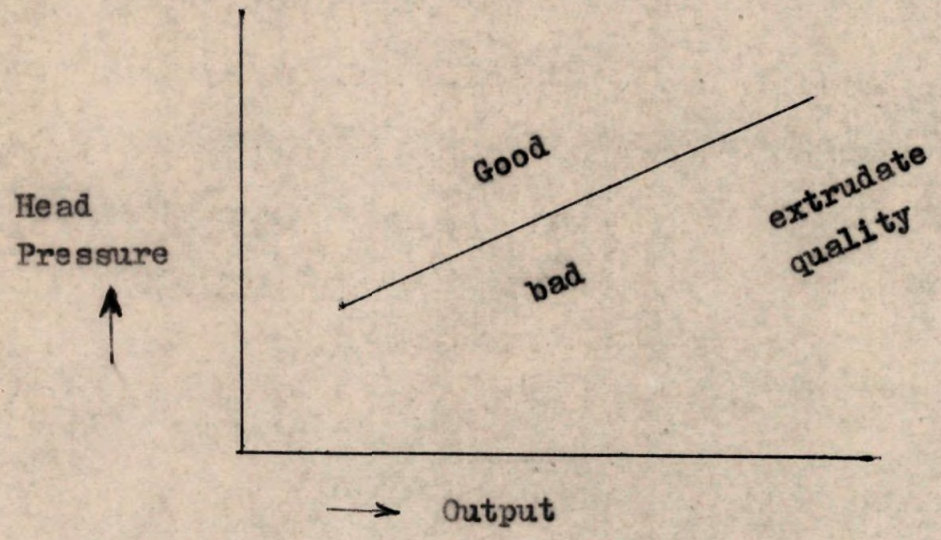
where L_1 = die land length (cm)

W = width of slit die (cm)

t_1 = die opening width (cm)

(3) Another parameter affecting the quality and quantity of extrudate is the extrusion pressure. The back-pressure developed at the die is a linear function of the output; assuming a constant speed. The greater the restriction of flow, the higher the pressure and lesser the output. On open dies, with low restriction; as is in the case of cane

extrusion, the higher output may be curtailed due to non homogenisation of the melt and poor surface finish resulting from the low heat generating capacity of low pressure working and the short residence time. However the breaker plate and screen pack offer some restriction to the flow and holds back non homogenised material to give extrudates of improved quality with a small reduction in output.



(4) Output of canes/hr. is one of the important aspect to be considered. The output/hr. can be given by the following equation.

$$Q = C\ P\ W\ t\ V$$

where Q = out put (kg/hr.)

C = a constant (6 in metric units)

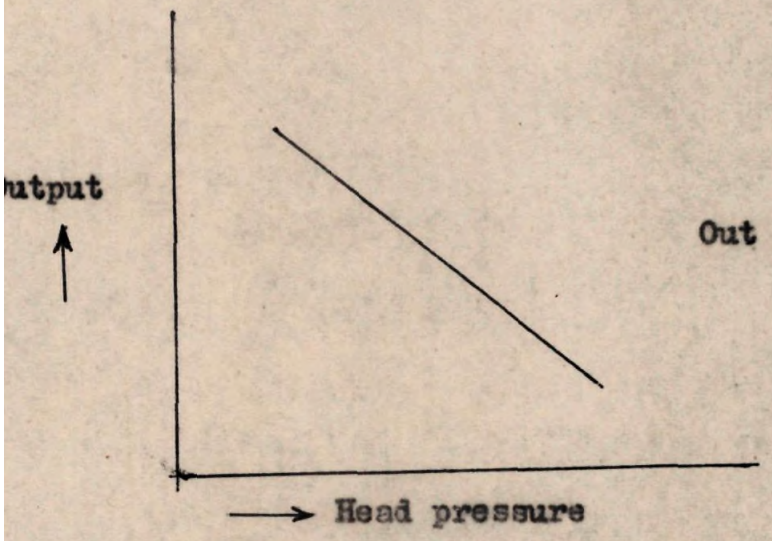
P = relative density of the material at 20°C.

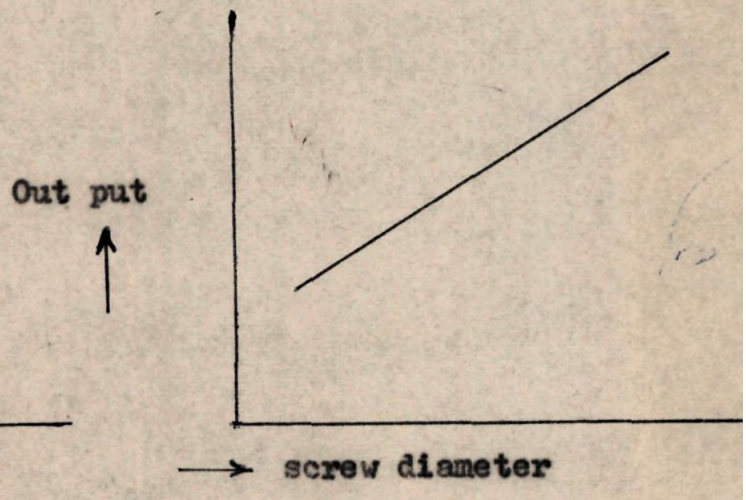
W = width of extrudate (cm)

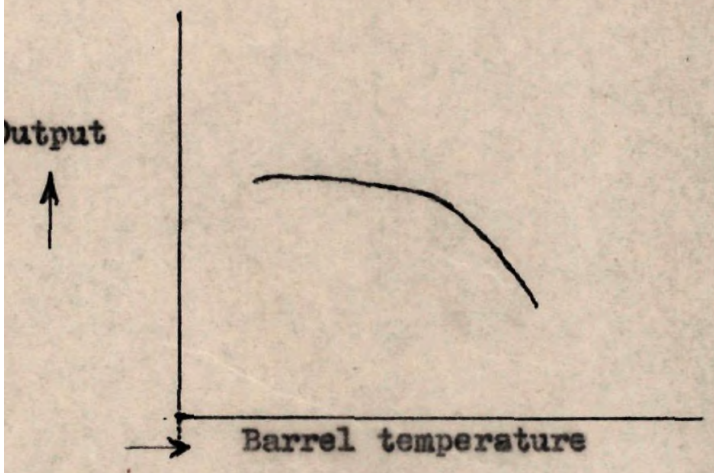
t = thickness of extrudate (cm)

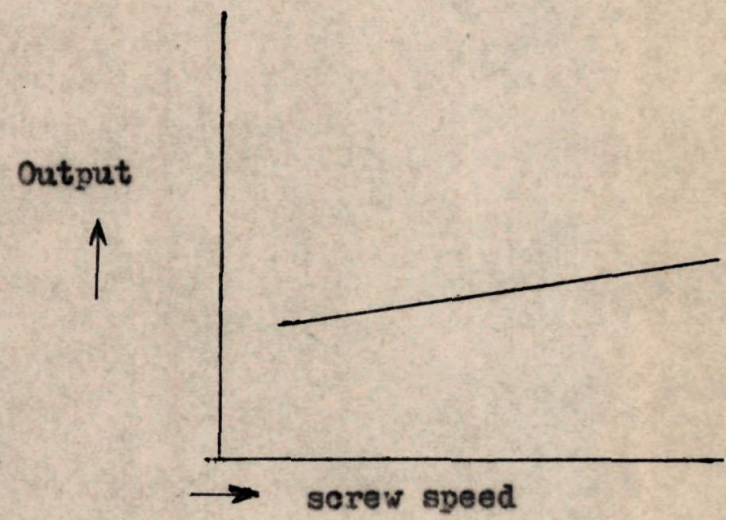
V = linear extrusion speed (mts./min)

The output can be related to some of the parameters of extrusion as shown below:









Reference:-

1. Encyclopedia of Polymer Science & Technology, Vol.9
2. Plastic Engineer's Data book Page - 63.
3. Extrusion of Plastics P.83.
4. Plastic engineer's Data book. Page - 75.

CHAPTER - III

PRODUCTION REQUIREMENTS

The various requirements of production are the availability of raw materials, power, water, skilled labourers, suitable location etc.

1. Raw Materials:- The raw materials required are:-

(a) Poly propylene:

Koylene-S 1730, manufactured and marketed by I.P.C.L. Ltd. is required at the rate of 3600 kg/month.

(b) Low Density Poly ethylene:-

Indothene- 22FA 002, manufactured and marketed by I.P.C.L. Ltd., is required at the rate of 500 kg/month.

(c) Pigments:-

Pigments of different shades having resistance to water & atmospheric conditions are used. In organic pigments like TiO_2, ZnO, iron oxides, cadmium pigments, chromium and molybidnum compounds, cobalt blues and ultra marine blue permit colouration in all shades. Organic dyes lack heat stability and are seldom used.

2. Electric power & Water:-

3 phase electric supply of 400 to 440 volts is necessary for operating the different machines in the factory. The consumption of power/hr. is 26 K.W. Water required for the factory can be taken from the town water supply scheme.

3. Availability of labourers:-

The process does not call for many skilled workers. Only one experienced operator is necessary in the beginning and two more can be easily trained out. The unskilled workers are easily available for packing, winding etc.

4. Plant location:-

Considering the above requirements, the factory may be set up near a town in Kerla, where the rent for the factory building is less. It has to be on the road side for easy transport of raw materials and finished goods.

5. Machinery:-

The various machines required for the manufacture of canes are:-

(a) Extruder with dies.

(b) Quenching tank.

(c) Stretching equipments.

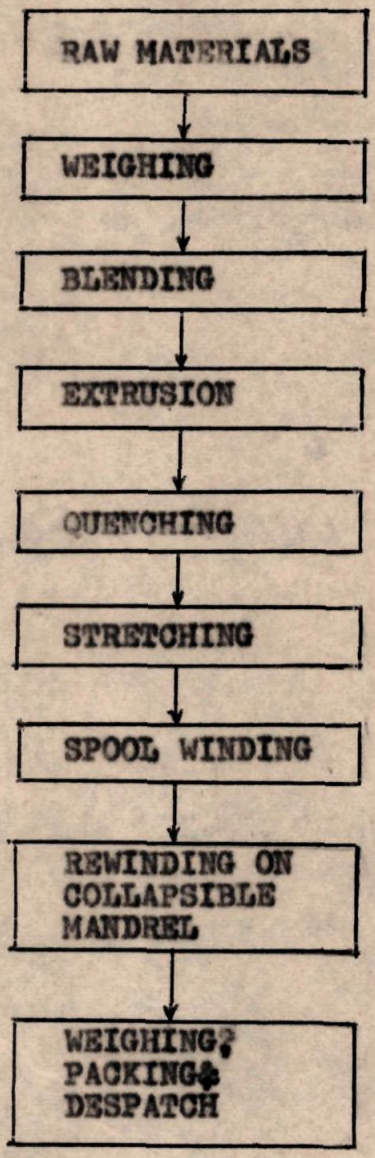
(d) Spool winder.

(e) Water pump.

CHAPTER-IV

PROCESS OF MANUFACTURE

The various steps in the manufacture of plastic canes could be clearly seen from the following flow chart.



Plastic canes are produced by the extrusion process. This is a contmuous process in which the canes are extruded through an extrusion die, in vertically downward direction, and allowed to pass through a quench bath where they get cooled. Immediately after this, the canes are stretched in a boiling water bath and finally they are wound on spools.

The details of the process of manufacture are as following:

1. Blending:- Blending is done to mix the resin pellets with the colorants. Dry blending is the method used. No intimate mixing is required.

Blending is done in batches of 10 kg. each. 9 kg. of poly propylene is mixed with 1 kg. of L.D.P.E. and 30 to 50 gm of pigments ina shallow Aluminium vessel, using wooden padles.

2. Extrusion:-

Extruders used for the manufacture of canes are in the size range of 1" to 1½" screw diameter (capacity 3 to 8 kg/hr) Such small extruders are used because canes can be produced only in single strands. (If the canes are produced in multiple strands the stretching will not be uniform.)

The extruder consists of the following parts.

a. Barrel:- The barrel is made from alloy steel, hardened and tempered. It is heated by electrical band heaters. Cooling arrangement is provided at the base of the hopper on the barrel.

b) Screw:- The screw is also made from alloy steel, and the tip of the screw is chrome plated. The screw has a helix angle of 20°, and L/D ratio 24.

The screw is driven by 7.5 H.P. A.C. motor, fitted with variable speed drive pully, belt and a reduction unit.

c) Hopper:- The feed hopper is with sight window, and sliding gate to block off the feed or regulate it when necessary.

d) Die head:- The cross head die is flanged to the extruder. In addition to the die, the die head also have a breaker plate and screen pack, which holds back impurities and unplastisised material.

The cross head and die head are fitted with band heaters.

The die orifice is adjusted to be in the exact centre of the die plate. The entries into the die orifice must have a conical form. The die orifice is in the form of a semicircle, and has a size of about 3 times the actual size of the product.

Different die plates are used for different sizes of canes (say 3 m.m., & 4 m.m.)

The blended raw material is fed to the hopper of the extruder, and the sliding gate is opened. The material get plasticised between the hot barrel and screw and is converted into a hot melt. The hot melt is forced through the die into the quench bath. The temperature of the barrel is kept at

200° - 230°C and that of the cross head and die are kept at 300°C.

3. Quenching:-

The extrudate coming out of the die head in vertically downward direction, pass through the air for a short distance and then enter the waterbath (Quench bath). The temperature of water in the Quench bath is kept at 40 - 50°C. Cooling in warm water helps to eliminate the problem of internal stresses in the cane and also aids in better shape retention of the canes. The canes are now led around a guiding roller located in the lower part of the Quench bath. After leaving the cooling bath, the canes pass through a take off system of goddet rolls before entering the orientation bath.

4. Stretching:-

Stretching equipment consist of two goddet units and an orientation water bath. The first goddet unit is fixed with four aluminium goddet rolls out of which two are driven and two are idle. The goddet rolls are driven by ½ H.P. D.C. motor coupled with suitable gear box.

The second goddet unit also have four aluminium rolls out of which two are driven and two are idle. The goddet rolls are driven by 2 H.P. D.C. motor coupled with suitable gear box.

The orientation water bath is fitted with number of electrical heaters, for heating the water to the boiling temperature.

The canes are stretched in a water bath at 95-100°C. The stretching of canes is achieved by running the second set of goddet rolls at a higher speed (7 to 8 times) than the first set of rolls. Thus a stretching of 700 to 800% is given to the canes. By this hot stretching, molecular orientation and thereby improved tensile strength is achieved.

5. Winding:-

Winding canes are made in spools. A single station spool winder is used for this. The drive for the spool winder is taken from the second goddet unit.

When one spool becomes full, it is removed and is replaced by another one.

From the spools, the canes are wound on a collapsible drum. The coils of canes are removed after collapsing the drum. The canes are then weighed out into coils of ½ kg, 1 Kg etc., packed in polyethene covers, and stored for despatch.

Quality Control:-

The desired qualities of plastic canes are its surface smoothness, good tensile strength, fast colour etc. To produce good quality extrudates, a steady flow rate, constant pressure, constant temperature and uniform extrudate composition has to maintained. These process variables dependent on each other, and a measure of quality is given by a variation of anyone of these.

The extruder and stretching equipment have seperate

control panels equiped with energy regulators and other suitable equipments to measure and control the quality of extrusion.

The % of stretching and there by the strength are controlled by properly adjusting the speed changing knob for goddet unit.

Colour fastness can be achieved by selecting the colourfast dyes, having stability to temperature and atmospheric conditions. A suitable combination of in-organic pigments serve this purpose.

Another aspect of quality control, is to reduce the scrap. Scraps generally occur at the starting of fresh batch. Percentage scrap can be reduced by restricting the number of change overs from one variety to another in one shift.

About 1.0 to 1.5% of canes is lost as scrap. 0.5% of it can be added with fresh granules of suitable batch without affecting the properties of the canes. The rest of the scrap can be sold out for reworking.

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CHAPTER - V

CAPITAL REQUIREMENTS

The capital requirements of a firm can be given under the following heads:-

1. Fixed capital.
2. Working capital.
3. Gross capital.
4. Total manufacturing cost.

1. Fixed capital:-

The estimated fixed capital is as follows:-

a. Plant and Machinery	-	Rs.1,01,300.00
b. Miscellaneous fixed assets	-	Rs. 15,000.00
Total	-	Rs.1,16,300.00

The details of fixed capital are given in Annexure - I.

2. Working Capital:-

The costs involved in the operation of the plant for 1 month is taken as the working capital. The working capital can be classified in the following heads:-

a.	Rent/month for factory building	- Rs. 800.00
b.	Raw material cost + cost of purchasing & stocking.	- Rs.81,000.00
c.	Cost of utilities	- Rs. 2,000.00
d.	Salaries & wages	- Rs. 4,800.00
e.	Other overheads	- Rs. 800.00
Total working capital/month		- Rs.89,400.00

Details of working capital are shown in Annexure-II.

3. Gross Capital:-

It is the sum of fixed capital and working capital.

Gross Capital = 1,16,300 + 89,400 = Rs.2,05,700.00

4. Total Manufacturing cost:-

It consists of all direct and indirect costs involved in the manufacture and involves the following heads:-

a. Raw material cost	-	Rs. 81,000.00
b. Salaries & wages.	-	Rs. 4,800.00
c. Utilities	-	Rs. 2,000.00
d. Overhead expenses	-	Rs. 800.00
e. Rent/month for building	-	Rs. 800.00
f. Interest on loans:		
(1) K.F.C. @ 11.85%	-	Rs. 976.19
(2) From Bank @ 15%	-	Rs. 1,117.50
g. Depreciation on fixed capital @20% per annum	-	Rs. 1,938.33
Total	-	Rs. 93,433.00

Sales turn over:-

Canes produced/month	-	4,000 Kg.
Selling price of canes	-	Rs.25/kg.
Receipt from 1 month's sales	-	Rs.10,000.00
Gross profit	=	Rs.6567.00
Less 30% for selling & distribution	-	Rs.1970.00
Net profit/year (before taxation)	-	Rs.55,164.00
Income tax to be paid	-	Rs.17,574.82
Profit/year after taxation	-	Rs.37,589.18

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SOURCES OF FINANCE:-

1. Kerala Financial Corporation:-

85% of the total cost involved for purchase and erection of machinary and other equipments can be taken from K.F.C. at an interest of 11.85%. Repayment has to be made in 17 half yearly instalments, and the repayment starts by the end of the second year. The pay back period is 10 years.

2. Nationalised Banks:-

100% of the working capital can be taken as medium term loan. The interest is 15%.

3. Own Capital:-

15% of the fixed capital is met from own hands. This amount is utilised for the preoperative expenses.

Loan from K.F.C.	=	Rs. 98,855.00
Loan from Nationalised bank	=	Rs. 89,400.00
Own money	=	Rs. 17,445.00
Total investment	=	Rs.2,05,700.00

PROFITABILITY

The financial viability of a project is guaged through profitability. The following factors are examined in profitability calculations.

1. Rate of return on own capital.
2. Rate of return on fixed capital.
3. Percentage profit on sales turn over.

1. Rate of return on own capital:-

Own capital	-	Rs. 17,445.00
Net profit/year	-	Rs. 37,589.12
Rate of return on own capital	-	215%
	=	2.15

2. Rate of Return on Fixed capital:

Fixed capital	-	Rs. 1,16,300.00
Net profit/year	-	Rs. 37,589.12
Rate of returnon fixed capital	-	32.32%
	=	0.3232

3. **Profit on sales turn over:-**

Annual receipts from sales	-	Rs. 1,20,000.00
Net profit	-	Rs. 37,589.12
% profit on sales turnover	-	Rs. 31.32%
		= 0.3132

BREAK EVEN ANALYSIS

Break even quantity = $\frac{F}{P-V}$

Where F = Fixed costs

P = Price/kg of cane.

V = Variable cost/kg of cane.

P = Rs.25/kg.

Variable cost:-

Raw material	=	Rs. 81,000.00
Utilities	=	Rs. 2,000.00
Direct labour	=	Rs. 3,600.00
Selling & distribution charges.	-	Rs. 1,970.00
Total	-	Rs. 88,570.00

Variable cost/kg. cane = $\frac{\text{Rs.88570.00}}{4000}$ = Rs.22.14/kg.

F = cost of production + distribution - variable cost

= 93433 + 1970 - 88570 = Rs.6833.00

Break Even quantity = $\frac{6833}{25 - 22.14}$

= 2389.16 kg/month.

ABILITY TO PAY BACK LOANS

1.	Annual Net Profit	-	Rs. 37,589.00
2.	Depreciation on fixed capital	-	Rs. 23,260.00
	Available surplus/year	-	Rs. 60,849.00
3.	Less personel drawings	-	Rs. 27,897.33
4.	Amount used for repayment of term loans.	-	Rs. 32951.67
5.	Term loan to be paid back	-	Rs. 98,855.00

The loan can be paid back in 3 years.

C O N C L U S I O N

The proposed project can be concluded as follows:-

1.	Total fixed capital	-	Rs. 1,16,300.00
2.	Working capital	-	Rs. 89,400.00
3.	Total investment	-	Rs. 2,05,700.00
4.	Personels required	-	11
5.	Annual production	-	48,000 Kg.
6.	Break even production	-	2389.16 Kg/month.
7.	Rate of return on fixed capital	-	32.32%

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ANNEXURE - 1

Machinary & Equipments:-

a.	One 40 m.m. extruder with equipments.	- Rs.	85,000.00
b.	Two dies (for 3 m.m. & 4 m.m. canes)	- Rs.	1,800.00
c.	Packing charges	- Rs.	1,600.00
d.	Central excise duty @ 8%	- Rs.	7,072.00
e.	Central sales tax @ 4%	- Rs.	3,819.00
f.	Insurence @ 1% on Rs.99291.00	- Rs.	1,000.00
g.	Erection & Instalation charges	- Rs.	1,000.00
h.	Water pump, tool kit, weighing scale etc.	- Rs.	6,000.00
i.	Transport, electrification, furniture & other equipments	- Rs.	9,009.00
	Total fixed capital	- Rs.	1,16,300.00

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ANNEXURE - II

Working Capital

1.	Rent/month for building	-	Rs. 800.00
2.	Raw material cost:		
	a. Poly propylene, 3600 Kg @ Rs.19/-	-	Rs. 68,400.00
	b. Poly ethylene, 500 kg @ Rs.21/-	-	Rs. 10,500.00
	c. Pigments	-	Rs. 1,500.00
	d. Cost of purchase & Stocking	-	Rs. 600.00
	Total	-	Rs. 81,000.00

3. **Cost of Utilities:-**

(a) **Water.** Water is required for cooling the extruder screw, for the water baths and meeting the exployees' amenities.

Water required/day - 1200 litres.

water charge/month - Rs.50/=

(b) **Electrical Power:-**

The power consumption of the factory is as follows:

	Machine		K.W./hr.
1.	Extruder drive motor.	-	5.6
2.	Heaters in the barrel	-	5.6
3.	Take off equipments & water bath	-	13.87
4.	Water pump	-	0.37
5.	Fan, lights etc.	-	0.37
	Total	=	26 K.W.

Power consumed/hr. = 26x0.7 = 18.3 KWh.

Power consumed/day = 440 units.

Power consumed/month (25 days) = 1,11,00 units.

Electricity charge/month @ 15 ps/unit = Rs.1665.00

(c) Other consumable items - Rs.285/=

4. Salaries and wages:-

	Designation	Pay/month	Nos.	Total
a.	Manager	Rs.800/-	1	Rs. 800.00
b.	Clerk/Typist	Rs.400/=	1	Rs. 400.00
c.	Operators	Rs.600/=	3	Rs.1,800.00
d.	Unskilled workers.	Rs.300/=	6	Rs.1,800.00
		Total		Rs.4800.00

5. Other overheads/month - Rs. 800/=

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