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NATIONAL RESEARCH COUNCIL OF CANADA
PRAIRIE REGIONAL LABORATORY

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BY

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INTRODUCTION

The publication of these data was undertaken to sum up information gathered during several years pilot plant study on strawboard production. These straw fiberboards have similar properties to wood fiberboards which are currently used by the building trade. The availability of immense quantities of fiber present in waste straw prompted the investigation.

Sufficient information has been gathered from these studies to estimate the yields of board and the general properties of boards made from straw. Various pulping methods were tried and it was found that the best strength to density relation was obtained by subjecting the straw to a standard NaOH pressure digest process. For this reason this report on the estimated cost of production of 1/2 inch fiber building board is based on the so called standard soda process. This process is widely used by the manufacturers who pulp straw for boxboard.

The estimates are based on the smallest plant considered economically sound by pulp and paper engineers. The process as given in this report is not necessarily the last word in plant layout etc. Before a process is finalized, some discussion should be undertaken with pulp and paper engineers familiar with the pulping of straw and also with equipment engineers who are familiar with pulping and board forming equipment.

Availability of straw and straw technology is fairly well discussed in "Wheat Straw as a Pulp Source," (Sallans, Sinclair and Stone, Chemistry in Canada, Dec. 1951). There should be enough waste straw within an area of 15 mile radius to supply a mill of the size projected in this report. Even if the mill capacity were doubled the greatest hauling distance would not exceed 21 miles. It is estimated that the consumption of fiber building boards for the Prairie Provinces in 1949 was 70,000,000 sq. ft. The estimated production of this mill would be around 20,000,000 sq. ft. per annum.

In the final planning of a straw board plant the availability of power, sewer and water and fuel would have to be considered before the site of the mill was selected. It would also be necessary to locate in a sure crop district where the average yield was reasonably good to reduce hauling costs to a minimum. There would be some advantages in locating near a small town, one of the main reasons being that straw could be gathered from all directions around the plant. Locating near or on a good highway should be considered as in these modern times much freighting is done by truck rather than rail.

PROCESS

An idea of the general process is given in the schematic flow sheet Figure 1 and can be broken down into four main steps. (1) Straw gathering and preparation (2) Fiber preparation (cooking, refining etc.) (3) Board formation and drying (4) Handling the finished product (packaging, storage etc.) The plant would have a capacity of 40 tons of straw (8% moisture) per day (which should produce about 64,274 sq. ft. of 1/2 inch board).

The diagrammatic flow sheet Figure 2 indicates the amount of the various materials, with the exception of water, required for each day of operation. Water requirements and use of white water are given in Figure 3.

Sodium hydroxide required is 4% of the dry weight of straw charged to the digester. Steam consumption (2000 lbs. per ton of straw) is based on figures obtained from boxboard plants. Sizing materials other than rosin may be used for water proofing fiberboards but rosin has been found to be one of the best and easiest to handle. Three percent rosin on dry fiber weight, precipitated with 4.5% alum to pH 5.4 gives sizing adequate to meet building code standards. The estimation of gas requirements are based on 50% efficiency in the drier. 70,380 lbs. of water have to be removed from the board each day.

Daily water requirements are calculated on the basis of reusing 50% of the water. The other 50%, along with water evaporated in the drier, has to be made up with fresh water. Reuse of white water is encouraged for two main reasons: (1) Recovery of fines, (2) Reduction of pollution of rivers in which the waste is dumped. The ultimate of course would be a completely closed system in which all the white water was reused. Such a system would require that some water purification equipment be included to prevent the continual accumulation of digested material and fines which would build up to a point where they would interfere with board formation.

Figure 4 gives the material balance between dry straw and dry fiber in board form for one day's production. The greatest loss, 11.94 tons, is solubles from the NaOH digest. This large loss has prompted investigation of methods for preparing straw pulp by other means than alkali digestion.

STRAW PREPARATION

Because straw is an annual crop it must be gathered at one time in the year. All of it would not have to be moved to the plant site at one time. In fact it would be

Schematic Flow Sheet of Strawboard Process

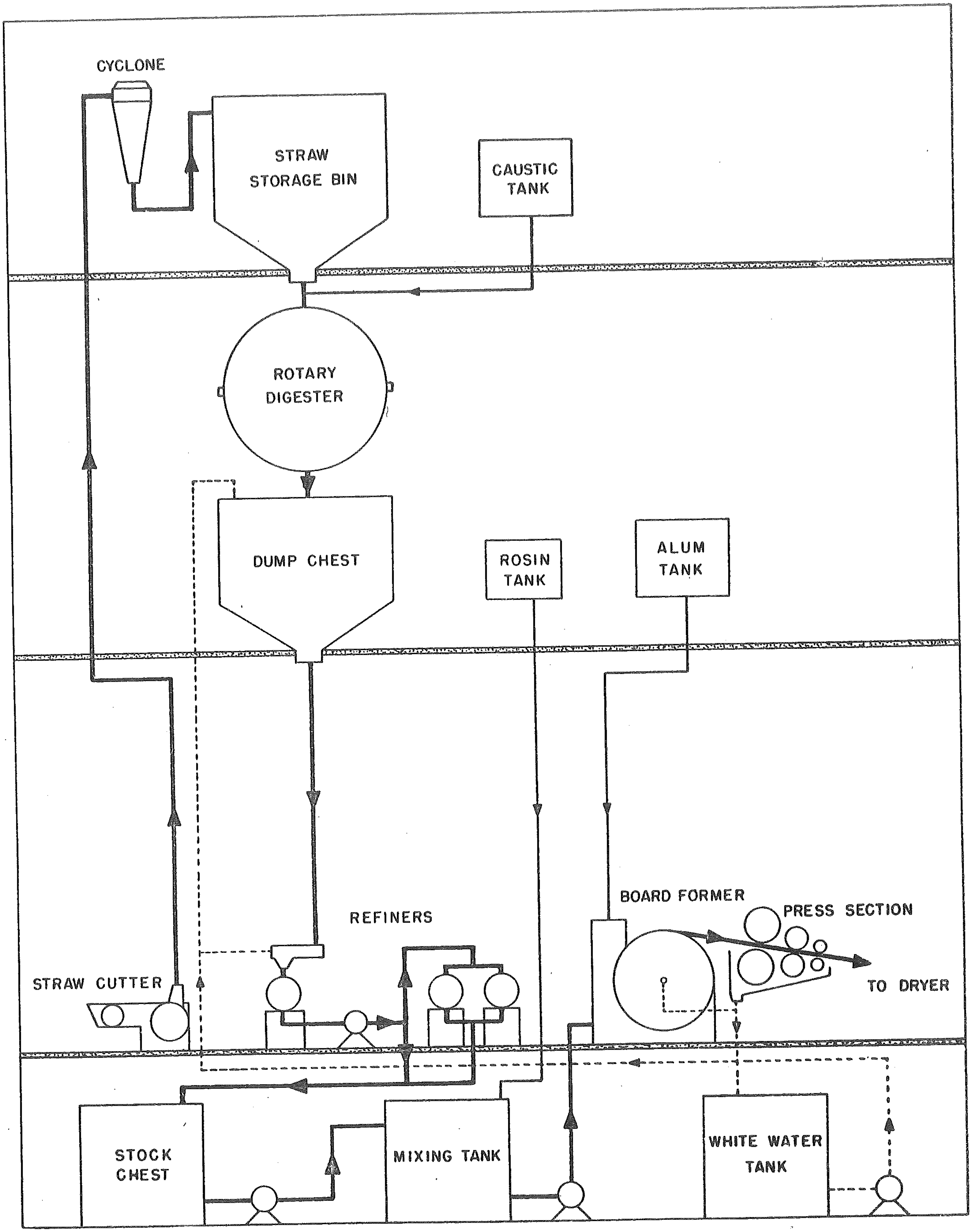

Figure 1.

DIAGRAMMATIC FLOW SHEET OF STRAWBOARD PROCESS

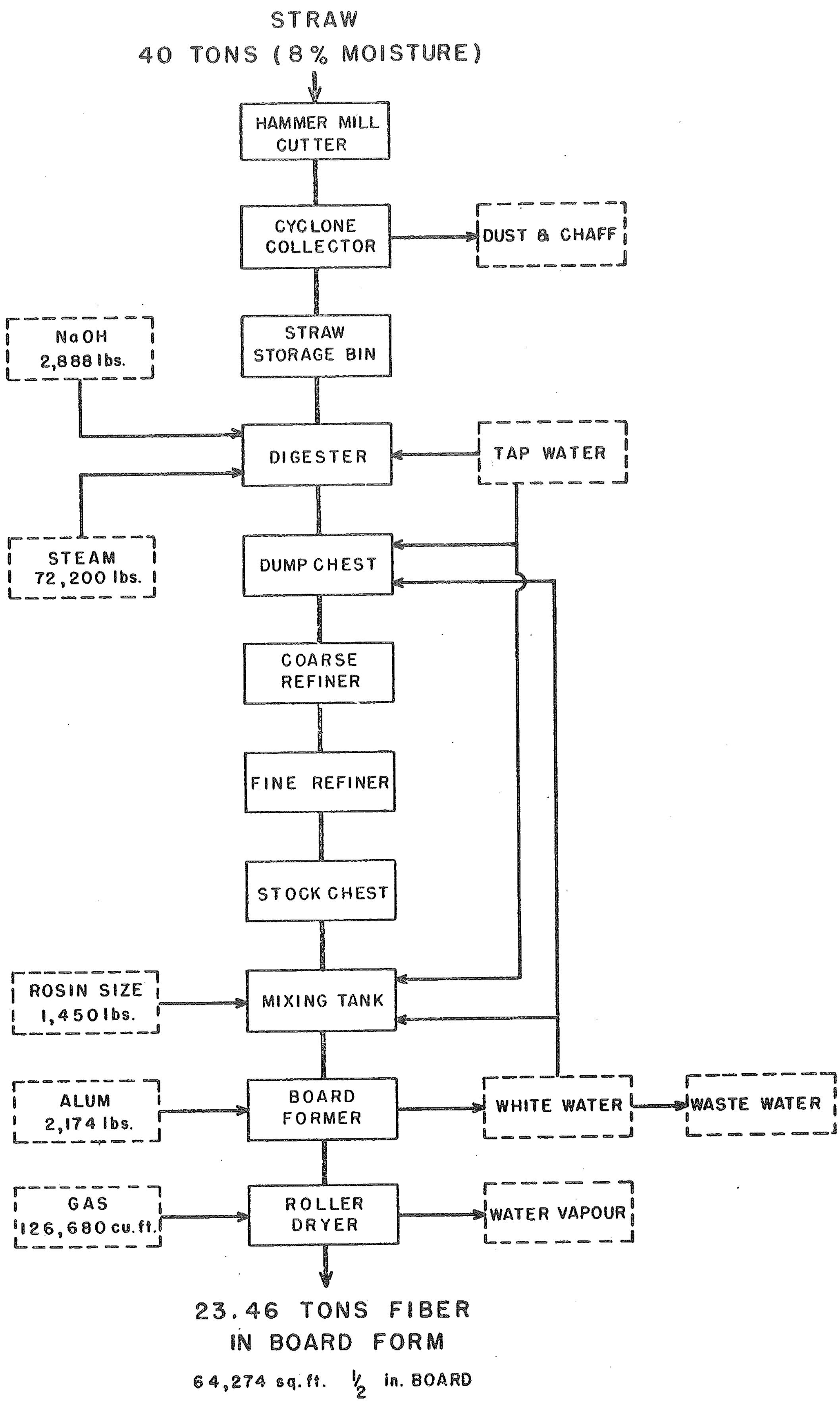

Figure 2.

DIAGRAMMATIC FLOW SHEET OF DAILY WATER REQUIREMENTS

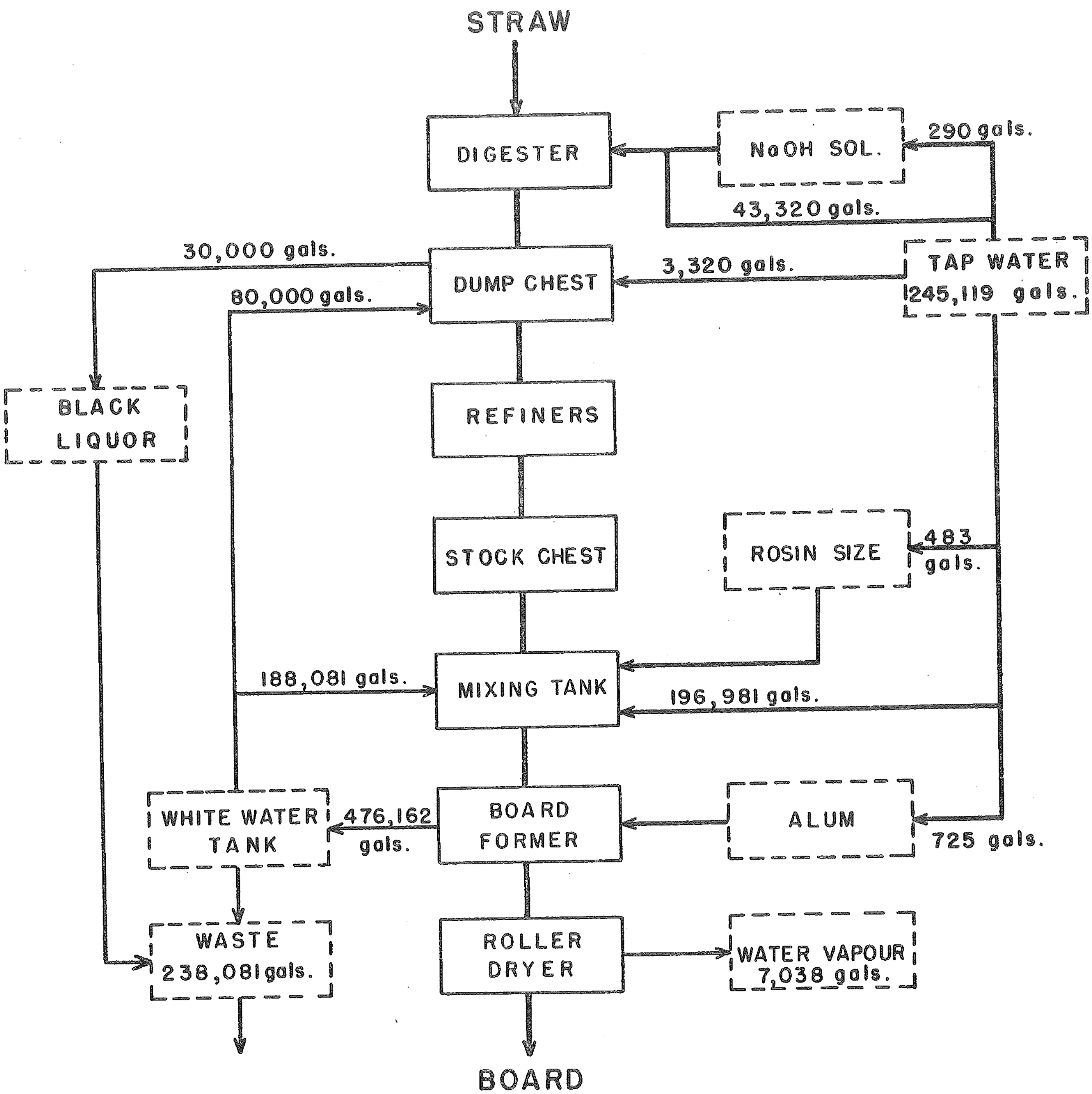

Figure 3.

DIAGRAMMATIC FLOW SHEET OF STRAW AND FIBER BALANCE

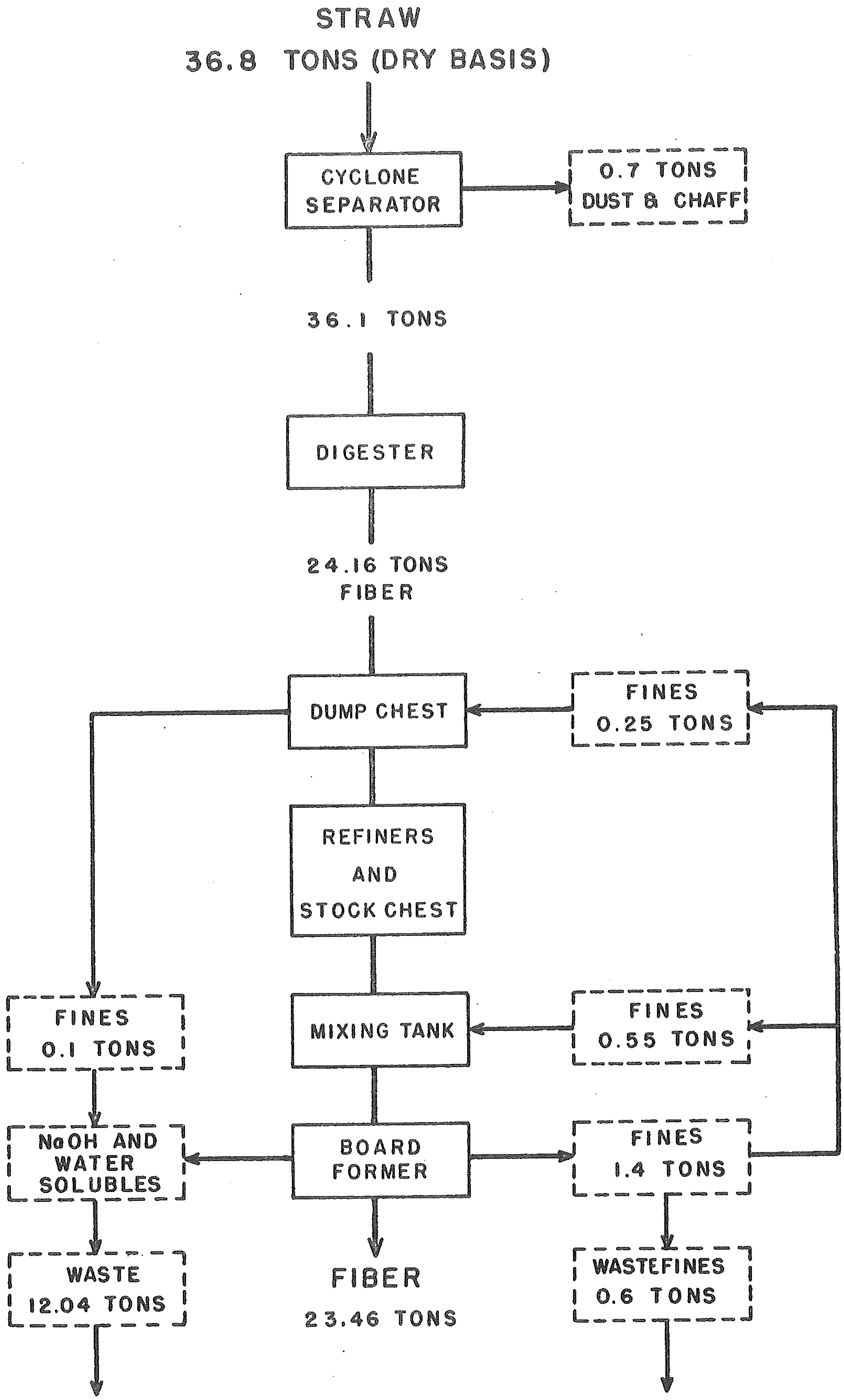

Figure 4.

safer, to stack it at various points and then haul it in as required. The straw should be baled for ease of handling.

The baled straw is cut and possibly broken up further with a hammer mill. Then it is transferred pneumatically to the top of the building into a cyclone collector mounted over the straw storage bin. The fine chaff and dirt is carried off by the air at the top of the cyclone and discharged outside the building.

FIBER PREPARATION

Straw from the storage bin is packed in to the rotary globe digester where it is digested with NaOH and water. A 14 foot diameter digester will hold about 6 1/2 tons of straw if properly loaded. On the basis of a plant using 40 tons of straw per day the digester would operate on a 4 hour cycle. That is the digester would be filled with straw; water and NaOH added, steam pressure raised to about 60 p.s.i., this pressure held for at least one hour and then released and the digester dumped in the 4 hour period.

After digestion the straw pulp is dumped into a large tank or pit where it is mixed with water to make a slurry which would pass through the first or coarse refiner. From the coarse refiner most of the pulp is passed through the fine refiner. The flow sheet shows three refiners because it is estimated that 3-36 inch refiners would have about the capacity required to handle the 24 tons of pulp which could be expected from 40 tons of straw. Two larger refiners would probably do the work satisfactorily but the refiner stage would not be as flexible.

After refining the pulp stock is dumped into the stock chest located in the basement. The pulp stock is transferred by pump into the mixing tank where the rosin size is added.

BOARD FORMATION AND DRYING

From the mixing tank pulp is dumped into the cylinder vat of the board former. Alum to precipitate the rosin size could be added here. Alum addition is controlled by a valve operated by a pH regulator. The sensing element could be located either in the vat or in the white water discharge.

The cylinder on the board former picks up the fibers by a filtering process. A cylinder with a 9 foot face running at approximately 5 1/2 feet per minute would make about 64,000 sq. ft. of board per day. The fiber mat is doctored off the cylinder on to a screen or a felt which carries it through the press section. The pressure rolls compress the mat and squeeze out a large amount of water. A good press section will reduce the water content to about 60 percent. The board leaving the press section is rigid enough to be supported by a roller conveyor.

Before going into the dryer the board is cut to lengths which are multiples of 4 feet. A length of 12 feet would be best for passing through the dryer. These 8' x 12' sheets are transferred to the decks of the dryer by an automatic tipple arrangement. It is estimated that a dryer running at an optimum temperature will dry a board in 2 1/2 hours. The 8 deck dryer 200 feet long would have about twice the capacity required to dry 64,000 sq. ft. of board per day. But drying engineers recommend 200 feet as the minimum length for a roller dryer to maintain the proper zone temperatures required to prevent checking and warping.

HANDLING THE FINISHED BOARD

When the finished board emerges from the dryer it can be automatically cut into any size which may be in demand by the building trade. Sheets 4' x 8' are the most common size at present. Some of the boards could be cut to 2' x 4', then coated with asphalt, and sold as sheathing boards. Others could be cut to an even smaller size and marketed as ceiling and wall tiles. Most fiber boards whether of the 4' x 8' size or the smaller are usually packaged in heavy wrapping paper. Automatic packaging machines are available for this type of work.

The packaged boards would be either loaded directly into freight cars, loaded into transport trucks, or stored for later shipment. Even though this packaged material is quite bulky a generous storage space is provided by a building of the size recommended in this report. All stacking of finished boards, wrapping paper, etc. should be handled by a suitable fork lift truck.

EQUIPMENT

Table I gives a complete list of equipment required to set up a strawboard plant. In estimating the cost of some of the equipment prices were taken from quotations obtained as long as six years ago and then adjusted by the difference in the wholesale price index between the time the quote was obtained and the present. Prices given include installation and freight. There will naturally be some differences due to hauling and erection costs depending on the location of the mill. The equipment is available from most manufacturing companies who specialize in pulp and fiber board machinery. A list of these companies may be found in the Canadian Trade Index.

Some reduction in the cost may be achieved by the purchase of second hand equipment. Caution should be observed in this respect and any used machinery should be assessed by a qualified engineer prior to purchase.

BUILDING AND LAND

Cost of the building for this plant is the average of estimates obtained from three sources. No attempt was made to detail the layout of the plant but a rough plan was drawn to arrive at a reasonable cubical content. The building best suited to this type of plant would have a three story section at one end to accommodate the storage bins, digester and refiners, one above the other, so that material transfer would be by means of gravity.

A long low one story section would have to extend out from the three story section. This could be partitioned down the middle. One side would be used for the 200' drier and the other for packaging and storage.

Office and laboratory space could be located in either section of the building.

The estimate of the cost of land may appear low. However, a plant of this type would be best located in a good wheat farming district near a small town where land values are much lower than in larger industrial areas.

Actually costs of land and servicing, if the plot is not too far from existing water mains, etc., is a small part of the total cost of setting up the plant. Estimated cost of a building 40 feet wide by 400 feet long with a three story section at one end and having a cubical content of 420,000 cu. ft. with a partially excavated basement of 38,000 cu. ft.

would be	$297,700.00
Cost of 5 acres of land	1,250.00
Cost of servicing sewer, water and gas	2,000.00
Total	$300,950.00

If adequate pumping facilities to supply water to the plant are not available the additional cost of a pumping station should be included. A pump rated at 400 g.p.m. having a 4 inch inlet and outlet would deliver approximately 500,000 gallons of water per day which should be adequate for plant requirements.

LABOUR REQUIREMENTS

In estimating the cost of labour the wages are not for any one locality but a mean average across the prairies over a period of several years. Labour costs could vary considerably depending on whether the plant was located in or near a large city or in or near a small town where the services of farm help could be obtained somewhat cheaper during the winter months. Man power requirements are given in Table II. These are based on 24 hour operation (3 shifts) and are possibly conservative. This means that to stay within these limits of manpower every effort should be made to have the plant as automatic as possible. The importance of automatic operation should be considered at all times. Nearly every plant has a certain amount of down-time due to breakages or failures of one type or another and unproductive labour at these times can soon cut production profits.

MANUFACTURING COSTS

Table III gives a daily cost estimate based on 300 working days per year for producing 64,274 sq. ft. of 1/2 inch fiber building board. The unit costs given here are average for the Prairie Provinces and will vary considerably depending on location. The unit cost of $9.39 per ton for straw was computed by adding together the cost of baling $3.93 per ton, cost of hauling $0.46 per ton and allowing the farmer $5.00 per ton for the straw in the field. These estimates of baling and hauling costs were obtained from the Agricultural Engineering Department of the University of Saskatchewan.

Cost of power, which next to labour and straw is the largest daily expense, may appear too high. However electrical power on the prairies is usually produced by steam generating plants and power authorities claim that it costs nearly one cent a kilowatt hour to produce power by this means.

Cost of materials etc. are calculated to a daily basis to arrive at an overall daily manufacturing cost. A working capital or reserve fund of $181,667.10 is included in the total investment. This is equal to the cost of operation for 90 days and would be required to start the plant and should be kept at this figure for emergencies. When estimating the fixed charges no interest or dividends were included because the method of financing the venture would influence the return on the capital invested.

CONTROL LABORATORY

Estimated cost of equipping a small control laboratory is included in Table I. The plant considered in this report would not be large enough to maintain a full time control engineer but it should have equipment for testing freeness of pulp, density of the finished boards, concentration of NaOH solutions, and possibly the strength of the finished board.

The laboratory would be only for control of operations and to check the finished product to keep its quality within acceptable limits. No provision is made for manpower for the laboratory in labour requirements. The testing could be done by one of the skilled employees from the department which required a test and quality tests on the finished product could be done by the mill superintendent.

DISCUSSION

The board yield data used in these estimates is based on small scale pilot plant studies. The average yield of pulp was found to be about 65 percent and the average density of an acceptable board was 17.5 lbs. per cu. ft. Yield data is based on the yield of dry fiber in board form as percent of dry straw after it has been chopped and passed through the cyclone collector. There is reason to believe that this yield of 65 percent is conservative. W.H. Palm and H.J. Ostrowski of Hinde and Dauch Paper Co. (Pulp and Paper Magazine of Canada, Vol. 54 No. 8, 1953), report yields of straw pulp as high as 70 percent and they are making box-board pulp which would be a finer grade than that required for building board.

If pulp yield were increased, to 75 percent it would make quite a difference in the unit cost of production. On the basis of a 75 percent yield the plant would produce 74,178 sq. ft. of board from 40 tons of straw. This would reduce the unit cost of manufacturing from 3.14¢ to 2.7¢ per square foot.

By keeping the density of the board to a minimum, consistent with adequate strength properties, more square feet of finished board could be made from a given amount of pulp. This strength to density ratio could be improved as the operators of the refiners and the board former became more familiar with the equipment.

Before a venture such as this is undertaken much thought should be given to the selection of key personnel because it is well known that the success or failure of any organization or plant is largely dependent on management. Location of the plant and marketing of the manufactured article also have a great bearing on the success of the venture.

Table IV gives the data on the total investment required for a plant this size. Table V gives the total yearly expenditure if the plant is operated at 100% capacity.

Figure 5 shows the relation between operating at rates below 100% of plant capacity and manufacturing costs. A line indicating a hypothetical net selling price of $0.05 per sq. ft. was drawn in to indicate the break even point at which the plant could operate and still not lose money. Apparently if a net selling price of $0.05 per sq. ft. could be realized the plant could operate at 27-28 percent capacity and still break even. On the other hand if the plant could get this price and operate at 100 percent of capacity a gross profit of $359,000.00 per annum would be realized. Provision would have to be made out of the gross return for such items as interest or dividends on capital investment, income taxes, advertising etc. Another line indicating a selling price of $0.07 per sq. ft. is included in the graph Figure 5. Five cents is estimated as a reasonable selling price for board in 4' x 8' sheets because boards of this type made from wood fiber are currently selling at $0.078 per sq. ft. Seven cents per sq. ft. should be a reasonable price providing 50 percent of the finished board is cut into ceiling tile which sell at $0.12 per sq. ft. This seven cent line was included to show the effect a special product would have on the profits and break even point of the plant.

The production of specialty boards of this type might require some additional equipment but the added cost would be insignificant compared to the total equipment cost. Labour requirements should not change as there will normally be two men on the cut off section at all times. For these reasons the same manufacturing cost was used for both types of boards.

The directors of the plant should be aware of every possibility of producing special types of boards. Equipment for making acoustic tiles etc. could be added. Investigation of the production costs for these tiles is outside the scope of this study, but from retail prices this would appear to be a profitable venture. For instance 3/4 inch acoustic tile retails for approximately 33 cents per sq. ft. and the estimated manufacturing cost of 3/4 inch fiber board, based on data from this report, is 4.7 cents per square foot. The spread of 28.3 cents per sq. ft. should cover additional manufacturing costs and leave a handsome margin of profit on the venture.

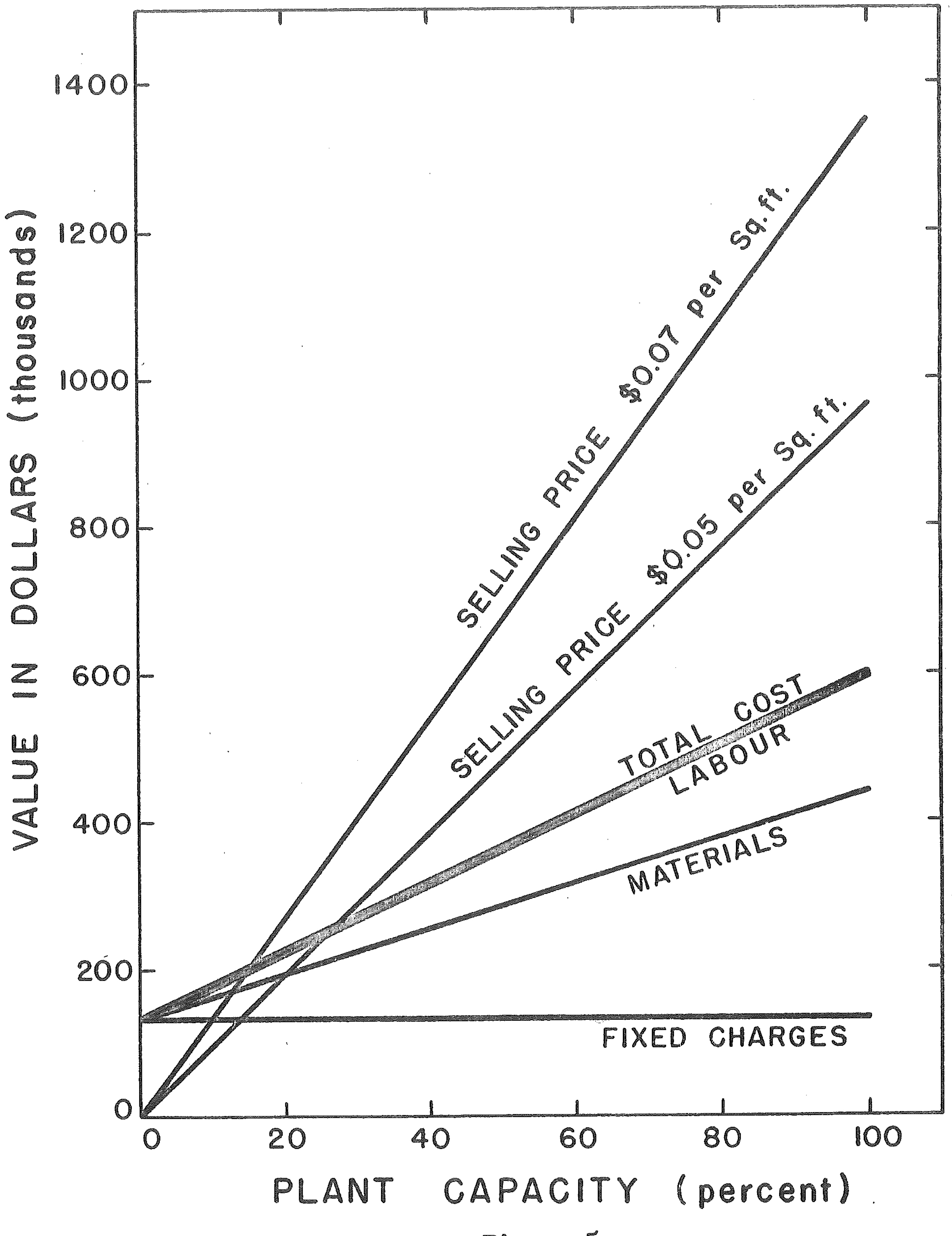
VALUE IN DOLLARS (thousands)
1400
1200
1000
800
600
400
200
0
SELLING PRICE $0.07 per Sq.ft.
SELLING PRICE $0.05 per Sq.ft.
TOTAL COST
LABOUR
MATERIALS
FIXED CHARGES
0
20
40
60
80
100
PLANT CAPACITY (percent)

Figure 5.

Another product from a strawboard plant which might be worth considering is the manufacture and sale of straw pulp for use in making corrugating paper or boxboard. The process is essentially the same as for production of fiber board pulp except that a much finer grade of pulp is needed. The straw would require more thorough digestion and refining to a higher degree followed by screening. The screen rejects could be blended with some of the original pulp to make fiber wall boards and the fine pulp could be dewatered and sold to a boxboard plant in the form of wetlap.

A graph showing the relation between unit cost of production in cents per sq. ft. and plant capacity is given in Figure 6. The curve indicates the effect of fixed charges on production costs. Obviously the most efficient production is realized when the plant is operated at 100 percent of capacity. This of course is not possible at all times, however it is obvious from the graph that the deleterious effect of fixed charges on unit cost of production is not too serious even down to 50 percent of capacity.

As mentioned previously data in this report are based on the batch type soda process. This process using spherical rotary digesters appears to be the only process used in North America to pulp straw. Some minor modifications are made by some mills in the use of neutral sulphite or lime in the digesting medium. Straw pulping processes of the continuous type which are used in other parts of the world are the Celdecor-Pomilio Process and the Morley Process. Both of these are British developments and are used in many parts of the world to pulp straw for fine grades of paper. A good outline of these various processes is given by J.E. Atchison in "Processes Available for Production of Pulp from Sugar Cane Bagasse" (Paper Trade Jour., June 20, 1952) and also in the text book Pulp and Paper Manufacture Vol. 2.

Although these continuous processes are used for pulping straw for fine papers there is a possibility that they could be used to prepare a coarse pulp of the type required for fiber building board. To assess the two types of processes, that is the batch and continuous, they would have to be run on comparable materials and costs of production compared. Experience has shown that by using a continuous manufacturing process production costs can usually be reduced. In view of this there is every reason to believe that one of the continuous processes might reduce the unit cost of manufacturing fiber board. The most significant saving would be in labour costs but this saving would be offset somewhat by higher fixed charges and higher power requirements.

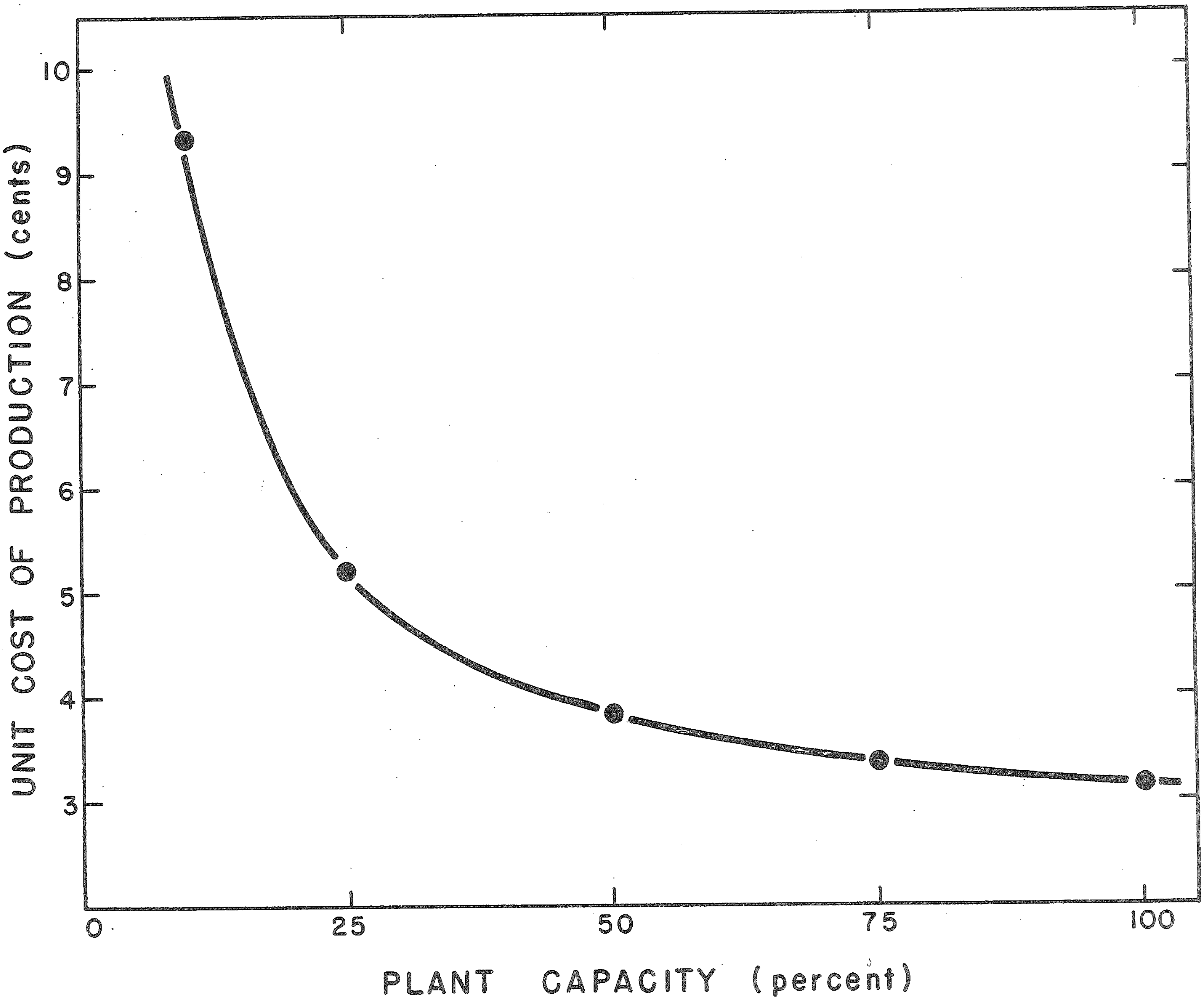
UNIT COST OF PRODUCTION (cents)
10
9
8
7
6
5
4
3
0
25
50
75
100
PLANT CAPACITY (percent)

Figure 6.

TABLE I

EQUIPMENT REQUIRED FOR STRAWBOARD PLANT

		Cost
Steam Boiler		
100 H.P. gas fired		$6,000.00
Straw Cutter		
24" hammer mill with cutter attachment .	$894.00	
25 H.P. Motor	609.00	
Motor starter	110.00	
Total		$1,613.00
Straw Storage Bin		
10 ton cap. approx. 3000 ft. 14 x 14 x 14 feet with sloping bottom 3 feet deep .	$705.00	
Discharge mechanism	300.00	
Total		$1,005.00
Digester		
14 ft. diameter rotary globe, single shell	$14,000.	
10 H.P. Motor	330.	
Motor starter	71.	
Total		$14,401.00
Chemical Tank		
Steel tank 600 g. cap.	$450.00	
Stirrer and motor	200.00	
Total		$650.00
Dump Chest		
2000 cu. ft. 12 x 12 x 12 feet with sloping bottom 3 feet deep	$741.00	
Agitator	700.00	
Conveyor	300.00	
Total		$1,741.00

TABLE I (Cont'd)

Refiners

3 Required, 36" disc, 300 H.P. Stainless Steel		
Unit price with motors $18,500.00	$55,500.00	
Starters	600.00	
Total		$56,100.00

Trash Pump

400 gallons per minute		
Complete with 5 H.P. motor.....	$795.00	
Starter	38.00	
Total		$833.00

Pulp Stock Pumps

3 Required, 400 gallons per minute, Complete with 10 H.P. motor		
Unit price $1,800.00	$5,400.00	
Starters	114.00	
Total		$5,514.00

Stock Chest

40 x 20 x 12 feet deep, 59,000 gals.,		
Concrete construction	$2,000.00	
Motor, starter and agitator	1,700.00	
Total		$3,700.00

Mixing Chest

40 x 20 x 12 feet deep, 59,000 gals.,		
Concrete construction	$2,000.00	
Motor, starter and agitator	1,700.00	
Total		$3,700.00

Rosin Tank

Steel construction 500 gal.	$450.00	
Stirrer and motor	200.00	
Total		$650.00

Alum Tank

Steel with rubber or plastic lining, 800 gal.	$600.00	
Stirrer and motor	200.00	
Total		$800.00

TABLE I (Cont'd)

White Water Tank	
Concrete construction 40 x 20 x 12 feet deep 59,000 gals.	$2,000.00
Board Former	
Single cylinder vacuum former with vacuum pump, Cylinder 8' dia. and 9' face complete with motors and drives	$80,000.00
Roller Dryer	
8 deck, 200 ft. long, gas fired with loading tipple and cut off saw, complete with motor	$278,000.00
Trim Saws	
Saws and carriage	$1,500.00
Packaging Machine	
Complete with conveyor	$4,000.00
Fork Truck	
High lift, 2 ton, gas driven	$8,000.00
Truck	
2 ton, Stake rack	$3,042.00
Hoist	
Electric, 2000 lb. capacity	$297.00
Hoist	
Hand operated, 6000 lb. capacity	$181.00
Controller P.H.	
With valve for alum	$1,570.00
Recorder	
Steam pressure for digester	$120.00

TABLE I (Cont'd)

<u>White Water Tank</u>	
Concrete construction 40 x 20 x 12 feet deep 59,000 gals.	$2,000.00
<u>Board Former</u>	
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<u>Hoist</u>	
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<u>Controller P.H.</u>	
With valve for alum	$1,570.00
<u>Recorder</u>	
Steam pressure for digester	$120.00

TABLE I (Cont'd)

Laboratory	
Control laboratory and equipment	$2,883.00
Office Equipment	$690.00
Tools and Maintenance Equipment	$1,000.00
Plumbing and Electrical Installations	$10,000.00
Stock of Valves, Fittings, etc.	$1,000.00
	$490,990.00

TABLE II

LABOUR REQUIREMENTS

Duties	Number Required	Type of Work	Wages
Straw Handling	6 men - 2 per 8 hr. shift	General Labour	$1.00/hr.
Straw Cutting and Conveying	6 men - 2 per 8 hr. shift	General Labour	$1.00/hr.
Digesting	3 men - 1 per 8 hr. shift	Skilled Labour	$1.50/hr.
	6 men - 2 per 8 hr. shift	General Labour	$1.00/hr.
Refining	3 men - 1 per 8 hr. shift	Skilled Labour	$1.50/hr.
Board Forming	3 men - 1 per 8 hr. shift	Skilled Labour	$1.50/hr.
Drying	3 men - 1 per 8 hr. shift	Skilled Labour	$1.50/hr.
	3 men - 1 per 8 hr. shift	General Labour	$1.00/hr.
Trimming and Packaging	6 men - 2 per 8 hr. shift	General Labour	$1.00/hr.
Shipping and Storing	6 men - 2 per 8 hr. shift	General Labour	$1.00/hr.
Maintenance	6 men - 2 per 8 hr. shift	Skilled Labour	$1.50/hr.
Office	3 men - 1 per 8 hr. shift	Male Stenographer	$1.00/hr.
	1 Manager		$20.00/day
	1 Superintendent		$16.00/day

TABLE III

DAILY COST OF PRODUCING 1/2 INCH FIBERBOARDS

40 tons straw (8% moisture) = 64,274 sq. ft. of board

Materials	Amount	Unit Cost	Cost per day
Straw	40 tons (8% moisture)	$9.39 per ton	$375.60
NaOH (Flake)	2888 lbs.	4.10 per 100 wt.	118.41
Rosin Size	1450 lbs.	6.60 per 100 wt.	95.70
Alum	2174 lbs.	1.85 per 100 wt.	40.22
Kraft Paper	400 lbs.	15.00 per 100 wt.	60.00
			$689.93

Utilities			
Water	245,119 gals.	$0.05 per 1000 gals.	$ 12.26
Steam	72,200 lbs.	0.40 per 1000 lbs.	28.88
Gas	126,680 cu. ft.	0.25 per 1000 cu. ft.	31.67
Electricity	17,111 k.w.h.	0.015 per k.w.h.	256.66
Gasolene	50 gals.	0.25 per gal.	12.50
			$341.97

Labour			
Manager	1 man	$20.00 per day	$ 20.00
Superintendent	1 man	16.00 per day	16.00
Skilled Labour	18 men	12.00 per day	216.00
General Labour	36 men	8.00 per day	288.00
			$ 540.00

Fixed Charges

Depreciation of Building	5% of 297,700.00	.....	$14,885.00
Depreciation of Equipment	10% of 490,990.00	.....	49,099.00
Insurance and Taxes	2% of 791,940.00	.....	15,838.80
Maintenance of Building	5% of 297,700.00	.....	14,885.00
Maintenance of Equipment	8% of 490,990.00	.....	39,279.20
		Total	$133,987.00

Daily Fixed Charges (basis 300 working days/yr.) $446.62

Total Cost of Manufacturing per day $2018.52

Cost of Manufacturing per sq. ft. of board $ 0.0314

TABLE IV

CAPITAL INVESTMENT

Building and Property			$300,950.00
Equipment Cost			490.990.00
Working Capital	Materials and Utilities for 90 days	$92,871.00	
	Labour	48,600.00	
	Fixed Charges	40,196.10	
		$181,667.10	$181,667.10
			$973,607.10

TABLE V

ANNUAL PRODUCTION COST

Cost of materials	$206,979.00
Costs of Power, water, steam etc.	102,591.00
Labour	162,000.00
Total Manufacturing Costs	$471,570.00
Annual Fixed Charges	133,987.00
Annual Production Costs	$605,557.00

Expected Annual Production 19,282,200 sq. ft. of board.