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MEDIUM-DENSITY FIBRE PANELS 1/

by

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*) Translation from the Italian prepared by the organizer of the Course.

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Introduction

Among the products manufactured with forest material which have enjoyed in the last few years the most amazing output increase there are certainly medium-density fibre panels obtained with dry process; manufacture of this up-to-date panel began in the United States in 1966 and in that year it probably did not exceed 40.000 tons.

Durign the period from 1966 to 1971, the increase in the world output capacity as regard medium - density fibre panels manufacture has been relatively low: from 200 tons per day, output reached the level of 1.000 - 1.100 tons per day; in the course of these years, several technical difficulties had to be overcome, in order to design plants able to obtain panels with really satisfactory features and, simultaneously, also the marketing of these panels turned out to be difficult, because their introduction on the market implied fighting against some established uses and habits in this field.

From 1971 onwards, the world output curve has been definitely increasing, with varying increase rates from 25% to 55% a year; at the end of 1975, output exceeded 3.800 tons per day; in 1976, the total output in the United States is supposed to exceed 1.500.000 m3, and a proportional increase is due to take place, most probably, in the other Countries which already have begun this particular activity in the field of wood panels, such as Japan, West Germany, New Zeland, Yugoslavia and others.

In the same way as was previously the case for particles-panels,

the reasons for succes of medium-density fibre panels are to be ascribed first of all to the possibility of use, in their manufacturing process, of by-products of deforestation, (such as big and small branches, branch tops, brushwood ect.),scraps from other wood processes (stock butts, sawmill trims, saw dust and chips, waste wood coming from other wood industries, such as wastes from plywood, veneer planing , joinery, etc.).

In a similar way as allowed by particles panels, even though at a lower degree and with some limitations as regards nature and type of the materials used, it is possible to manufacture medium-density fibre panels starting from agricultural by products (stems of plants which give textile fibres, such as cotton and hemp, sugar cane after use, etc.): this feature can be particulary interesting for those Countries which are typically agricultural and do not rely on considerable forests or which have scanty wood availability, also bearing in mind that medium-density fibre panles represent, with their specific features, a real "re-made wood"; they are more than any other type of panel near to (or even exceed in some aspects) the possibility of processing and using, the price advantages, and the prerogatives of massive wood.

The density and specific weight of natural wood depend on the number of fibres making up a volume unit and on the density characteristics of the fibres, whereas weight and density of fibre panels are practically independent from the relevant values which identify timber, or other raw materials of the wood cellulose family, from which one has to start to manufacture them.

Also starting from very hard and heavy wood types, fibre panels with excellent features can be manufactured, such as high mechanical resistance, keeping their specific gravity between 600 and 700 kg/m3 . Still in comparison with natural wood, as regards its possibility to be machined (milling, drilling ,beading etc.) it should be considered that medium-density fibre panels can be easily machined uniformly in all directions; also easy and cheap are surface finish operations of any kind, coating and enamelling, veneering and plasting, etc.

Another specific advantage of medium-density fibre panels, which on the other hand is an advantage featured by any type of wood panel, plywood and hard fibre panel etc. , is represented by large sizes, an advantage which means easy and econimic use: it is now currently possible to make panels in sizes 2.00 x20.00 mt, that is panels having an area of 40 sq.mt. or more.

Their thickness varies in general between 8 and 25 mm, but there are no technical difficulties in manufacturing panels with thickness 6 or 30 mm.

In the manufacturing Countries of subject panels, the demand of forniture industries largely exceeds the availability and this gives rise to a real "prime" on prices in comparison with competitor panels, that is particles panels; but the higher cost can be easily neutralized, when considering lower processing expenses and better quality of furniture prodiced with fibre panels.

They are moreover particularly interesting for all the most important uses in the building industry: coatings, fixed and movable walls, floor foundations, elements for floors on different levels , etc.

In short , it can therefore be said that the first ten years of

life of mediumdensity fibre panels have allowed not only to overcome every technical and operating difficulty, but also to introduce this new product into the highest market interests.

Therefore, after having introduced the general aspects of this new industrial branch and of its outcome, this report intends to explain the features of a typical plant, allowing medium output rates, and of its elements, also giving some indication - which we hope is going to be useful - on the operation principles, on the overall convered area which is necessary for the relevant industrial factories, on the energy requirements (heat and steam, electric energy) and on the weight of the machinery and mechanical installations which compose every sector of the plant under examination.

I Description of the manufacturing process to obtain medium density fibre panels, with "dry" system.

In this survey, we are going to indicate as basic raw material timber in the form of small diameter stocks (from 8 to 15 cm) and of branches (diameter from 5 to 8 cm) , materials which may be considered as by-products of deforestation , largely integrated by industrial waste, such as sawing mills'trimmings, chips of various nature, drillings, shavings and saw dust.

The materials in fairly regular and large pieces (stocks and branches, trimmings and offcuts) are stored in regular piles and up to 4 - 5 mt in height on the special yards of the factory, with some cares (bearing lines sufficiently above the ground

level) in order to avoid biological alteration of the materials which remain at the basis of the pile itself.

For laying of this timber in piles, the use of fork lifts and of buckets with Diesel motors is necessaty.

The smaller size materials (chips and saw dust) can be conveniently stored into bins, if the quantity to be used is relatively modest or if supplies are costinuous or if processing takes place continuously; otherwise it is necessary to create large bulk stacks and, if the climate of the place where processing takes place reaches certain average season temperature and moisture or plain levels, the problem of good preservation of the materials for a relatively long period may arise, in that those climate conditions would imply a deteriorating attack from fungi, moulds and bacteria.

It is not the case here to examine the means to prevent degradation of piled up timber: it is enough to state that this degradation is possible and, as an example, a system is indicated to insufflate, at low pressure, and through special sheet channels equipped with slots and simply lying on the ground, a mixture of air and combustion products; this gaseous mixture at moderate temperature (35 - 40^{o}C or even less) creates inside the stacks an unfavourable environment for development of a parasite attack, it prevents rain water from penetration also when protection coverings are not available and it determines a decrease in the timber moisture rate, which makes the converting operations due to take place easier and more economic.

Large size timber, lifted with buckets and laid onto trucks, is led towards the first converting stage, to reduce it into chips , which

is carried out through powerful and robust machines called in fact "chippers".

After mixing with the material in chips coming from the abovementioned stacks or from the storage silos, if any obtained chips are introduced into a general feed hopper equipped with an hydraulically controlled extraction device, which starts them at high speed; they are then moved to a belt conveyor, in varying quantities, with the aid of an intermediate screw.

The conveyor belt introduces timber into a washing plant in which any foreign matter is eliminated (sand, mould etc.), which might cause damages to the subsequent machines belonging to the plant, or even jeopardize the finisched product.

The washing plant consists of a deep container , into which the chips are forced, and of a tilted screw stirrer, at the ground of which water is recovered and filtered in order to be introduced once again into the cycle.

After washing, the material is conveyed to other hoppers with smaller dimensions arranged above the grinders and equipped in their turn with hydraulic extraction and proportioning devices, which also also allow to break the "vaults" which the chips may build between the hoppers' walls and which would hamper regular descent towards the vertical outlet canalazations.

Starting from grinding and up to the "felt" forming station (from which, by hot-pressing, the panel is then obtained), the material is treated in two separate preparation lines.

From the dosing hoppers timber is then conveyed, through an hermetic screw and a vertical fitting equipped with vibrator, to the pre-heater , inside which a steam pressure is kept, which can

reach 12 atmospheres: the screw we mentioned before is conical, and this allows to build, at the heater's inlet, a material "plug" which stands such pressure, though allowing a regular and uniterrupted feeding.

Under the effect of heat and steam, lignin, which is the natural binder of wood fibres, becomes soft, and this allows to subsequently separate fibres one from the other with a minimum of energy needed and without deteriorating them.

By means of another screw, timber coming out from the pre-heater is introduced into the "disk grinder" : the material is forced to pass between a static disk and a rotating disk and this determines separation of fibres.

Under the effect of the steam pressure kept inside the grinders, the fibre is blown through a valve and a blowing nozzle into the dryer; at this point is also placed a special deviation valve, which allows to convey the fibres to a centrifugal separator, which separates them from steam and recycles them, in case they have an exceeding moisture content (as is the case, for example, when starting the plant); this would alter the conditions for regular operation of the drying unit and the following operations.

Drying of the fibre is carried out in two stages, in blow type dryers, in which hot air is used both as dehydrating vehicle and as trasport means.

Each dryer is equipped with a combustion chamber working with fuel oil or with gas: combustion gases are adequately mixed with outside air in order to reduce their temperature to the degree for dryer operation; to restrict the fire risk, this temperature is kept on a relatively low level, especially in the fist stage, where the smallest fibres may rest on the walls and then become over-heated.

The first stage is represented by a vertical drying tower and the fibre material is introduced into the lower part to be extracted from the upper part; fibres are then separated from drying gas and from steam produced in the first stage, moved by the same fan which introduces the gaseous mixture into the tower, by means of a centrifugal separator.

From this stage , fibres pass to the second stage, which is also represented by a vertical tower and into which another fan introduces the hot gaseous mixture coming from the corresponding combustion chamber.

Again a centrifugal separator takes care of successive separation of fibre and , through an extraction system, the material passes to the resination treatment , that is application of a synthetic resin being catalyzable and thermosetting.

At this point it ought to be said that, in order to obtain sufficiently water-repellent panels, it is necessary to apply a small quantity of mineral wax to fibres , in a similar process as is done for particles panels processing (we intend paraffin wax) ; this application can be done simultaneously with resination, by mixing wax in an emilsion with the solution of synthetic resin, or applying it to fibres when melted , before resination.

The experience has shown however that the best results are obtained when applying ozocerite (fossil wax) , brought to melting in tanks with heating jacket, directly into the grinders, through proportioning pumps and spraying nozzles, which are in their turn heated and kept at a considerably higher temperature than the wax melting temperature.

The fibre coming out of the centrifugal separator situated below the second drying stage is introduced in a storage hopper, which allows to have the necessary reserve among the first sections of the plant and the sections for resination of the material and for panel formation; the air dischareged by the centrifugal separator is in its turn conveyed into a secondary centrifugal separator having high performances, which separates the fibre fraction which might have escaped the first separator; this fraction is so collected end set in the cycle once again.

The resin which is usually employed for medium density fibre palels is an aminoplastic product, based on urea and formic aldehyde, or melammine ; it can be purchased as concentrated solution (approx. 65%) and stored into tanks protescted against temperature excesses, if the chemical industry which manufactures it is at such a distance as to make its trasport convenient; beyond a certain number of kilometers, it can be seasonable to purchase the product in the form of powder and, in this case, is is necessary to prepare it to make a solution at the moment of real use.

A catalyzer, or hardener , must be added to resin; it is generally purchased in powder.

A special appliance takes care of automatic and continuous proportioning of the two components, of addition, which is also automatically proportioned, of diluting water and of their minute mixing.

Fibre and binding mixture are then introduced, with the desired ponderal ratio, into the glueing machines.

Proportioning of fibre coming out from the storing hopper, extracted by a screw, is carried out by means of a weighing conveyor belt, which is overhung and oscillating; the corresponding proportioning of the prepared resin is carried out through special precise metering pumps, connected with scales which weigh the fibres so as to keep the percentage of resin on the weight of this material scrupulously constant, as has already been said.

Almost all manufacturing companies adopt now the same type of glueing machine: it consists of a cylinder which can be opened, placed horizontally, with double wall for machine cooling during its operation through water circulation; this cooling allows to avoid resin and fibre deposit and therefore to reduce cleasing and maintenance operations to the very minimum; the cylinder has a feed inlet and an outlet hole with counterweight lock; inside it there is a rotating hollow shaft, equipped with three series of arms having different shapes and purposes.

In the shaft cavity, the glueing mixture is introduced under pressure , and it passes to the intermediate series of amrs, straight and hollow themselves, carrying at their end a spraying nozzle; the first series of arms ends with helical blades and its purpose is to distribute in the section the fibre , to project it forward; the third series has the shape of robust spatula, with reinforced ends to reduce the wear due to abrasion; this series has the task of distributing resin uniformly in the fibrous mass.

This is deposited into a hopper equipped with conveyor-scraper which spreads it uniformly and with extractor-proportioning unit which transports it towards a series of disintegrator rollers which eliminate any clots; there is then an Archimedean screw with two

outlet screws, which separates them into as many percentages which are then pneumatically conveyed to the station where felt to be pressed is formed.

A centrifugal separator separates again the glued fibres from the transport air and this moves downwards to feed the forming station , which includes three distribution heads, in each one of them the mass is uniformly spread on the whole length.

A continuous conveyor made of filtering cloth slides below the forming station and receives proportioned fibre when falling; fibre forme in this way the felt; below the conveyor there are three vacuum boxes, one for each distribution head, vacuum being kept with as many vacuum fans; fibre adheres this to the belt during the whole passage below the station, and , after the station itself, felt which has been formed is normalized and levelled by a special roller.

The fibre in excess, separated by the roller, as well as the fibre recovered by the air coming of the centrifugal separator, and of the fan belonging to the first vacuum box (the air coming from the other two fans does not need to be filtered) is set in cycle once again.

The conveyor belt transports subsezuently the felt towards a press for preliminary pressing, having another rubber conveyor belt (considerably thick) , which reduces its height to 1/3 or 1/4 of the original thickness : this press has a low pressure section, having the task to let most contained in the fibre felt out, and a second high pressure section, for definite pre-pressing.

Felt leaves then the filtering belt and is moved to another compact belt, made of plastic reinforced by inserted cloth, along which

edges are ground and transverse cut takes place (by means of a circular saw which moves diagonally) to have the length corresponding to the finisched panel; also the wastes coming from these longitudinal cuts and transverse cuts are recovered and re-set in the working cycle.

Before being introduced into the high pressure section of the preliminary press, fibre felt passes through an electromagnetic appliance which may spot the accidental presence of metal foreign matter: the parts of the felt where this takes place those which, for other reasons, must not be forwarded, are automatically eliminated after passage under the fractioning saw.

After this operation, the felt sections are forwarded at higher speed towards other three conveyor belts arranged in series, and then onto a steel belt synchronized with the last accelerating belt, which passes through the heated-paltes press ; the steel belt takes care simultaneously of felt charging into the press and of extraction of the pressed panel.

The pressin the most important machine in the whole plant, a real "heart" for the plant itself: it has only one pressing room and, for resasons of a given output to be obtained , it has considerable sizes; the lower plate is fixed, whereas the upper plate, driven by many hydraulic cylinders, is a adjustable in height according to the desired panel thickness to be obtained; each cylinder is equipped with a stroke adjuster, which also adjusts pressure, which allows to eliminate the traditional system involving metal spacers; in fact this system had incanveniences and it was not able to ensure the highest panel calibration .

The heastes plates have strong thickness, from 90 to 120 mm according to the press dimensions, with perfectly flattened surface and

with a system of inside canalizations through which the heating flow is circulated , thus ensuring best temperature uniformity. In order to avoid any overheating of the lower plate and also of the upper plate, which would determine their deformation and consequent wrong gauging of the panels, the paltes are accurately insulated from the platforms and, to avoid any possible heat passage, a special device for refrigerating water circulation is placed between plates and platforms; again , to prevent possible differences in temperature between the lower part and the upper part of any platform, the same water is also circulated outside the plates themselves.

Temperature at which platforms are kept is around 200°C and specific pressure exerted on the felt reaches 34 - 35 kg/sq.cm. For press starting, mineral oil is preferred at present , and also for its heating diathermic oil preferable as compared to overheated water under pressure , in that the former allows to install automatic boilers under atmospheric pressure and without the need of qualified attending staff.

At the press outlet, panels are forwarded to a rotating rack , which allows to leave them cool adequately; they are then passed to the squaring up section, along which automatic saws take care for grinding of edges, and then to the fractioning section, in which the panel is sawn into parts having submultiple sizes as regards its original lenght and width: both section are arranged in series. Panels move then to conditioning in a special room, where they are left in piles for a few days, so as to allow stabilization of the glueing resin and uniform spreading of moisture which has remained in the panel after pressing.

The last operations, before panel storage , are gauing and smoothing, obtained with their passage in contact smoothing machines, with two or three pairs of belts arranged above and below and operatin, therefore, on both sides; at last , testing , trademark application and separation of the various quality levels.

The grinding dust, eliminated through suction and then separated from the air in a sleeve filter , as well as trimmings deriving from the squaring up operation and saw dust are not used again in the working cycle, but they are used to feed the boiler.

II

Basic data relating to a typical plant for medium density fibre panels manufacture, with dry sestem: its verious elements and features of same.

- medium rated output capacity, that is referred to panels having thickness 19 mm and specific weight 700 kg/m3 140 tons per working day (24 hours) = (200 m3;
- panel sizes, 1830x18;300 mm, to be subdivided for example into 5 panels with sizes 1830 x 3.660 mm;
- panel thickness ranging from 8 to 25 mm;
- specific gravity from 600 to 650 kg./m3.

Overall sizes of this plant; its arrangement and the size of the industrial factory needed to contain it (excluding ancillary buildings and storehouse with packing and forwarding department) are indicated in the enclosed drawing I.

Preparation of fibres

Processing begins with transformation into big chips, by means of milling chip-former with double head and with feeding belt having a 2 mt. length (not indicated in the drawings), which needs a pawer of 150 kw; these chips are laid near the first feeder of the whole manufacturing line, next to the material already in small pieces as mentioned in chapeter I.

The two raw materials are inserted into a concrete tank (drawing II, No. 020100) ; with a capacity of approx. 60 m3 , on the bottom of which a couple of hydraulically driven automatic feeders is arranged; downstream the tank , a 6 m screw moves the material on a tilted belt conveyor (same drawing, No. 200200), with a length of 60 mt and a width of 650 mm; another conveyor follows , with length 5 m and width 800 mm, equipped with magnetic detector for spotting and elimination of possible metal foreign matter (same drawing , No. 020300) .

The washing plant, which includes also the system for sand and mould elimination , the timber extraction plant and the water re-cycling plant are indicated at No. 020 400.

Under reference No. 020500 you see the conveyor-scraper which has the task of adjusting the material quantity which is inserted into the hoppers 020600 (each with 10 m3 capacity), equipped with hydraulic device for grinders ' feeding .

Total weight of the metal parts which compose the appliances as above mentioned : approx . 40 tons; total installed power : 100 kw.

The pre heaters with relevant screw-feeding system and the grinders, built with stainless steel or, in any case, with anti -

acid steel, are indicated with No. 030100 ; under the grinders you see the small plant (No. 040100) for melting and introduction in pre-fixed proportions of ozocerite into the grinders themselves; from these , through the special valve No. 030200, the micture fibre steam passes to the drying units, or, in the starting phases, it is temporarily deviated do the centrifugal separator No. 030300.

Fibre drying , application of glueing resin (bonding agent)

Under reference numbers 030400 of drawing II you see the burners of the two dryer's stages; on their side you see the combustion oil tanks, the oil pre-heaters and the primary air fans; at the subsequent pair 030400 you see the two drying phases and , at reference number 030500, the screw conveyor which introduces the fibres into the store hopper (not indicated in the drawing, also because it is not always necessary) ; then , with reference No. 030600, the oscillating conveyor belt pro - portioning unit, enclosed into an airtight metal chamber, feeding the glueing machine 030700, which has already been explained before; the applicances for preparation of the resin mixture and for its proportioned pumping into the glueing machine are indicated with reference No.040200, always in the drawing II .

The total weight of the machines and relevant devices, from pre-heaters to glueing machines, is 85 tons, and the corresponding electric power installed is 2120 kw.

Pneumatic trasport of resinated fibre, its metering and storage, forming and pre-pressing of fibre felt.

In drawing III , under reference No.050100, you see the pneumatic device , fan, centrifugal separator and fibre extracting device, for the trasport from the glueing machines to the propotioning silo 050200; this , built with section iron and with steel plate , is, as regards its upper part, a scraping unit for levelling; which distributes fibre on the whole available length, and, on the bottom, it is a variable speed conveyor which conveys the material towards a line of disintegrating rollers which represent the front closing of the silo itself.

A screw situated below recesive the material, subdivides it into two fractions, and introduces it into as many pneumatic conveyors which, through centrifugal separators 050300, feed the forming station. This, indicated with reference No.050400, has three fibre distribution heads type "pendistor" and allowe to form a felt having rated width 1.830 mm; three levelling rollers are placed before the heads and, in coincidence with the heads and under the forming belt, the vacuum boxes are situated, whose suction fans are indicated with reference No. 050600.

It can be noticed that the levelling rollers assembled after the first and the third head of the forming station send the extracted material back, through pneumatic conveyors, to the centrifugal separator situated above the central head , while the roller arranged after the second head sends the material to centrifugal separator 050510 which sets it into the proportioning silo again.

The forming station is followed by the preliminary press (No.050800), which includes the low-pressure and high pressure sections ; between the two, the detector is placed, which intervenes in case of presence of metal foreign matters. The pressure exerted by the rollers of the preliminary press is given by hydraulic devices; rotating brushes take care to keep the press rubber carpets clean.
Further on , the saw for longitudinal trimming of the pressed felt are indicated, and the saw for operation with transverese cuts: the material deriving from trimming and cut is brought back to the first and third head through pneumatic belts 050700. Weight of the installations described in this paragraph, 160 tons totally; electri power installed :1015 kw.

Transport of fibre felt, hot - pressing , cooling of panels, their squaring up, sectioning and piling up.

On drawing IV you see the end part of the third section , at accelerated speed, of the felt conveyor belt; upstream this section there are other two sections, still at higher speed, which take care of convenient spacing of out felts between each other; the second high speed section is equipped with a deviator which allows to send to a disintegrator the possibly irregular felt sections.
The one-station hot press, through which a continuous steel belt passes, for introduction of the felt to be pressed and extraction of the pressed panel, has a power of 11.900.000 kg., which determines a specific pressure of 34 kg/sq.cm.; the thickness of hot

plates is 120 mm, the maximum opening between them is 300 mm and the number of cylinders controlling the upper plate is 44.

After the press, another deviator with disintegrator is installed, which allows to eliminate faulty panels; then the rotating rack in cooling chamber No. 070100 , with 12 rays, with roller devices for automatic charge and discharge; there is then the group of saws for squaring up of panels and their division into sections, two of which for longitudinal cuts, equipped with mills for trimmings' disintegration, two for head xuts, also with disintegrating mills, and four for intermediate cuts.

The sectioned panels are then forwarded to the device 070300 for automatic piling up, which inclused a hydraulic lifting table, a series of motorized rollers-plates and a device for alignment of panels arranged in a pile.

Weight of machines and equipment of this section, about 500 tons; electric power installed 770 kw.

Conditioning warehouse, gauging-smoothing, selection

On drawing V you see, on the right, the warehouse in which panels are stored and left for the time as necessry to complete cooling of piles, polymerization of the binding resin and uniform spreading of moisture inside the panels themselves.

From the warehouse, the panels are frowarded to the gauging - smoothing unit, of "contact" type, with one or several pairs of counterposed belts (one pair, in the drawing) , indicated with

No. 080100 ; for automatic feeding of this machine there is a track on rollers, on which fork lifts lay piles of panels, a hydraulic lifting table with pneumatic device and with motorized roller system for feeding of each panel, and a ther gliding plate before the machine.

The selection plant, which allows to undertake two panel selections, (first and second choice) receives panels directly from the gaugin-smoothing unit : it is indicated with No.080200 and it includes a testing conveyor, with mirrir system for simultaneous examination of upper and lower side of the panels, a shifting section with two outlets, each of them equipped with hydraulic lifting table, extractor and alignment device for panels and gliding plates on rollers with notches for taking of piles by means of fork lifts. Total weight of machines and appliances of this section, about 100 tons; installed electric power 460 kw.

Heating plant

In the heating plant a boiler is installed for output of the steam needed for the wood grinding plant and for other ancillary services; the total quantity of steam needed is 6-tons per hour, corresponding to about 4.000.000 Cal/hour.

Operating pressure in the boiler 15 atmospheres.

For press heating, installation of an oil-operated boiler is foreseen, having a power of 2.500.000 Cal/hour, and being able to reach a temperature of about 220°C.

Protection against fire

The fire danger for plants like this must obviously be taken into deep consideration and prevention must be extremely scrupulous: the installations designed for the plant as described use water as anti-fire means: in the most dangerous points, the action of water is integrated by the issue of halogen gases which ckoke the flames.
The detectores which automatically operate the plant are of the infrared "Firefly" type in the points where fire might begin.

Main specific technical data

These data are referred to manufacture of panels having athickness of 19 mm. and a specific gravity of 700 kg/cm.
Timber consumption (anhydrous weight) for each ton of panels produced .....1 ton

steam quantity needed for each ton of panels .....1 ton

energy " " " " " " " .....400 kwh

fuel oil consumption for dryers, for each ton as above , 120 kg. binding resin consumption (urea-formaldehyde, anhydrous weight), for each ton as above .....90 kg

ozocerite needed , as above .....20 kg

hardener needed, as above .....2 kg

The following will also be needed:
water (900 l/min are needed for cooling plants) ....1.000 l/min

compressed air (7 atmospheres) 10 m3/min

Staff needed

- for management and administration :	1	factory manager
	1	sales manager
	1	production chief engineer
	1	chemical engineer
	1	mechanical engineer
	1	electr.engineer
	1	production assistant manager
	2	accountants
(staff needed follows)	2	salesmen
	1	administration manager
	2	technicians
	2	secretaries
	2	shorthand - typists
	2	employees
	3	shop foremen
	1	chief of the yard
	1	store manager
	1	maintenance chief engineer
	1	chief electrician
	1	spare shop foreman

on the whole , 28 persons

- workers: 3 x 3 shifts on the timber yard, total 9
2 x 3 shifts at fibre preparation, total 6
1 x 3 shifts at the glue dept., total 3
1 x 3 shifts at forming station, total 3
3 x 3 shifts at the press section, total 9
2 x 3 shifts at trimming and grind., total 6

panels selection, warehouse, packing
inside trasports in this section,
boiler, total 15

1 x 3 shifts, mechanics total 3
1 x 3 shifts, electicians total 3
1 x 3 shifts, aids for above-ment. total 3
1 x 1 shifts, lubrication total 1
3 x 2 shifts, cleaning total 6
1 x 3 shifts, janitors, total 3
4 x 1 shifts, maintenance total 4
3 x 1 shifts, electric plants total 3

(workers follows)

1 x 1 shifts, conditioning
warehouse, total 1
2 x 1 shifts, joiners total 2
2 x 1 shifts, drivers total 2

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on the whole 82
about half of which specialised and
1/3 qualified or semi-specialised

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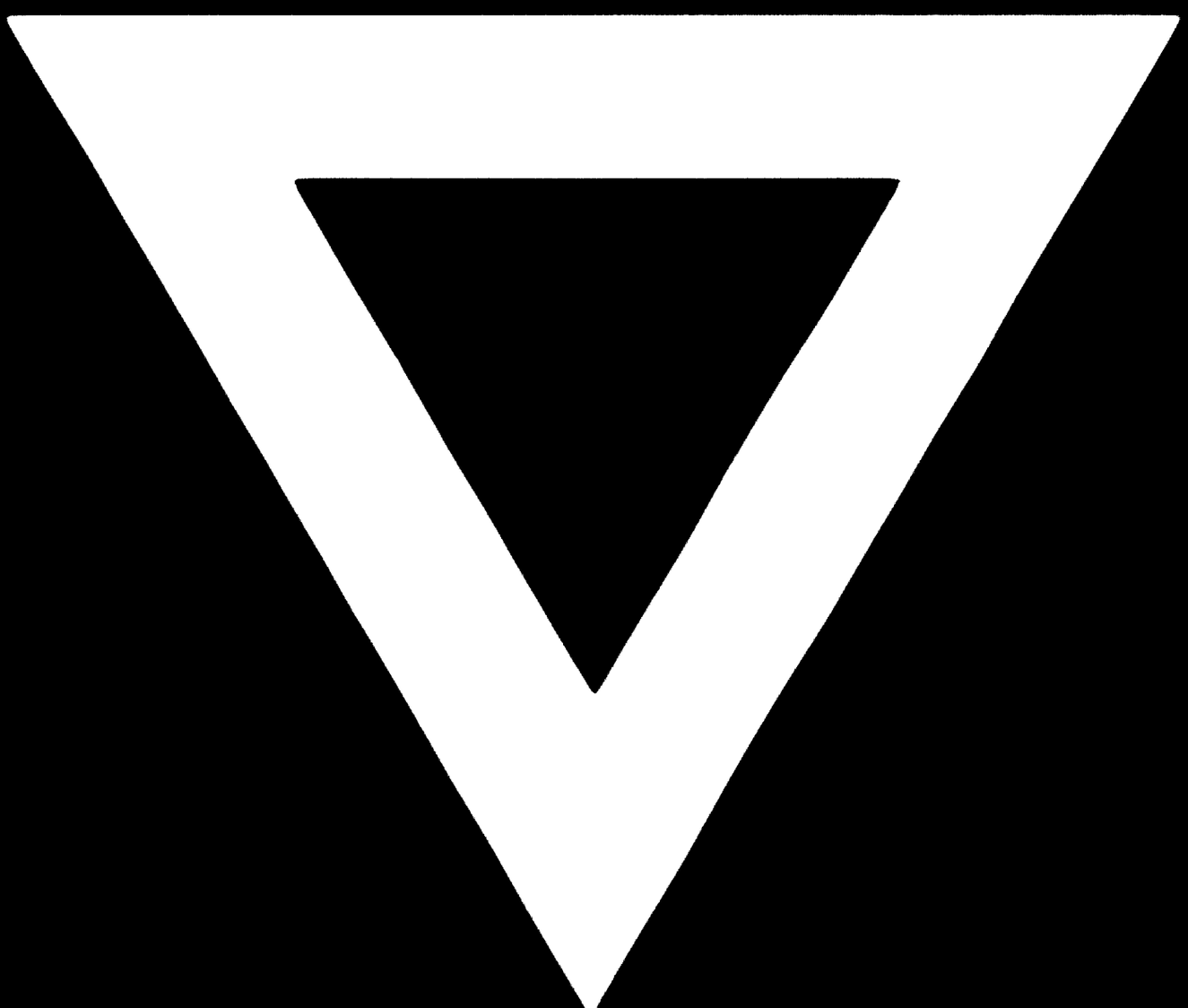

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