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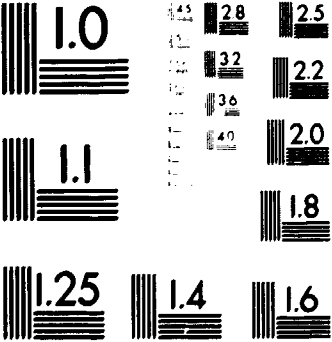

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PARTICLE BOARD - TECHNOLOGICAL PROCESS AND SOME PROPERTIES*.

Prepared by

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1. INTRODUCTION

A brief chronology of the evolution of considerations and practical approaches to particle board will be outlined in this introduction. The first initial ideas related to particle board go back to the end of the last century; to be more particular to the year 1887 when Ernst Hubbard suggested the production of boards made of waste materials in one of his articles published in Germany. Efforts were pursued later along the same lines in the United States (Watson, 1905) and Germany (Beckmann, 1918 and Freudenberg, 1926). In addition to a number of other advocates of this idea, two Americans (Carson, 1932 and Nevin, 1933) continued with the efforts to put it into practice. Loetcher of the United States was the first, in 1935, to even embark upon production in a prototype plant. In Switzerland, Pfhol and Chappius obtained patent rights in this field, and the former is considered the author of the widely known European patent covering the manufacturing of particle board. The technical options related to the manufacturing of particle board were put into practice primarily due to the economic crisis in 1940 and 1941, obviously with a number of risks involved in the project. The first plant, although rather small, went into operation in 1941 at Trofit Werke in Bremen, Germany. Inadequate and too expensive synthetic adhesives are considered to have been a major obstacle to practical production in the years before 1941. Fred Fahrni has considerably improved the process of industrial production of particle board and, therefore, has been considered one of the leading pioneers in this field. After World War II, activities related to the development of particle board were significantly intensified, particularly within the framework of the Institute for Wood Studies in Braunschweig (Dr. W. Klauditz), as well as by manufacturers of adhesives and woodworking machines. By 1949 production of good urea-formaldehyde adhesives had been achieved, and simultaneously a number of special machines required in individual stages of particle board production were also developed.

The period after 1950 is characterized by a gradual expansion in the production of particle board, based on experiences gained through trial runs, new marketing strategies and development of new manufacturing facilities in the years 1941-1950. The first production of particle board in Yugoslavia goes back to 1961; 13 small-scale plants with an annual capacity of 6,000 tons had been erected by the year 1964. Modern, technologically adequate and economically viable production of particle board in Yugoslavia, however, began only after 1970; by 1976 4 up-to-date particle board plants had been established in Slovenia in the following enterprises: GLIN in Nazarje, LESNA in Slovenj Gradec, BREST in Cerknica and MEBLO in Nova Gorica.

The following table gives comparative data for sales of particle board and fibreboard on the international market (in 000 m^3):

Region	Particle board[1/]		Fibreboard[1/]		Plywood[1/]	
	1981	1982	1981	1982	1981	1982
Europe	23,569	22,922	4,066	4,225	3,444	3,286
Yugoslavia	789	830	114	110	153	152
Soviet Union[2/]	5,000	5,300	-	-	2,000	2,000
Canada	715	600	740	560	2,086	1,700
U.S.A.	6,100	5,000	4,900	4,600	14,800	14,300

[1/] Estimates are given for 1982 (source: ECE, Geneva, 1982).

[2/] Fibreboard sales figures were not available for the Soviet Union.

For the sake of comparison it may be mentioned also that the world output of plywood exceeds that of fibreboard.

This paper outlines the specific technological process applied in the LESNA, Slovenj Gradec, particle board plant, as well as some characteristic features of this type of production and of particle board in general. Problems, however, related to this topic are certainly much more extensive and numerous than may be considered by a paper of this scope.

2. SOME PROPERTIES AND CHARACTERISTICS OF PARTICLE BOARD

Before proceeding with this paper it is necessary to define particle board. According to T. Maloney the definition of a particle board is: "A generic term for a panel manufactured from lignocellulosic materials (usually wood), primarily in the form of discrete pieces or particles, as distinguished from fibres, combined with a synthetic resin or other suitable binder and bonded together under heat and pressure in a hot press by a process in which the entire inter-particle bond is created by the added binder, and to which other materials may have been added during manufacture to improve certain properties. Particle boards are further defined by the method of pressing. When the pressure is applied in the direction perpendicular to the faces, as in a conventional multiplaten hot press, they are defined as flat-platen pressed; and when the applied pressure is parallel to the faces, they are defined as extruded".

The ISO (International Organization for Standardization) definition is as follows: "Panel material manufactured under pressure essentially from particles of wood and/or other ligno-cellulosic fibrous materials (for example wood chips, sawdust, flax shives, etc.) with or without the addition of an adhesive, hydraulic binders being excluded".

It is particularly in highly developed and industrialized countries that properties and characteristics are specified clearly for individual types of products. This field is regulated in national standards elaborated within separate committees or standardization unions. Some of the most known standards that spell out technical regulations covering particle board are:

DIN	68 763	Deutsche Industrie Normen
DIN	68 761, Teil 1	
DIN	68 761, Teil 4	
BS	5 669	British Standard
ASTM	D - 1037	American Society for Testing and Materials
ASTM	D - 1554	
ISO	820	International Organization for Standardization
ISO	821	

ISO 822 International Organization for Standardization
ISO 823
ISO DIS 4025
ISO P 5606

In order to facilitate the solution of problems within the international framework, the ISO has embarked upon the elaboration of international standards for particle board. In Yugoslavia properties of particle board are stipulated by the national standard JUS:

JUS D.C5.030
JUS D.C5.031
JUS C.C5.032

It is necessary to stress here the close correlation between standardization efforts, on the one hand, and the technological progress made in individual countries on the other. Particle board standards, for example, in West Germany are thoroughly developed as they have been permanently updated and thus followed the technological progress in this field.
The following chapters of the paper will outline some of the most significant mechanical properties of particle board spelled out in the DIN standards. All data and figures apply to particle board used in the furniture industry, and hence reflect the level of progress and requirements of this industry. Properties required for individual types of particle board are closely related to the purpose for which they are used. The standards, for example, specify the properties of particle board used in building and construction. The vast majority of the standards stipulate properties of individual particle board thickness classes. Let us examine some particle board properties required in furniture industries; this type of particle board is defined in the standards as general purpose particle board:

Thick class mm	Bending strength N/mm2	Tensile strength N/mm2	Thickness swelling %	Moisture content %
DIN 13-20	16	0.35	8	5 - 11
JUS 14-19	18	0.41	8	9 ± 3

Let us here underline the fact that most national standards, including DIN, stipulate minimum values; the JUS, however, contains three quality classes of particle board (Extra, I, II) and the above JUS figures only apply to top quality particle board. Individual standards differentiate among varying thickness classes; this paper covers the thickness class generally applied in the furniture industries.

The Yugoslav standard for general purpose particle board (JUS D.C5.031) contains three thickness classes; in addition to that specified in the table on page 4 there is one class up to 14 mm and one above 19 mm, whereby thickness intervals are always 1 mm.

Most national standards classify particle board on the basis of the following criteria:

Manufacturing process:	Flat pressed
	Extruded
Structure:	One-layer
	Three-layer
	Multi-layer
	Graded layer
Face surface:	Pressed
	Sanded
	Coated
	Veneered
Density:	Low-density
	Medium-density
	High-density
Particle board type:	In terms of applied adhesive
	In terms of purpose

The following basic standards cover the properties of unprocessed particle board in West Germany and Yugoslavia:

Standard / Purpose of use	DIN	JUS
For general purposes	68 761	D.C5.031
For building	68 763	D.C5.032

The table below gives comparisons among indivudual types of particle board specified in the above-mentioned standards:

Standard / Purpose of use	DIN	JUS
For general purposes	V 20	TP 20
For building	V 100	TP 100
	V 100 G[1/]	TP 100 G[1/]

[1/]Protection against Basidiomyceten.

The next table indicates adhesives used according to DIN standards:

Resin / Type of board	UF	PF, P PR,	UFM[1/]
V 20	X	-	-
V 100	-	X	X
V 100 G	-	X	X

UF Urea-formaldehyde resin

PF Phenol-formaldehyde resin

P Phenol resin

PR Phenol-resorcinol resin

UFM = UF - Melamine resin

[1/]Subject to special approval of an authorized institution.

[2/]Additional protection against Basidiomyceten.

Durability and resistance of boards to climatic conditions, i.e. micro climate, are defined in JUS D.C5.032 (Particle board with horizontal particle distribution for building purposes):

TP 20	Boards resistant when used indoors, not resistant to atmospheric climatic conditions
TP 100	Boards resistant to high relative air humidity, with limited resistance to atmospheric climatic conditions
TP 100 G	Boards resistant to high relative air humidity, with limited resistance to atmospheric climatic conditions; additionally protected with a fungicide.

3. DESCRIPTION OF THE TECHNOLOGICAL PROCESS

(a) Storage of wood-based raw materials

About 140,000 m^3 of wood-based raw materials of varying assortments and species are needed for the existing maximum annual outputof 90,000 m^3 of particle board. The structure of the wood-based raw materials required is as follows:

Coniferous species	65 %
Broadleaved species	35 %

The ratio of woodworking waste and shavings to round logs is 60 : 40, and the structure of the 60 % of woodworking waste is as follows:

Chips	30 %
Sawdust	25 %
Off-cuts from sawmills	45 %

Obviously the above ratios may change to a certain extent from one year to the other. The average monthly stocks of wood-based raw materials are two months' requirements. The plant has 10,000 m^2 of asphalt-covered storage space, and slightly more than 10,000 m^2 of storage space on non-surfaced soil. Some raw materials are transported to the plant by rail, but the majority reach it by road (trucks and lorries).

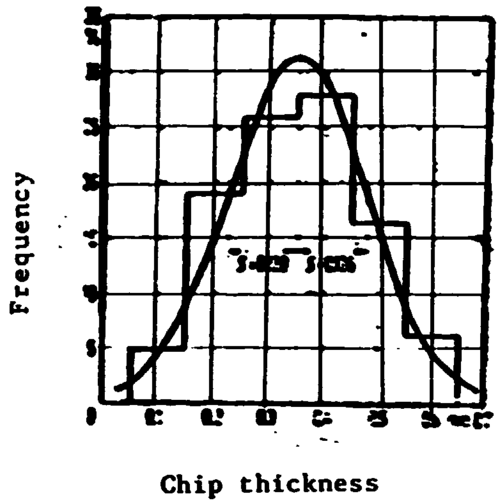
(b) Particle preparation

Particle preparation consists primarily of the manufacturing, classification and drying of particles. Depending on the structure of wood-based raw materials, different flakers are utilized to process particles. Two

U - 74 drum flakers manufactured by the HOMBAK company are used for long round logs and partially for scantling and slabs, two Pallmann ring flakers are used for chips, and a chipper manufactured by Kloeckner is used for the preparation of chips from sawmills' scantlings.

The refining of surface layer particles precedes drying and follows pre-drying; the flaking stage is accomplished in ring refiners manufactured by the ALPINE Company. The preparation of surface layer particles is separated from the preparation of core layer particles. The general feature of the technological process used in this particular plant for three-layer particle board is the separate preparation of surface and core layers that precedes the particle spreading stage. Sawdust is classified mechanically prior to storage in a silo and drying. Particles are stored in separate silos according to their varying properties, and the quantitative dosing required for each individual layer is monitored and adjusted to the specific requirements for each board thickness. The next stage is drying. Prior to drying the moisture content of particles varies: in summer it is lower than in winter, and may, in extreme cases, be as much as 130 per cent. Surface layer particles must be dried to about 3 per cent moisture content, and core layer particles to around 2 per cent. The drying of surface layer particles goes through two stages: during pre-drying the particles are dried to 35 - 45 per cent moisture; during the consequent flaking in the ALPINE ring refiners and the final drying, the target moisture content is reached. The drying itself occurs in tube dryers manufactured by Buettner with continuous fresh air operation. Once dried, the particles undergo air classification in classifying machines manufactured by Keller; the particle air separation is applied separately for surface and core layers. Once this stage is over the particles are transported to dry-particle silos.

The quality and thickness of surface and core layers' particles vary. The envisaged thickness of surface layer particles is 0.20 - 0.30 mm, and that of core layer particles ranges between 0.40 to 0.50 mm. It is desirable that the distribution curve be as narrow and sharp as possible, i.e. that the distribution be as even as possible.



This is an example of normal distribution of particles; in practice the curve may be lower or shifted more to the right or to the left in its own axis, i.e. asymmetrical.

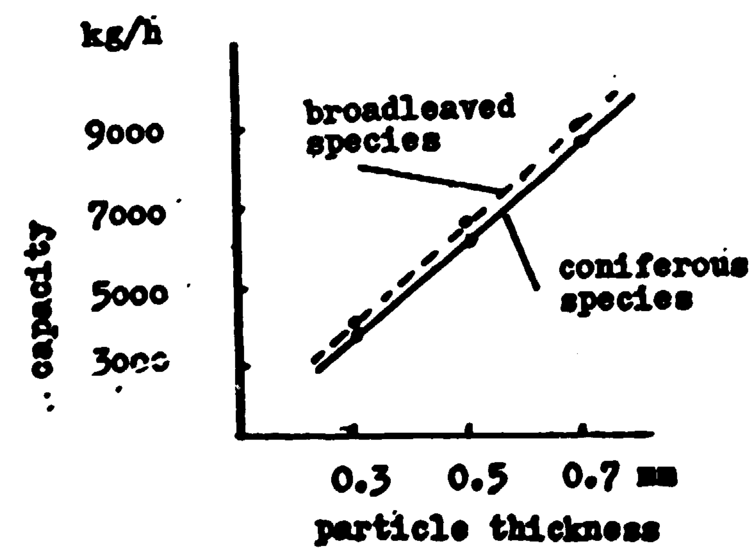
The quality and form of the particles obviously can also be influenced by other factors, such as:

- The type of wood-based raw material (form and species of wood)
- The moisture content of the wood
- The setting of the woodworking machines

The flaker's capacity, on the other hand, will depend also on a number of factors:

- The type of wood-based raw material (round logs or industrial wood residues)
- Particles' thickness
- The wood species (coniferous, broadleaved)
- The moisture content of the wood.

The impact of wood species and particles' thickness may be illustrated by the curve of the flaker's capacity in hours, shown below:

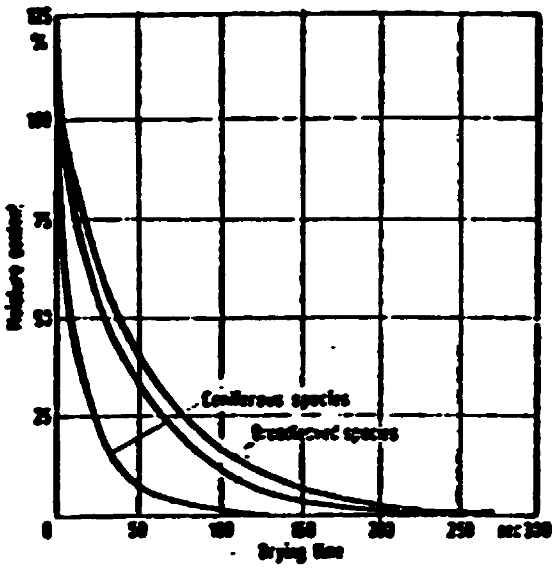


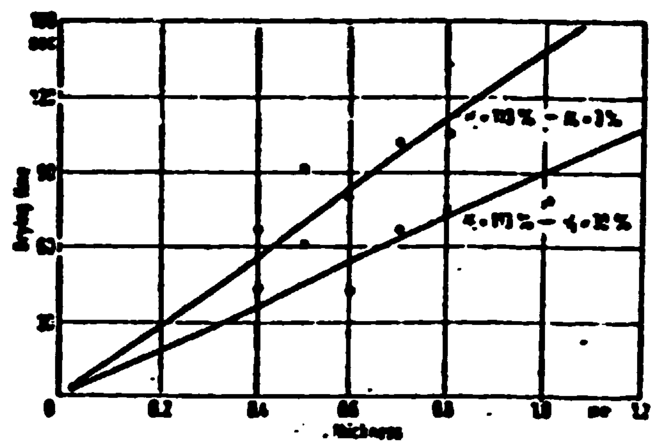
Ring flaker capacity for Type KHZ-14, KLOECKNER Co.

The type of particles used obviously influences the drying process itself which, generally, depends on the following properties:

- The moisture of the particles
- The thickness of the particles
- The species of wood

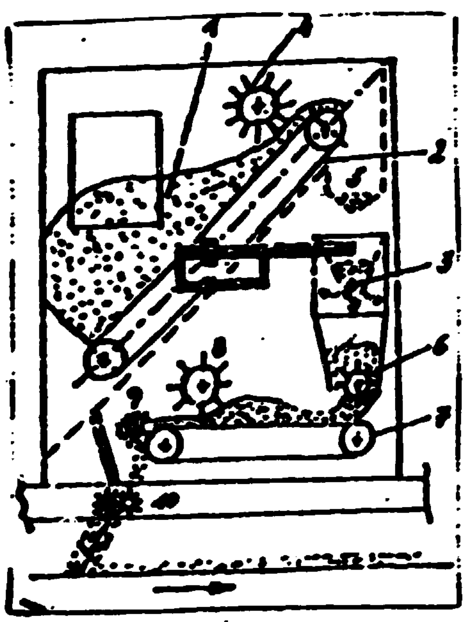
The moisture content, in particular, exudes correlation with wood species, and together with the particles' thickness it influences the time and quality of drying. The following two diagrams illustrate drying time and quality:





(c) <u>Gluing and spreading of particles</u>

The particles are transported from both the dry particles silos for surface and core layers to weighing scales, a flattening hopper, and gluing machines. The gluing is performed in two KTT-350 gluing machines manufactured by DRAIS; one of them is used for the surface and the other for the core layers. The nozzles for glue distribution are located along the axis of the gluing machine; the gluing process thus implies a centrifugal motion of the particles from the axis towards the outer casing of the gluing machine. The casing itself is cooled by water. The particles travel in circles from the flattening zone through the gluing zone towards the zone of subsequent mixing. The gluing is based on the use of a glue mix, composed of urea-formaldehyde adhesive, a hardening agent, a paraffin emulsion and water. The mix is prepared separately for the surface layer and the core layer. The hardening agent is used to control and regulate the timing of the glue-binding process that follows the previously described stages and only takes place in the hot-pressing stage. The surface layer moisture content ranges from 11 to 12 per cent, and that of the core layer between 8 and 9 per cent. The glue mix is usually prepared in a special room. Once the particles are all covered by glue they travel from the gluing machines to spreading machines manufactured by WUERTEX; here two spreading machines are utilized for the spreading process for the surface layer, and another two stations for the core layer.



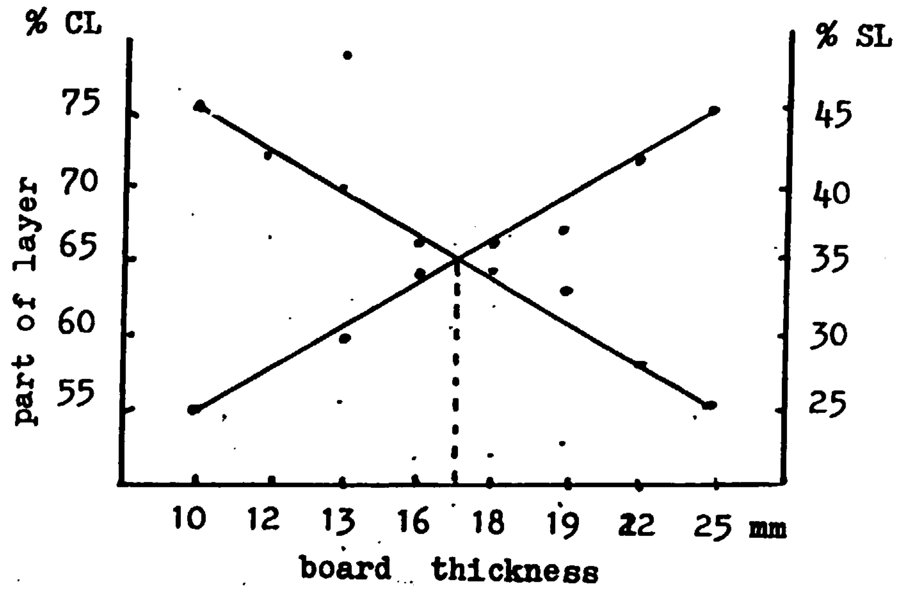
1. Loading hopper
2. 7. Infeed and outfeed conveyors
3. Weighing hopper
4. 8. Kick-back rollers
9. Outfeed brush roller
10. Needle roller

The above figure illustrates the spreading method used in our specific spreading machines. A combination of gravimetric and volumetric spreading is applied in this specific type of mat forming. The particles are spread on the forming belt that is moving to the press.

A metal detector and a pre-press are located next to spreading machines. A continuous cold pre-pressing process is the next stage, where a pressure of 0.30 - 0.40 N/mm^2 is used in the pre-pressing stage.

The pre-pressing itself boosts the strength and homogeneity of the chip mat, which is of paramount importance in view of the risk that the mat structure may be impaired during the transportation of the mat along different conveyors. This problem is much less significant in the technological processes that imply the use of special support plates or wire screens.

The particle size of the surface layer is smaller than that of the core layer, and the quantity ratio between the surface layer and core layer particles depends on the board thickness desired. See the diagram below:

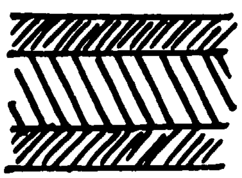


CL = Core Layer

SL = Surface Layer

The diagram indicates a specific feature of the specific type of technology used in our plant, i.e. that the share of the core layer grows with the increase in board thickness, and vice versa.

An example of the surface layer/core layer ratio for a 17 mm thick particle board 65 / 35 per cent is shown below:



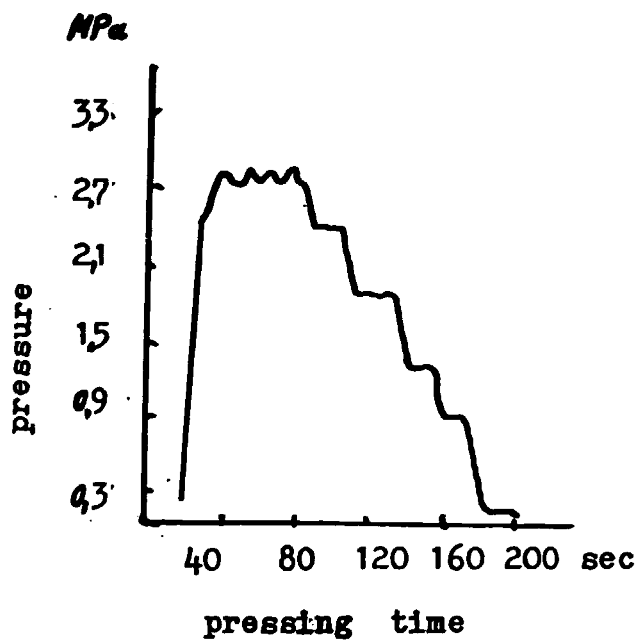
SL 17.5 %

CL 65 %

SL 17.5 %

(d) Pressing of the particle mat

From a forming belt the mat travels to an accelerating belt and a feeding belt towards the press. A special tray belt press loader, located prior to the press, is now loaded with mats; this discharging service is used to feed the seven-day light press. Pressing temperatures range from 150° C to 180° C, depending on the board thickness. The press manufacturer is SIEMPELKAMP.



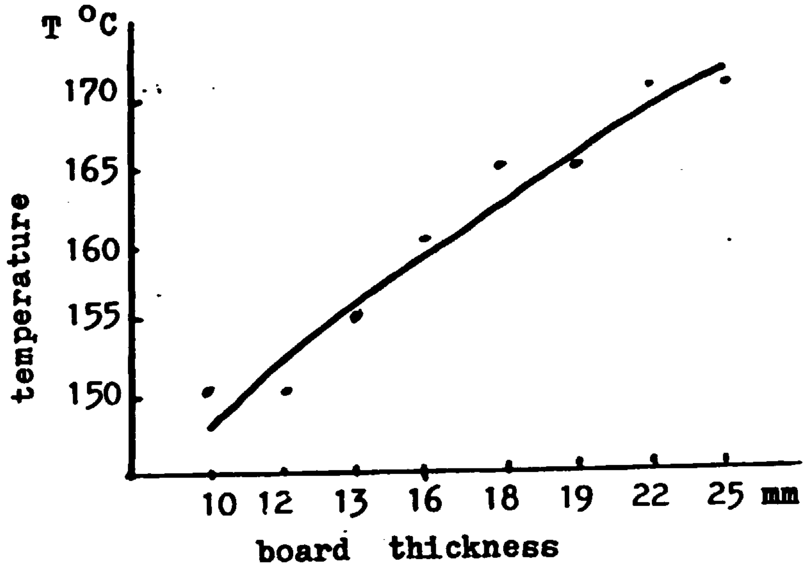
Analyzing the above diagram the following stages may be observed:

- Press closing time
- Chip consolidating time
- Vapour-removal time

In functional terms, on the other hand, the following procedures are involved:

- Secondary routines (press loading and discharging)
- Press closing
- Maintenance of nominal board thickness

The diagram below shows pressing temperature and its dependence on particle board thickness:



The technology described here involves water-heating of the press. There are obviously other systems in which the heating medium could be thermal oil and where temperatures considerably above 200° C can be achieved. That high temperature is certainly inconceivable in water-heating systems. In addition to adequate pressure the temperature of at least 103° C in the board core is another prerequisite of a good pressing procedure. The entire technological process and the glue polymerization depend on the above temperature. The specific pressing pressure is 2.8 N/mm^2. Pressing time primarily depends on:

- Pressing temperature
- Pressure
- Mat thickness

Pressing time is expressed by the pressing factor (f_p) that is determined by the following ratio:

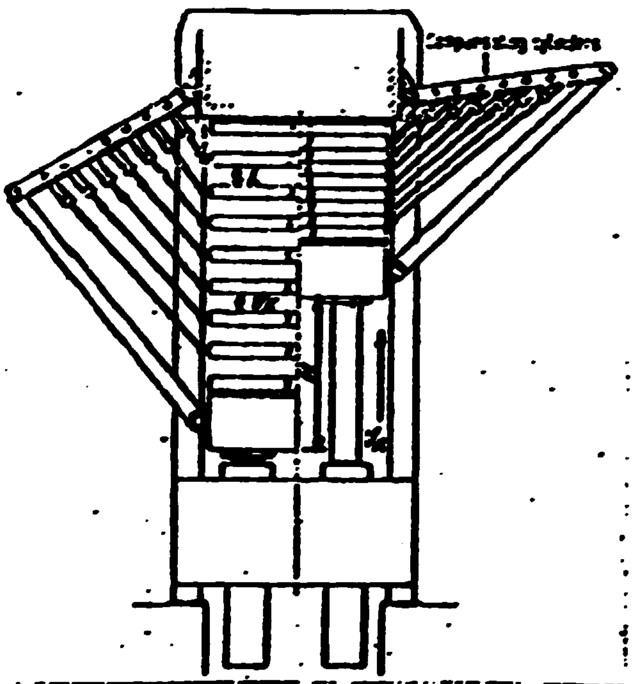
$$f_p = \frac{t_p}{a_b} = \frac{t_p}{a_n + 1.5} \quad \text{(min/mm)}$$

f_p = pressing factor a_b = gross board thickness

t_p = pressing time a_n = net board thickness

When the operation time is longer (in difficult working conditions during winter) the pressing factor for a 16 mm thick board amounts to f = 0.23 min/mm. In normal operating conditions the pressing factor may be reduced to 0.20 min/mm.

Press closing is simultaneous, i.e. all the mats in the press are in contact with heating plates simultaneously. The figure below illustrates the press closing cycle:



L = light opening (mm)

V_e = light closing speed (mm/sec)

H = maximum possible press lift

$$V_E = \frac{V_k}{n} \; ; \qquad ts = \frac{n \cdot L}{V_k} = \frac{H}{V_k}$$

V_k = cylinder speed (mm/sec)

n = number of openings

t_s = closing time of the press without mat (sec)

Particle board strength in general, and bending and tensile strength, in particular, depend on press closing time. Boards produced in an operation that involves rapid press closing are characterized by:

- Good bending strength
- Normal tensile strength

The density profile of such a board looks like the graph on page 17.

If the press closing time is longer, the tensile strength will increase and bending strength will be normal. The pressing process can be monitored freely; hence the particle board properties that certainly depend on technical possibilities, too.

Special distance bars can be used to regulate the board's thickness in the press itself; the distance bars are inserted into the press and correspond to varying board thicknesses. Electronic monitoring of nominal board thicknesses is also possible; here no distance bars are used and only the four press edges are monitored.

Once the pressing cycle is finished, the boards leave the press and have a moisture content of about 7 per cent and a termperature of almost 100° C. The cooling stage begins immediately after pressing. The boards are loaded onto a special turning device and cool down to some 60° - 70° C. The next is the curing stage during which the boards are stored for three to seven days. The main characteristics of the curing process are:

- Equalization of moisture content inside the boards
- Final binding, i.e. glue condensing, stage
- Equalization of intrinsic tensions

(d) Sanding and cutting to size

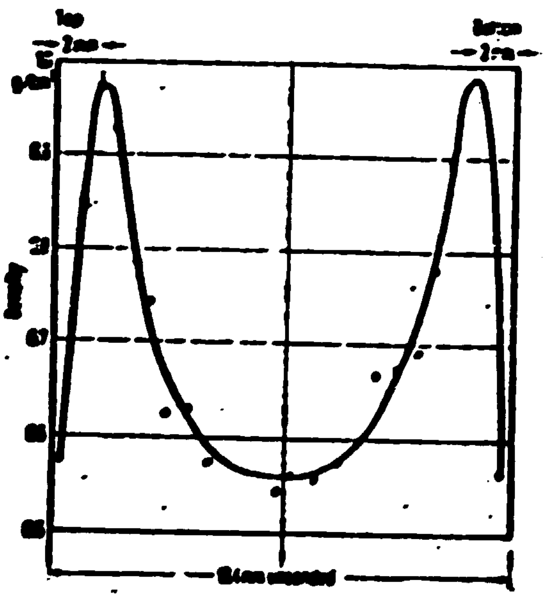
Once the curing stage is over the boards are sanded on a wide-belt sanding machine manufactured by BISON-BAEHRE; the machine has six heads and three motors. In the first stage the board thickness is balanced and in the next two stages the boards are fine-sanded.

The feed speed is 10 to 20 m/min and it depends on:

- Board thickness
- Thickness tolerance

- Surface layer density
- Further use of the boards (purpose)

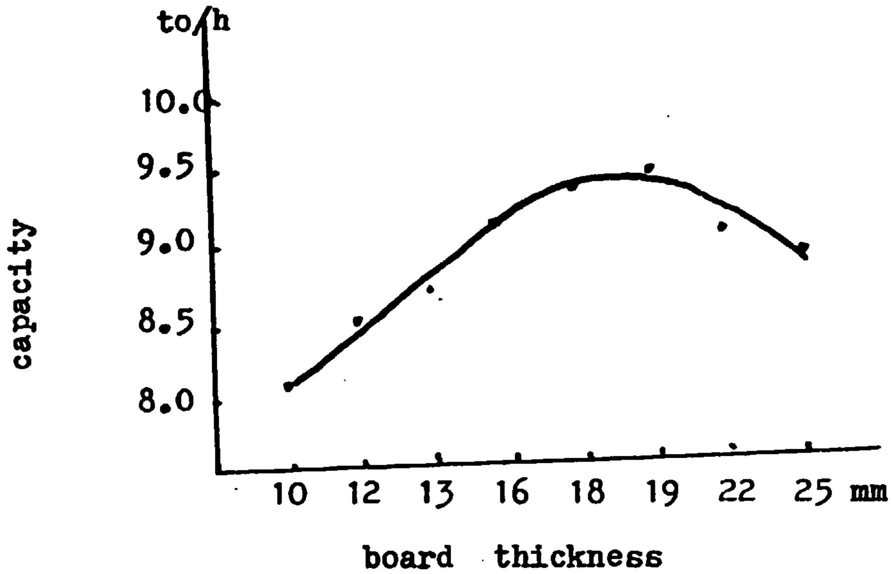
The boards that are to be improved at later stages of the process and whose density ranges between 900 and 1,000 kg/m^3 are sanded at a low feed speed (10 - 15 m/min). The normal boards, aimed for further processing and used in furniture manufacturing, are sanded using a combination of sanding papers, the grain size of which is 40 to 80. The. sandind is then followed by longitudinal squaring, transverse squaring and, if necessary, the boards are then cut into two or more pieces. The boards are then inspected and graded on special tables; the grading is based on mechanical properties determined by laboratory testing, as well as visual determination of board surface quality. Tolerated thickness variations after sanding depend on the boards' thickness; variations tolerated for a particle board with a thickness up to 20 mm is ± 0.30 mm, and for thicknesses above 20 mm it is ± 0.40 mm. When discussing the sanding procedure the following significant element for the determination of some particle board properties must be understood. It is the cross-section density profile of a board. A typical profile of this type is shown below:



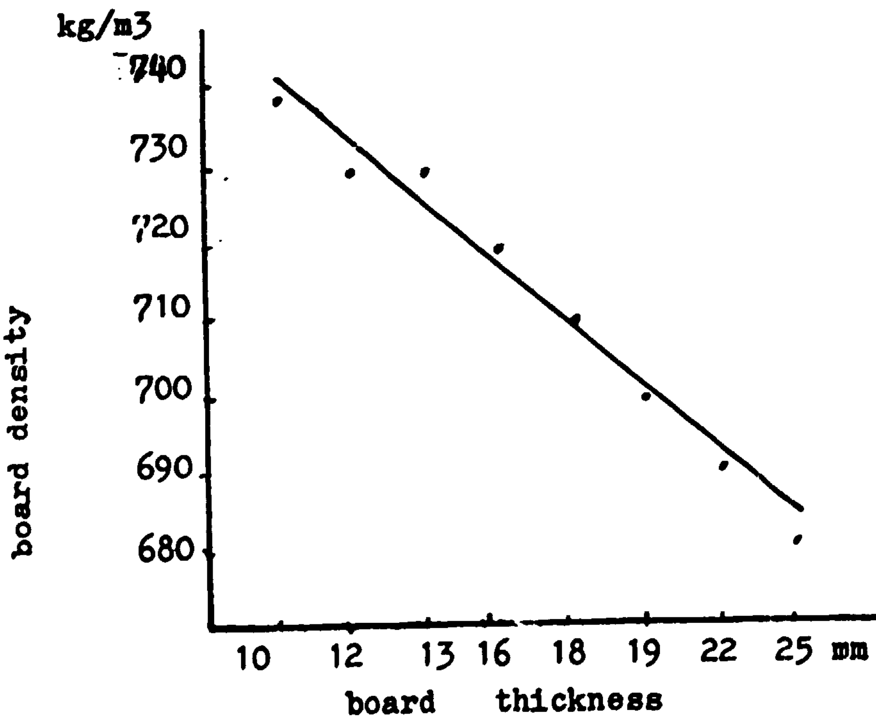
In this connexion we must point out the need to remove (by sanding) a portion of surface layer which is immediately followed by a layer with high density. In this manner desired surface quality may be achieved.

4. SOME CHARACTERISTIC FEATURES OF THE PRODUCTION PROCESS

The basic net size of the boards, in the case of the factory visited, is 2,050 x 5,500 mm, and their thickness ranges from 6 to 28 mm. The plant's capacity is correlated to board thickness and indicated in the diagram below:



Like capacity per hour, the board density is also correlated to board thickness:



The diagrams indicate that board density declines with the increase in board thickness. The plant is in operation 355 working days a year, and it operates in three shifts, with four teams. Major repair and reconstruction or overhaul operations are planned on an annual basis.

The plant employs a total of 230 persons. Some 40 per cent of all boards are further improved on two SIEMPELKAMP KT lines (using the short pressing cycle procedure). The annual output has recently approached 90,000 m^3 of which some 2.5 million m^2 are surfaced with melamine resin impregnated paper. Sixteen mm boards account for some 60 per cent of the entire output and this thickness is used almost exclusively for surface improved boards.

The consumption of the most significant raw materials and power per unit of product in this plant meets the following standards:

Wood-based raw materials	1.55 m^3/m^3
Adhesive	100 kg/m^3
Power	160 kwh/m^3
Fuel oil	65 kg/m^3

The above power figure does not comprise the power used for both KT lines for the surfacing of particle board, nor the power obtained by sanding dust used as fuel in the boiler room. The figure, however, covers the power required for technological steam and to fire the drying machines.

All other costs are relatively small, and the above standard consumption of basic raw materials and power accounts for two-thirds of all costs incurred. The salaries, for example, only represent about 6 per cent of the plant's total expenditure. In addition to the above variable costs, annuities and interests, both in dinars and hard currency, account for a major part of the fixed costs.

5. QUALITY CONTROL

There is a well-equipped laboratory and qualified experts who closely follow the technological process in all of its stages. Every day quality control of the input of raw materials is undertaken; in the production process quality control follows individual production stages, and end products are submitted to thorough scrutiny as well. In terms of organ- organization, the quality control department is closely related to the technology department.

The quality control of the following raw materials is a routine operation in the plant:

- All types of wood (shavings, chips, sawdust)
- Adhesive (specific weight, pH, dry substance content, gelation time, viscosity)
- Paraffin (melting point, purity)
- Paper used for surface improvement of boards' moisture content, resin content)

The most significant quality controls during individual stages are:

- Moisture of particles (dry and wet particles)
- Structure and form of particles
- Gluing mix (dry substance, gelation time, viscosity)
- Gluing of particles
- Boiler water (pH, hardness, etc.)

Polluted water is also analysed (e.g. dry substance content, pH, formaldehyde and oxygen content, temperature).

The following properties of the particle boards are controlled:

- Moisture content of thechip mat
- Bending strength
- Tensile strength
- Swelling
- Board thickness
- Density

The above quality control routines and properties are those for the TP 20 boards used for general purposes.

The boards, as a rule, should be monitored in compliance with the relevant standards. The JUS D.C5.031 applies to boards used for general purposes, and the JUS D.C5.032 applies to boards used for construction.

No Yugoslav standard is available for improved boards that have not been dealt with in this paper. Therefore the quality control of the end product is, in this case, based on the American NEMA* LD 1-2.01, LD 1-2.02, LD 1-2.05 and the German DIN 68 765 standards. The properties of the boards that are spelled out in the basic standards, however, may also be determined on the basis of the standards required by specific methods.

The JUS requires the testing of one board of each thickness class per day. In practical terms one board is tested in each shift. The quality control results are processed statistically by calculating the mean value $\bar{x}$ and the standard deviation . The results are then recorded on special control cards. The calculation method itself is laid down in a special standard.

Once a year boards are tested by an authorized institute that eventually issues the certificate on their properties. One board in each thickness class is tested in this framework.

Occasionally the free formaldehyde content in the boards is also tested by the plant. For this purpose a special perforator method is used as stipulated by FESYP.** Yugoslav standards have not so far required the checking of the free formaldehyde content. Hence no maximum values that may be contained by individual board types are prescribed in our standards. Speaking about free formaldehyde, the German standard DIN 68 761 (part one) is applied conditionally; i.e. it is still in a testing stage. It applies to general purpose boards and its paragraph 3.4 that deals with the free formaldehyde emission requires at least the E3 emission class for the boards in question. For the sake of explanation of this problem let us emphasize that guidelines have been elaborated for the territory of the Federal Republic of Germany that cover classification of boards in terms of free formaldehyde emission. The following classification of emission classes is contained in table 1 of the guidelines:

* National Electrical Manufacturer's Association, 155 East 44th St., New York 10017, U.S.A.

** European Federation of Particle Board Manufacturers' Associations, Wilhelmstrasse 25, 63 Giessen, F.R.G.

Emission class	Emission value in ppm HCHO	Perforator value in mg HCHO/100 g of an absolutely dry board
E1	0.1	10
E2	0.1 to 1.0	10 to 30
E3	1.0 to 2.3	30 to 60

Emission of free formaldehyde is indeed a problem the solution of which can no longer be postponed, even in Yugoslavia. In this field efforts made by both particle board manufacturers and the manufacturers of adhesives to reduce the emission can already be noticed and observed.

6. CONCLUSIONS

This paper deals with some properties and characteristic features of particle board, as well as the technological process of its manufacture. The properties and required quality of the boards have been related to the technical legislation and standards available. The paper briefly outlines the technological process used in a specific plant at this moment. The author attempts to single out those properties that are common to all particle board manufacturers, particularly those of three-layer flat pressed particle boards that are based on a belt-transportation of the chip mat to the press.

The plant described in this paper manufactures the largest assortment and range of boards in Yugoslavia in terms of the sorts and types of particle board. Let us enumerate them once again:

TP 20	Boards used for general purposes
TP 100	Boards for use in construction and building
TP 100 G	Boards additionally protected against fungi
OP	Surface improved boards

The TP 100 G board was produced industrially for the first time in September 1983. The plant also manufactures a board resistant to termites (TP 100 GT is the internal code number for this board), which is particularly suitable for use in tropical and subtropical climatic conditions, characterized by the problem of termites, and where inadequate boards may have disastrous consequences.

The paper does not cover the technological process used in the manufacturing of surface improved boards that are also produced in the plant in question.

Some diagrams have been used also for outlining the specific technological process and properties of particle board; they either refer directly to the technological process described or can be found in literature.

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3. Anon. : Wood-based Panels International, January/March 1983.

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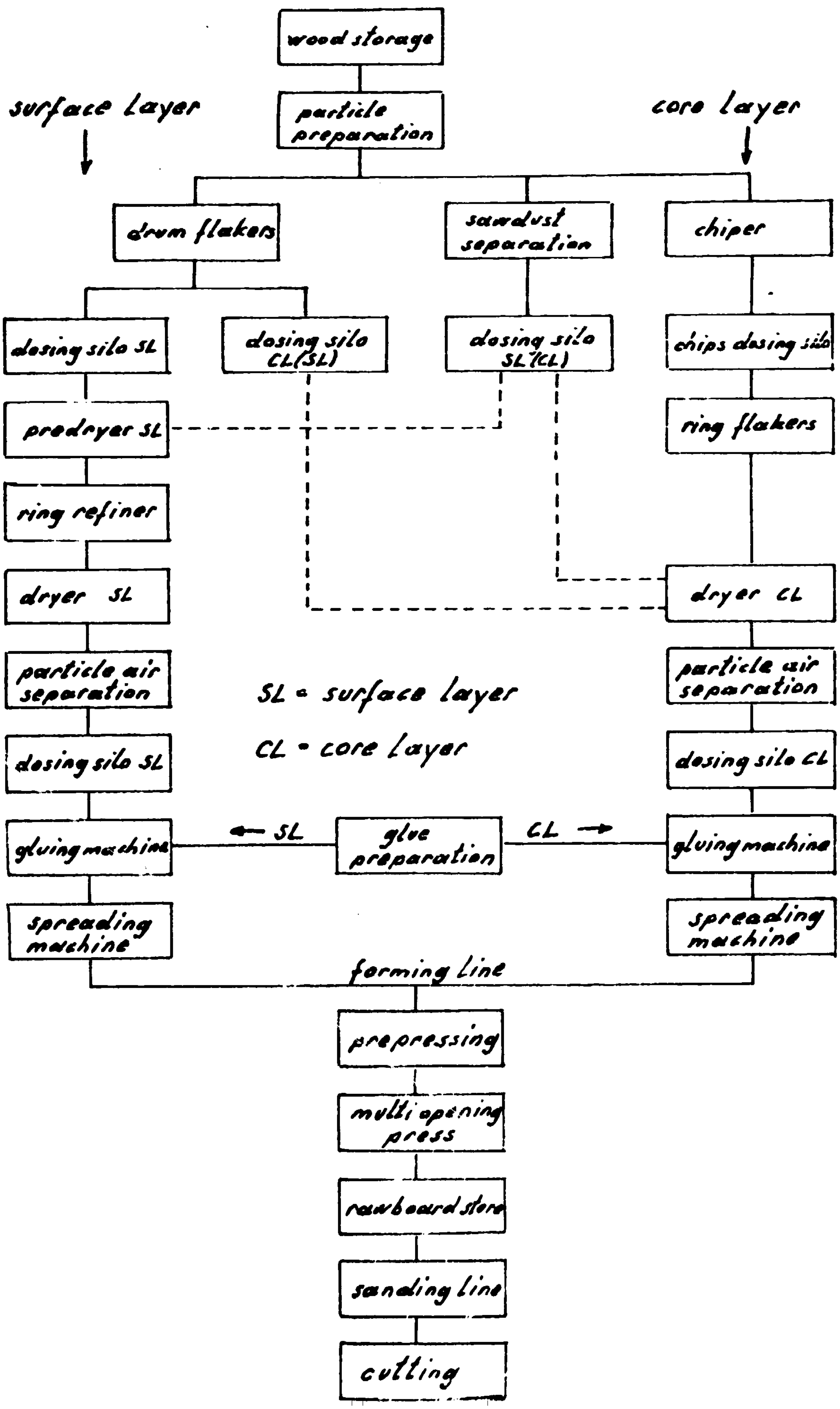
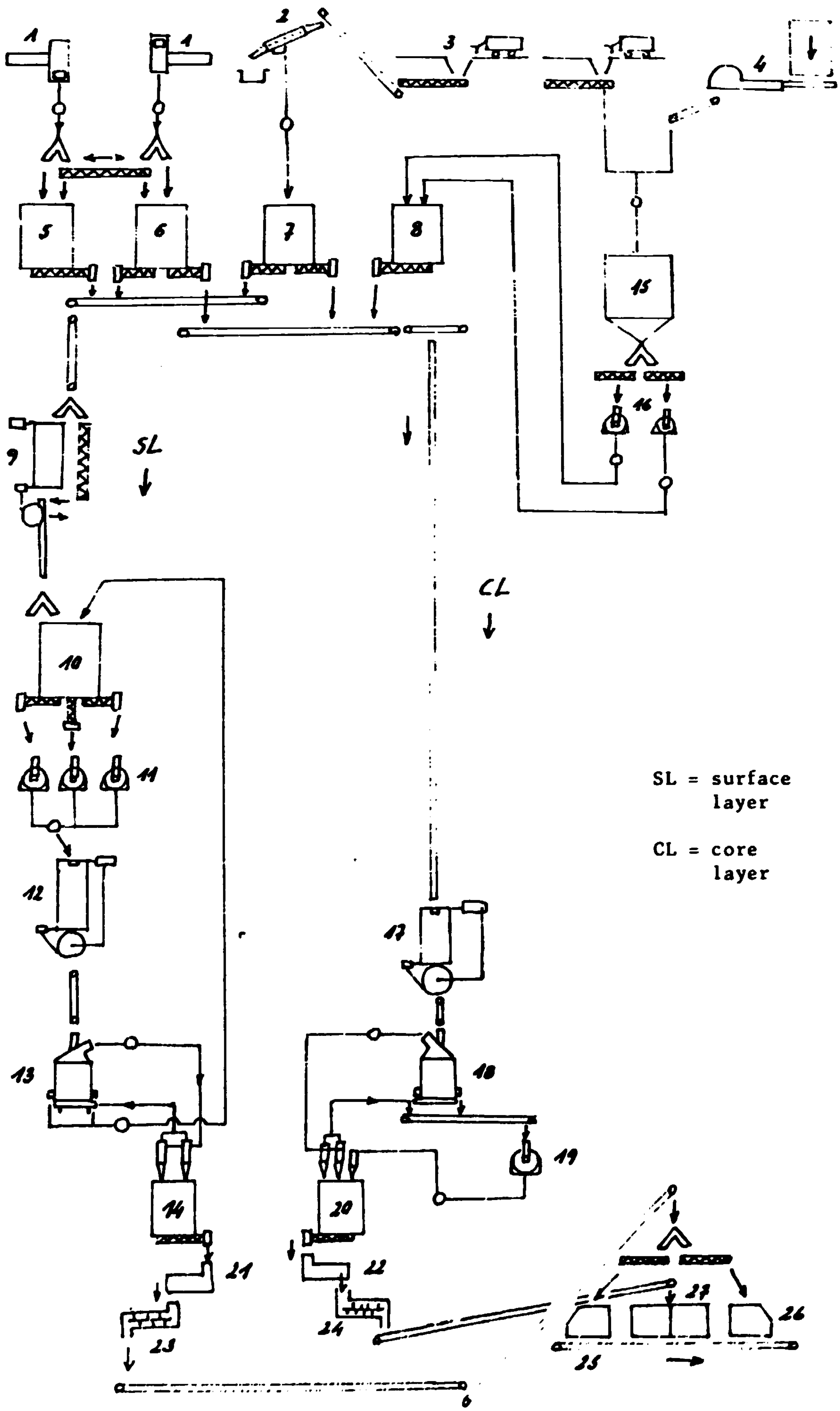
5. Deppe, H. J. : Tuscherbuch der Spanplattentechnik, DRW-Verlag, Stuttgart, 1977.

ANNEX

TECHNOLOGICAL PROCESS FOR PARTICLE BOARD PRODUCTION



LAYOUT

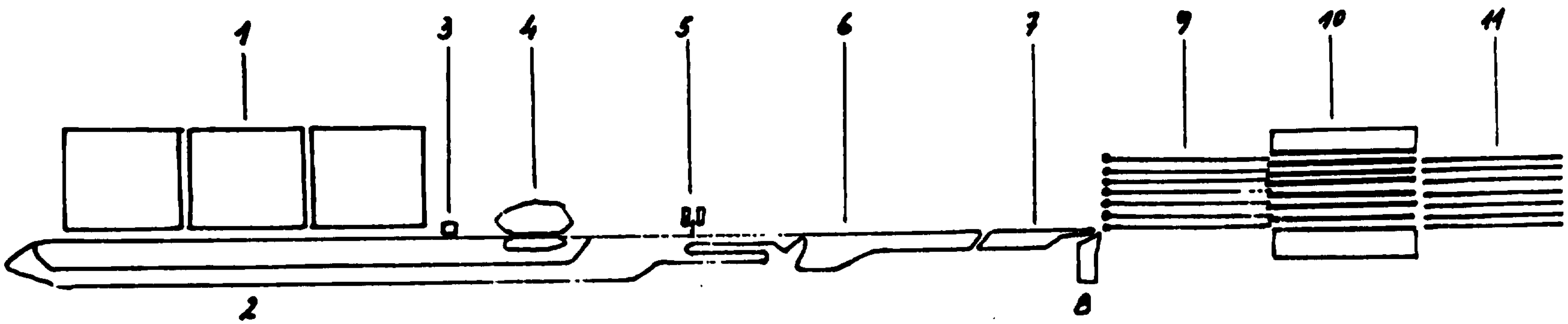


SL = surface layer

CL = core layer

1.	Flakers	
2.	Vibrating screen	
3.	Sawdust	
4.	Chipper	
5.	Coniferous wood	Wet particle silo
6.	Broadleaved wood	Wet particle silo
7.	Coniferous sawdust	Wet particle silo
8.	Ring flakers particles	Wet particle silo
9.	Pre-dryer	
10.	Dosing silo	
11.	Ring refiners	
12.	Dryer	
13.	Air classifier	
14.	Dry particles dosing silo	
15.	Chips dosing silo	
16.	Ring flakers	
17.	Dryer	
13.	Air classifier	
19.	Ring refiner	
20.	Dry particles dosing silo	
21, 22.	Balance silo	
23, 24.	Gluing machine	
25, 26.	Surface layer spreading machine	
27.	Core layer spreading machine	

CONTINUOUS FORMING BELT SYSTEM



1. Spreading (forming) machine
2. Forming belt
3. Metal detector
4. Continuous pre-press
5. Mat-separating device
6. Acceleration station
7. Feeding station
8. Reject mat hopper
9. Tray belt press loader
10. Hot press
11. Discharging device