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23p
table
series
2/19/95
2/19/95

DP/ID/SER.A/1720
12 April 1995
ORIGINAL: ENGLISH

ASSISTANCE IN THE ESTABLISHMENT
OF A PILOT FURNITURE PLANT

DP/DRK/86/011

THE DEMOCRATIC PEOPLE'S REPUBLIC OF KOREA

Technical report: Training manual on veneering*

Prepared for the Government of the Democratic People's Republic of Korea
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

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V.95-53016

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PREFACE

This training manual is one of a series prepared by a UNIDO Furniture Production Expert, Radmilo Malis, while serving as Chief Technical Adviser of a UNDP financed and UNIDO executed project in the People's Democratic Republic of Korea, to assist in the establishment of a Pilot Furniture Plant in Pyongyang (Project DP/DRK/86/011).

This manual deals with veneering.

The manuals were written to achieve two major goals, first: to give trainees a broader view of an industrial system and second: to serve as a practical guide to machine operators and assemblers, thus enabling them to better perform their duties.

A particular attention has been devoted to materials and their correct utilization, to the design and quality of products, to the organization of the work areas and to safety measures.

The description of the machines is based on those bought for the Pilot Furniture Plant.

These manuals have been written in such a way that they can also apply to other similar factories and to vocational training institutions.

The entire scope of the training envisaged to be given, with the intended audience for each topic is given in Annex I.

The syllabus, namely the topics, the duration of lectures (theory) and practical work and the level of competence attained after completion of the course on this topic is given in Annex II.

1. Introduction

Veneering consists of gluing veneer sheets on the surface of wood based panels in order to improve their quality. The gluing of these sliced veneers is carried out, either on a single daylight press with automatic loading or with a multi-daylight press on manual or automatic loading and unloading.

In the case of the Pilot Furniture Plant, a multi-daylight press (with six openings) with manual loading and unloading will be used and this manual refers to such a press.

The preparation and spreading of glue is an integral part of the veneering operation. A glue mixer and a glue spreading machine will therefore be described as well as a typical composition of a glue mixture.

2. Glue and other ingredients in a glue mixture

Thermosetting adhesives, in particular formaldehyde glues, are suitable for veneering wood-based panels. The choice of glue mixes must be made taking into account the type of press, the type of veneer and the type of substrate used.

It is important to know whether the press has automatic or manual loading and at what temperature it operates. The thickness of the veneer and the species of wood used must be known. Accordingly, the substrate, its porosity, its moisture content and the temperature and pressure it can withstand are important data for choosing an appropriate glue mix. An important factor is also the form in which the glue is supplied, i.e. in powder or liquid form.

In the case of the Pilot Furniture Plant, the press has manual loading, and operates at a temperature between 100 and 110°C. The pressure can be changed depending on the substrate. Hardwood species (oak, ash, elm) will be used to produce veneer of a thickness between 0.5 and 0.7 mm.

Two kinds of substrates will be veneered: particle board and plywood. Liquid urea formaldehyde glue will be used. It is advisable to prepare the glue mixture in accordance with the recommendations of the glue producer, at least at the beginning. Later on, the glue composition could be modified depending on the conditions existing in the factory and according to the experience gained by the operator over a certain period of time.

Commercial urea formaldehyde liquid has a solids content ranging from 50 to 65 per cent. This is stated more precisely in a certificate given by the producer. The glue mixture is composed of glue, water, extender, filler and hardener.

Extenders are finely milled vegetable products capable of swelling with water and forming starch at high temperatures. Wheat or rice flour are particularly suitable as glue extenders. It is always advisable to use 5 to 10 per cent of flour, based on liquid syrup, though a glue mixture based on urea can contain up to 50 per cent of flour.

Fillers are mostly mineral products used to reduce cost and extend the glue. The most satisfactory fillers are calcium sulphate or finely ground kaolin. Wood flour can also be used as a filler. In no case should sanding dust be used.

A hardener is a catalyst which initiates the polymerization process in the glue. It is usually an organic acid or ammonium chloride which, when dissolved in water, produces acidity and, as a consequence, polymerization.

Some other glue characteristics such as: reactivity, viscosity, solids content and free formaldehyde should be known in order to use the glue correctly.

Reactivity indicates the speed of reaction under given conditions during the gluing phase as the glue converts to a solid, irreversible condition. It is measured by a standard test on gel time. Reactivity of the resin varies with the temperature and the type of hardener used. At high temperatures gel time is shorter, i.e. the reactivity is higher. For example, the composition of glue gel time is three hours at 20°C, 24 minutes at 40°C, and 50 seconds at 80°C, 22 seconds at 110°C. This means that the press must be filled, closed and full pressure achieved within the gel time.

Viscosity is an essential characteristic of thermosetting resins and can be determined either on the amount of syrup or of dissolved powder. The measurement of viscosity is related to a given temperature and is carried out with a viscometer (eg. Happler, Ford cup, etc.). Viscosity is dependent on many factors, among which are the solids content, the degree of condensation, the temperature at which it is measured etc.

The viscosity of the thermosetting resin syrup increases due to slow and continuous polymerization until all the mass gels. In principle, one can continue to use a glue until the initial viscosity is doubled. The initial viscosity is given in the producer's glue certificate.

The solids content is of interest only in liquid adhesives. Urea syrups have a solids content between 64 and 66 per cent. The most common test method consists of drying a small sample of glue at 120°C until the constant weight is reached. The solid content of the glue can be deduced from the difference in weight between the liquid glue and its constant weight.

Free formaldehyde is important in urea adhesives because recent legal regulations in many countries prescribe a maximum free formaldehyde content.

For correct gluing, apart from the glue characteristics already mentioned, the application conditions for glue, such as the species of the wood, the spreading of glue, the open time, the pressure and pressing times must also be known.

A more viscous mixture will be used for porous woods than for those with closed pores. Some woods are more difficult to glue due to the presence of resinous or greasy substances, and require special preparation. However, sliced veneer does not normally require any special preparation.

The moisture content is very important for correct gluing and should normally range between 7 and 12 per cent depending on the species of the timber. Excessively dry or wet timber will cause defects. Dry timber absorbs the water from the glue mix rapidly, and the glue is dried prematurely. Wet timber develops vapor during hot pressing with the formation of bubbles, and pressing time must be considerably increased.

Glue is usually spread on a four rollers glue spreading machine. The amount of glue to be applied varies depending on various factors. For hot gluing, it can range from 100 to 200 gr/m² on one face. It can be generally said that the lower weight of the spread can be used on compact and smooth surfaces, applied by four roller glue spreaders with rubber rollers and using glue mixes with a low level of extender. The gluing should be made with short open time, using a high pressure and with fast press closing. Heavier spreads are made on porous woods and rough surfaces and using glue mixes with higher quantities of fillers. These are applied with longer open times, lower pressures and slower closing times for the press.

Open time is the time between the spreading of the glue and the moment when the maximum pressure is attained. For hot gluing, the time of loading into the press is important and must be shorter if the temperature of the press is higher. Normally, this must not be greater than three minutes at 100°C, or one minute at 120°C.

Pressure is an important parameter of correct gluing. In general, a lower pressure can be used if the surfaces are smooth and well matched with sufficient glue spread. Higher pressure must be used with rough surfaces, poor matching between the surfaces and low weight of glue spread. Accordingly, the pressure can vary from 5 to 15 kg/cm². For veneering particle board, 5 to 7 kg/cm² is an appropriate pressure.

Pressing time is the time required to achieve the polymerization of the glue by the formation of a hard, infusible and irreversible mass at a given temperature and for a particular glue mix. For hot gluing, the pressing time is the sum of two times, one of conveying heat from the heated plates through the veneer to the glue line and the other for hardening the glue. For urea formaldehyde glue at 110°C, it could be 1.5 minutes plus 0.5 minute/mm of veneer thickness. For example, if the thickness of the veneer is 0.7 mm, the pressing time would be 1.5 + 0.5 x 0.7 = 1.85 minutes or roughly 2 minutes.

Hereunder are some data of urea formaldehyde glues:

- Commercial form	solution, powder;
- shelf life (months)	solution 3, powder 12;
- colour	none;
- hygiene	skin irritation on long term work;
- moisture content of wood (%)	4-12
- dry substance of glue (%)	50 to 70
- pot life (hours)	6-8
- spreading (grams of solution/m ²)	100-200
- assembly time, open (hours)	10-15
- pressing time, hot (minutes)	1.5 minutes plus 0.5 minute/mm

-	pressure (kg/cm ²)	5-18
-	temperature (°C)	110-140
-	maturing time (hours)	48 to 72
-	water resistance	humidity proof
-	temperature resistance	good
-	micro-organic resistance	extraordinary
-	organic solution resistance	extraordinary
-	colour defects	slight
-	wearing of knives	normal

3. Preparation of working glue mixture

The working glue mixture should be prepared by the operator of the glue spreading machine. The quantity to be mixed depends on the consumption during the pot life of glue, or if consumption is higher, on the capacity of the mixer. The composition of the glue mixture will be prepared in accordance with the prescription given by the glue producer. If such a composition is not prescribed, then for veneering particle board with hard-wood veneers, the following formulation could be used (for urea formaldehyde) in parts per weight:

-	Liquid glue syrup (with a solids content of 50 per cent)	100
-	extender (flour)	20
-	water	20
-	hardener (ammonium chloride)	7
(This mix has a:		
-	gel time at 100°C of	40 seconds
-	and pot life at 20°C of	5 hours)

Initially, a small quantity of the mixture should be prepared and gluing tests should be carried out to ascertain that the quality obtained is adequate. This must be done whenever a new glue is used.

The most simple glue test can be done by gluing two pieces of wood with flat and smooth surfaces, and, after the glue has dried, split the joint. If the splitting occurs in the wood and not in the glue line, the glue quality is satisfactory. Such a test can be repeated with a gluing mixture containing less expensive extenders or more fillers as long as the glue is stronger than the wood. In a case where the glue does not give satisfactory results, the percentage of glue should be increased and more hardener should be added.

The mixing procedure is very simple and should be done as follows:

- 10 liters of liquid glue should be poured and mixed in the mixer;
- 0.7 liters of hardener should be poured and mixed;
- 2 kgs of extender should be added and mixed;
- 2 liters of water should be added and mixed.

This quantity corresponds to the capacity of the existing mixer. The glue mixture must not contain lumps of extender. The glue mixture prepared must be used within its pot life, i.e. within 5 hours, but it is better if it is used in a shorter lapse of time.

4. Glue control and controlling instruments

It is necessary for a furniture factory to have simple instruments to control viscosity, solids content and perhaps also pH value. A Ford cup No. 4, with a 100 cm³ volume and a stopwatch are enough to control viscosity (fig. 1). The viscosity is measured by the seconds it takes for the glue to flow out through the bottom opening of the cup when its contents are at 20°C.

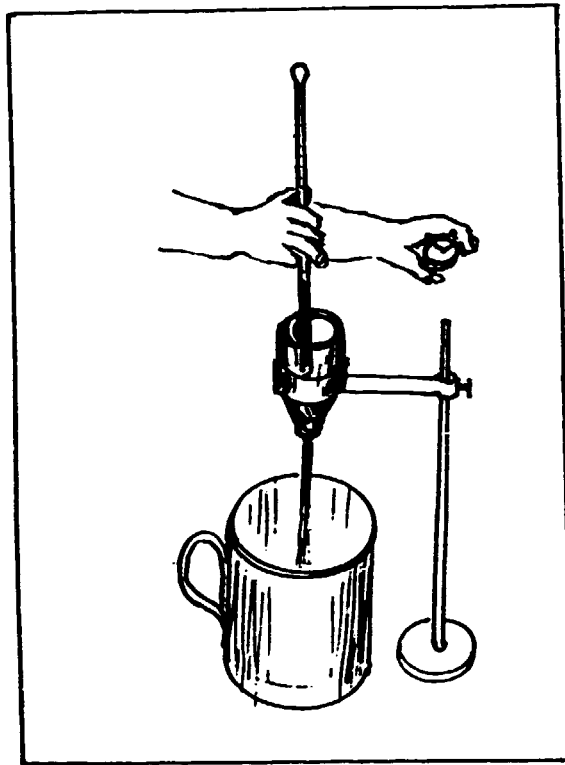


Fig. 1: Viscosity, measured with a Ford cup.

To control the solids content, a scale accurate to 0.01 g and a drying oven with the possibility of controlling the temperature are necessary. A small glue sample is first weighed and then dried at 120°C until a constant weight is reached. This weight is used to calculate the percentage of the dry content, dividing the weight of the solids by the weight of liquid glue and multiplying it by 100.

The pH value of liquid glue is determined by using litmus paper and the standard pH values scale. Sometimes, the pH value must be known to select the correct hardener and its proportion in a glue mixture.

The bond strength of glue can be controlled by making a gluing test, as described above.

5. Operating instructions for a glue mixer

A glue mixer is a simple device which is easy to operate. Its components are: a pot, an electric motor and an impeller at the end of a shaft. It could also be equipped with a pump.

The mixer should always be stopped when the pot is filled with the glue mix ingredients. The pot should always be covered before mixing. The mixer should also always be washed at the end of a working shift and when it is no longer needed.

All parts of the mixer coming in contact with the glue should be of stainless steel.

6. Glue spreading machine

There are various models of glue spreading machines; all have a heavy rigid frame on which the glue spreading rollers are mounted.

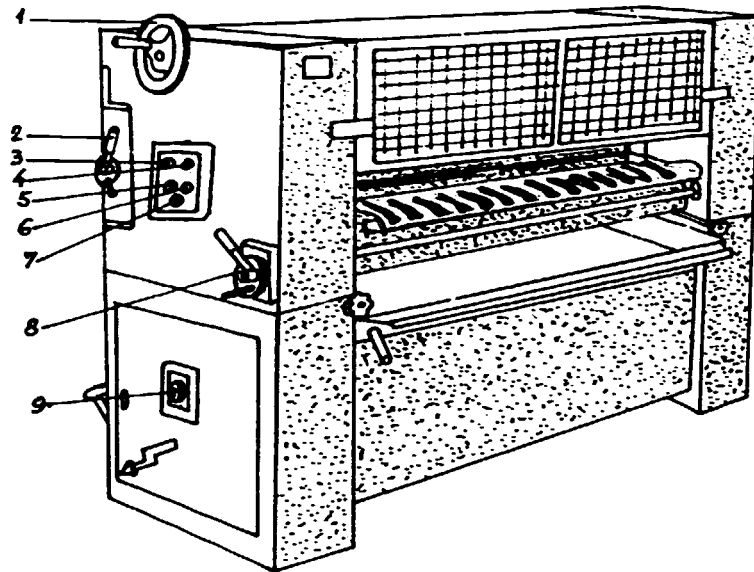
The glue spreading system consists of two pairs of opposed rollers. One pair spreads glue on the upper side and the other on the lower side of the panel to be veneered. Each pair of rollers consists of a spreading roller and a doctor roller which regulates the quantity of glue applied. The spreading rollers have a surface of rubber (65 to 70 Shore) that is grooved with a pitch of 1.25 mm.

The quantity of glue applied can be regulated by adjusting the distance between the spreading and doctor rollers. These must be parallel, thus ensuring equal spreading of glue on the whole surface of the panel. If the rollers are not parallel, the correcting screw located on the eccentrics with levers must be regulated.

The thickness of the panel is adjustable from 0 to 100 mm moving the upper spreading roller by activating the handwheel and controlling the thickness on a millimetric indicator plate.

On the left side of the machine, there are two doors giving access to the drive gears. The working speed is infinitely variable up to 18m/min.

The panel outfeed conveyor is fitted with a series of disc rollers. Fig. 2 shows a glue spreading machine Model R4, which is installed in the Pilot Furniture Plant.



- Key:**
- (1) Hand wheel for regulating the thickness of the panel
 - (2) Lever for closing upper rollers and adjusting quantity of glue spread
 - (3) Push-button to start rollers
 - (5) Push-button to stop rollers
 - (4)+(7) Push-buttons for washing rollers (not installed)
 - (6) Emergency push-button
 - (8) Lever for closing lower rollers and adjusting thickness of glue spread
 - (9) Main switch

Fig. 2: General view of the glue spreading machine, Model R4
(Italpresse)

7. Glue consumption control

The consumption of glue should be controlled for two reasons: (a) glue is an expensive material, and (b) using too much or too little glue can cause many veneering problems, such as its breaking through or blistering the veneer.

Controlling the quantity of glue spread is simple and can be done quickly and often by using an appropriate scale. Weighing a part of a panel before and after spreading glue, and dividing the weight difference by the surface area of both sides of the panel, one can calculate the glue consumption. A satisfactory consumption is one close to 120 gr/m².

8. Operating instructions for a glue spreading machine

The following refers to the glue spreading machine Model R4 shown in fig. 2 above.

By closing the main switch (11), the control light placed on the push-button panel is lit, showing that the machine is ready to start operation. The protective fences must be closed before starting the machine. If one of them is open or if the protection rod is pushed against the machine, the emergency light will be lit indicating that the electric connection is switched off. The machine can be started and stopped by pushing the respective push-buttons: "rollers-START" and "rollers-STOP".

The rollers close by activating the levers (2) and (9). After this operation, the glue can be spread between two pairs of rollers. In case the doctoring rollers are not perfectly parallel to the spreading rollers, the glue will not be uniformly spread on the panel. In that case, the sliding and lower guards must be taken off. The screws on the excentrics must then be regulated by levers (2) and (9) (fig. 3).

S- Screw to adjust roller
to a parallel position.

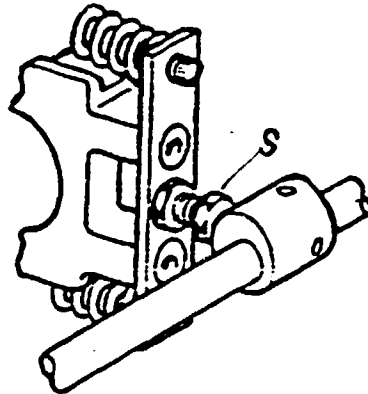


Fig. 3: Regulating rollers to a parallel position.

Feeding the panels into the machine should be done one at a time, using alternatively the centre and both sides of the rollers. The machine can be switched off by pushing the protection bar against it.

9. Cleaning the glue spreading machine

The glue spreading machine must always be cleaned after finishing a shift and when not used. Particular care should be taken that the rollers are cleaned. If glue dries in the grooves of the spreading cylinder, many problems can occur affecting the quality of spreading, resulting in a higher glue consumption, creating machine vibration. The rollers will most probably have to be replaced.

The machine is cleaned with water at the end of a batch and when it is stopped. The rollers must not be scrubbed. The best way to wash the machine is with a rubber hose and a strong stream of water. A medium hard brush can be used to remove layers of glue.

10. Hydraulic hot press

There are various types of single and multi-daylight hot presses. A multi-daylight hot press, similar to the one installed in the Pilot Furniture Plant with manual loading and unloading is described hereunder. It is a six daylight press with steam heated hot plates (fig. 4).

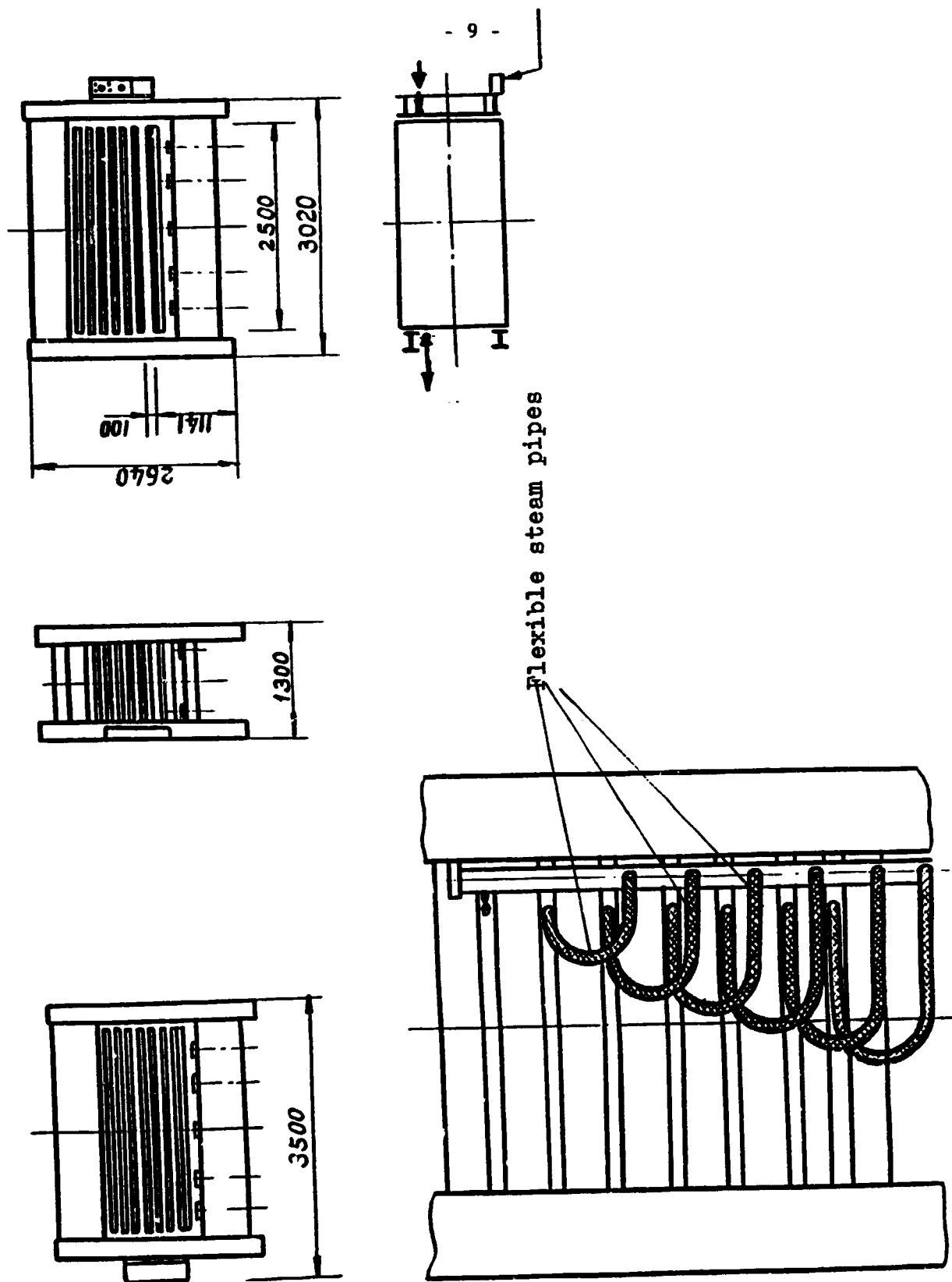


Fig. 4: Steam heated six daylight press

The press construction consists of a heavy rigid frame supporting the hydraulic and heating systems. The hydraulic system comprises the low and high pressure hydraulic pumps (fig. 5) which are driven by the same electric motor, a hydraulic gear box, a filter, valves and hydraulic pipes connecting the pumps to eight hydraulic cylinders.

The heating system consists of seven hot platens and flexible pipes connecting the individual platens to the steam distributor.

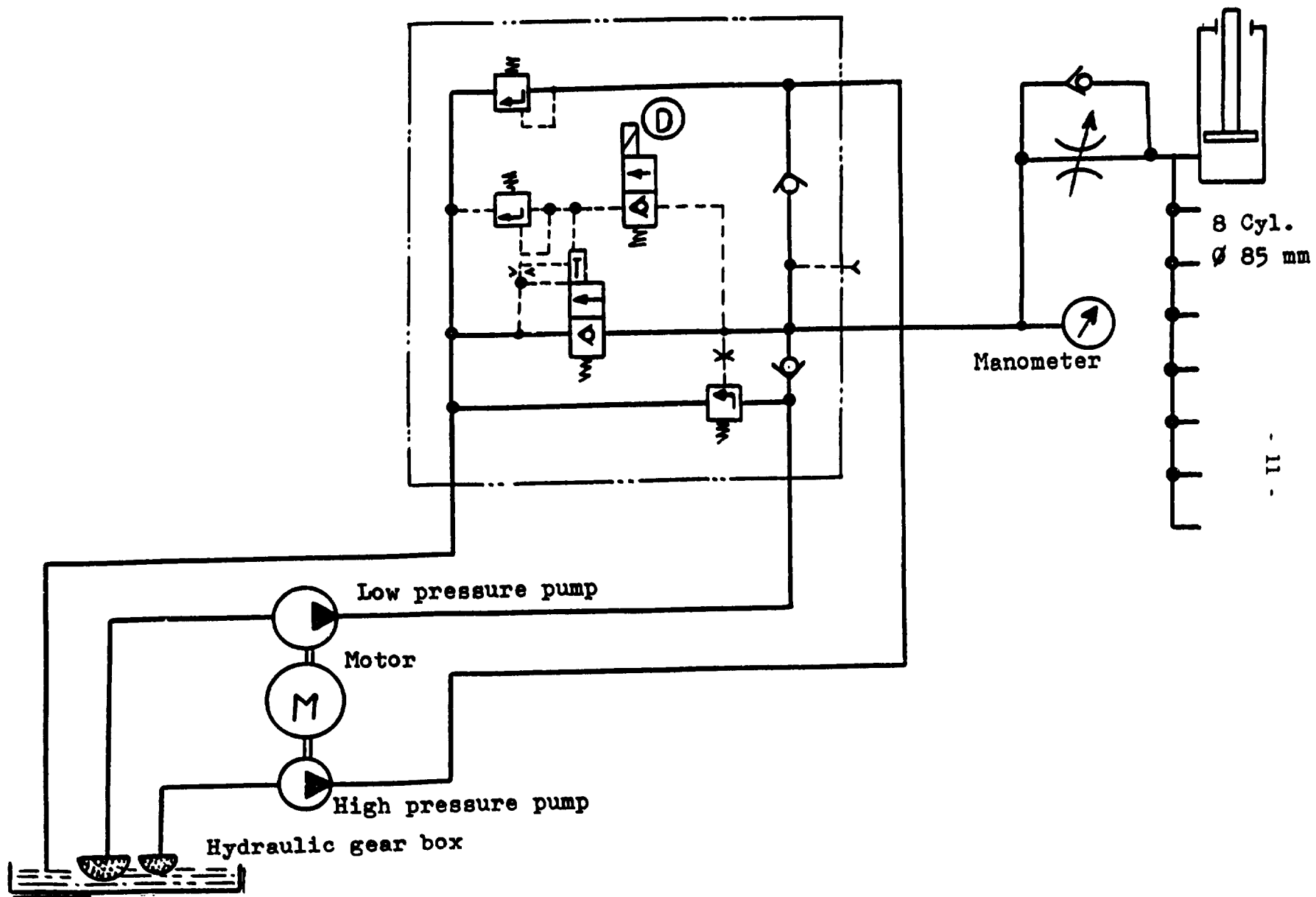
The heating and the hydraulic system, a frame, and governing and controlling instruments are the main components of the press.

The heating platens are the most important parts of the heating system. They are drilled so that steam can circulate through the plates, producing the required temperature on their surfaces (fig. 6).

Pressure can be regulated as required. The specific pressure in the hydraulic system must be related to the specific pressure on the surface of panels to be veneered. The specific pressure in the hydraulic system is shown on the manometer. That pressure, multiplied by the surface of all hydraulic cylinders gives the total pressure. The specific pressure on the panels (kg/cm^2) multiplied by the surface of the panels in one opening must be equal to the total pressure of the press.

Usually, for each particular press, a working diagram is prepared and used (fig. 7).

Fig. 5: The hydraulic system of the press



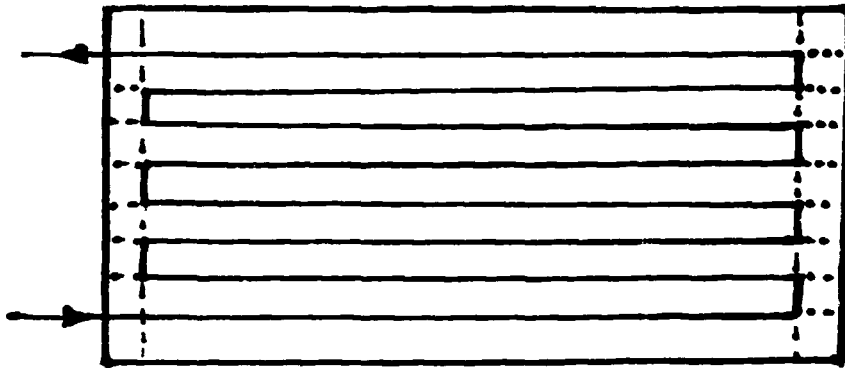


Fig. 6: Steam flow through the heated platens

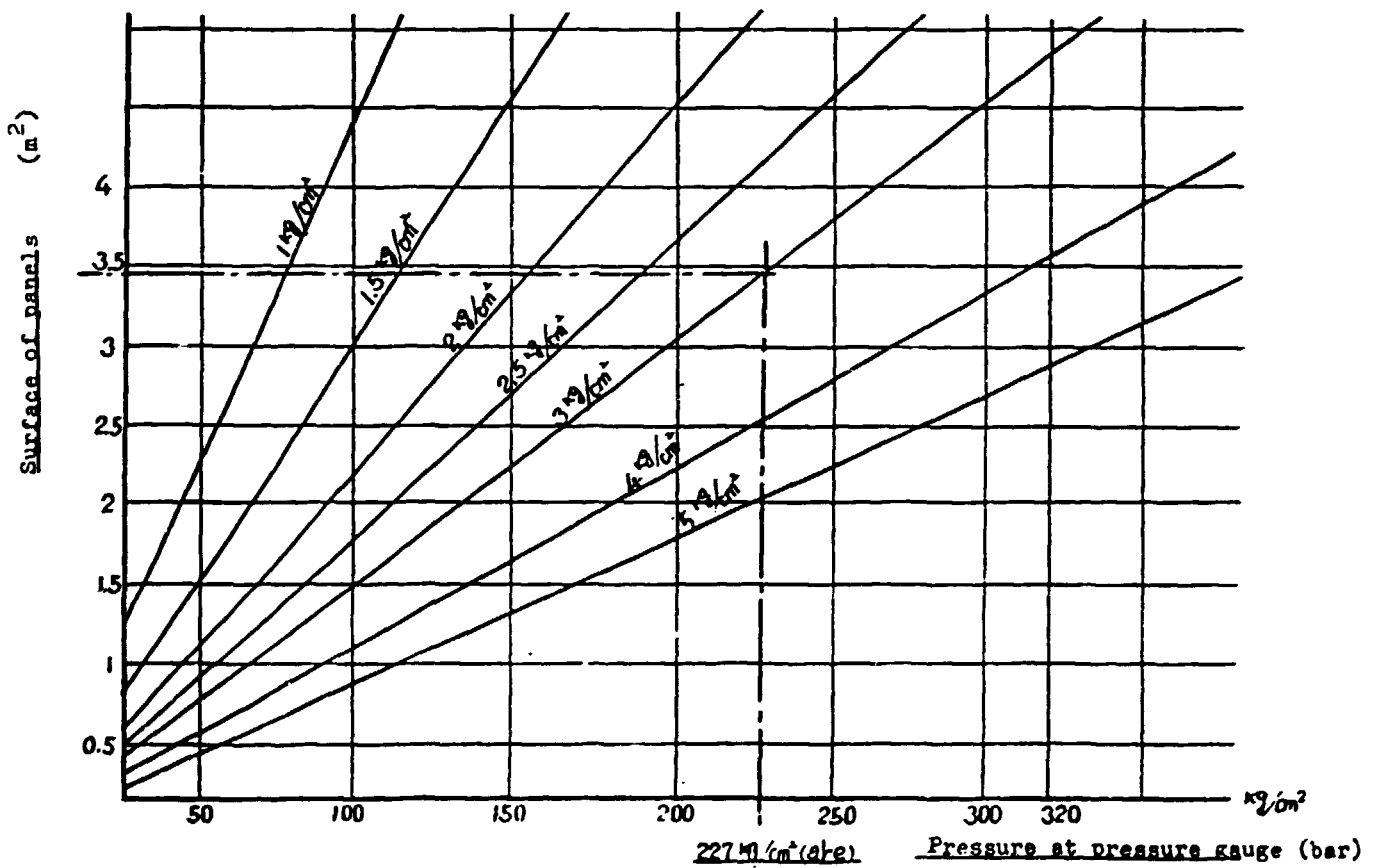


Fig. 7: Operation diagram for the press SCF/8.

11. Governing temperature and the pressure in the press

The temperature of the heating platens corresponds to the steam temperature. Usually, it is between 110° and 140°C. In the case of the Pilot Furniture Plant, the maximum temperature of steam is 110°C. This means that the working temperature of the press will be about 105°C. The actual temperature in the press is indicated on a thermometer.

The pressure time depends on the temperature in the press and on the glue mix's composition. Lower temperatures require longer pressing times and vice versa. However, by adding more hardener and less extender, the pressing time could be shortened. It could be determined also by experience. The pressing time is determined by setting a special timer allowing the press to open automatically when the set time expires. At a temperature of 105°C, and with the glue mixture recommended earlier in the text, a satisfactory pressing time would be of 3 minutes. This means that the instrument should be set on 2½T and, if the result is not satisfactory, moved towards 3T until the veneering strength (or veneer strength) is achieved. On attempting to tear off the veneer, it must break through the wood material, but not through the glue line.

The specific pressure (kg/cm²) of the panels to be veneered depend mostly on the properties of these panels. The pressure must not be too high - this might destroy the panels. In the case of veneering low quality particle board, the specific pressure must not exceed 4 kg/cm², and to achieve a good board quality, 5 to 6 kg/cm². For veneering plywood, the appropriate pressure is 6 kg/cm².

Relations between the specific pressure on the veneering panels and the manometer pressure is given in the working diagram shown in fig. 7 above.

The starting data is the surface of the panels (in m²) to be veneered in one daylight. From that value, shown on the vertical axis of the diagram, going horizontally to the slope line with the corresponding specific pressure of veneers and then vertically down to the horizontal axis of the diagram, one can read the required manometer pressure. The required manometer pressure is set by turning the pressure gauge setting screw on the pressure gauge.

All governing and controlling instruments are placed on the control panel (fig. 8).

- 1 - General switch
- 2 - Emergency stop
- 3 - Downstroke push-button
- 4 - Upstroke push-button
- 5 - Automation exclusion selector
- 6 - Timer
- 7 - Pressure gauge setting screw
- 8 - Pressure gauge
- 9 - Upstroke push-button

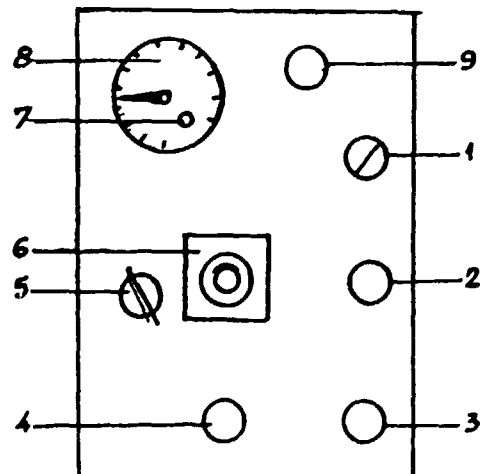


Fig. 8: Control panel on the hydraulic press.

12. Operating instructions for a multi-daylight hot press

These instructions refer to the hydraulic hot press, model SCF/8-S, and its control panel, which is shown in fig. 8 above.

Before starting the veneering operation, the press must be closed and the oil level in the gear box checked in order to ensure that it has not reached its minimum height of 160 mm.

The general switch (1) should be turned and the DOWNSTROKE push-button (3) should be pushed till the lowest platen has reached the stop position (press completely open).

The required pressure should be set on the pressure gauge (8) by adjusting the pressure gauge setting screw (7).

The automation exclusion selector (5) should be set on position "1" (automation "on").

The pressing time should be set on the timer (6), with a scale from 1T to 6T. 1T equals 1 minute.

The steam valve should be opened and the temperature of the hot press platens should be checked on the thermometer. They should be at the required level.

Now the press is prepared for filling with sandwiches of panels and veneer, i.e. the panel substrate is covered with veneer sheets on both sides after passing through the glue spreading machine. The panel layers are separated with laths for each opening. After filling all six daylight, the pallet is moved next to the press. Filling the press is done manually and must be done quickly. The assistants put the panel sandwiches in the press and the operator should control and correct the position of the panels.

The panels must be placed in the press openings and centered in relation to the axes of the press. If a little panel is to be pressed, some inserts of the same thickness must be inserted above the pistons (fig. 9).

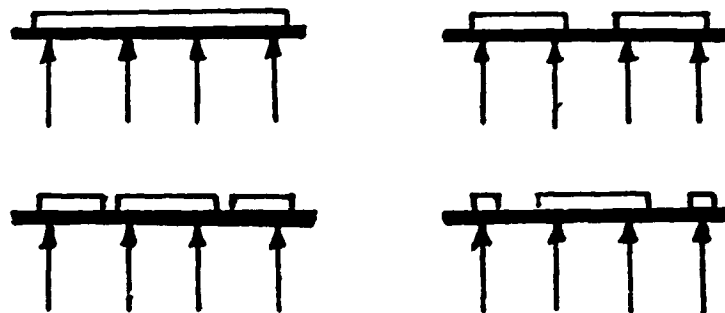


Fig. 9: Centering panels along the press' axes.

As soon as the press is filled, the two UPSTROKE push-buttons (4) and (9) should be pushed. These push-buttons should not be released until the press gauge pointer has passed the green section of the scale.

At this point, the press reaches the pre-set pressure automatically.

Working with the automatic selector (5) (set on position 1), the press is automatically opened once the pressing time set has elapsed. The push-button DOWNSTROKE (3) can also be used to lower the movable platens.

Unloading is done on the opposite side of the press. The operator, using a softwood lath, pushes the panels through the openings between the platens, and the assistants take them on the other side and pile them up on pallets.

During pressing and unloading, the new charge is prepared and the loading operation can then be repeated.

13. Protection and cleaning of the hot press platens

From time to time, but at least once a week, the surfaces of the hot platens must be cleaned. This can be done with hot water and medium hard brushes. Any existing layers of glue or other dirt must be removed, and the plates must not be scratched.

The steam channels drilled in the platens must also be cleaned periodically, but this must be done by the maintenance personnel.

14. Organization of the work area

The veneering work area (glue spreading and pressing) can be organized as shown in fig. 10.

The panels to be veneered (1) should be brought to the right side of the glue spreading operator.

The glue mixer should be installed on the left side of the operator, between the glue spreader (2) and the stock of glue and other glue mix ingredients (4).

The disc conveyor (5) is placed on the outgoing side of the glue spreader, and on both sides of this conveyor, pallets (7 and 8) with veneer sheets are placed, one for the face veneer and the other for the back veneer. The conveyor is extended with a work table (6) for assembling the sandwiches. These sandwiches are piled on a pallet (9) and separated by wooden laths.

The pallet with the completed panels for all six daylight is moved to position (10), in front of the press (11).

After veneering, the parts are piled on pallets (12) and moved to the cooling area (13) where they should stay at least 24 hours before further processing.

- (1) Panels to be veneered
- (2) Glue spreading machine
- (3) Glue mixer
- (4) Stock of glue and other ingredients
- (5) Disc conveyor
- (6) Work table for assembling sandwiches
- (7) Pallet with veneer sheets
- (8) Pallet with veneer sheets
- (9) Pallet for assembled panel/
veneer sandwiches
- (10) Press load completed
- (11) Press
- (12) Veneered panels
- (13) Cooling area for pallets with
veneer panels

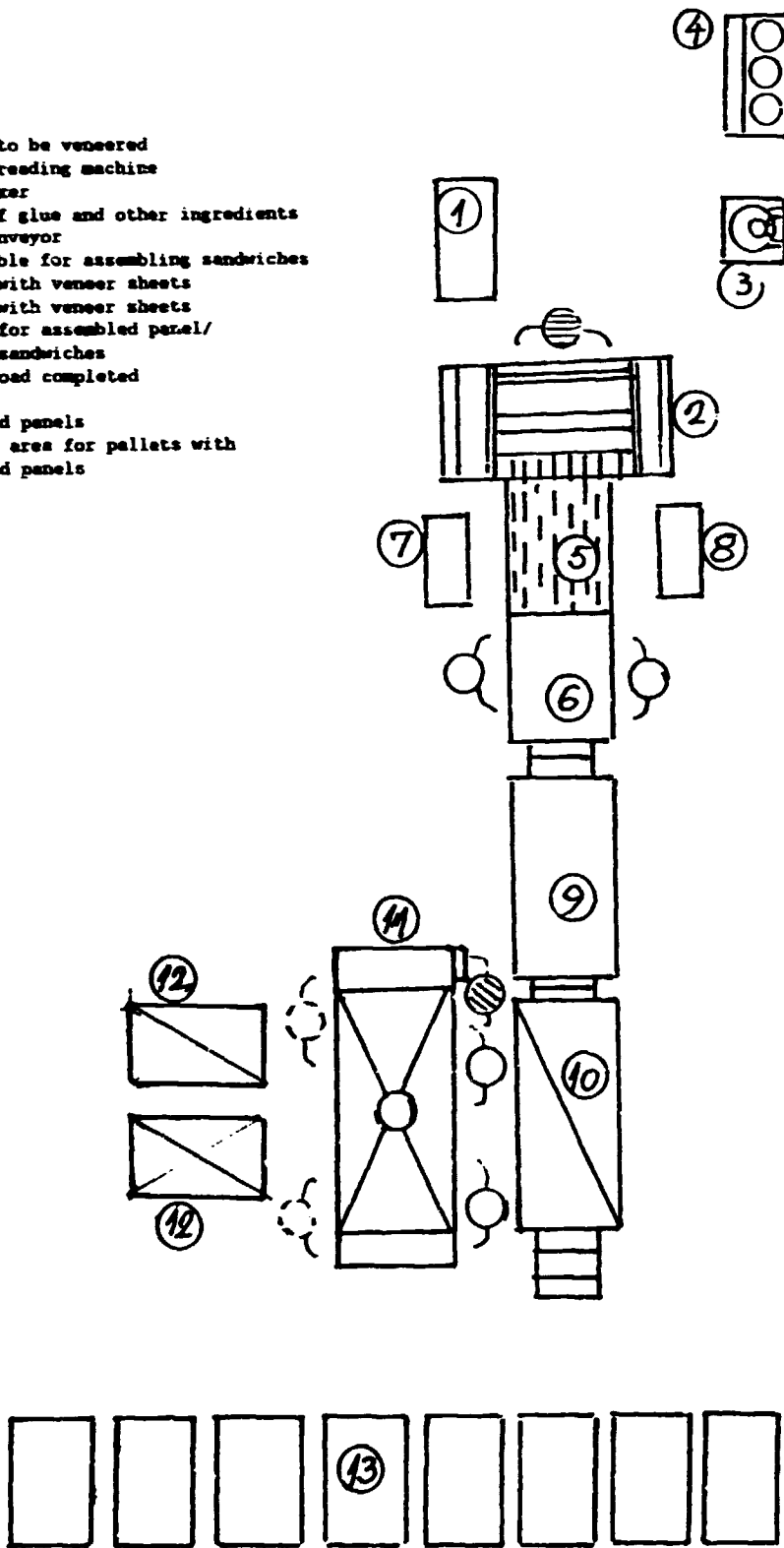


Fig. 10: Organization of the veneering work area.

15. Safety measures

Apart from general safety measures, the workers performing the glue spreading and pressing operations must comply with the safety measures pertinent to these machines.

(a) For the glue spreading machine:

- The adequate working clothing must be worn, with narrow sleeves.
- If a woman operates the glue spreading machine, she should wear pants, not a dress or a skirt. She must also wear a kerchief around her head.
- The protection bar must always be in order.
- The machine must not be used without protective guards.
- Only piece may be fed into the machine at a time.
- The people working with glue and on assembling the sandwiches must wear gloves to protect their hands against skin irritation.

(b) For the veneering press:

- Only trained operators are allowed to operate the press.
- The adequate ventilation must be installed. This will eliminate harmful gases emanating from the glue during pressing.
- Manual loading of the press must obviously stop before the press begins to close.
- The safety trip cord must always be in order.
- The workers who load and unload the press must wear gloves.

ANNEX I

TRAINING PROGRAMME FOR FURNITURE MANUFACTURING

1. Introduction

This training programme is designed to accomplish the objective and outputs foreseen in the project "Assistance in the Establishment of a Pilot Furniture Plant" (DP/DRK/86/011).

Referring to the project document, the immediate objective is to "train wood technicians and machine operators in the efficient operation of all the machinery and maintenance of tools, so as to manufacture furniture of medium quality", and also to "train managerial staff in overall management techniques including introduction to the marketing of furniture products".

This objective will be achieved through the accomplishment of outputs Nos. 6, 8 and 10.

Output No. 6 states: "20 wood machinists, 10 assemblers and four team leaders trained in the efficient use of the available manufacturing equipment, able to manufacture furniture of medium quality acceptable for export."

Output No. 8 states: "Two wood technicians trained to design and make the required production fixtures aimed at attaining accurate machining of components parts."

And output No. 10 states: "Design of overall factory organization, with established work preparation, cost accounting and management procedures, with managerial staff trained in (a) factory management based on modern industrial production methods and in (b) the basic elements of marketing."

The planned activities of the quoted outputs are:

For output No. 6:

- 6.1 Prepare a training programme for furniture manufacturing.
- 6.2 Prepare a training manual for each of the major production operations.
- 6.3 Train 20 machine operators, 10 assemblers and four team leaders to manufacture furniture of acceptable quality.

For output No. 8:

- 8.1 Train two wood technicians to design, produce and maintain jigs and other furniture production fixtures.

For output No. 10:

- 10.3 Train factory management in modern industrial production methods.
- 10.4 Acquaint the managerial staff with the basic elements of export marketing.

Training labourers is an integral part of production in modern industrial enterprises. Technical and technological developments are offering, practically on a daily basis new products and methods which make human work easier, safer and more productive. To follow such advances, people working in industry have to learn and to train in order to acquire new knowledge and skills necessary for the handling of modern equipment and processes.

In developing countries, such training has a decisive importance for the fuller utilization of new production techniques and for mastering new technological processes. To avoid unnecessary mistakes and to gain indispensable skills, training courses are the most rational mode, because people can learn, in a short time, the best ways of performing their production duties.

2. Training programme for the Pilot Furniture Plant

This training programme is designed to meet the specific requirements of the Pilot Furniture Plant. The main topics covered in the programme are:

1. Wood, affiliated products and other materials used in the production of case furniture;
2. Furniture products: design, construction and quality standards;
3. Production organization and work preparation;
4. Panel sizing;
5. Veneer trimming and joining;
6. Veneering;
7. Processing of veneered furniture parts: trimming, tenoning edge banding and drilling;
8. Moulding and routing;
9. Sanding;
10. Finishing;
11. Preassembling, assembling and packaging;
12. Tools, jigs and measuring instruments;
13. Quality control;
14. Safety measures in the furniture production;
15. Management based on modern industrial production methods;
16. Basic elements of marketing.

The main goals of this training are to enable workers, not only to learn how to perform their jobs, but also to understand the industrial production system as a whole.

Courses numbers 1, 2, 3, 12, 13 and 14 are foreseen to be attended by all workers to be trained, while the other courses are intended only for the workers who will perform the respective production operations.

All these courses are independent from one another, but in their totality they represent an integral training programme for the production of casegoods furniture in a medium size factory.

3. Methodology of training

There is an old Chinese wisdom which says "What I hear I will forget, what I see I will remember, and what I have done I will know." The output of this training should be knowledge learned by workers who will increase their ability for effective production. To achieve this, the training method will rest on three steps as follows:

1. Explain (to hear),
2. Demonstrate (to see), and
3. Try (to do).

Short manuals, written in a simple language, understandable to the workers, will be prepared for each course, translated into Korean and distributed to the trainees. All graphs, tables and formulae will be adjusted to the level of understanding of the people to be trained.

Theoretical teaching will take place in a classroom and its duration will be adapted to the minimum of theory which has to be known for a certain job. This part of the teaching will be performed by the expert (CTA) and the Chief of the Technical Department in the Pyongyang Wood Processing Complex (PWPC).

The practical part of the training will be organized at work areas for the respective work operations. For that purpose, the work areas must be organized correctly, including production documents, materials, tools, jigs, gauges, pallets, protective devices and everything that is necessary for productive, safe and good quality work. The expert will explain and show how to check a machine, tools, jigs and, in the case of wrong adjustments, how to correct them and prepare the equipment for correct use. The expert will show the correct way of performing operations and continue to supervise these operations until he concludes that proper work is fully accepted and that the quality of production is satisfactory.

The Chief of the Technical Department and other engineers who have undertaken training abroad will also collaborate in performing this practical training. Some practical experience of the trainees will help in the practical part of training.

Course No. 12 (tools, jigs and measuring instruments) should be conducted by the Tool Maintenance Expert.

Course No. 13 (Quality control). The manual prepared during the CTA's first mission can be used.

Courses Nos. 15 and 16 ("Management based on the modern industrial production methods" and "Basic elements of marketing") are foreseen for the managerial staff and will be conducted in a way to initiate discussion and an active participation of the trainees.

4. Selection of trainees

The persons to be trained will be selected by the counterpart, according to their duties and to the topics of the training programme. Besides workers who will directly perform particular production operations, all other people concerned with certain aspects of the production, such as foremen, members of the management, maintenance personnel etc. could be included in the training.

It is recommended that in selecting the trainees attention should be paid that their physical and psychological abilities be in accordance with the requirements of the pertinent jobs.

The list of trainees is an integral part of the training programme, and it determines the number of copies of the training manuals to be prepared and distributed for every course.

5. Training programme

TITLE	TRAINING HOURS	
	Theoretical	Practical
1. Wood, affiliated products and other materials used in the production of case furniture	4.5	1.25
2. Furniture products: design, construction and quality standards.	2.75	0.5
3. Production organization and work preparation	4.75	2
4. Panel sizing operation	2.75	3.5
5. Veneer trimming and joining	2.75	4.5
6. Veneering	5	4.5
7. Processing of veneered furniture parts: trimming, tenoning, edge banding and drilling	4.5	9.25
8. Moulding and routing	2.75	4.75
9. Sanding	0.25	4.75
10. Finishing	4.25	6.75
11. Preassembling, assembling and packaging	4.5	8.5
12. Tools, jigs and measuring instruments	5.75	4
13. Quality control	5	2.5
14. Safety measures and work protection in the furniture industry	5.5	1.25
15. Management of production in a modern industrial factory	10.25	4
16. Basic elements of marketing	5.25	-
GRAND TOTAL	70.50	62.00

Detailed syllabi for each topic are given in Annex II.

ANNEX II

Topic 6: Veneering.

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
		Theoretical	Practical	
6.1	Introduction	0.25	--	Understanding the purpose of the course.
6.2	Glue and other ingredients in a glue mixture	0.5	-	Ability to select a glue in accordance with the type of veneer and the type of press, and to select other ingredients of a glue mixture.
6.3	Preparation of a glue mixture	0.5	0.5	Ability to prepare a glue mixture in accordance with a formula.
6.4	Glue control and controlling instruments	0.25	0.5	Ability to control the viscosity, dry solids content and to use simple control instruments. Knowledge of gluing tests.
6.5	Operating instructions for a glue mixer	0.25	0.25	Ability to operate a glue mixer.
6.6	Glue spreading machines	0.5	0.5	Knowledge of construction and working principles of a glue spreading machine.
6.7	Control of the consumption of glue	0.25	-	Ability to control the consumption of glue.
6.8	Operating instruction for a glue spreading machine	0.5	0.5	Ability to set up and to operate glue spreading machine.
6.9	Cleaning the glue spreading machine	0.25	0.25	Understanding the importance of cleaning the machine and how to clean the glue spreading rollers.
6.10	Hydraulic hot press	0.5	0.5	Knowledge about construction and working principles of a hydraulic hot press.
6.11	Governing pressure and temperature in the press	0.5	0.25	Ability to determine the pressure according to the surface to be veneered and, given the diagram, to select the pressing time for a given temperature.

ITEM	TOPICS	TRAINING TIME (in hours)		LEVEL OF COMPETENCE TO BE REACHED
6.12	Operating instructions of a hydraulic hot press	0.5	1	Ability to operate multi-daylight hot presses with manual loading and unloading.
6.13	Protection and clearing of the hot platens of the press	0.25	--	Understanding the importance of cleanliness and how to clean and protect the hot platens.
6.14	Organization of the work area	-	0.25	Ability to organize the work area in a rational way.
6.15	Safety measures	0.25	0.25	Understanding dangers which may occur because of improper use of glue spreading machines and hydraulic hot presses, as well as safety measures necessary for safe work.
TOTAL		5.25	4.75	