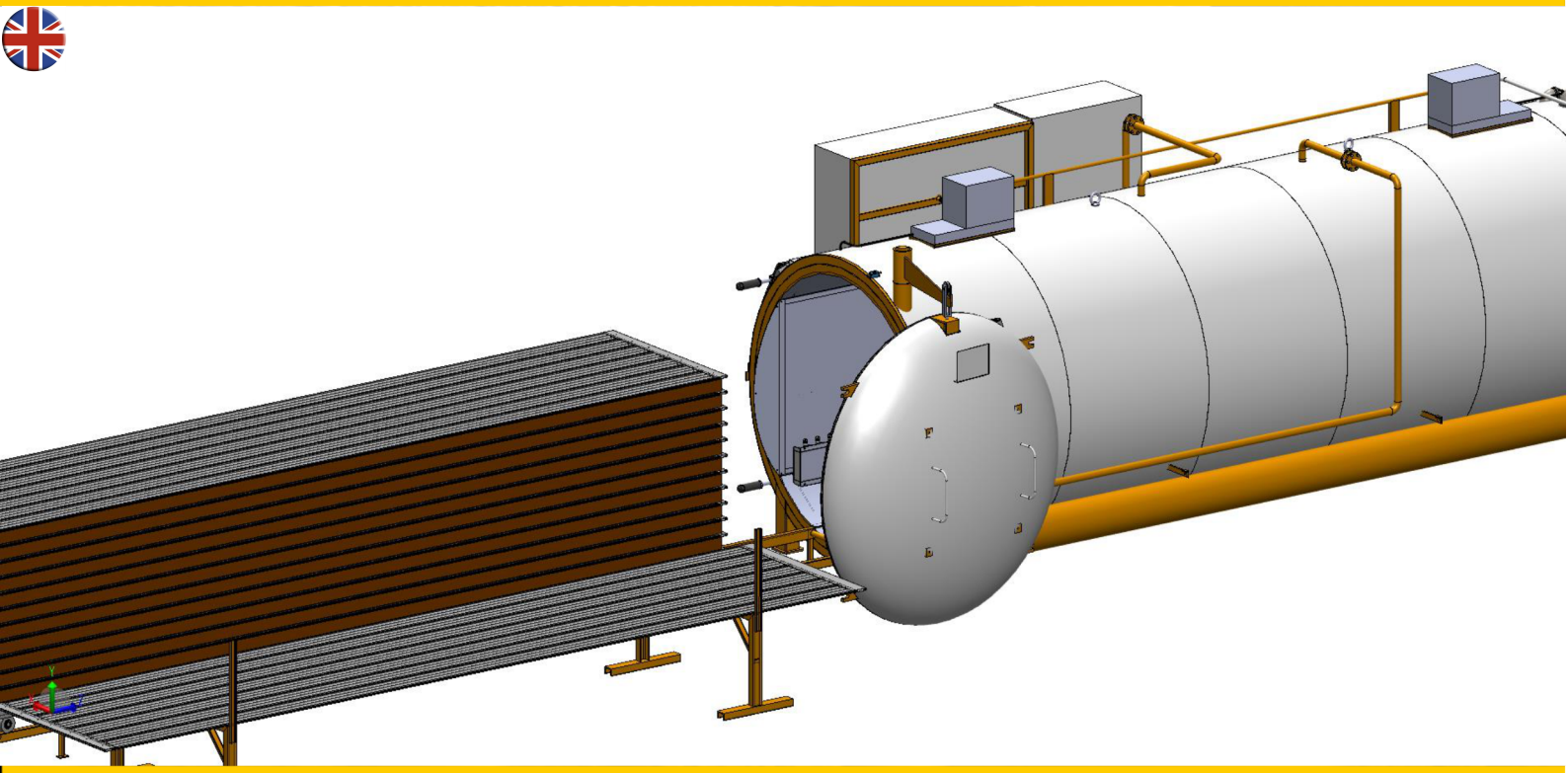

VACUUM DRYER
ES SERIES

SISTEMI PER
TRATTAMENTO DEL LEGNO

SISTEMAS PARA
EL TRATAMIENTO DE LA MADERA

SYSTÈMES POUR
LE TRAITEMENT DU BOIS

SYSTEME ZUR
HOLZBEHANDLUNG

СИСТЕМЫ ПО
ОБРАБОТКЕ ДЕРЕВА

ISVE WOOD
WOOD TECHNOLOGICAL PARTNER

ISVE GROUP
COMPETITIVE SUSTAINABILITY

INTRODUCTION

This brochure is a short reference book regarding the characteristics and application possibilities of the ES-ESC Vacuum driers produced by I.S.V.E. Srl..

Data, characteristics and illustrations are purely indicative. I.S.V.E. Srl reserves the right to make whatever changes it deems necessary.

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5.1 Model ES Junior and ES 2 driers.
5.2 Top opening model ESC driers.
5.3 Large capacity model ES driers.

Apendix 1: air-bag pressing.
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1. INTRODUCTION

The modern technology applied in the wood workshops has resulted in the optimisation of the use and machining times of the raw materials.
However to try and save 0.5 mm on the thickness of a plank or 1 m. a second in the speed of a machine tool without paying the same attention to the **"non quality"** of the drying operation, can cause **losses in yield of between 5 to 10% on the aforementioned machines.**
The drier must therefore be considered as a machine which is part of production, guaranteeing a real saving on the raw material and on the quality of the finished product.
To dry quickly and without defects is the objective we at ISVE have been pursuing in over 30 years of research into the application of vacuum systems.
The results we have achieved are of two kinds:

1. quantitative:

- increase of speed in the drying process compared with traditional systems;
- operating costs reduction;
- reduction of storage volumes of material being dried.

2. qualitative:

- maximum homogeneity of final moisture;
- maximum reduction of cracking and warping defects;
- maintaining of the natural characteristics of the wood (colour, knots, etc.);
- elimination of xylophages and other parasites.

To invest in the quality of a drying plant means to invest in the quality of one's wood.

2. THE OPERATING SYSTEM

The core of the plant is the control system no longer based on dedicated electronic cards, such as the Vacutronic, but on high-level products easily available on international markets. The core of the heating system is an innovative power controller able to heat wood with high precision.
The PLC is Siemens brand of latest generation.

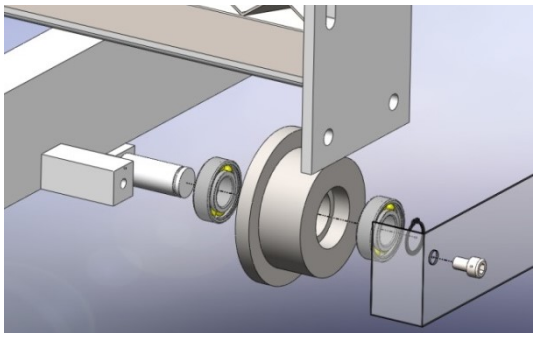
Siemens PLC of latest generation (S7-1200)

The operating cycles are stored in different work programs, which can be easily used by the operator even remotely with smartphones.

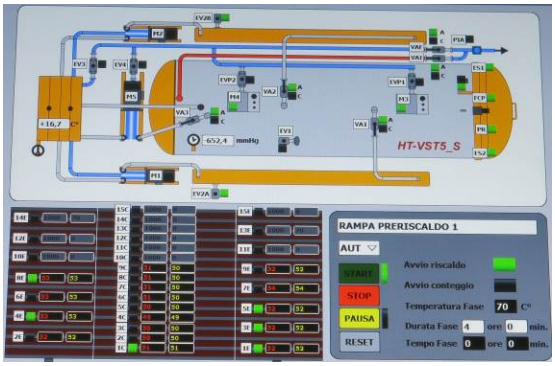
NEW GENERATION ISVE DRYING KILNS

SIEMENS PLC: the new ISVE drying kilns are fitted with S7-1200 Siemens PLC of latest generation. The control system allows monitoring carefully all the cycle phases realizing continuously self-testing on the plant components.

CAREFUL 3D DESIGN: all plants are carefully designed by using 3D software of latest generation.
The instruction manual includes layout and expoded diagrams to easily ask for assistance or spare parts.

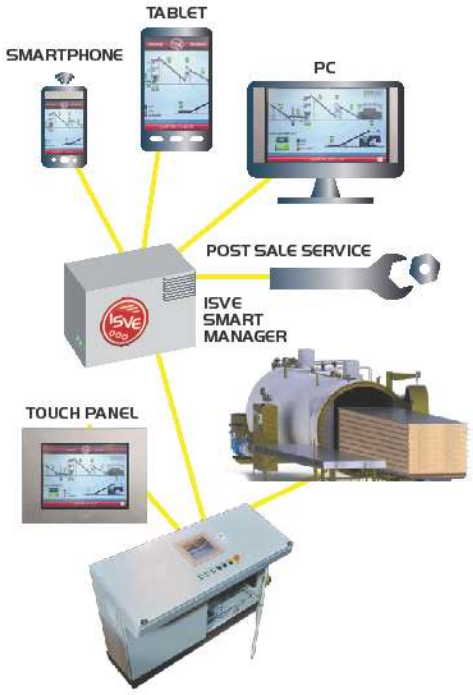


STACK PARTIALIZED HEATING: thanks to sophisticated electronics and to a new software for electrically heated dryers, it is possible to heat the stack differently, providing heat only where necessary and avoiding unnecessary overheating of wood.



MADE IN ITALY and 24 MONTHS GUARANTEE: ISVE checks the plants during each phase of manufacturing. The high-quality installed components let us granting 24 months guarantee to our international customers.

ISVE SERVER CONNECT: all plants can be connected via Web to provide real-time information concerning the operation of the machine.



3. THE VACUUM SYSTEM: the secret of ISVE drying quality

Drying of wood by exposing it to the open air or when using traditional driers always the following processes:

- removal of water from the surfaces of the planks by exposing them to hot air (PHASE 1);
- migration of the moisture from the centre where planks are more humid towards the more dried surfaces (PHASE 2).

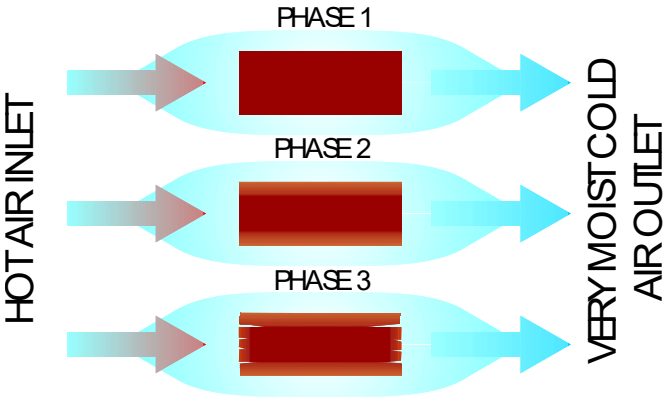
If the two processes are not carried out in perfect harmony **abnormal tensions may be created** (PHASE 3) causing warping and cracking of the wood.
The reliability of a traditional drying system is therefore tied to the need to use quite long process times so as not to create differences in moisture levels within the same area to be dried. This process is however valid for lowering the water content in 'green' wood.

Drying, using a vacuum process, enables two natural physical principles to come into play:
1. a reduction in pressure (to create a vacuum) causes the water present in the wood to transform into steam at low temperatures (45°C at –700 mmHg);
2. the water steam always moves from the hot areas to the cold ones.

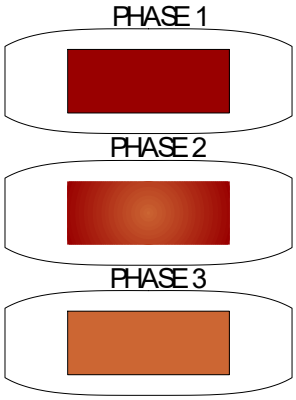
The first principle guarantees rapid removal of the water steam starting from **the centre** of the wood mass and a drastic reduction of the needs for thermal energy, in that the operation is carried out at low temperatures.
The second principle enables the quantity of moisture removed from the wood to be controlled and regulated, second by second, by adjusting the temperature of the condensers.
The synergy of the two processes enables the moisture in the wood to be lowered uniformly and without causing stress.
Considering the high technology applied to these machines and the possibility of being able to adjust each process phase very precisely, drying in a vacuum is very suitable for establishing a definite percentage level of moisture in the wood. This result is of incomparable importance, especially and above all during the later finishing and assembling phases of the semi-finished product.

In the case of wood which has cavities of resin, drying in a vacuum guarantees also the complete evaporation of vegetable solvents, thus causing irreversible crystallization of the resin itself.

TRADITIONAL DRYING



VACUUM DRYING



According to estimations made by our customers, so we can summarize the advantages of ISVE vacuum drying kilns than conventional systems:

Drying times

Type of ISVE kiln	**Wood essence**	**Reduction of time than traditional driers**
Dry Kiln ISVE with plates ES	FIR	43%
Dry Kiln ISVE with plates ES	BEECH	75%
Dry Kiln ISVE with plates ES	OAK	70%

Thermal energy consumption

Type of ISVE kiln	**Wood essence**	**Reduction of thermal energy consumption than traditional driers**
Dry Kiln ISVE with plates ES	FIR	27%
Dry Kiln ISVE with plates ES	BEECH	63%
Dry Kiln ISVE with plates ES	OAK	48%

Electricity consumption

Type of ISVE kiln	**Wood essence**	**Reduction of electric energy consumption than traditional driers**
Dry Kiln ISVE with plates ES	FIR	68%
Dry Kiln ISVE with plates ES	BEECH	76%
Dry Kiln ISVE with plates ES	OAK	65%

The above figures refer to the thickness of 50 mm.

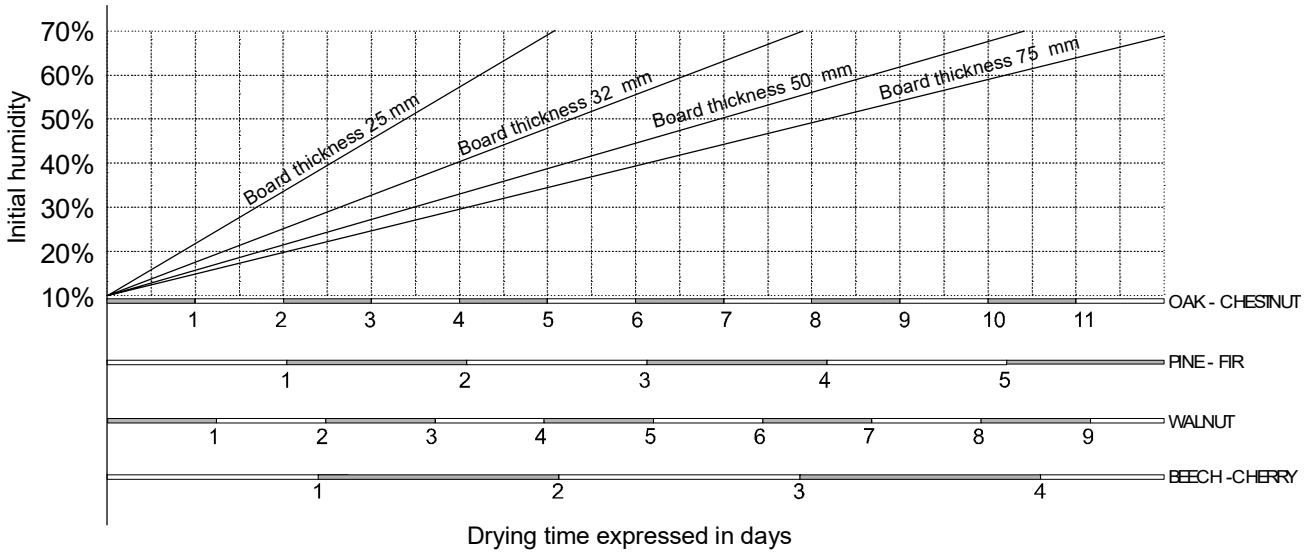
4. HOW TO CHOOSE WHICH ES OR ESC IS THE MOST SUITABLE FOR ONE'S REQUIREMENTS?

How to choose a vacuum drier, but above all how to calculate its size according to one's requirements?

The main parameters to be taken into consideration are as follows:

- volume of wood to be dried per unit of time.
- type of wood (pine, fir-wood, oak, etc.)
- thickness of semi-finished product in mm.
- initial moisture level.

From the graph below, some indications can be had of drying times on the basis of initial moisture level and thickness of wood.



By centring the initial moisture level of the semi-finished product with the vertical line of the thickness and then by moving down to where the whitish-grey lines of the different types of wood are crossed, the duration of the drying process, expressed in days, can be set.

From this result it is easy to see how the reduction in drying times means smaller capacity driers can be used compared with the volume of wood to be dried

The advantages are clearly several and range from saving of space to easier insertion in the company drying process logistics.

Not last, the monolithic characteristics of ISVE driers allow an easy relocation of them as a result of any reorganization of the production lines of the company.

Quality of drying and **design quality** are two important features of ISVE ES and ESC driers,
making them simple to use and easy to insert in the company production cycle.

5. ISVE ES AND ESC CONTINUOUS VACUUM SERIES OF DRIERS FOR SEMI-FINISHED PRODUCTS

The ISVE ES and ESC series of driers are particularly suitable for drying semi-**finished products** using various types of wood.
In order to achieve optimal results, the wood must be heated gradually and homogeneously.
This result using model's ES and ESC is achieved thanks to a series of aluminium plates which spread the heat produced by the electric resistors or the hot water which flows inside the special coils.
The rational use of the thermal energy produced does not penalise the use of a precious energy source such as electricity but it enhances it thanks to the drying process being completely computerised (however, the possibility always remains of connecting up to a hot water supply source if available).

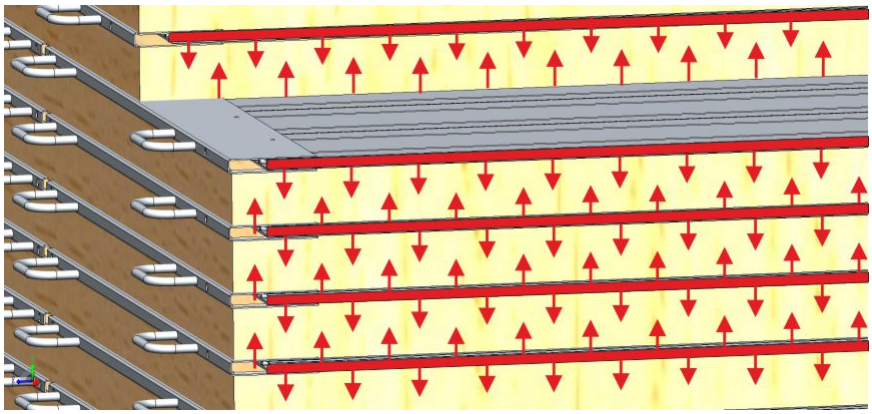


Figure 5.1: heat diffusion system of ISVE ES and ESC drier series.

The reduced size compared with the productivity of these units produces noticeable saving in terms of space and easy housing on the company premises without the need for any special brickwork or connections.
The quality materials used in the construction of the autoclave, such as stainless steel and aluminium, guarantee long resistance against corrosion, whereas the choice of components from leading Italian and foreign companies means they are able to achieve a high level of reliability. These characteristics, common to all ISVE driers, result in very high-quality drying, short working times with reduced operating costs.

5.1 MODEL ES JUNIOR and ES 2 DRIERS

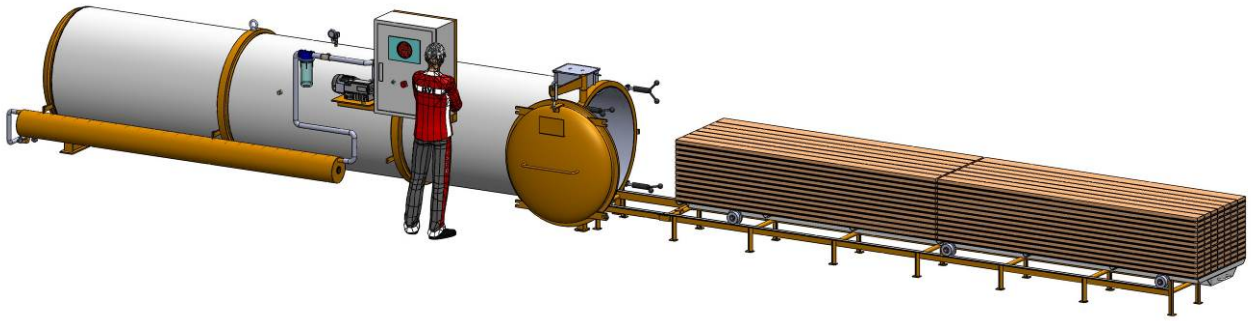
The ES Junior series of continuous vacuum driers are the ISVE mini driers traditionally used by small craftsmen.
They enclose all the technology and experience developed over twenty years of research into the application of the vacuum process in the treatment of wood.

The machine, operating at low temperatures, allows the timber to lose its water content without subjecting it to thermal changes which can cause cracking and warping. The evaporated water which remains in suspension in the container keeps the drying material surface continuously humidified, avoiding in this way the formation of small cracks which, in other drying systems is quite frequent. The humidity level which is necessary between environment and material is constantly maintained by a condenser which precipitates the steam in suspension. The conditioning of the drying chamber is kept constant and programmed in advance using probes connected to the heating and condensing circuits and to the timber. This conditioning of the environment sets the transmigration process of the water through the cellular walls of the timber in motion. Passing from their inside walls towards the surfaces, from which the water is continuously evaporated until the desired drying conditions are reached. The condensed water which deposits at the bottom of the dry kiln, is periodically expelled in order to maintain the environmental conditions constant. In this type of kilns, we normally install oil lubricated vacuum pumps able to drain the wood condensed water throw a special stainless steel made condenser.

In this way the following advantages are had:

QUICKNESS OF DRYING: owing to process without air and at low temperatures which enables hourly decreases in moisture never before reached by any other system.
PERFECT RESULTS due to: no cracks and no warping; no colour changes; no internal tension; unchanged strength of the dried material.
POSSIBILITY OF DRYING: very thick material and with a very high moisture level, such as planks and wood of all kinds, semi-finished items.
LOW OPERATING COSTS thanks to low thermal loss; a rational use of thermal and electric energy; no need of manual operations.
LOW MAINTENANCE COSTS deriving from: simple and rational construction; simple automatic devices; anticorrosion materials.

Main Characteristics



- Autoclave Kiln:
  - steel coated with epoxy products for the treatment of wood without tannin.
  - AISI 304 stainless steel for drying wood containing corrosive agents (oak, chestnut, etc.)
  - Insulating covering
- Carriage opening.
- Electric control panel with PLC for automatic running and stopping of dryings.
- moisture control probes of one or more sample units.
- Automatic draining of condensed wood water.
- Aluminium electric heating plates.
- Plate holder stands.
- Oil lubricated vacuum pump by Becker company.

Accessories on request:

- Airbag pressing system
- Disinfecting System against xylophage using insecticide tablets.

To start up the machine all that is required is an electric socket and an exhaust for the condensed water.

5.2 MODEL ESC DRIER WITH TOP OPENING

The ESC series vacuum driers are particularly suitable for carpenter workshops with problems of space.
Top opening means that the whole length of the autoclave can be used without having to extract the carriage, thus drastically reducing the overall size.

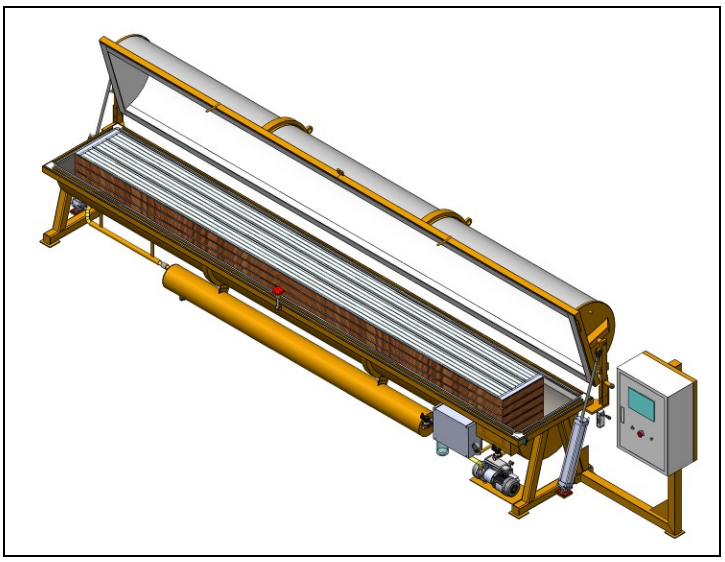
The machine, operating at low temperatures, allows the timber to lose its water content without subjecting it to thermal changes which can cause cracking and warping. The evaporated water which remains in suspension in the container keeps the drying material surface continuously humidified, avoiding in this way the formation of small cracks which, in other drying systems is quite frequent. The humidity level which is necessary between environment and material is constantly maintained by a condenser which precipitates the steam in suspension. The conditioning of the drying chamber is kept constant and programmed in advance using probes connected to the heating and condensing circuits and to the timber. This conditioning of the environment sets the transmigration process of the water through the cellular walls of the timber in motion. Passing from their inside walls towards the surfaces, from which the water is continuously evaporated until the desired drying conditions are reached. The condensed water which deposits at the bottom of the dry kiln, is periodically expelled in order to maintain the environmental conditions constant. In this type of kilns too, we normally install oil lubricated vacuum pumps able to drain the condensed wood water throw a special stainless steel made condenser.

In this way the following advantages are had:

QUICKNESS OF DRYING: owing to process without air and at low temperatures which enables hourly decreases in moisture never before reached by any other system.
PERFECT RESULTS due to no cracks and no warping; no colour changes; no internal tension; unchanged strength of the dried material.
POSSIBILITY OF DRYING: very thick material and with a very high moisture level, such as planks and wood of all kinds, semi-finished items.
LOW OPERATING COSTS thanks to low thermal loss; a rational use of thermal and electric energy; no need of manual operations.
LOW MAINTENANCE COSTS deriving from: simple and rational construction; simple automatic devices; anticorrosion materials.

Main characteristics

- Autoclave Kiln:
  - steel coated with epoxy products for the treatment of wood without tannin.
  - AISI 304 stainless steel for drying wood containing corrosive agents (oak, chestnut, etc.)
  - Insulating covering.
- Shell-opening of the cover throw pneumatic pistons.
- Electric control panel with microprocessor with PLC for automatic running and stopping of dryings.
- Moisture control probes of one or more sample units.
- Automatic draining of condensed wood water.
- Aluminium electric heating plates.
- Oil lubricated vacuum pump by Becker company.



Accessories on request:

- Airbag pressing system
- Disinfecting System against xylophage using insecticide tablets.

To start up the machine all that is required is an electric socket and an exhaust for the condensed water.

5.3 MODEL ES LARGE CAPACITY DRIERS

The ES series of continuous vacuum driers with capacities from 3 to 20 m^3 for large carpenter works or timber yards looking for **quality** in drying coupled with high **productivity.** These plants enclose all the technology and experience developed over thirty years of research into the application of the vacuum process in the treatment of wood.

The machine, operating at low temperatures, allows the timber to lose its water content without subjecting it to thermal changes which can cause cracking and warping. The evaporated water which remains in suspension in the container keeps the drying material surface continuously humidified, avoiding in this way the formation of small cracks which, in other drying systems is quite frequent. The humidity level which is necessary between environment and material is constantly maintained by a condenser which precipitates the steam in suspension. The conditioning of the drying chamber is kept constant and programmed in advance using probes connected to the heating and condensing circuits and to the timber. This conditioning of the environment sets the transmigration process of the water through the cellular walls of the timber in motion. Passing from their inside walls towards the surfaces, from which the water is continuously evaporated until the desired drying conditions are reached. The condensed water which deposits at the bottom of the dry kiln, is periodically expelled in order to maintain the environmental conditions constant. This type of machine can be equipped with both vacuum pumps lubricated with oil and water. In the latter case and if the machine is mainly used for drying wood not acid, you can give it a water recycling system for the vacuum pump.

In this way the following advantages are had:

QUICKNESS OF DRYING: owing to process without air and at low temperatures which enables hourly decreases in humidity never before reached by any other system.
PERFECT RESULTS due to no cracks and no warping; no colour changes; no internal tension; unchanged strength of the dried material.
POSSIBILITY OF DRYING: very thick material and with a very high moisture level, such as planks and wood of all kinds, semi-finished items.
LOW OPERATING COSTS thanks to low thermal loss; a rational use of thermal and electric energy; no need of manual operations.
LOW MAINTENANCE COSTS deriving from: simple and rational construction; simple automatic devices; anticorrosion materials.

Main Characteristics

- Autoclave:
  - steel coated with epoxy products for the treatment of wood without tannin.
  - AISI 304 stainless steel for drying wood containing corrosive agents (oak, chestnut, etc.)
  - Insulating covering
- Carriage opening and plates and wood holder carriage.
- External carriage rails.
- Electric control panel with PLC for automatic running and stopping of dryings.
- Moisture control probes of one or more sample units.
- Stainless steel condenser pipes installed at the bottom with two cooler fans.
- Hot water circulation pump for the kilns equipped with hot water heating plates.
- Four-way motorized valve to be connected up to a hot water source.
- Automatic exhaust of condensed wood water.
- Aluminium electric heating plates or by hot water provided of fast joints.
- Plates holder stands.
- Oil or water lubricated vacuum pump eventually equipped with recycling system.

Accessories on request:

- Airbag pressing system
- Disinfecting System against xylophage using insecticide tablets.

To start up the machine all that is required is an electric socket and an exhaust for the condensed wood water.

On request, these machines can be suitably prepared for temperate climate, therefore they are equipped with insulation and condensers. In this case they are called PLUS (Ex. ES1600 / 5000 PLUS or ES2200 / 10000 PLUS etc.).

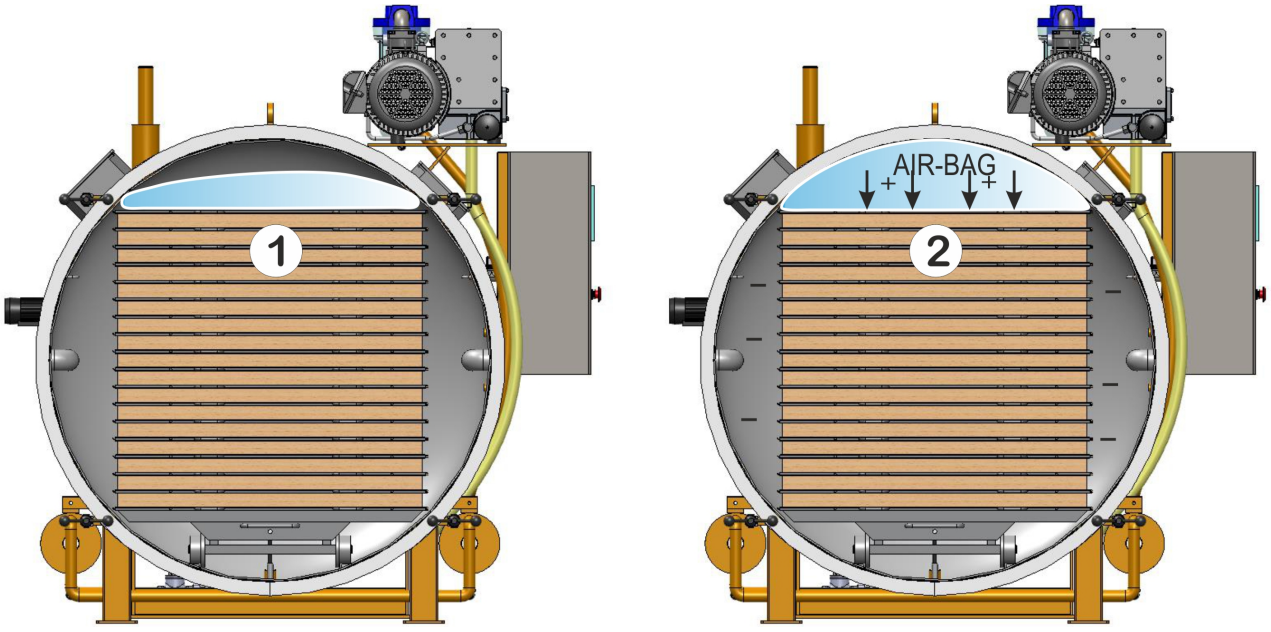
APENDIX 1: AIR-BAG PRESSING

Dry the wood without subjecting it to physical stress is a guarantee in terms of stability and durability of the product. The **constriction** of wood fibers by subjecting the stack abnormally at large pressure forces can be especially inconvenient for long pieces.
In this case, the subsequent processing destabilize the balance of forced fiber downloading abnormally internal stresses resulting in breakage and distortion.

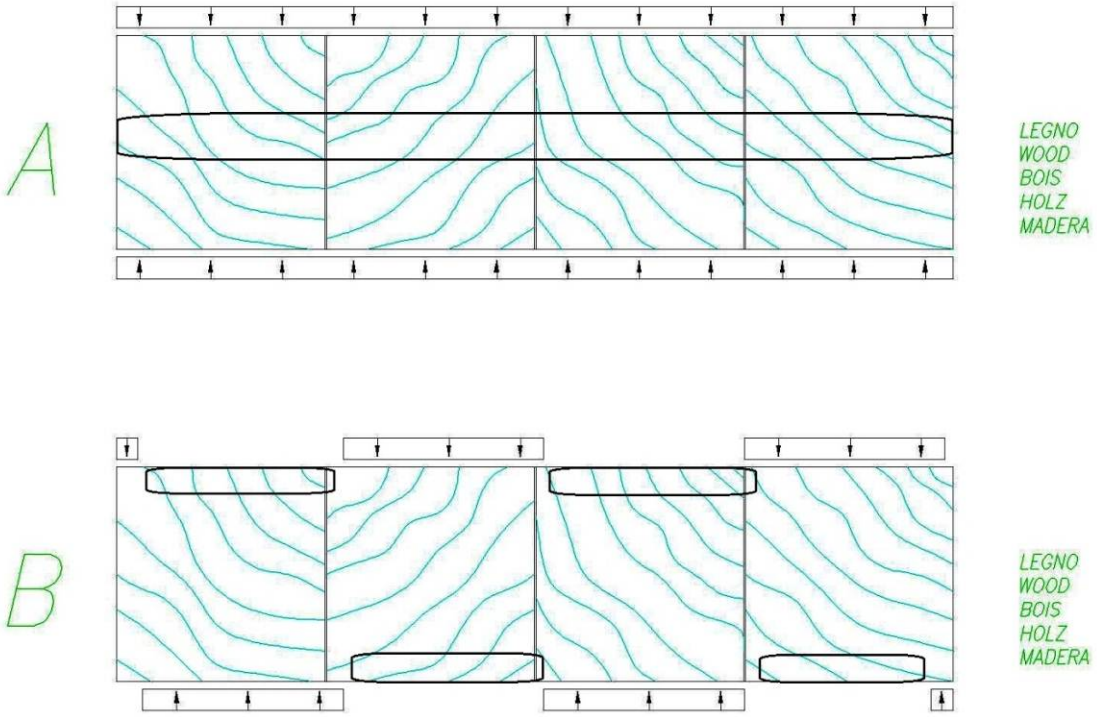
The air bag pressing allows to exercise **gradually pressure** and to adjust them easily even under maximum vacuum. This technique is used for thin semi-finished where the action of pressure can avoid distortion or even correct the surface bending of some pieces.
Fundamental prerogative of the use of this technique is the processing cycle of dried semi-finished, which must not provide for subsequent removal of material.

Main features:

- Cushion of air at double cavity to transfer the atmospheric pressure at the pile of wood on the inside of the autoclave.
- System of automatic inflation during the vacuum phase.
- Possibility to adjust the force of action throughout the drying cycle.



APENDIX 2: COMPARISON BETWEEN USE OF "INTEGRAL" AND "GRID" SURFACE HEATING PLATES IN "ES" DRYERS WITH HOT WATER HEAT SYSTEM



= Heat

= Coldest areas

A = option with integral plates – the wood coldest areas is the central one

B = option with grid plates – the wood coldest area is the outside one*

*Grid plates must be used for woods subjected to a faster drying outside with consequent formation of a waterproof surface, called "crust".