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TIMBER DRYING PROCESS AND APPARATUS

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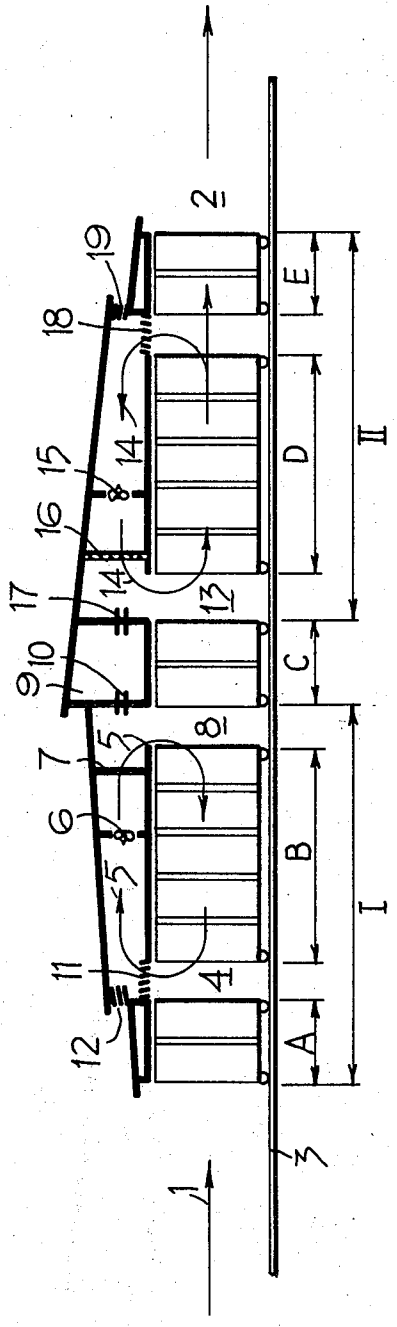

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TIMBER DRYING PROCESS AND APPARATUS

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ABSTRACT OF THE DISCLOSURE

Timber is tunnel-dried in two successive drying zones preferably separated by a moisture equilibration zone. The parameters of the drying air streams in the two zones are monitored and adjusted completely independently from one another, the two air streams being introduced and withdrawn separately and without intermixing to achieve optimal rapid drying to near the fibre saturation point in the first zone and optimal gentler drying in the second zone.

Background of the invention

The present invention relates to a method and apparatus for drying timber.

In accordance with South African Patent No. 60/4,481 a longitudinal timber drying kiln is known in which the timber is fed in from one end and, after having passed through the kiln is removed at the opposite end, the timber being positioned crosswise to the airflow in the kiln. The kiln is subdivided by air baffles designed to split the airflow fed from a single fan unit and heating chamber so as to cause part of the air to move through part of the charge in one direction relative to the feeding direction of the timber and through another part of the charge in the opposite direction.

In the above drying apparatus in which a portion of the spent air is allowed to leave at that end of the apparatus where the dried timber is removed, a corresponding amount of fresh air being introduced at the same end whilst the remainder of the air is re-circulated, drying does not always proceed under optimal conditions. This may then result in excessively harsh drying conditions in parts of the kiln resulting in splitting of timber and case hardening and non-uniform drying of the different parts of the cross-section of the logs. Somewhat similar apparatus is described in German Patent 210,636 and U.S.A. Patent 1,729,675. In the latter case the spent air from the first zone is reused with further heating in the second zone.

The invention has as its objects an improved control and optimalisation of drying conditions for the drying of timber. The invention is particularly advantageous when drying at moderate temperatures.

Summary of the invention

A timber drying process in accordance with the invention is of the type in which drying with circulating air takes place in two zones in succession, drying conditions in the second zone thereof being more gentle than in the first zone, improved by the feature that:

(A) The relative moisture contents of the drying air and the temperature thereof are monitored in each zone individually, and separately and maintained in a predetermined range for such zone also individually and separately;

(B) The air throughput is maintained for each zone at a predetermined rate also completely independently one from the other; and

(C) The air streams of said zones remains substantially separate throughout their respective drying cycles.

In accordance with the preferred process the two zones are in communication with one another, the airflows in the said two zones being controlled individually in accordance with the air resistance offered by the load in said zones for substantial pressure equalisation to exist at the locality or localities of communication between said zones. In that manner the airflows in each zone proceed individually in spite of the said communication, allowing separating baffles to be wholly or partly dispensed with.

In accordance with the preferred process, conditions in the first zone are controlled essentially for the "free moisture" of the timber to be removed quickly and economically without setting up severe stresses in the timber. Moreover, in the said first zone the drying air is preferably directed in counter current to the direction of feeding the timber.

In the said first zone the temperature is maintained substantially constant at a predetermined level, the humidity of the drying air is monitored, preferably before the entrance of the air into the timber and the humidity is depressed to the required predetermined level by adding an appropriate proportion of fresh air to the drying air and removing a corresponding amount of spent air from circulation.

The spent air thus removed is preferably used to preheat fresh timber, preferably substantially to the temperature of the said first zone prior to entering the said first zone.

By "free moisture" we mean that amount of moisture which can be removed before or up to the stage at which the timber has reached what is known in the art as "fibre saturation" or the "shrinkage intersection point." Tests have shown that if drying is continued at approximately the same rate, relative to temperature and airflow beyond that critical point of drying, splitting of the timber results to an excessive extent and also such twisting and bending as may be ascribed to uneven drying.

The invention, therefore, provides for drying after having reached that stage to proceed more gently. Heating, humidity and fresh air control may proceed in the said second zone substantially according to the same principles as applied to the first zone, according to a predetermined schedule conductive to the removal of cell wall moisture in a comparatively gentle fashion and designed with regard to the species and thickness of timber. Moreover, preferably the drying air in the second zone moves in co-current to the direction of feeding of the timber. The portion of spent drying air removed from the second zone and replaced by fresh air is preferably passed through that portion of the timber about to leave the drying system, thereby subjecting said timber to a period of final gentle drying and internal and external equilibration with the partly moisture-laden, drying air at a temperature at or near the previous drying temperature.

In accordance with the preferred process the timber intermediate between leaving the first zone and entering the second zone is subjected to a period of maintenance at elevated temperature, more particularly on the average at substantially the average temperature of said

zones but in the substantial absence of moisture removal. The purpose thereof is to achieve at least partial and, if possible or practical, substantially complete moisture equilibration between the various parts of the timber, thereby to reduce or substantially eliminate any moisture gradient between the centre of the timber and the surface, to prevent case hardening or to substantially reduce or relieve temporary case hardening where such may already have occurred and to relieve drying stresses.

The apparatus in accordance with the invention comprises a drying tunnel having a timber inlet end and a timber outlet end and divided into two interleading principal successive drying zones improved by the feature that: Each zone has completely independently and separate from the other zone its own complete set of air blowing means, heating, humidity and fresh air control means, separate fresh air inlet and spent air outlet passages.

In accordance with the preferred apparatus the humidity control means comprise a humidity sensing device coupled to a humidity regulating device comprising means for deflecting part of the spent air stream of the respective zone out of the apparatus combined with coacting means for causing a substantially corresponding amount of fresh air to enter into the zone to be forwarded to the heating means of the zone. For example, each zone comprises an air outlet subsequent to the locality at which the spent air of the zone leaves that portion of the timber through which the air of said zone is being circulated, a fresh air inlet subsequent to the said air outlet in the direction of air circulation, a ventilator across said circulatory passage, a second ventilator across the air inlet and means for opening and closing both ventilators coupled to one another so as to open the one ventilator in a predetermined relationship to the closing of the other ventilator and vice versa.

In accordance with the preferred apparatus the spent air outlet passage of the first drying zone, counted from the timber inlet end of the apparatus incorporates a timber preheating zone. Similarly the air outlet passage at the outlet end of the apparatus preferably incorporates a timber equilibration and final drying chamber or outlet chamber through which the timber of the second zone passes before leaving the apparatus.

Intermediate between the aforesaid two drying zones a conditioning, equalising and stress-relieving compartment is preferably situated, which is preferably in communication with both drying zones, but substantially outside the path of the circulatory air of both zones.

It is an important feature of the preferred embodiment in accordance with the invention that humidity control proceeds entirely by utilising the moisture being removed from the timber by the drying process and the controlled substitution of fresh drying air for a corresponding amount of moisture laden drying air removed from circulation. However, if desired or required the invention is not limited to that specific embodiment but also includes the case where steam, water, or humid air is introduced from an extraneous source to raise the humidity to a predetermined level.

Brief description of the drawing

The invention and the manner in which it may be put into practice will be further described in the following by way of example with reference to the accompanying drawings which shows diagrammatically in side elevation, partly broken away, a drying apparatus in accordance with the invention.

Description of the preferred embodiment

Referring to the drawing the apparatus comprises two major zones marked I and II. Arrow **1** shows the general direction of movement of the timber relative to the apparatus, arrow **1** being shown at the entrance side to the apparatus whilst **2** quite generally represents the outlet end of the kiln. The timber is carried through the kiln continuously or preferably, in the particular example diagrammatically shown, by movement at predetermined intervals, whilst supported on trolleys carried by rails **3**. The timber is loaded on the trolleys crosswise, stacked with sticks between each sawn timber layer to permit the passage of air, the width of the kiln being designed to accommodate a standard length of timber, e.g., 24 feet. Each timber load has a height in accordance with the height of the kiln, say between 8 and 10 feet high, and each trolley will take a load, say five feet wide.

The timber according to a predetermined programme enters the apparatus from **1**, first into the compartment of zone I which is marked A. This compartment is designed to take say one or two trolley loads of timber depending on kiln capacity, and serves simultaneously as the outlet passage for moisture-laden air from zone I. In that manner the timber inside compartment A is preheated substantially to the temperature of zone I with little or no drying. Between compartment A and compartment B of zone I a clear vertical passage **4** is maintained through which the air of zone I circulates as indicated by arrows **5** namely in counter-current to the general direction of progress of the timber through the kiln. Above compartment B of zone I the passage **4** enters into a heater and blower chamber comprising fans **6** and heating coils **7**. This is followed in the direction of air circulation by a further vertical passage **8**. The drying air entering passage **8** from the heating coils passes a control room **9** from which dry and wet bulb thermostats project into the air passage. The dry bulb thermostats **10** control the heating coils **7** to give the exact temperature required.

The wet bulb thermostat on the other hand controls through servo-motors or other suitable means the degree of opening or closing of a humid air ventilator provided at the upper end of passage **4** and which determines what proportion of the circulatory air having passed through compartment B will be recycled to the heating coils and what proportion will leave the apparatus through compartment A. This humid air ventilator is coupled to a fresh air ventilator **12** which is opened to allow the entrance of fresh air in relationship to the extent of closing of ventilator **11**.

Whereas compartment A may be designed to hold for example one or two loads of timber compartment B may be designed to hold say five or six loads depending on capacity of the kiln. The fans and heating coil aggregate are proportioned in accordance with the capacity of the kiln as well as the species and size of the timber for which the kiln has been designed.

Underneath the control room **9** the conditioning, equalising and stress-relieving compartment C is situated which may, for example, be designed to take again one or two loads depending on the capacity of the kiln and allowing for a residence time of say eight hours or more for the purposes explained further above. This equilibration process for say eight or more hours is assisted by the high temperature of the timber, and it will be understood that, because compartment C is substantially outside the air movement of both drying zones, little or no actual moisture removal takes place in compartment C. In this example there are no baffles between zones I and II and apart from the resistance offered by the timber stacked in compartment C, substantial communication exists between zone I and zone II. Nevertheless the circulatory air streams of the two zones are substantially separated because fans **6** and **15** are so dimensioned that substantially the same pressure is maintained in passages **8** and **13**.

From compartment C the timber enters into compartment D of drying zone II after passing through vertical passage **13** which like vertical passages **4** and **8** has a width of say 4 to 5 feet. In compartment D the air is circulated co-currently in respect of the general direction of movement of the timber, as indicated by arrows **14**, the

purpose being to ensure that the timber is dried under ever increasing gentleness of the drying conditions. Above compartment B, the air circulating fans **15** followed by heating coils **16** are provided, the air after passing through the heating coils, sweeping past a second set of dry and wet bulb thermostats **17** projecting from control room **9**. Again the dry thermostat controls the heating coil **16** whilst the wet bulb thermostat via a servo-motor or the like controls the opening and closing of the humid air ventilator **18** coupled to a fresh air ventilator **19** substantially in the same manner as in the case of zone I.

The moisture-laden spent portion of air which in accordance with the setting of the ventilators is caused to leave the apparatus passes through compartment E which is the outlet chamber for the dried timber. In compartment E again one or two stacks of timber may be maintained depending on the design of the kiln. In compartment E, the final moisture extraction takes place under the most gentle conditions under which substantial equilibrium between the heart and the outside layers of the timber is attained at least by approximation.

It will be understood that the above system is designed to operate substantially independently of ambient moisture and temperature conditions.

Example

It is intended to dry 37 mm. thick timber having a 180% moisture content based on dry weight with 25 mm. stickers crosspiled between each timber layer. The timber enters the apparatus in countercurrent with exhaust air (corresponding to the recycle air of zone I) having a dry bulb temperature of 95° Fahrenheit, a wet bulb temperature of 92° Fahrenheit, a relative humidity of 88, the equilibrium moisture content (E.M.C.) being 18.1. The residence time of the timber in compartment A is eight hours. The residence time in compartment B is twenty-four hours, and where the timber leaves compartment B (passage **8**) the air has a dry bulb temperature of 115° Fahrenheit and a wet bulb temperature of 90° Fahrenheit. Its relative humidity is 38 and its E.M.C. 6.5. Compartment B has an average temperature of 120° Fahrenheit. Where the timber enters zone II, (passage **13**), the dry bulb temperature of the air is 125° Fahrenheit and the wet bulb temperature 90° Fahrenheit. The relative humidity is 27 and the E.M.C. is 4.8.

The recycled air of compartment D (or that which enters compartment E) has a dry bulb temperature of 115° Fahrenheit, a wet bulb temperature of 90° Fahrenheit, a relative humidity 38; the E.M.C. is 6.5.

The air velocity in compartments B and D is approximately in the range of 1.20–2.00 m./sec.

The residence time of the timber in compartment D is again twenty-four hours.

The residence time of the timber in compartment E is eight hours. The moisture content of the timber leaving the kiln is between 10 and 12%.

What I claim is:

1. A timber drying process of the type in which drying with circulating air takes place in two zones in succession, drying conditions in the second zone thereof being more gentle than in the first zone, improved by the feature that:

(A) the relative moisture contents of the drying air and the temperatures thereof are monitored in each zone individually, and separately and maintained in a predetermined range for such zone also individually and separately;

(B) the air throughput is maintained for each zone at a predetermined rate also completely independently one from the other; and

(C) the air streams of said zones remain substantially separate throughout their respective drying cycles.

2. A process as claimed in claim **1** in which the two zones are in communication with one another, the airflow in the said two zones being controlled individually in accordance with the air resistance offered by the load in said zones for subsantially pressure equalisation to exist at the locality or localities of communication between said zones.

3. A process as claimed in claim **1** in which the temperature at a predetermined locality of a zone is montored and maintained substantially constant for such zone by an adjusted heat input whilst simulaneously, also at a predetermined locality for such zone the relative humidity of the drying air is monitored and is depressed to the required predetermined level by adding an appropriate proportion therefor of fresh air to the drying air and removing a corresponding amount of spent air from circulation.

4. A process as claimed in claim **3** in which the humidity of the drying air is monitored before the entrance of the air into the timber.

5. A process as claimed in claim **3** in which the said spent air removed from the first of said zones is discharged in contact with the timber about to enter the first zone thereby preheating said timber.

6. A process as claim in claim **3** in which the portion of spent drying air removed from the second zone and replaced by fresh air is passed through that portion of the timber about to leave the drying system.

7. A process as claimed in claim **1** in which the timber intermediate between leaving the first zone and entering the second zone is subjected to a period of maintenance at elevated temperature but in the substantial absence of moisture removal.

8. A process as claimed in claim **1** in which humidity control proceeds entirely by utilising the moisture being removed from the timber by the drying process and the controlled substition of fresh drying air for a corresponding amount of moisture-laden drying air removed from circulation.

9. A timber drying apparatus comprising a drying tunnel having a timber inlet end and a timber outlet end and divided into two interleading principal successive drying zones improved by the feature that:

each zone has completely independently and separate from the other zone its own complete set of air blowing means, heating, huimidity and fresh air control means, separate fresh air inlet and spent air outlet passages.

10. Apparatus as claimed in claim **9** in which the humidity control means comprise a humidity sensing device coupled to a humidity regulating device comprising means for deflecting part of the spent air stream of the respective zone out of the apparatus combined with coacting means for causing a substantially corresponding amount of fresh air to enter into the zone to be forwarded to the heating means of the zone.

11. Apparatus as claimed in claim **10** in which each zone comprises an air outlet subsequent to the locality at which the spent air of the zone leaves that portion of the timber through which the air of said zone is being circulated, a fresh air inlet subsequent to the said air outlet, in the direction of air circulation, a ventilator across said circulatory passage, a second ventilator across the air inlet and means for opening and closing both ventilators coupled to one another so as to open the one ventilator in a predetermined relationship to the closing of the other ventilator and vice versa.

12. Apparatus as claimed in claim **9** in which the spent air outlet passage of the first drying zone, counted from the timber inlet end of the apparatus incorporates a timber preheating zone.

13. Apparatus as claimed in claim **9** in which the air outlet passage at the outlet end of the apparatus incorporates a timber equilibration and final drying chamber through which the timber of the second zone passes before leaving the apparatus.

14. Apparatus as claimed in claim **9** in which said two zones are in communication with one another with substantial pressure equilibrium across said communication.

15. Apparatus as claimed in claim 9 in which between said zones an intermediate interrupted drying zone is provided adapted for the accommodation and maintenance therein of timber before its transfer from the first zone to the second zone of the two aforesaid zones.

16. Apparatus as claimed in claim 15 in which said intermediate zone is in communication with both drying zones, but substantially outside the path of the circulatory air of both zones.

References Cited

UNITED STATES PATENTS

1,508,283 9/1924 Kerst ---------- 34—223

WILLIAM J. WYE, *Primary Examiner.*

U.S. Cl. X.R.

34—223