

WIND TUNNEL KILN DRYING

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History

There is nothing new about the basic idea of drying lumber in a wind tunnel. For many years it has been the practice in certain localities to dry lumber by stacking it in the open in a favorable location and letting nature do the work. In one sense of the word, the wind tunnel is simply a "glorified air-drying" process. Among the first wind tunnels to be installed was at Timber Structures, Inc. in Portland in 1945. It has been in operation ever since, although it did not fulfill their needs when it was necessary to bring the lumber down to 7 to 8% moisture content for gluing operations. It is entirely practical for drying 1" and 2" common lumber to 16 to 20% moisture content.

Description of the Wind Tunnel

This type of dryer consists simply of a long, inexpensively constructed tunnel with one or more fans at one end to draw outdoor air through heaters and force the heated air lengthwise of the tunnel, through cross-stacked loads of lumber. The heated air is discharged into the open atmosphere at the opposite end. Drying temperatures are low--generally between 100° and 125° F.

Aims of the Wind Tunnel Project

The wind tunnel idea is used extensively in various industrial drying processes. The main reason tunnel dryers have not heretofore found wide employment in the lumber industry has been the lack of means to properly control drying conditions. In addition, information as to proper operating procedures has been lacking. Efforts have been directed toward the development of a system of automatic control adapted to this type of dryer and developing information as to proper types of fans and air velocities. Too much air as well as too little air can cause the dryer to be unsatisfactory. Further, it is important to have suitable operating procedures for this type of dryer.

Drying Temperatures and Drying Speed

While drying temperatures employed in the wind tunnel are usually below 125° F., depending on the lumber item and other factors, temperatures in conventional types of dryers very seldom go below 130° F. and more usually run between 150° F. and 200° F. The main result of this difference in temperature is considerable difference in speed of drying.

In wind tunnel drying it is necessary to accept the disadvantage of slower drying in order to obtain the advantages involved, and in those cases where the disadvantages resulting from slow drying overbalance the advantages, wind tunnel dryers are not suited.

Dryer Installation Cost

Because the wind tunnel is considerably slower than regular kiln drying, extra holding capacity is necessary to produce the same drying capacity. For example, where a high temperature kiln might require 30 M board feet holding capacity to afford 10 M per day drying capacity for Fir dimension, a wind tunnel would need around 80 M holding capacity to provide the same drying capacity. In other words, a larger building is necessary for the same drying capacity.

Despite this necessity for a larger building, the installation cost of a wind tunnel is much less than the cost of installing a high temperature dryer, the comparison being made on the basis of equal drying capacity. Because of the low-drying temperatures, a very simple, inexpensive type of building construction is entirely satisfactory; the required fan equipment is relatively inexpensive and easy to install; heating equipment in the case of steam is also low-cost; the automatic control equipment adaptable to the wind tunnel costs less than one-third that required for high temperature kilns.

Method of Handling Lumber

The lumber is stacked in unit packages, the stickers being placed so that they will line up with the kiln trucks. Lengths are segregated to a certain extent, but individual pieces in a package may vary as much as six feet. The pieces are piled so that the packages are even on one end. The trucks are eight feet wide and therefore will take two tiers of unit packages. These are piled three packages high, 3 x 4 separator bunks being used. In one tier the even ends of the packages are loaded flush at one end of the truck load, and in the other tier the even ends are flush at the other end of the load. This arrangement is essential to the even flow of air through the tunnel when random-length stock is handled in unit packages. The unit stacks are brought to the tunnel by means of straddle carriers and are loaded onto kiln trucks with a lift truck.

The rate at which the stock is moved progressively through the tunnel depends on the item being dried. A dry load is removed from the tunnel and a green load is admitted at the opposite end.

Lift trucks unload the dry lumber from the kiln trucks and carry the empty trucks back to the green end of the tunnel. Straddle carriers remove the dry unit packages to the storage place.

The operation is so regulated that the loading and unloading requires only a few minutes of carrier and lift truck time each day. The kiln trucks are set up at the green end of the tunnel so that the lift truck operator can load them whenever he is free from other duties about the plant. When the load is completed, it is pushed into the tunnel by means of the lift truck.

Control of Drying Conditions

Three principal factors affect drying conditions in the wind tunnel:

- (1) Temperature of the air entering at the "dry end" of the tunnel.
- (2) Volume or velocity of air passing through the tunnel.
- (3) The rate at which lumber progresses through the tunnel.

The air volume can be controlled by sliding dampers behind the fan or changing the RPM of the fan. The rate of progression of lumber through the dryer is, of course, simply a matter of dryer operation.

Wind Tunnel Drying Cost

Comparing wind tunnel drying costs with conventional high temperature kilns, the following will be observed:

- (1) Sorting, stacking, unstacking, transportation and storage costs in general will be the same.
- (2) Interest on dryer investment. Installation cost is so much lower in the case of wind tunnel dryers that interest charges are very much reduced.
- (3) Depreciation. The combination of lower installation cost plus long life of the equipment due to mild drying conditions should bring a large reduction in this charge.
- (4) Maintenance and repair. There is no reason to expect this item to be any higher than for kiln drying. If anything, simplicity of equipment and milder operating conditions should lower this cost.
- (5) Steam. Steam consumption is one-third to one-half that in high temperature kilns.
- (6) Electric power. Power consumed by the fans is much lower than that in high temperature kilns, the comparison being made on basis of kilowatt hours per M feet of dry lumber.
- (7) Supervision and operating labor. Less than for high temperature kilns.
- (8) Fire insurance. The BLO-R-DRY takes a lower rate than a high temperature kiln. Insurance cost on equipment is less because of lower value.
- (9) General overhead. Costs of this nature are less than for other drying methods.

Other Considerations

Factors other than cost may affect the suitability of wind tunnel dryers for particular situations.

One important consideration is the question of large fixed investment versus small fixed investment in the lumber-drying installation. Although interest on investment is a small item of cost even with high-priced kilns, for various reasons a large fixed investment in drying equipment might be undesirable or impossible. A demountable building can be erected for this purpose and thus becomes eligible to qualify for a lease arrangement. In this case, the entire package can be obtained for a small down-payment and the monthly payments may be charged direct to operating expense.

In some mills a progressive drying operation has definite advantages by simplifying lumber storage handling. Progressive operation affords a constant,

even flow of lumber rather than the intermittent movement of large batches, which characterizes charge kilns.

In the effect on lumber, low-temperature drying has two advantages and one disadvantage. Low temperatures allow the stock to retain a brighter color. Further, it has been found that high temperature to a certain extent reduces the strength of wood. On the other hand, wind tunnel drying does not set the pitch on those items where pitch-bleeding might be a source of trouble.

Based on the foregoing general information, BLO-R-DRY was placed on the market a little over a year ago,----the heating equipment being engineered and installed by the Iron-Fireman Mfg. Co.

Application of the BLO-R-DRY

The BLO-R-DRY is eminently suitable for the drying of common boards and common dimension. In addition, we believe that this type of dryer has considerable possibility in the drying of siding, flooring strips, one-inch finish and those items of industrial stock which do not need to be dried below 16% to 20% moisture content. The main performance limitation is the drying of items two inches and over in thickness to very low moisture content; in such cases, drying time is so much increased that this type of drying in all likelihood becomes impracticable.

A study of actual weights, which as the rate increases, becomes an important factor. Green surfaced Douglas Fir ships on 2500#, but check-ups have shown that over a year's average there is generally a considerable overweight which is a penalty to the shipper. On the other hand, dry surfaced ships on 2200# and underweights can run better than 300#.

The goal of any capital investment is profit. The three definite factors that are involved in this investment are the savings in overweights, the gain in underweights and the spread in the price between green and dry. Reduced to figures this can result in the following,----based on \$1.41 per 100# freight rate:

Saving of overweights	200#	@\$1.41	\$ 2.82
Additional for underweights	300#	@\$1.41	4.23
Spread, dry over green per MBM			12.00
	Total	-----	<u>\$19.05</u>

In addition to the above, there have been many times in the history of the lumber industry when it has been next to impossible to move green dimension, but even in such times dry stock has been in demand.

From the more technical aspects of BLO-R-DRY, these factors should be considered:

The temperature range for this type of drying is between 100° F and 125° F, depending on the specie and size of stock to be dried. This is considerably lower than commonly used kiln temperature and somewhat above good air-drying temperatures. In the BLO-R-DRY this is constantly controlled night and day with

a steady current of air. Under certain conditions in the peak summer drying season, there are periods when the boiler can be shut off and the fans left on.

Temperatures used are not high enough to set the pitch in clear items. This type of drying is not recommended for such items as cross-arms or thick stock as a considerable variation between shell and core is liable to occur.

The species that have been most successfully dried so far include Douglas Fir, Western Hemlock, and White Fir. As yet, no tests have been made on drying Pine. There is the possibility of risk of blue stain in drying this specie. From discussions on this subject, there appear to be two schools of thought and apparently this can be only settled by actual test runs. From minor tests run on second growth Redwood studs, it would appear that this type of drying might be highly successful. Some samples showed the weight to be cut in half.

In a kiln in which the lumber is stacked correctly and the loads are well-baffled in the kiln building, the rate of circulation of air through the stickered lumber runs between 250 and 300 ft. per minute. When the entire kiln charge is in balance and the entering air is 110° F, the leaving air will be around 70° F. If the relative humidity of the entering air is 35%, it will be near 100% at the leaving end.

The travel time for 2" common Fir from the green end to the dry end is approximately seven days. A dry load is pulled out and a green load is shoved in, moving the loads in front forward. The holding tunnel for the normal installation is 112 feet long which accommodates 14 loads built on 8 foot kiln cars. Each kiln car consists of 6 fork lift packages built 2 wide and 3 high. If the stock averages 20 feet long there will be approximately 12,500 feet on a kiln car of 6 packages. Two of these kiln cars can be pulled each day, or a capacity in this case of producing 25 M per day or 175 M per week.

Shipping weights are definitely of interest to the mill owner. Underweights become a source of income. Data compiled for instance on 2 x 4 RL common White Fir that had a green surfaced weight of 2900# per M was brought down to less than 1700#, or, in other words, the elimination of over 1200# of water per M BM. The same general ratio also applies to Douglas Fir and Western Hemlock.

The uniformity of moisture content in this type of drying is very good. In a recent test there were the usual heart pieces on the low side and a few sinkers on the high sides, but better than 80% fell in a range of 12 to 16% MC.

The cost of fuel oil is directly related to outside temperatures when all of the air volume is pulled from the outside to the heating coils. This can be generalized in the table below based on using PS 300 oil at .08¢ per gallon:

<u>Outside Temperature</u>	<u>Gallons per Hr.</u>	<u>Cost per Day</u>	<u>Cost per M</u>
0 to 30°	25	\$48.00	\$1.92
35 to 50°	20	38.40	1.53
55 to 70°	15	28.80	1.15
75 to 90°	10	19.20	.77
95 to 100°	5	9.60	.39

NOTE: If the outside temperature is 90° F or more with a low relative humidity (30% or less that closes down operations), no heat is required---fans only.

Based on the figures listed above, it can be readily seen that in colder climates and during cold spells in a mild climate, the use of a return-air duct is advisable. Through tests made in some of the first installations made, it was found that although the value of the heated air entering the dry end had been entirely used up, there was considerable heat left in this air at the green end. Through the use of a drop-roll curtain at the green end, this air can be recirculated and a considerable saving made in the amount of fuel consumed. Through the use of dampers, any desired mixture of fresh air and air returned may be made.

To summarize this report, it can be concluded that the basic principle of engineered air drying in a wind tunnel is indeed a sound one. With this realization, BLO-R-DRY has made many refinements that make this type of drying more efficient and entirely practical. We confidently feel that this low-temperature, progressive kiln will now find a permanent place in the lumber-drying field.