INCREASED AIR DELIVERY AND ITS EFFECT ON KILN PERFORMANCE

Lyle Carter
Moore Oregon-Canada
Portland, Oregon

We at Moore Oregon have been doing some field work relative to improving velocity in dry kilns. The information gained is not new or surprising. However, it does graphically display some points we tend to forget.

Air velocity is a lot like boiler capacity that Bill Brubaker talked about yesterday. When you have lots of it you tend to get sloppy and waste it until the schedule which has been satisfactory has to be lengthened to get the lumber dry. It's only then you look for ways to improve the kiln efficiency.

Improved air velocity can be attained by making improvements in one or more of the following areas.

1. Improved stacking and stickering.
2. Improved baffling. This includes replacement or repair of baffles as well as improving their method of placement and operation.
3. Improved fan performance which includes increased horsepower, speed, or new fan system.

All of these items are valid means of improving air velocity and uniformity.

The work we have done points out the fact that substantial improvement can be gained from improved stacking, stickering and baffling.

The first case in point is of a double track by 54 foot kiln with line shaft fan system and steam heated.

A full set of air velocity readings were taken. The sticker openings were marked with chalk where the readings were taken, so accurate comparisons could be made. (The average velocity was found to be 314 FPM).

The fans were changed to our new line shaft fans and with the original cribs of lumber in the kiln, a new set of velocity readings were taken. The readings were taken in the same marked sticker openings and found to average 487 FPM. This is an improvement in air velocity of 55%.

Here I should note that the stacking and baffling of this kiln was not at its best. There were missing baffles and voids through the loads caused by multiple length sorts. The velocity readings were taken as the kiln was being used. No changes were made prior to taking the velocity readings.

At a later date, we returned to the kiln and attempted to simulate good baffling by tacking strips of veneer over areas where baffles were
missing. The stacking was pretty good and there was no abnormal
areas between cribs.

Velocity readings were taken and had increased to 716 FPM. Comparing these new air velocities with the previous readings, we
found an improvement of 56%.

These are actual velocity readings from an actual kiln.

It's interesting to note that a 55% increase was experienced when
the fans were changed, and a 56% increase was experienced when
stacking and baffling was improved.

The information which follows is general in nature and it is
presented to give a magnitude to the importance of the various points
of good baffling, stacking and stickering.

Table 1. Total area open for air passage

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Baffle Leakage</td>
<td>8.6%</td>
</tr>
<tr>
<td>2. Between Loads</td>
<td>9%</td>
</tr>
<tr>
<td>3. Bolster Opening</td>
<td>11%</td>
</tr>
<tr>
<td>4. Sticker Opening</td>
<td>71.4%</td>
</tr>
</tbody>
</table>

This table represents the total area open for air passage through
a 54 foot charge of lumber with reasonably good stacking, stickering
and baffling.

Note that the sticker area represents 71.4% of the area available
for air passage. In other words, 28.6% of the available air passages
by-passes the lumber.

For the purpose of this comparison, we have assigned realistic
velocities through these open areas:

- Velocity through sticker openings = 500 FPM
- Velocity through bolster openings = 1000 FPM
- Velocity between loads = 1350 FPM
- Velocity through baffle leakage = 1000 FPM

Applying these velocities to the areas outlined in Table 1, we can
get a good idea of the relative volume of air passing through the
respective areas.

The volume actually passing through the sticker openings is
probably less than shown here due to the boundary layer effect which
Dr. Mackay discussed yesterday.
Table 2. Relative volume of air passing through respective areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Baffle Leakage</td>
<td>12.6%</td>
</tr>
<tr>
<td>2. Between Loads</td>
<td>18%</td>
</tr>
<tr>
<td>3. Bolster Opening</td>
<td>16.5%</td>
</tr>
<tr>
<td>4. Sticker Opening</td>
<td>52.9%</td>
</tr>
</tbody>
</table>

Note that because of the greater velocity through the larger openings, only 52% of the air flow produced by the fans passes through the sticker openings.

This is a simplified approach to help you analyze the efficiency of your kiln air system.

Tables 3 and 4 represent a situation which happens every day.

1st. Assume 8 feet and 10 feet material have been evenly mixed in each crib.

2nd. We have assumed a very common mistake in placement of the end wall baffles. That is, so that the last section of wall baffle meets the edge of the load at 90 degrees rather than being parallel with the lumber. Baffles placed in this way leaves an additional open area of approximately 2 square feet top and bottom at each end of the kiln.

Table 3. Total open area

<table>
<thead>
<tr>
<th>Area</th>
<th>Volume (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Between Loads</td>
<td>10.2%</td>
</tr>
<tr>
<td>2. Around Baffles</td>
<td>6.5%</td>
</tr>
<tr>
<td>3. Misplaced Wall Baffle</td>
<td>4.6%</td>
</tr>
<tr>
<td>4. Bolster</td>
<td>8.5%</td>
</tr>
<tr>
<td>5. Mixed Lengths</td>
<td>24.9%</td>
</tr>
<tr>
<td>6. Sticker Opening</td>
<td>45.3%</td>
</tr>
</tbody>
</table>

Table 3 shows that under the conditions that 54.7% of the available air passages by-passes the lumber.

By applying similar velocities to these areas, we arrive at Table 4, which shows relative volumes of air passing through the respective openings.
Table 4. Total volume

1. Between Loads 14.1%
2. Leakage Around Baffles 9%
3. Misplaced Wall Baffle 6.4%
4. Bolster 11.6%
5. Sticker Opening 24.8%
6. Mixed Lengths 34.1%

Note that only 24.8% of the air flow produced by the fans passes through the stickered openings.

In this situation, over 75% of the power consumed by the fans is used doing unnecessary work. That is, moving large volumes of air through voids in the lumber and around the lumber through misplaced or missing baffles.

In the kiln we are discussing here, that means that 30 H.P. is wasted. At $0.02/ KWH, this could amount of $3500 per year.

Yesterday, Mr. Mackay stated that increasing velocity requires great increases in horsepower. This is true providing the volume delivered remains constant.

However, I believe that by improving the efficiency of the baffling system so that more of the available air is directed through the sticker opening, the volume the fan must produce can be reduced.

Reduction of drying time is possible. The reduction in drying time possible depends on many factors; some are: speed, cut, kiln, schedule, steam available.

Some authorities on the subject believe that for a 20% increase in velocity, a 10% reduction in drying time is possible. Our tests have not been extensive enough for us to determine if this relationship holds true. However, our preliminary data indicates a significant reduction in drying time is possible, through easily attainable increases in velocity.

The first steps in improving air velocity in any kiln are to take special care in the stacking, stickering and baffling.

The fifth slide shows the desired way of baffling a kiln charge. Items to take special note of are:

1. Place loads on bunks so that they are in line and will provide a consistent uniform edge for the floor baffles to lay against. You can see that if the loads are not placed square or that the loads are not somewhat even edged on the bunks, an opening is created which will contribute to the overall losses.

2. Keep loads of consistent height. Any difference in heights of loads will cause the ceiling baffles to leave a gap, again contributing to the overall losses.
3. Keep ends of loads uniform. Don't leave long ends sticking out the ends of loads. These ends most likely will be lost to degrade and the space they create between loads contributes substantially to the overall losses.

4. Avoid multi-length sorts in the same crib. When it's necessary alternate the ragged end so you don't leave a void all the way through a crib.

5. Place the end wall baffles as shown on this drawing. This reduces the openings around baffles to a minimum.

A baffle system which has been properly designed will have the following points:

1. The ceiling baffles will extend to a point near the outer edge of the load.

2. The floor and ceiling baffles will extend the length of the kiln.

3. The top of the floor baffle will be close to the bottom of the wall baffle.

These are the most important points in correctly stacking and baffling a kiln charge. There is much more to stacking, stickering and baffling to attain uniform air delivery than mentioned here. I have tried to bring out ways to generally improve the efficiency of the baffle system. That is to direct more of air volume produced by the fans through the sticker openings.

Unless the heated air passes through the sticker openings, it cannot give up its heat or absorb moisture directly from the wood being dried.

The value of increasing baffle efficiency can be measured in shorter drying times, better uniformity of moisture content, higher quality lumber and decreased power costs.

By following these points you will be on your way to improving the efficiency of your kiln.