A NEW APPROACH TO CONTROL AIR FLOW THROUGH THE STICKERS

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A NEARLY PERFECT DRY KILN BAFFLING SYSTEM

Introduction

IEES installed the first true computer based steam management and dry kiln control system 5 years ago. This system had such precise control that we were able to begin a much more exact identification of why even modern kilns don't do a better job of drying lumber. One of the areas of investigation was air flow.

Two years ago we were asked by a mill in Gold Beach, Oregon to provide the necessary application engineering for new kilns. We presented them with a number of advanced concepts. Some of these were based on information from over 500,000 kiln operating hours of precision steam flow and temperature measurements. Others were based on over 30 years of process engineering in other industries.

This project would not have been possible without a giant step of faith by Dick Tams the President of Tamco. Another key player was Tom Long who has the unique ability to take a good concept and convert it into a practical design which can be used by existing lumber mill personnel.

Background On Air Flow and Fans

What does air do in a modern lumber dry kiln?

a. Air is used as the TRANSPORT media for moving energy from one place to another.

b. Energy is extracted from the steam inside coils.

c. Energy is transferred to the colder fresh outside air in order to heat it to the point it can carry an adequate load of water vapor.

d. Energy is absorbed by the moisture as it evaporates from the lumber.

e. This large load of energy is dumped into the atmosphere in order to make room for more fresh air.

f. EVERY CUBIC FOOT OF AIR NOT GOING THROUGH THE LUMBER IS WASTING YOUR MILL HARD EARNED DOLLARS.

In this report we are talking about double track kilns which hold approximately 12,000 board feet for each 10 ft. of length. Most of you have seen and some of you still have the large diameter slow speed windmill looking fans. These were a good design when kiln schedules were less aggressive and took a long time. My own experience suggests even today lumber dry kilns haven't adapted the most cost effective fan design and arrangement that is common in other industries. Part of this is probably due to the fact there is little agreement on how much fan HP is needed. There really doesn't need to be this controversy. The chemical process industries, have for years, tested and proven how much fan HP is needed for a variety of drying processes. This knowledge is available to the forest products industry.

Most of the advances in size, HP and number of fans seems to have been directed towards the idea that the quickest and easiest way of fixing an existing kiln is to ADD fan HP. How much is needed? All of you have heard stores of 10, 20, 30% or more improvements when HP went up by 25%, 50% or sometimes 100%. I know that most if not all of you won't want to believe that we have achieved an average of 1,000 fpm through 5/8" stickers with fans pulling only 7 1/2 HP spaced 10 ft. apart, i.e. only 75 HP in a 104' kiln.

How is this possible? We looked at the major inefficiencies in typical modern kilns. Remember we don't have any stock in any electrical utility. Therefore, we think that every dollar spent on wasted electricity is money down the drain. We looked at the following areas.

a. Air coming in one vent going through the fan and exhausting before it does any useful work.

b. Location and efficiencies of fans and shrouds.

c. BYPASS AIR THAT DOESN'T GO THROUGH THE STICKER AREA of the lumber.

d. Air that leaks in or out around doors, roofs, vents, etc.

We applied information from the chemical process industry to determine the amount of air necessary to remove moisture at the rate of the best conventional kilns. The conclusion was that a sledge hammer, i.e. greatly increased fan HP, was being used where a tack hammer would do the job. The electrical utilities must really like this approach. An extra 75 HP on one dry kiln at 5 cents KWh lets you pay the electric company an extra $27,000 per year. If you have four kilns the electric utility receives an extra $100,000 every year.

This paper concerns Item C above. IEES also provides application engineering on the other items.

Relationship Between Air Velocity Steam Coil Performance

The boiler can provide a hot fluid (steam) to the inside of the pipes around which fins are attached. The pipe size is related to the steam side of this thermodynamic problem.

I didn't get very far into this presentation without using thermodynamics did I? I'm afraid that thermodynamics is at the heart of the problem we're trying to solve. If you know that steam is a lot hotter than hot water, then you understand enough about thermodynamics to understand why the new air baffles do such a good job.

The fin side of the coil is related to the air side of the problem. There is a mill in California that installed two coils in a 104' double track kiln. Each of these coils is 5 ft. high by 7 ft. long and only two rows deep. At 50 psi header pressure these coils condense 12,000 lbs. of steam per hour. You probably have over 2,200 sq. ft. of "face" area in your 104' kiln vs. only 140 sq. ft. of face area in this kiln.

How can this be possible? AIR VELOCITY AT THE COIL FACE. The reference kilns have over 2,500fpm vs. under 500 fpm in your typical conventional kilns. By-pass air in your existing kilns is killing your coil performance. After saying this, we still used more conventional coils in the reference kiln. However all of the air has to go through the coils - NO BYPASS.

What Should the Ideal Kiln Baffle Do?

Is it possible to have ideal kiln baffles? Maybe. This is a list of key features of what air baffles should be.

a. The operator can't forget to put them in place.

b. It must be very difficult for either the fork lift operator or the lumber to snag or otherwise ruin the baffles.

c. They should prevent excess air flow across the entire top layer of lumber.

d. In conjunction with the fans and coils assure nearly uniform flow through every air slot in the lumber.

e. Help hold the top few rows of boards flat in certain products to help prevent warp.

f. Allow for wide variation in height of cribs and nonuniformity of cribs.

g. To block the air flow past the end of the lumber.

h. To allow for large variations in how close the last crib comes to the end of the kiln.

i. Where cribs have "square ends" prevent air flow to reduce end check.

The system installed in the three reference kilns addresses all of the above except Item i. We will be installing the device for it later.

Performance of the Total Kiln Air Baffles

An attempt was made to simulate what the kiln performance would be without the new baffling system in place. We were not totally successful. We tried to have as much bypass air as typical modern kilns. Those with top baffles both sides, floor baffles and end baffles. During the test simulating average bypass air, we still had 500 fpm through the stickers which would be good for a 104' double track kiln pulling 75 HP on the fans.

Performance of the "Wrap It" System

Conditions during the air flows tests:

The 60 ft. kiln had approximately 72,540 Bd. ft. of product. The product was 2" thick with 5/8" X 5/8" stickers approximately 18" O.C. The inlet and exhaust fans were full on. Each delivers a little over 20,000 cfm. Air temperature was approximately 65° F.

Chart "A" is with fans in the forward mode and the baffles in the kiln simulated "standard kiln" conditions.

Chart "B" has the same conditions as Chart "A" except with the "WRAP IT" system in place.

Chart "C" has the same conditions as in Chart "B" except the fans have been reversed.

On the left hand side is the air slot number starting with number one on the bottom and number 45 as the last air slot at the top.

Column numbering is counting from the door end as No. 1 and No. 13 next to the far end wall. Each column represents 54" for 58 ft. of product in the kiln.

Performance of the Total Kiln Air Baffles

We used a very accurate temperature compensated air velocity measuring probe. Sierra Model 618 SS48 I-200. Air flows were taken approximately 1-2 inches within the slot. Twelve readings were taken top to bottom. The first column of readings were taken approximately 18" from the far end of the kiln. The next column of readings were taken 6 ft. from the first reading. The readings were so uniform that it was decided to skip every other reading. Therefore, the next column of reading's is 12 ft. from the last set of readings and continuing along the kiln.

These readings were repeated with the fans reversed. During the tests the intake and exhaust fans were on at 100%. The kiln was full of product. the product was 8/4 or 2 inches thick and stickers were more or less on 18" centers. The stickers are 5/8" X 5/8". There was approximately 18" to 24" of open space between the door and the end of the first product.

As you can see from Chart "A" except for slots 44 and 39 and column 1, the air flow was very uniform. In fact it is more uniform than any other kiln we've measured. The 500 + fpm would be considered quite good.

In Chart "B" with the "WRAP IT" system in place air flows essentially doubled. Equally significant is that slot 44 is at least as high as the average or somewhat higher. Imagine how much this will improve the uniformity of drying.

The somewhat lower air flows on Chart "C" with fans reversed is about the amount of variation due to fan efficiency changes between forward and reverse.

Chart "A": Simulated Standard Kiln

Column:	13	11	7	3	1	Avg
Slot						
44	330	300	220	250	250	270
39	480	450	520	400	400	450
35	450	500	600	420	450	484
31	550	550	500	400	400	480
29	570	520	550	400	370	482
24	530	520	550	500	500	520
20	520	550	550	550	400	514
16	520	520	520	500	350	482
14	570	570	500	500	450	518
9	520	580	530	520	550	540
5	550	550	520	520	350	498
1	550	570	520	520	250	482
Avg:	512	515	507	457	393	477
						Over all Avg

Chart "B": "Wrap IT" System Fans Fwd

Column:	13	11	7	3	1	Avg
Slot						
44	1000	1300	1300	1050	1100	1150
39	1000	1250	1250	1100	1000	1120
35	900	1250	1300	1100	1150	1140
31	1000	1250	1050	1050	850	1040
29	1100	1150	1200	950	950	1070
24	1200	1200	1300	1200	950	1170
20	900	1100	1050	1000	1000	1010
16	950	1050	1100	1150	850	1020
14	1250	1000	1100	1000	1000	1070
9	900	1000	950	1050	1050	990
5	1000	1200	1100	1100	900	1060
1	1000	950	1000	1000	500	890
Avg:	1017	1142	1142	1062	942	1061 Over all Avg

Chart "C": "Wrap It" System Fans Fwd

Column:	13	11	7	3	1	Avg
Slot						
44	750	900	1000	900	800	870
39	850	1000	950	900	900	920
35	850	900	950	800	800	860
31	1000	950	1000	750	1000	940
29	950	950	950	800	950	920
24	1050	950	1000	850	800	930
20	1000	1050	850	850	900	930
16	1000	1000	900	850	900	930
14	1100	1000	900	800	850	930
9	900	950	950	900	650	870
5	950	1250	950	900	850	980
1	1150	1050	850	750	600	880
Avg:	963	996	938	837	833	913 Over all Avg

One interesting result is something I've always suspected but never had an opportunity to test, is the low reading at the TOP of the crib. Slot 44 the top slot was very low and slot 39 was lower than the slots further away from the fans. The reason being the high amount of bypass air over the top, starves air from the top few slots.

Something similar occurs at the end near the door where there was an 18" - 24" gap which allowed lots of by-pass air. When we install the end baffle part of the "WRAP IT" system we expect to also make the air flow in the first column as uniform as in the other columns.

Another benefit of the "WRAP IT" system is in association with the programs demonstrating variable speed fans. Since we have demonstrated over 1000 fpm air flow with only 75 HP of fan, we may have reduced the full speed fan HP to nearly as low as the low speed used with variable speed fans in dry kilns. With a uniform air flow as we have obtained, it should be possible to use variable speed fan drives and reduce fan HP far below what others have been able to do in conventional kilns.

I would like to end with a question. Based on 5 cents per kWh electrical rates, how much should a mill be willing to pay for a system that will save over $30,000 per year per kiln in electricity? In addition it may provide as uniform drying as some multi-zoned kilns obtain.

What This New Approach Can Mean For Your Kiln

I think all of us will agree that uniform air flow is essential for a kiln to dry lumber uniformly. In the past, one approach was to add fan HP. One location put 300 fan HP in a 104 ft. kiln. The extra 225 HP at 5 cents kWh will cost an additional $81,000 per year per kiln.

In a typical kiln, lots of air by-passes the heating coils as well as the lumber. The "WRAP IT" baffling system while forcing the air through the product can also assist increasing air flow through the heating coils. Increased air flow can increase the heat extracted from the existing coils. It may be possible to make the drying process uniform enough without other major changes to the kiln.