# Lumber Drying Heat Exchanger Design Study/DFM

## SII Dry Kilns

Western Carolina University

### PROBLEM STATEMENT

Before sale, lumber is dried, and its moisture removed in a steam-heated "kiln:"

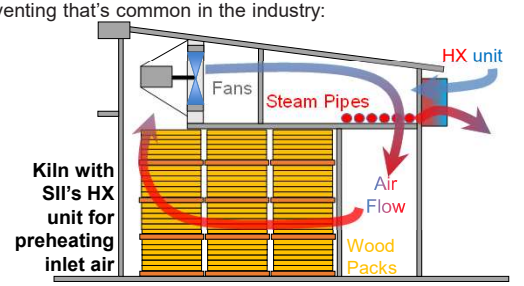
Fully loaded drying kiln

Kiln drying prevents timber and lumber from warping once installed in homes, furniture, and other products.

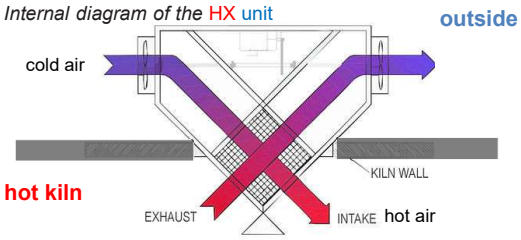
SII builds kilns that vent hot moisture from heated lumber.

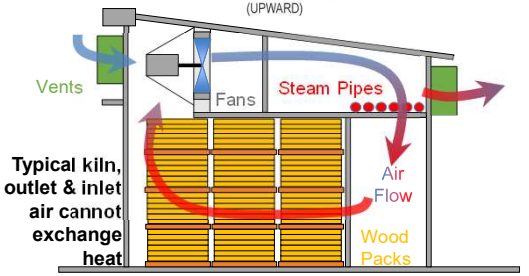
SII sells a heat exchanger (HX) unit that preheats inlet kiln air with outgoing moisture.

We simulated & quantified the energy saved by preheating with SII's "HX" unit, which differs from the direct moisture venting that's common in the industry:




Kiln with SII's HX unit for preheating inlet air

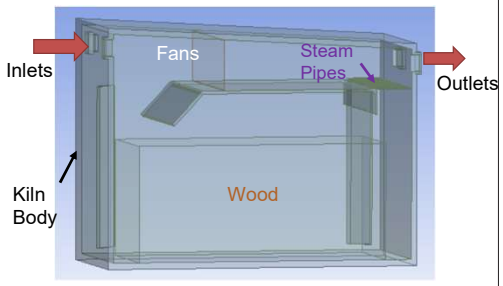


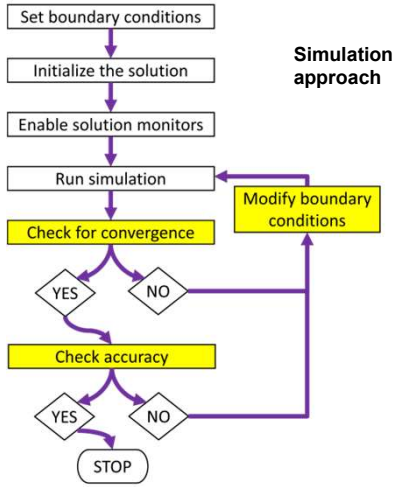

Typical kiln, outlet & inlet air cannot exchange heat

### FINAL DESIGN, APPROACH, PLAN

- Set a power value on the steam pipes to achieve 150° F for wood drying.
- Compare power values when kiln inlet air is preheated with a HX unit (inlet temp. of 138°F) and without a HX unit (inlet temp. of 50°F).




| Simulation input data | Red Oak without HX | Red Oak with HX |
|---|---|---|
| Fan speed | 400 ft/min | 400 ft/min |
| Inlet pressure | 14.69 psi | 14.69 psi |
| Inlet velocity | 200 ft/min | 200 ft/min |
| Outlet conditions | Pressure = 14.69 psi | Pressure = 14.69 psi |
| Incoming air temperature | 50°F | 138°F |
| Power supplied to kiln | Varies | Varies |




Simulation approach

### RESULTS

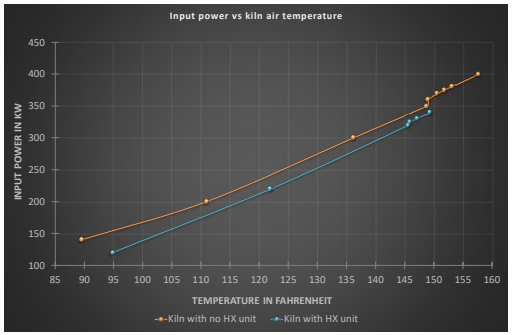
The simulations showed:

That a standard kiln requires 370kW to maintain 150°F.

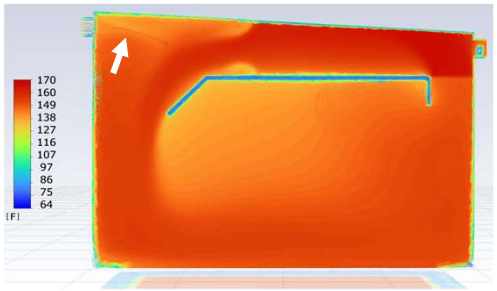
The kiln with an HX unit only needed 340kW to maintain 150°F.

$$\frac{370\text{kW} - 340\text{kW}}{370\text{kW}} * 100\% = 8.1\%$$

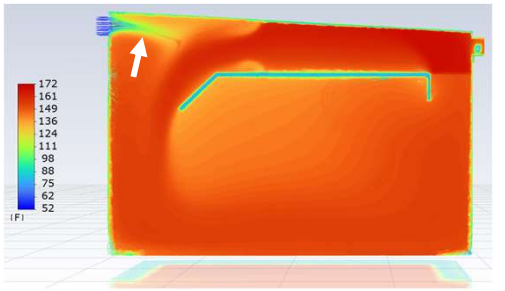
Thus, the simulations show that a lumber kiln uses 8% less energy when retrofitted with SII's HX unit.




Simulation results for kiln with a HX unit



Simulation results for kiln without a HX unit



### SUMMARY AND CONCLUSIONS

The team was tasked with simulating the effects of an HX unit on a dry kiln to verify the design and performance of this product alongside energy savings.

- **Based on the results acquired from the team's simulations, it can be concluded that an HX unit saves a measurable amount of energy (8%) during lumber drying**.
- An 8% energy savings equates to ≈$1,868 in monthly savings for gas-fired heat and ≈$3,650 in monthly savings for electrical heat. [Based on current market rate for NC from bls.gov]

### FUTURE WORK

- Simulation accuracy would be enhanced by detailed wood and humidity modeling for use with wet-bulb and dry-bulb kiln temperature data.
- Detailed HX unit modeling, atop overall kiln modeling, would likely reveal design modifications that could enhance energy savings.

### TEAM & ACKNOWLEDGEMENTS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