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KILN SIZE AFFECTS ENERGY REQUIRED TO DRY LUMBER

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ABSTRACT.—Energy requirements for lumber drying kilns can depend on kiln size and range from 18,000 Btu/lb water evaporated for a 10 board foot capacity kiln to 1,600 Btu/lb water evaporated for a 100,000 board foot capacity kiln.

The rising cost of fossil fuels is triggering a big push to conserve energy in the manufacture of wood products, so the lumber industry is taking a closer look at the energy consumption of wood-drying kilns. Wood moisture content and species, drying schedule, ambient conditions, leaks in the kiln, and kiln size all affect the amount of energy needed to dry the wood but many people are not aware of the great effect that kiln size has on the energy required to dry wood.

The energy used in a lumber dry kiln can be divided into the heat required to:

1. Raise the temperature of wood substance and water in the wood.
2. Evaporate the moisture (includes the energy to overcome the hygroscopic forces).
3. Raise the temperature of air and water vapor for venting.
4. Raise the temperature of the kiln.
5. Compensate for losses by conduction, radiation, and leaks through the walls, doors, and roof.

The magnitude of each category may vary somewhat depending on drying conditions, kiln type, and wood type, but usually the heat required to evaporate the moisture consumes the most energy.

To demonstrate the effect of kiln size on energy requirements, we theoretically calculated the heat required to dry wood in kilns of different capacity while keeping all operating conditions and kiln construction details the same. We assumed that southern pine of 0.48 green specific gravity dried from 105 to 10 percent moisture content at 190 °F in 82 hours. Ambient temperature was 70 °F and overall heat transfer coefficients were 0.15 Btu/hr ft^2 °F for the walls and roof and 0.80 Btu/hr ft^2 °F for the floor. The heat required to dry the lumber ranged from 1,600 Btu/lb of water evaporated in a 100,000 board foot kiln to almost 18,000 Btu/lb of water evaporated in a 10 board foot kiln (fig. 1).

As shown below for a 25,000 board foot kiln drying southern pine from 105 to 10 percent moisture content by a standard schedule, most of the energy was needed to evaporate moisture from the wood.

Energy needed to:	Total energy *(Percent)*
Heat wet wood	8
Evaporate moisture	64
Heat air and water vapor	8
Heat kiln	3
Compensate for heat losses	17

As kiln size changed, the energy to heat the wet wood, evaporate the moisture, and heat the air and water vapor per board foot of lumber remained nearly constant. Conversely, the energy required to heat the

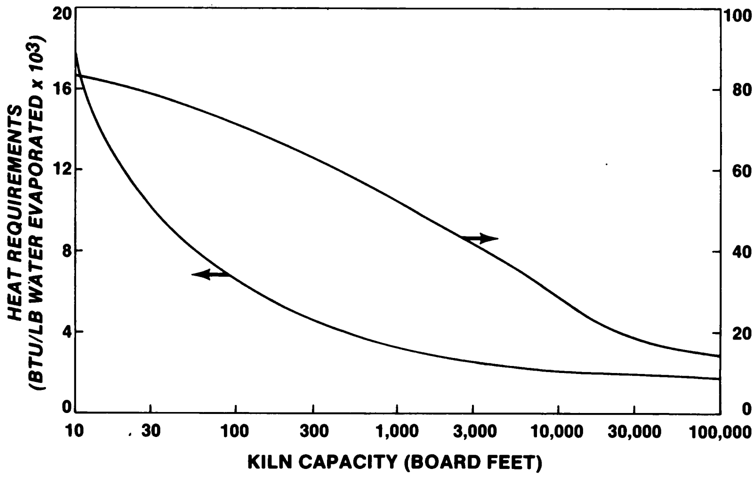

Figure 1.—*Heat loss and heat required to dry 2-inch thick southern pine at 190°F in kilns of different capacity.*

kiln and to compensate for heat losses changed significantly as kiln size changed. As kiln capacity decreased, heat loss increased. Heat losses accounted for more than 70 percent of the energy required to dry the lumber in kilns of 100 board feet or lower. Thus, energy requirements in Btu/lb water evaporated increased as kiln size decreased.

The energy required to heat the kiln and to compensate for losses is proportional to the surface area of the kiln, whereas the remaining heat requirements are proportional to the volume of the kiln. Thus, the ratio of the volume to surface area of the kiln affects energy requirements. Larger kilns have a greater volume/surface area than smaller kilns.

Experimental values of energy requirements obtained from the literature for high temperature drying of southern pine are consistent with the previous theoretical calculations (table 1).

Table 1.—*Energy required to high temperature dry southern pine in different sized kilns—experimental data*

Kiln size	Volume per surface area	Btu/lb water evaporated	References
120,000	3.0	1,630	Taylor
120	1.3	6,770	Koch
3	0.3	10,600	Rosen

The implications of the effect of kiln size on energy consumption are important when comparing different kilns or drying techniques to find which is the most energy efficient. When comparing different sized kilns for energy efficiency, make sure that kiln size is not the overriding influence for energy requirements. Also, specific statements on the effect of kiln conditions on energy requirements of small experimental kilns (1,000 board feet or less) may not apply to the larger commercial kilns (20,000 board feet or more).

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