

TECHNICAL NOTE NUMBER 199

FOREST PRODUCTS LABORATORY - U. S. FOREST SERVICE - MADISON, WISCONSIN

AIR CIRCULATION IN DRY KILNS

Circulation of the air in a dry kiln is a very important factor in the artificial seasoning of wood. Without a controlled movement of the air it is impossible to maintain the proper temperature and humidity uniform throughout a kiln. Evaporation of moisture from the wood cools and humidifies the atmosphere next to the wood. In order that drying may progress it is continually necessary to replace this cooled, moistened air with a fresh supply of warmer, drier air. This can be accomplished only by a good circulation which will remove the moist, cool air from the kiln or will return it to the lumber after it has been warmed and dried.

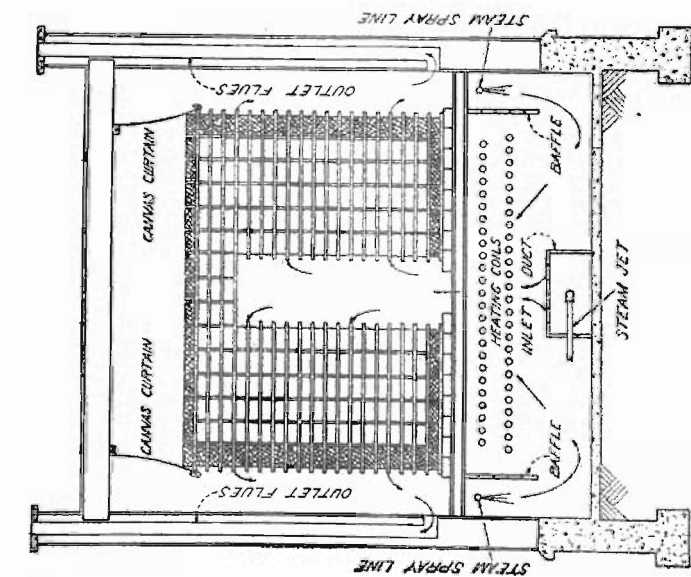
In any kiln a certain amount of circulation is natural. The heating coils are continually heating the air, and the evaporation of moisture from the wood and heat losses through the building walls are continually cooling the air. The heated air rises. Some of it escapes through cracks at the top of the kiln, and the rest of it enters the lumber where it is cooled as it picks up moisture. The cooled air drops and is recirculated over the heating coils until it is warm enough to rise again.

If flues or vents for the escape of hot air from the kiln and intakes for the entrance of cold air are provided, the natural circulation can be considerably increased. The kiln, being warmer than the surrounding atmosphere, will act as a chimney, and the draft that is created will speed up the movement of the air inside the kiln. Circulation may be further increased by the use of inspirators, aspirators, or steam spray lines. A steam jet in the intake duct is a good inspirator. Aspirators may be in the form of a coil of steam pipe in the uptake flue. Steam spray lines running the full

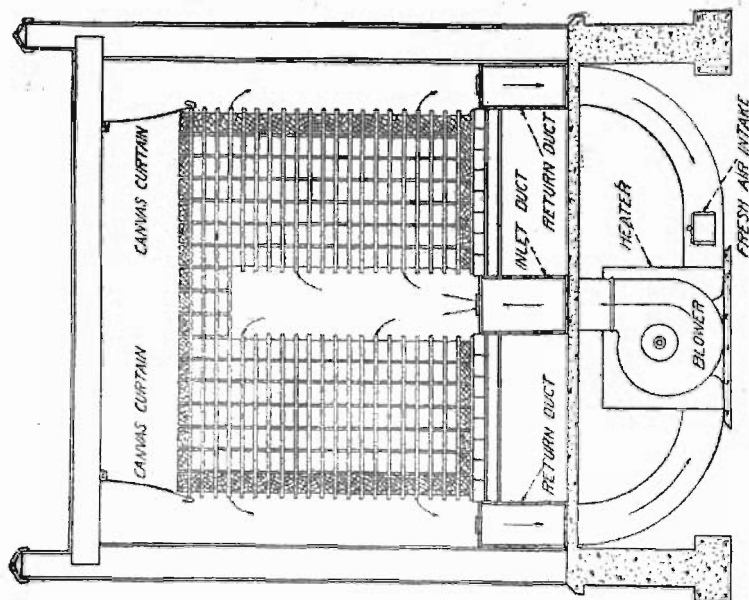
length of the kiln may be installed in the passages through which the air returns from the lumber to the heating coils if the design of the kiln permits. These steam jet lines act as recirculators and humidifiers. Their successful operation depends upon the removal of certain quantities of air from the kiln continuously, either through flues or through accidental leakage. If the air is not allowed to escape at all it will soon become saturated, and no further drying will take place. The steam spray lines can be replaced by condensers which will serve to cool the air and at the same time remove some of the moisture from it. The cooled air will then naturally fall and pass to the heating coils as fast as the hot air rises from the coils. This natural system of recirculation does not depend upon changing the air in the kiln to remove the moisture evaporated from the wood. Water sprays of the proper temperature may be substituted for the condensers. Water sprays permit a better control of the humidity and may be directed to produce a higher circulation.

The modern blower kiln produces circulation by mechanical means, usually by a centrifugal blower of the ordinary type, but sometimes by disk fans. The blower draws the air from the kiln through suitable return ducts and then discharges it again into the kiln through inlet ducts. The air is passed over heating coils on the way and its humidity is increased, if necessary, by means of a steam jet. Leakage is usually sufficient to keep the humidity as low as desired, but intakes may be provided for drawing a certain amount of fresh air into the system. This fresh air is comparatively dry, and mixing it with the kiln air displaces some of the moist air and reduces the humidity of the whole.

The internal fan kiln makes use of one or more rows of disk fans within the kiln itself, and thus obviates the necessity of drawing the air from the kiln and blowing it back again. This arrangement has the advantage that the direction of the air circulation may be reversed simply by reversing the direction of rotation of



The composite drawing illustrates the various features found in most ventilated kilns. The steam jet in the inlet duct increases the amount of outside air drawn into the system. The steam spray lines increase the circulation of the air inside the kiln. These spray lines in connection with the inlet ducts and the outlet flues serve to regulate the humidity. The baffles prevent the heated air rising next to the walls.



The cross section illustrates the ordinary blower kiln in which an external centrifugal blower produces the circulation. A fresh-air intake on the suction side of the blower can be opened if leakage of air through the walls is not sufficient to keep the humidity below the desired point. Steam jets can be used to raise the humidity if the air gets too dry.

the fans. This reversal of the circulation increases the uniformity of drying in the kiln.

It is difficult to specify the amount of circulation proper for different kinds of drying. For material which has previously been air dried only a small amount of circulation is necessary. For green material, however, or for any drying in which high humidities must be used, a rather rapid circulation is required. There is a limit beyond which the rate of circulation cannot be increased and maintained uniform throughout the kiln. A circulation rate of at least 25 feet per minute through the lumber is recommended by the U. S. Forest Products Laboratory for difficult drying. In certain unusual cases, as in the drying of Douglas fir common lumber, circulation rates as high as 75 feet per minute are found desirable.