The Use of Electricity to Dry Wood

by

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A Thesis

Presented to the Faculty

of the

School of Forestry

Oregon State College

LIBRARY
JAN 6 1958
OREGON STATE COLLEGE

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Forestry

June 1949

Approved:

[redacted]

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## Introduction

Timber is the great resource in the Northwest. The lumber industry is the backbone of Western Oregon. In order to keep pace with other industries and to keep our timber resources intact we cannot stand still. We have made many advances in the field of forest management and in finding new uses for wood products, but there has been no essential change in the method of lumber manufacturing, a method in which only 1/3 of the raw material becomes a finished product. The great bulk of our timber is cut for lumber.

Much lumber is decreased in value or made worthless because the present drying processes have not been perfected.

Any advancement in the manufacturing processes that will cut the waste or increase the valueof the finished product is welcome and needed. Of course, this can only be done if it increases the margin between cost of production and selling price.

In our present system, the wood is sawed, planed, and the lumber is either air dried or kiln dried. Both of these drying methods have undesirable features due to uneven drying, such as warping, checking, and shrinking.

The purpose of this paper is to explain a new method of drying lumber.

# The Theory of Electronic Heating of Wood

When an electric field is impressed on a substance, the free electrons, negatively charged, are acted on by a force opposite in direction to the impressed field. This statement is readily seen when the basic fact is considered that like electric charged particles repel each other. The direction of the field is considered to be from the positive plate to the negative plate. These free electrons cannot move very far without colliding with a molecule. This energy of motion is changed to heat energy when the collision takes place.

Now, if the direction of the impressed field is reversed it causes the electrons to move again, thus causing more energy to be transformed into heat. In electronic heating, a high frequency is used, which means that the direction of the field may be reversed as many as 50 million times per second.

The electrons and molecules of a substance, such as wood, occur uniformly throughout, so the heat produced is uniform.

When the flow of electricity through a conductor is broken by a non-conductor, there is still electrical activity. Part of this activity is called capacity current.

When an electric field is impressed on a substance, the molecules are rotated to line up with the field, and an effective displacement of the charge throughout the material takes place. Thus, more capacity current flows than would be the case if the electric field were impressed on free space. The ratio of the capacity current through the material to the capacity current which would flow if the same field intensity were applied to free space is called the dieletric constant.

At a given frequency, the power absorbed by a dielectric is directly related to its dielectric constant and the power factor. For wood these values are not constant but change with frequency as shown in the curves of Figs. 1 and 2. To assemble the data represented by these curves, measurements were made on a number of samples of fir plywood, Sitka spruce, and walnut all of which were 4 inches long, 2 and 1/4 inches wide and 1/4 inch thick.

There is also considerable change in power factor and dielectric constant as moisture content increases. In Fig. 3, curves are drawn which show this interdependence in the case of spruce for measurements made at constant frequency.

The curves of Figs. 1 and 2 show that the product of the dielectric constant and the power factor is reasonably close to a constant.

Thus it is possible to derive the equation:

$E = 2000\sqrt{pf}$ where

E = volts per inch of thickness of material being heated.

p = power in watts per cubic inch.

f = frequency of current in megacycles. [1]

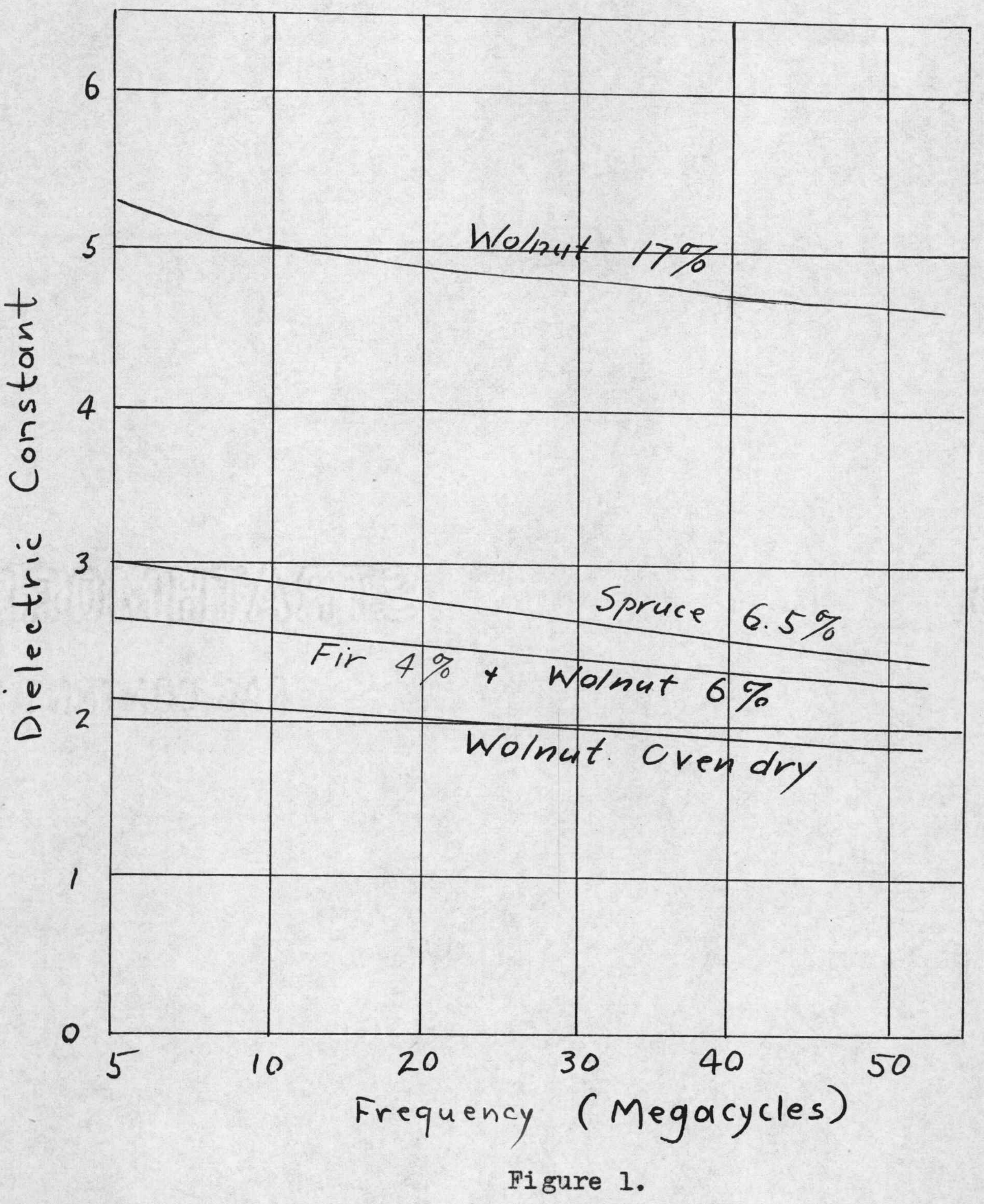
6
5
4
3
2
1
0
Dielectric Constant
Wolnut 17%
Spruce 6.5%
Fir 4% + Wolnut 6%
Wolnut Oven dry
5
10
20
30
40
50
Frequency (Megacycles)

Figure 1.

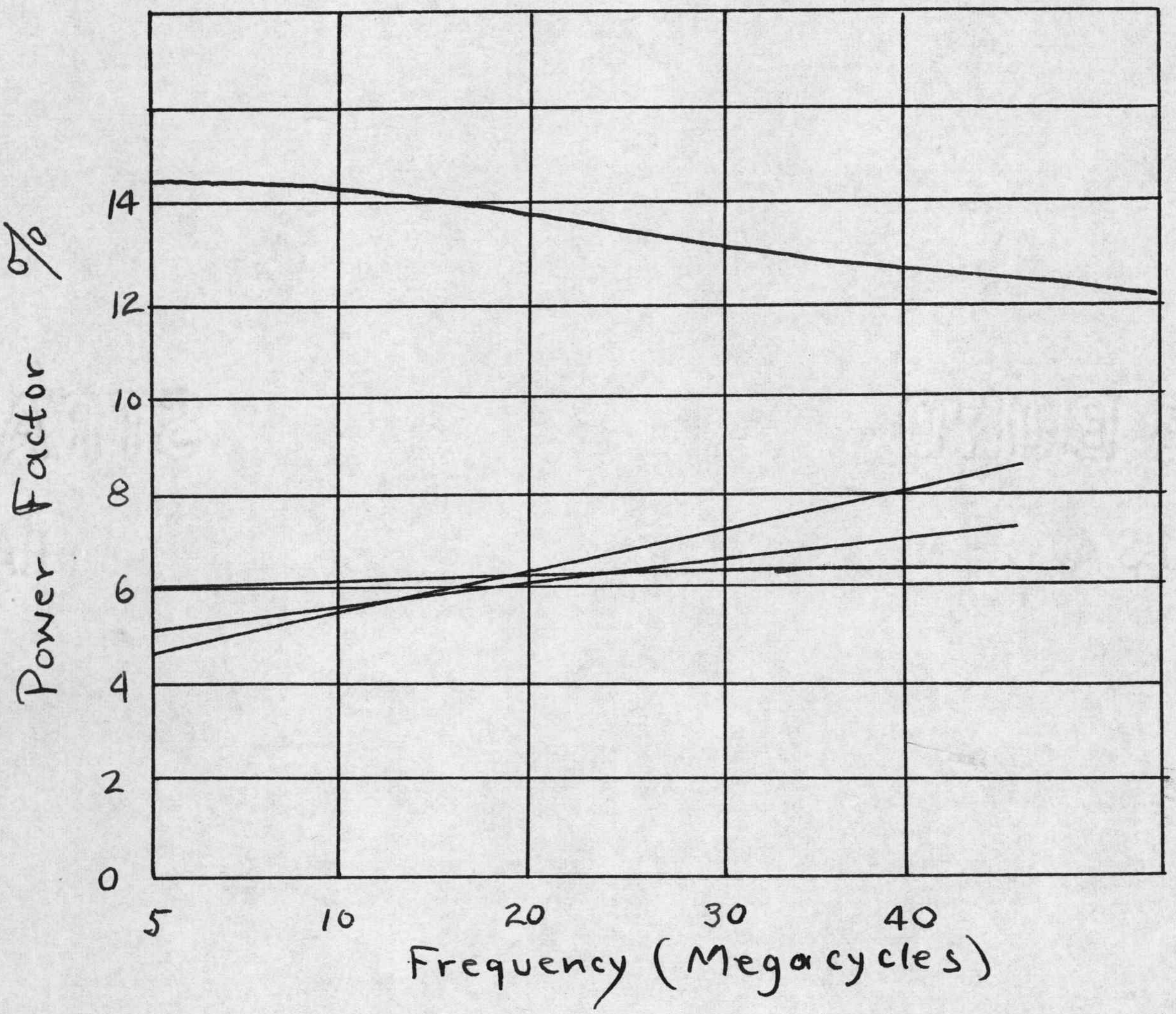
Power Factor %
14
12
10
8
6
4
2
0
5
10
20
30
40
Frequency (Megacycles)

Figure 2.

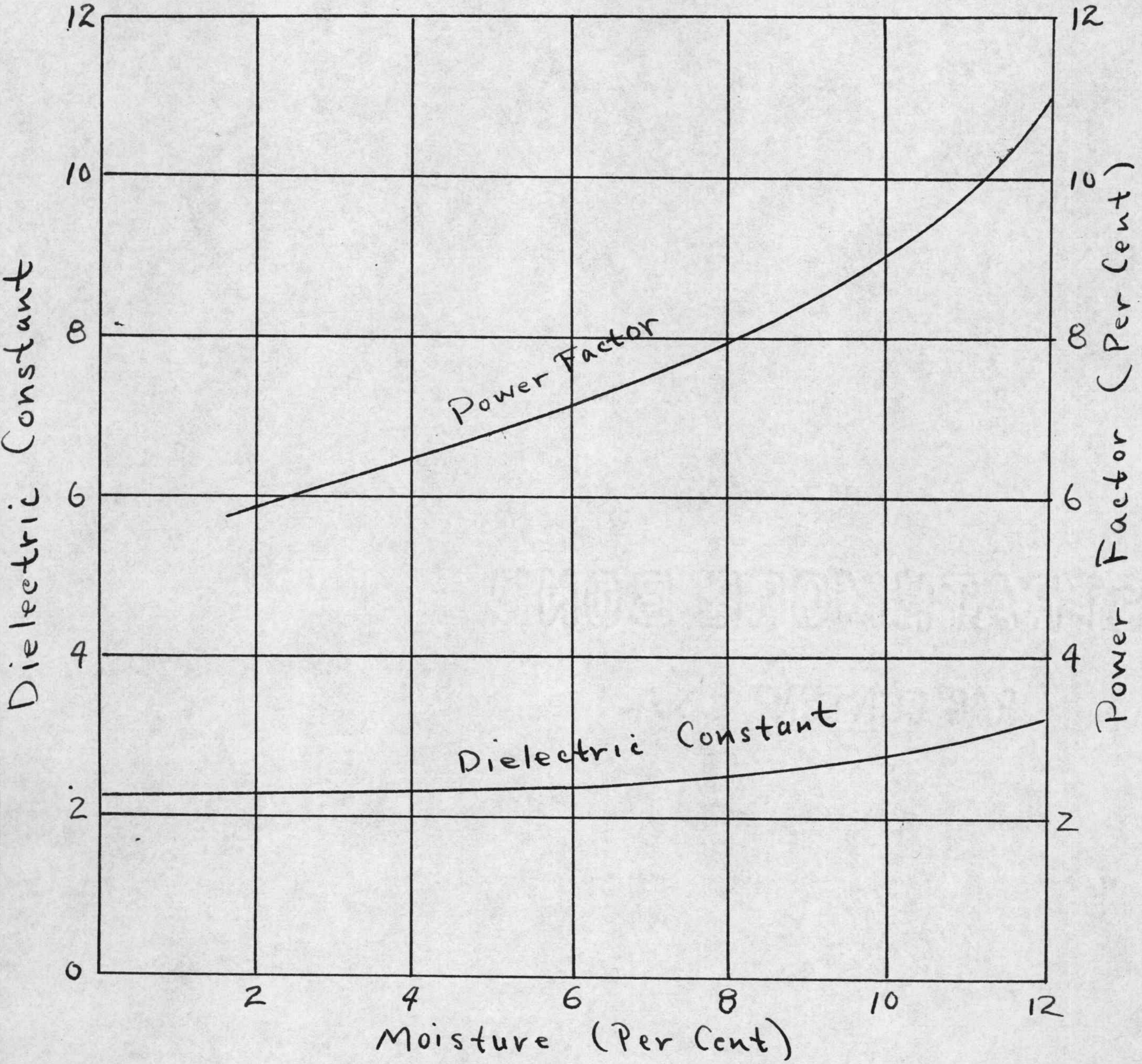
12
10
8
6
4
2
0
12
10
8
6
4
2
2
4
6
8
10
12
Dielectric Constant
Power Factor (Per Cent)
Power Factor
Dielectric Constant
Moisture (Per Cent)

Figure 3.

In planning an installation it is then possible to to determine the frequency needed for a certain desired voltage and temperature.

The energy required for the drying of a given material consists of the heat of vaporization of the liquid to be removed plus the heat required to raise the material to the temperature at which vaporization occurs. This can be used to determine a value for "p" in the above equation.

## Advantages of Electronic Dehydration

Many drying processes are slow and wasteful of space. This is especially true in the drying of bulky materials which are poor conductors of heat. In ordinary oven drying the drying progresses from the outer surfaces inward and the energy required to evaporate the moisture on the inside must be conducted through the outer portion. Since high frequency heating provides a means of generating heat uniformly throughout a nonconducting mass, its use results in the rapid and uniform drying of many materials.

## Economics of High Frequency Heating

While a superficial study of a contemplated application of dielectric heating may reveal a relatively high cost of equipment and a cost of energy absorbed by the product somewhat higher than the competitive forms of heating, typical installations invariably are highly economical for one or several of the following reasons:

(a) It produces results impossible by any other method of heating.

(b) Increased production is usually brought about.

(c) Output from present machines is increased.

(d) It occupies small space.

(e) It can be built into production lines.

(f) It assures optimum of results.

(g) It produces uniformly high quality results.

(h) Output and quality can be predicted and controlled.

(i) Operation can be timed and sequenced by semi-automatic means so that only unskilled labor is needed.

(j) The over all appraisal of investment, operating, labor and energy, production and quality usually prove overwhelmingly in favor of dielectric heating.[2]

Dielectric heating is feasible for drying only on high value products whose original moisture content is already low. At the present time large scale wood drying does not fall in this category.

One or more of the following conditions must be realized before a job ever results in a successful application:

1. Low cost per piece treated.

2. High quality of product.

3. Improved working conditions.

4. Special conditions which make other methods of heating not feasible.[3]

The cost to do a job divides itself into first cost and operating cost. Quite often the first cost of high - frequency heating equipment is higher than the first cost of conventional equipment to do the same job. Since this is true, it is inherently a high production tool. Occasionally, the unique advantages to be attained will justify this higher first cost on lower production rates of relatively valueable items. In order to take full advantage of the speed of high-frequency heating, often rather complex work handleing equipment is necessary. In some instances this can be very expensive.

In many instances the product is such that it is damaged by rapid heating. This takes the form of cracking because of uneven swelling or shrinking. Damage may be caused by pressure building up when the moisture turns to steam and the product is not porous enough to release the steam rapidly.

The one most important obstacle to high frequency drying of wood is the high cost of operation.

## Conclusions

Dielectric heating has some advantages over conventional methods of drying wood. It drys uniformly throughout, requires small space, and is capable of a large volume of output.

At present it is not feasible because of high first cost and operating cost.

This tool shows definite possibilities for helping the lumber industry in the future.

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