VARIOUS FACTORS AFFECTING THE STABILIZATION OF WOOD

A THESIS
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BY
ROBERT W. LABERGE

THESIS

This is to certify that the

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ROBERT W. LA BERGE

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Alexis J. Panshin
Major professor

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By

ROBERT W. LABERGE

A THESIS

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INTRODUCTION

Although wood is used in the construction of almost all modern dwellings, builders and owners of property often experience the instability of this indispensable material. For example, windows and doors cannot be opened or closed during certain periods of the year, and many other structural units are affected similarly by this seasonal change in dimension. To rectify this fault in wood has been the objective of many investigators, and from their investigations have been developed a number of substances called water repellents which retard the dimensional changes in wood. Yet despite all of this research, which has been considerable, there still exists uncertainty in regard to the proper methods and treatments to be used with various woods. To dispel a measure of that uncertainty is the purpose of the present study.

Two commercial water repellents labelled respectively (A) and (B) and one softwood (ponderosa pine) were used in the experiments, the results of which are presented in the report that follows. The investigation may be divided into three major parts:

1. The study of the effect of varying the sample and treating time on the percent absorption of water repellents.

2. A study of the effect of varying the specific gravity on the percent absorption.

3. The determination of the effect of sample size and treatment time on the water repellent efficiency.

HISTORICAL BACKGROUND

From the earliest periods of history to the present time, man has used various materials to render boats water-tight and to protect homes and buildings from excessive exposure to moisture. Today these substances are known as water-proofing compounds.

Little information exists on the progressive development of the process for waterproofing wood. Yet we do know that pitch (4) was used at an early time for sealing the seams of boats, and evidence for the use of materials like grass, burlap and sheets of lead beneath wooden structures to prevent the entry of water at their base was found in the ruins of Roman buildings 2,000 years old (6). No mention of treating wood with any other water impermeable materials exists from this period to the time of the discovery of the New World. Then it was learned by Pizarro (3) from his travels among the Peruvian natives that a rubbery substance called Caoutchouc was used by them to coat certain articles.

Later, a method which did not prove to be of immediate consequence but which laid a foundation for future investigators to follow was developed in 1812 by Lukin (7), who attempted to inject ship timbers with resinous vapors. Not long after this, in 1838, John Bethell (1), credited with being the first person to use cylinder methods for impregnating wood, coagulated the albumin in the sap of wood in order to render it water-proof.

No further developments in waterproofing occurred until the latter part of the nineteenth century when the patent offices were flooded

with applications for patents on almost every conceivable process for waterproofing wood. Confusing as this welter of processes appears to be at first glance, they can be classified into two broad categories, Chemical and Non-Chemical Methods.

A further study of these processes will quickly demonstrate that the Chemical Methods fall into three general classifications. Of these the first and simplest method is the surface sealer which prevents the interchange of moisture between wood and the surrounding atmosphere. Among the many workers who developed repellent efficiencies as high as 95 percent by this method are Hunt (12) and Dunlap (5).

A second chemical method consists of injecting material into the inner parts of wood. Thus the cell walls of the wood fibers are coated with a repellent which retards dimensional change.

The third and final chemical method modifies the wood substance. Stamm (21), for example, affected the crystal lattice of wood by using inorganic salts, but Herzog and Hung (22) approached the problem with a process quite different. After first softening the lignin, they then added substances of low vapor pressure to stabilize the wood. On the other hand, Stamm and Seborg (27, 28) evolved the method of bonding synthetic resins to wood. Probably the most advanced of the chemical methods was developed by Tarkow, Stamm, and Erickson (30), who formed a chemical derivative of wood by using acetic anhydride. Thus the resulting wood had less affinity for moisture.

Of the two non-chemical methods, the first uses high temperature, thereby rendering wood plastic with subsequent stabilization of the wood, whereas the second, used in making plywood, consists of placing the grains of adjacent pieces of wood at right angles to one another. The latter process is particularly effective for the prevention of excessive dimensional change.

Of these many methods and repellents, only a few have proved to be adaptable to commercial use. Even where repellents have been used commercially, their high cost has restricted their use only to those units which cause considerable trouble by their changes of dimension, units such as doors, window frames, and sashes. Such commercial repellents are manufactured either as concentrates or as ready-to-use solutions, the most popular being those which are dissolved in volatile solvents. Loss of the solvent deposits the repellent on the cell walls of the wood fibers.

Beset with many problems, the repellent industry faces considerable competition from the metal and plywood industries. Yet the prospects for the future appear promising, and further developments and advances may be confidently expected in this field.

GENERAL CONSIDERATIONS

The Hygroscopicity of Wood.

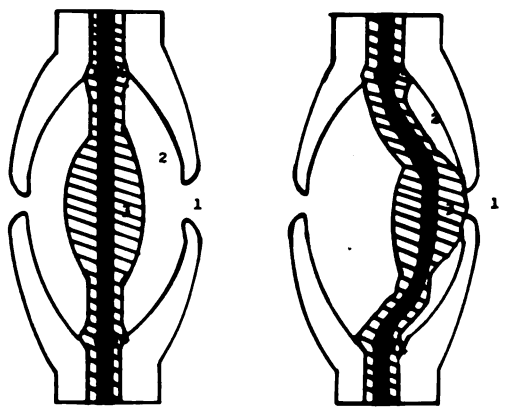
Because of its rigid nature, strength, and workability, wood has been used for many years as a structural material. One of the limitations in its use, however, is its hygroscopicity, i.e., the affinity which wood has for moisture. According to Stamm and Millet (26), wood behaves like a colloidal substance and possesses the property of moisture absorption, swelling, and shrinking. The similarity between a colloidal substance and wood becomes apparent by the fact that wood absorbs moisture from its surroundings, and it will continue to do so until the moisture content of the wood and that of the surroundings are in balance with each other. If the moisture content of the surroundings is increased, wood will continue to absorb moisture until the fiber walls become saturated. When such a condition as this exists along with the absence of free water in the fiber cavities, it is known as the fiber saturation point. The sorption and desorption of moisture by wood causes it to swell and shrink, which is indicated by changes in its dimensions.

The Permeability of Wood.

In studying the treatment of wood with chemicals, the early investigators sought to explain the inter-cellular movement of liquids. Erickson, Schmitz, and Gortner (8) believe that the unit responsible for liquid passage is a special structure of the cell wall called the pit

membrane, which is illustrated in the accompanying sketch. The pit membranes have valve-like structures called a torus, which under certain conditions can be pulled to one side of the pit aperture, and thus close the cell cavity. Artificial passageways may result from checks on the cell walls and will influence the movement of liquids. Phillips (17) states that there are fewer pit closures in the summerwood. Resin ducts and radial ducts were found by Teesdale (31) to be effective passageways for liquids. Scarth (18) and Teesdale (31) decided that summerwood was more penetrable than the springwood. An interesting point is brought out by Southerlan, Johnston, and Maass (20) that temperatures above 70 degrees centigrade cause increases in the penetrability. According to Hunt and Garratt (13), the tangential section is superior to the radial section in penetration.

SCHEMTIC SKETCH OF BORDERED PIT PAIRS IN SECTIONAL VIEW



(A) (B)

LEGEND

(A)	A normal bordered pit pair
(B)	A bordered pit pair with aspirated torus
1	Pit aperture
2	Pit chamber
3	Torus
4	Pit annulus

Wood Stabilization.

A few of the approaches to this problem have already been mentioned. It will be advantageous, however, to have an outline of the

methods used to stabilize wood. There are two approaches to the problem. By one method all the water is removed from the wood, and then various treatments are carried out in order to prevent moisture from reentering the wood. The other method consists of retaining the moisture in the wood and then using different treatments to stabilize that moisture. In turn, each of these two methods has many variations, which will be indicated by the following outline:

I. Moisture exclusion methods.

A. By formation of water-impermeable coatings on the surface of wood.

1. The manner in which the material is applied is to dissolve the impervious material in a non-aqueous solvent which has a low melting and boiling point. Anti-shrink and swelling efficiencies for this type of treatment are very good.

2. Another method of preparing a coating on the surface of wood is to use a material which can be applied in the liquid form and which, when exposed to the weather, will form an insoluble coating on the wood. Drying oils and semi-drying oils are examples of such materials.

3. Emulsions are used to cover the surface of wood. In order to make the material to adhere to the wood, some substance is added to break the emulsion, thus causing it to spread out and form a coating.

B. By formation of water-impermeable coatings within the wood, on the fibers, and within the fine structures of the fibers.

1. By direct coating of the fibers, using water-impermeable materials, with various penetrants and spreaders.
2. By replacing the water in the wood with a non-volatile substance (24).
3. By formation and precipitation of insoluble physico-chemical reaction products. Involved in this group are the colloids, saponifiable materials, and emulsions.
4. By the formation of insoluble and impermeable condensation products within the fiber structure of wood. The principle of this method is to form compounds of high molecular weight which will fill up the fine spaces of the fibers and coat the cell walls with the impermeable material.
5. By formation of polymerized products that are bonded to the fibers. The solutions are injected into wood, and, when the desired penetration is obtained, the solutions are polymerized with subsequent bonding to the fibers. (9), (14), (19), (27), (28), (29), (33).

C. By physical modification of the hygroscopicity of wood.

1. By heating at elevated temperatures (32).
2. By alternating the grain of wood at right angles to each other (28).

3. By heating wood in the presence of various gases, such as oxygen, hydrogen, and air (25), and in the presence of moisture (11).

D. By a chemical modification of the hygroscopic nature of wood.

1. By the use of acetic anhydride to produce a substance that has less affinity for moisture than the unaltered wood (30). Thionyl chloride (15) has been used to accomplish the same result.

II. Moisture retention methods.

A. By the use of surface sealers.

B. By concentrating the water of constitution.

1. Use of inorganic salts (21).

2. Use of organic compounds, such as sucrose, glucose, potato molasses, and sucrose-urea combinations (23), (16).

Laboratory methods for testing the water repellency of wood.

In order to arrive at a satisfactory comparison between specimens, a careful selection of samples is necessary. In regard to these samples, particular attention must be paid to the number of rings per inch, to the amount of summerwood present, and to the grain alignment. According to Browne and Schwebs (2), even when these variations among samples are controlled, there exist differences among samples that cannot be related to an easily recognized property. Some of these uncontrollable factors are the aspirated pits and surface checks in the cell walls

of wood. Differences in sample size will set up differences in treating results and water repellency. Large specimens absorb a moderate amount of repellent per cubic foot, which, according to Browne and Schwebs (2), is roughly proportional to the depth of penetration into the end grain of wood. A gradient of water repellent concentration is set up between the treated and the untreated portion. Therefore small specimens receive greater absorptions of water repellent per cubic foot.

Six methods have been proposed (2) for measuring the water repellency of treated wood: (a) The National Door Manufacturers' Association Method, (b) The Bureau of Ships Method, (c) Protection Products 1 and 7 day Methods, (d) The I. F. Laucks Curl Test, and (e) The Western Pine Association Swellograph Method. Up to the time of the writing of this report, there was found to be no one standard method used by the repellent industry to evaluate treated wood.

The manner in which the water repellent efficiencies are evaluated is determined by the formula developed by Stamm and Millett (26).

$$\text{Anti-shrink efficiencies} = \frac{\text{shrinkage and swelling of control samples} - \text{shrinkage and swelling of treated samples}}{\text{shrinkage and swelling of control samples}}$$

THE PROBLEM

The major objectives of this report are: (I) to determine if the sample size, treating time in proprietary water repellents, and specific gravity have any effect on the percent absorption of water repellents; (II) to determine if the sample size and treatment time in water repellents have any effect on the water-repellent efficiency.

(I) Absorption study.

A. Effect of varying the sample size and treatment time on the absorption of water repellents.

1. Selection and preparation of material for treatment.

It was decided to use for all studies in this report tangential sapwood samples of ponderosa pine (Pinus ponderosa Dougl.). The wood was carefully selected with respect to its density, number of rings per inch, and grain alignment. When received, the wood had an average moisture content of 10.5 percent. The wood was roughly cut and surfaced down to the dimensions of 6' x $1\frac{1}{2}$'' x $\frac{1}{2}$'' by the use of a joiner.

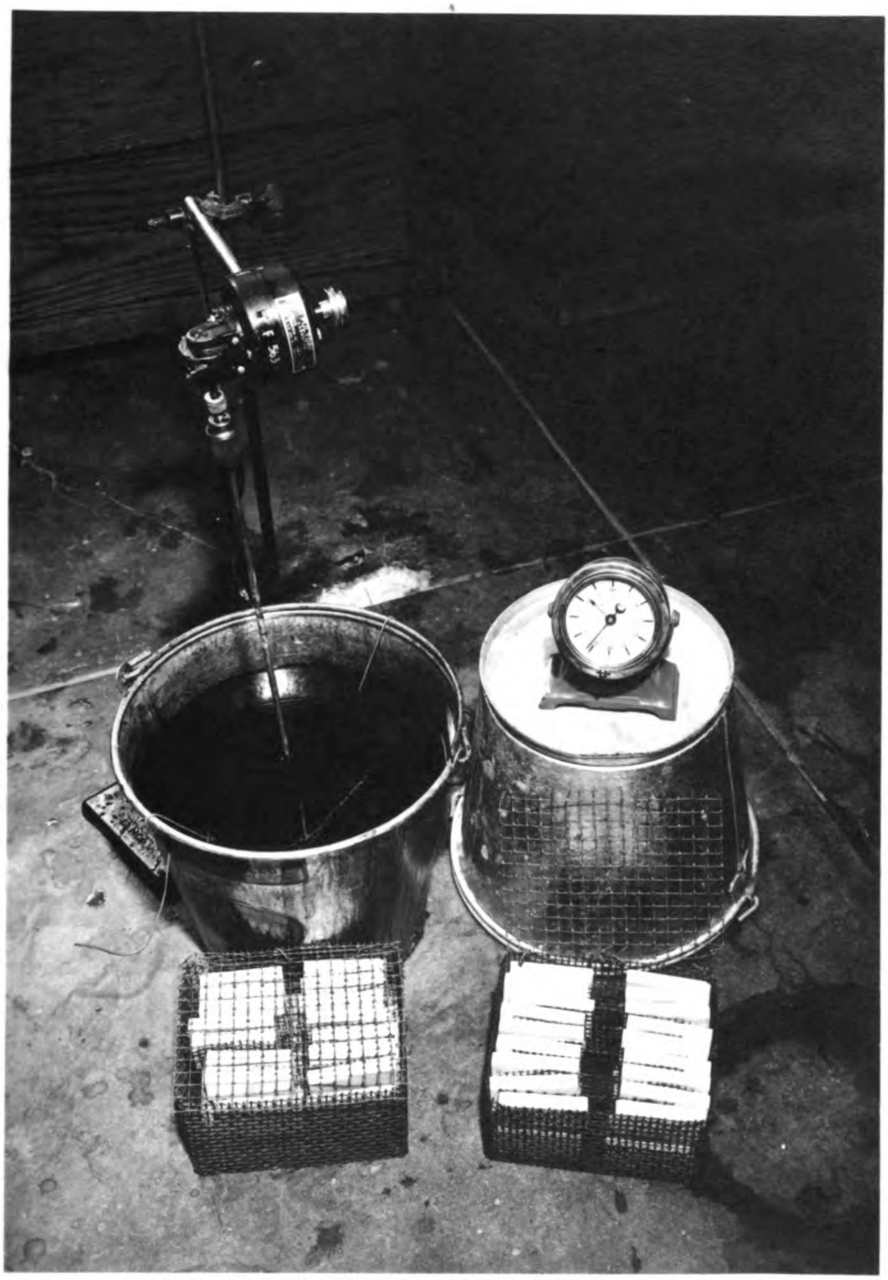
In the preliminary experiments there was a definite indication that the specific gravity had an effect on the percent absorption of water repellents, proof of which is given on page 13. Thus there were two possibilities of sample selection. One was to select all samples of a given specific gravity or

within a variation of 1 to 3 percent. The difficulty of obtaining this constancy and the small amount of material available prevented the selection of samples on this basis. The other method of sample selection was to use the average specific gravity in all stages of experiment. This being possible, therefore one hundred samples of each of the following dimensions were cut: 2" x 1½" x ½", 3" x 1½" x ½", 4" x 1½" x ½", and 5" x 1½" x ½", making a total of 400 samples.

The samples were then put into a conditioning cabinet for a period of two weeks at a temperature of 40 degrees centigrade. At that time, an equilibrium moisture content of 3.2 percent was reached.

Before the samples were treated with a water repellent, the 100 samples in the size group to be tested were weighed on a torsion balance and next arranged according to the second method of sample selection, i.e., by arranging the samples according to weight into two groups of 50 samples each. One group was to be used for repellent (A) and the other for repellent (B). These groups of 50 samples were further divided according to weight into five groups of 10 samples each. These groups represented the different treating times of 15 sec., 1 min., 3 min., 30 min., and 1 hour. Thus 10 replications, all of the same approximate specific gravity, were obtained for each test. The same sampling technique was followed for the other sample sizes.

PLATE 1



2. Treating procedure.

The samples for the various size and treating times were assembled in specially built wire dipping baskets (Plate 1). The wood samples were separated from one another by the use of wire-mesh screens, which prevented the pieces of wood from sticking to one another during the treatment. Preliminary tests having shown that the percent absorption increased when the solution was stirred, the repellent solutions were agitated during the test by a 60 cycle Fultork motor. This procedure resulted in the reduction of surface effects between the wood and the repellent solutions. The time of dipping in the repellent solution was determined by the use of a Kodak timer. The surfaces of the wood samples were wiped after being dipped in the repellent solution and weighed on a torsion balance. The increase in weight was recorded, and the net percent of absorption determined.

3. Discussion of treating data.

Tables 1 to 8 include the essential treating data for the study of the effect of sample size and treatment time, on the percent absorption. Graphical representation of the results is shown in Figures 1 to 5.

Results of the preliminary experiments (Fig. 1) show the shape of the absorption curve for prolonged periods of dipping. The curve reveals that within the first hour of dipping 55.9 percent of the total repellent was absorbed. It may be noticed (Tables 1

to 8 and Fig. 2 to 5) that large absorptions take place in a very short time, samples treated for 1/4 minute having comparatively high absorptions. This trend is evident throughout the sample sizes. The reasons for the rapid initial absorption may be accounted for by the porous nature and dry condition of wood samples. Further penetration of the repellent into the wood is retarded by the entrapped air in the wood, which creates a back pressure retarding the flow of solution. The overlapping arrangement of longitudinal tracheids and aspirated pits set up barriers to the free flow of liquids through the wood. Other factors have already been mentioned (see page 5) which cause a differential slowing down of absorption.

The over-all effect of increasing the sample size on the percent absorption is shown in Figure 4, where it is demonstrated that for small samples the percent absorption is large for both repellent (A) and (B). Increasing the size of samples one inch caused a considerable decrease in the percent absorption. Further increases in sample size show slight decreases in the percent absorption from one smaller to larger size, indicating that the effect of the end penetration is becoming less important. Water repellent (B) has larger absorptions for all sample sizes up to 4" x $1\frac{1}{2}$" x $\frac{1}{2}$" and for all treating times up to 30 minutes.

B. Effect of the specific gravity on the percent absorption of water repellent (B).

The purpose of this experiment is to substantiate the claim that the specific gravity influences the percent absorption of water repellents.

1. Sample selection and preparation.

Tangential sapwood ponderosa pine samples were selected for varying specific gravities. The grain alignment and number of rings per inch were kept constant. The samples were prepared in the same manner outlined in the study immediately preceding this, the only difference being the use of one sample size 3" x $1\frac{1}{2}$" x $\frac{1}{2}$". After the samples were cut to this dimension, they were measured with the extensometer used for determining the dimensional changes of wood (Plate 2). All samples that varied by 10 thousandths of an inch were discarded. The remaining samples were then conditioned in a cabinet at 40 degrees centigrade for two weeks, at the end of which time their moisture content was 3.25 percent. After being weighed and arranged according to increasing weights, the samples were next divided into four specific gravity ranges. (1) 0.3853 to 0.4128, (2) 0.4128 to 0.4404, (3) 0.4404 to 0.4679, and (4) 0.4679 to 0.4954.

2. Testing procedure.

The samples were dipped in agitated water repellent (B) for a period of 10 minutes, according to the procedure outlined on page 13. The samples were weighed after the treatment, and the net percent absorption determined.

3. Discussion of results.

A definite relationship was conclusively demonstrated to exist between the percent absorption of water repellent (B) and the specific gravity of wood (Fig. 6). The smaller the specific gravity, the larger are the percent absorptions. The effect of specific gravity on the percent absorption is more pronounced at lower specific gravities. It is evident from this experiment that a definite specific gravity range must be specified when one is working with absorptions of water repellents.

(II) Water Repellency Study.

The purpose of this study was to determine if the increasing of the sample size and the lengthening of the treatment time in water repellents had any effect on the water-repellent efficiency.

1. Selection and preparation of material for testing.

Untreated control samples were prepared from 6' x $1\frac{1}{2}$" x $\frac{1}{2}$" tangential sapwood ponderosa pine samples, the wood being cut into the following sizes: 2" x $1\frac{1}{2}$" x $\frac{1}{2}$", 3" x $1\frac{1}{2}$" x $\frac{1}{2}$", 4" x $1\frac{1}{2}$" x $\frac{1}{2}$", and 5" x $1\frac{1}{2}$" x $\frac{1}{2}$". The samples were then tested for uniformity of dimensions by an extensometer (Plate 2), and those with variations of ten thousandths of an inch were discarded. Ten samples for each size group were then selected and conditioned at room temperature for thirty days. The treated samples used for the absorption study were also conditioned for a period of thirty days in a manner similar to that which was

applied to the untreated control samples.

2. Testing procedure.

Plate No. 2 shows the apparatus used to measure the dimensional changes of wood. The immersion tank was filled with water and brought to a constant temperature by the use of equipment consisting of heating coils, electronic relay, and thermostat. A few drops of 1 percent sodium pentachlorophenate solution were first added to prevent bacterial and fungal growth, and the water in the tank was then agitated by a 60 cycle Fultork motor.

The untreated control samples were next taken, and the tangential dimensions were measured by the use of the extensometer (Plate 2). These samples were put in the immersion tank, and the change in their dimensions was determined every fifteen minutes for a period of six hours.

The samples treated with water repellent (A) and (B) for various sizes and water repellent treatment times were then tested for changes in dimensions in a like manner.

The water-repellent efficiency of each repellent was then calculated by the following formula:

$$\text{Percent efficiency of water repellent} = \frac{\text{Change in dimension of untreated control sample} - \text{Change in dimension of treated sample}}{\text{Change in dimension of untreated control sample}}$$

3. Discussion of results.

The essential data on this experiment are contained in Tables 13 to 17, and a graphical representation is shown in Figures 7 to 20.

Figure 7 shows the effect of sample size on the average dimensional change of untreated control samples. It shows that the most rapid change of dimensions takes place in the first two hours of immersion in water. In general, the larger the sample size, the greater the dimensional change. The manner in which the rate of swelling takes place is the same in all samples.

The over-all effect of varying the length of treating time in water repellents on the water repellent efficiency is not too great. The differences between the various treating times is less noticeable for the shorter water immersion periods.

The longer the samples were treated in repellent solution, the greater were the percent efficiencies during the shorter water immersion periods. Moreover, there is a definite over-all effect of the size of a particular sample on the water-repellent efficiency for all immersion periods in water. The smaller the sample size, the lower the percent efficiency. Further, the change in water repellency is greater for the first two hours of immersion in water. The percent efficiency for all treating times in repellents and sample sizes approaches a linear relationship for the longer immersion periods in water.

PLATE 2

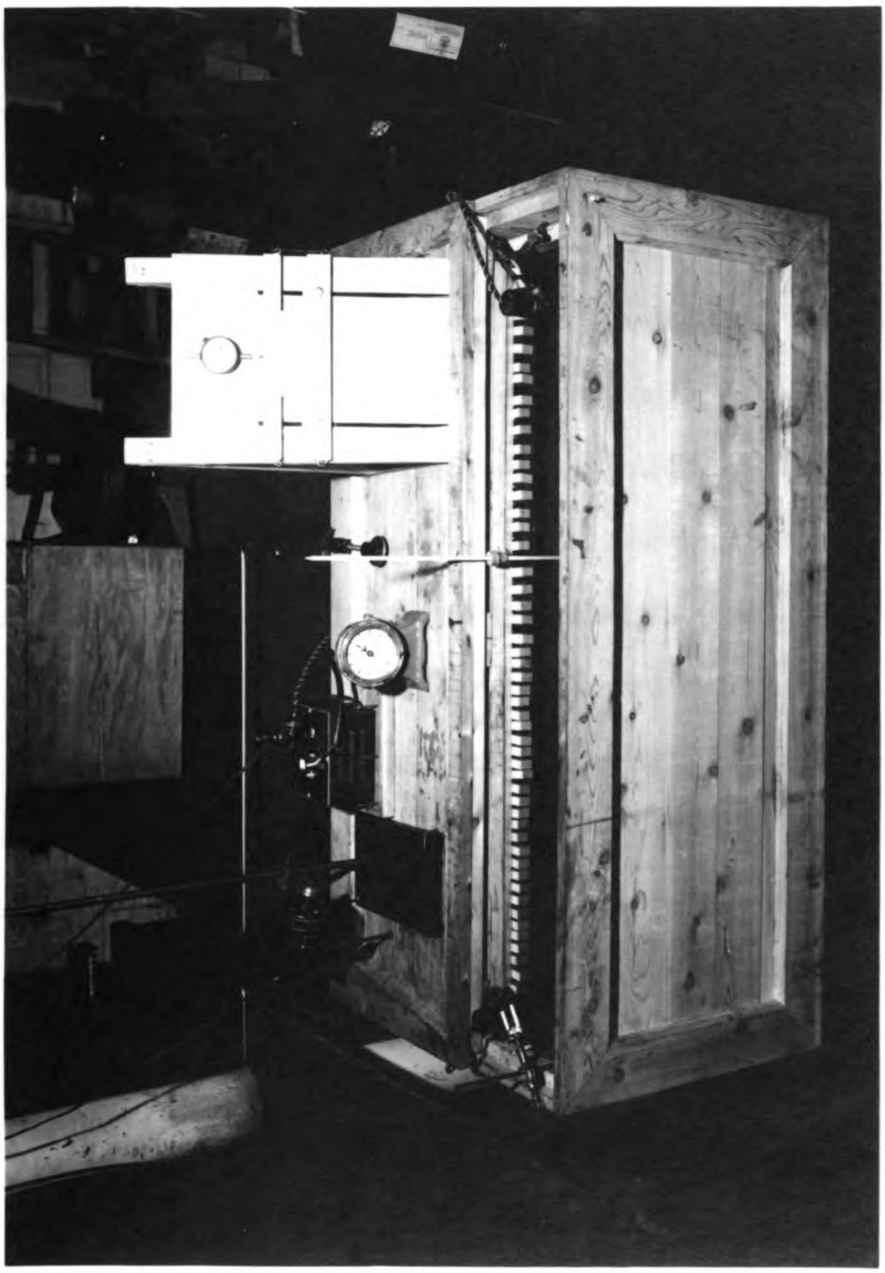


Figure 20 shows an evaluation of the water-repellent efficiencies of water repellents (A) and (B). The effect of sample size and treatment time in repellent solution on the water repellent efficiency is larger and more uniform in the case of water repellent (B).

After the completion of this study on water repellency, and additional experiment was made to determine if the specific gravity had any effect on the average dimensional change of samples immersed in water. Untreated control tangential ponderosa pine samples were used for the test with specific gravity ranges of 0.3853 to 0.4954, and the procedure already outlined (see page 17) was used to determine the average dimensional change. The results were subjected to a rank correlation analysis, from which it was determined that, for the specific gravity range used there exists little correlation between the average dimensional change and the specific gravity of wood.

ANALYSIS OF VARIANCE

Three analyses were made in order to establish the significance of the results. These were: first an analysis of the data on the absorption of water repellent by ponderosa pine samples; and second and third, analyses of the water-repellent efficiencies of samples which were treated with water repellents (A) and (B) and which were immersed in water for 15 minutes and 6 hours.

From the absorption analysis it was determined that the results obtained by varying the sample size were highly significant, particularly the effect of varying the treating times on the percent absorption. For each sample size and treatment time in repellent solution there was found to be no significant difference between the absorptions for water repellent (A) and (B). Therefore, it is concluded from the analysis of variance for absorption that the methods used to determine the effect of sample size and treatment time on the percent absorption of a water repellent are satisfactory.

The results of the analysis of variance for the 15 minute and 6 hour water immersion periods show that there was a highly significant difference in water repellent efficiency for all sample sizes and for samples treated with water repellents (A) and (B). However, the effect of treatment time in water repellent solution on the water-repellent efficiencies was not significant for the 15 minute water immersion period, but was significant for the 6 hour water immersion period.

Thus the sample size and type of water repellent appear to be the important factors affecting the water repellent efficiency. Only for long immersion periods in water does the treating time in repellent solution become important.

Analysis of variance

No. 1 Analysis of the data on the absorption of water repellent by ponderosa pine.

SOURCE	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SUMS OF SQUARES	SIGNIFICANCE
Totals	399	4663.9		
Sub-groups	39	3706.1		
Size	3	1386.4	462.1	173.7 **
Time	4	2133.0	533.2	200.5 **
Repellent	1	4.8	4.8	1.8 N.S.
Error	360	957.8	2.66	

No. 2 Analysis of the data on the percent efficiency of water repellents immersed in water for 15 minutes.

SOURCE	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SUMS OF SQUARES	SIGNIFICANCE
Totals	399	58,062.8		
Sub-groups	39	37,468.7		
Size	3	14,728.5	4,909.5	85.8 **
Time	4	111.4	27.8	2.0 N.S.
Repellent	1	1,384.2	1,384.2	24.2 **
Error	360	20,594.1	57.2	

No. 3 Analysis of the data on the percent efficiency of water repellents immersed in water for 6 hours.

SOURCE	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SUMS OF SQUARES	SIGNIFICANCE
Totals	399	156,113.9		
Sub-groups	39	65,785.2		
Size	3	47,454.2	15,818.1	63.0 **
Time	4	2,374.3	593.6	2.4 *
Repellent	1	11,210.3	11,210.3	44.7 **
Error	360	90,328.7	250.9	

LEGEND: N.S. = Not significant

* = Significant

** = Highly significant

SUMMARY AND CONCLUSIONS

The following factors affecting the stabilization of wood have been studied: 1. Effect of varying the sample size and treatment time on the percent absorption of water repellents (A) and (B). 2. Effect of varying the specific gravity on the percent absorption of water repellent (B). 3. Effect of varying the sample size and treatment time on the percent efficiency of water repellent (A) and (B).

1. It was especially important in this study to develop a proper testing technique in order to obtain reproducible results.
2. The results obtained by any absorption test are directly related to the specific gravity range used.
3. The rate of absorption of water repellent is the greatest during the initial stages of dipping, about 55.9 percent of the total absorption taking place the first hour of dipping. The rate of absorption decreases as the time of dipping increases. There is a rapid absorption of water repellent the instant wood comes in contact with the repellent solution.
4. The percent absorption of water repellents is influenced by the temperature of the wood and of the repellent solution, as well as by the agitation of the solution and the moisture content of the wood.
5. Increasing the length of sample decreases the percent absorption. However, increasing the length of sample beyond 3 inches showed

smaller differences in absorption than the shorter samples. This is owing to the effect of end penetration becoming less important as the size of the sample increases.

6. Water repellent (B) showed consistently higher percent absorption than repellent (A) for all sample sizes up to 4 inches in length and all treating times in repellent solutions up to 30 minutes.
7. Specific gravity influences the percent absorption of water repellents. The greater the specific gravity, the smaller the percent absorption.
8. In general, the greater the percent absorption, the higher were the water-repellent efficiencies.
9. The average dimensional change of untreated control samples immersed in water increased with the sample size, while the average dimensional change of treated samples decreased with the sample size. The water-repellent efficiency was increased by increasing the length of samples.
10. The average change in dimensions of treated and untreated samples immersed in water was larger for the first two hours of immersion in water than for the following 4 hours.
11. Varying the treating time in water repellents had little effect on the water-repellent efficiency.
12. Water repellent (B) showed greater repellent efficiencies for all sizes and treating times in water repellents.

13. The analysis of variance showed significant results for all stages of study, except for the effect of treatment time in repellent solution on the water-repellent efficiency for the 15 minute water immersion period. Treatment time in repellent solution was, however, significant when longer water immersion periods were used.

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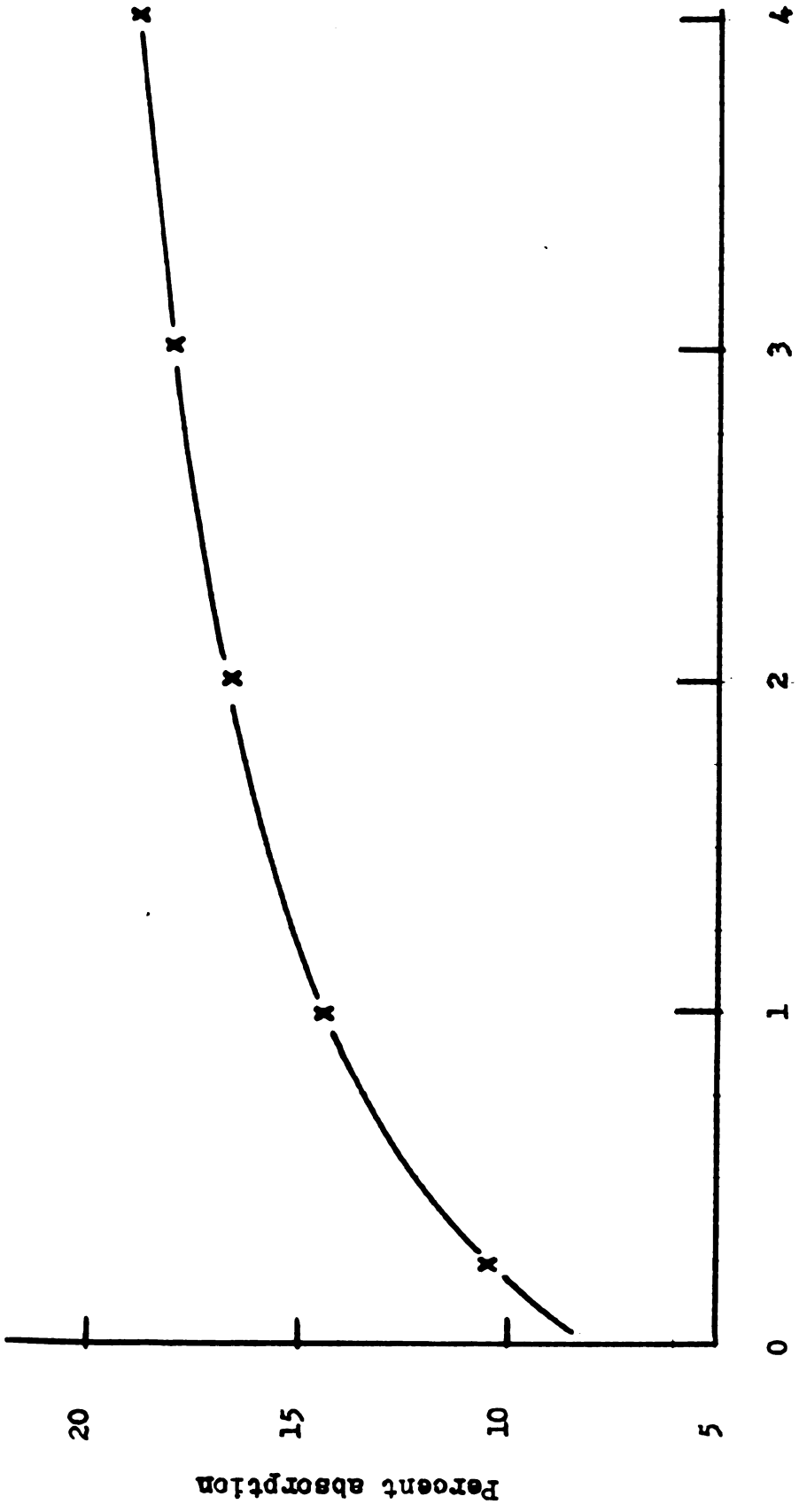

Figure 1 -- Results of preliminary experiments, effect of prolonged periods of dipping on the percent absorption.

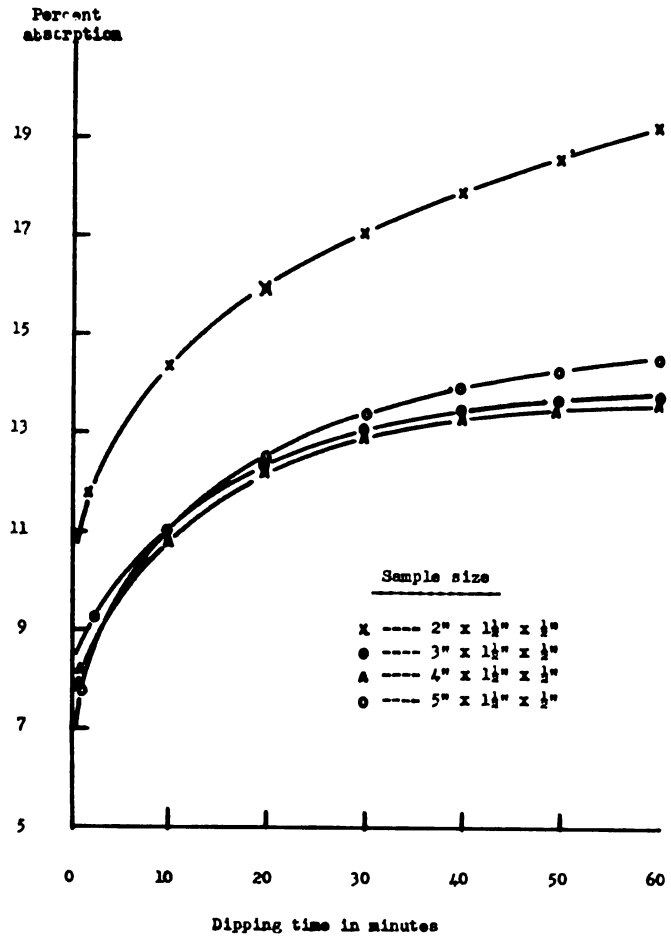

Figure 2 -- Effect of varying the sample size and dipping time on the percent absorption of water repellent (A).

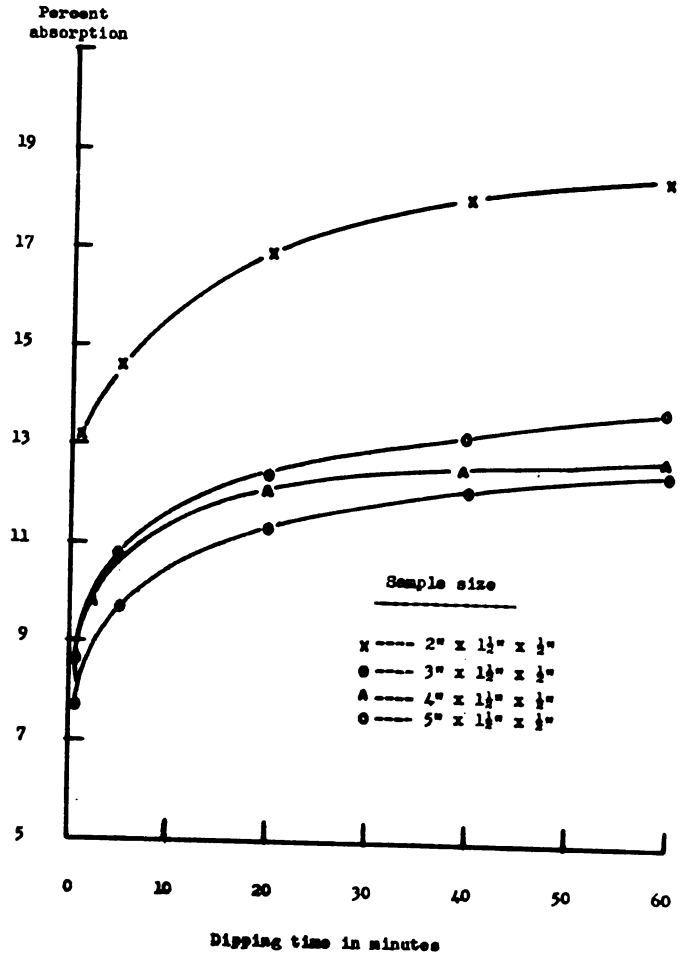

Figure 3 -- Effect of varying the sample size and dipping time on the percent absorption of water repellent (B).

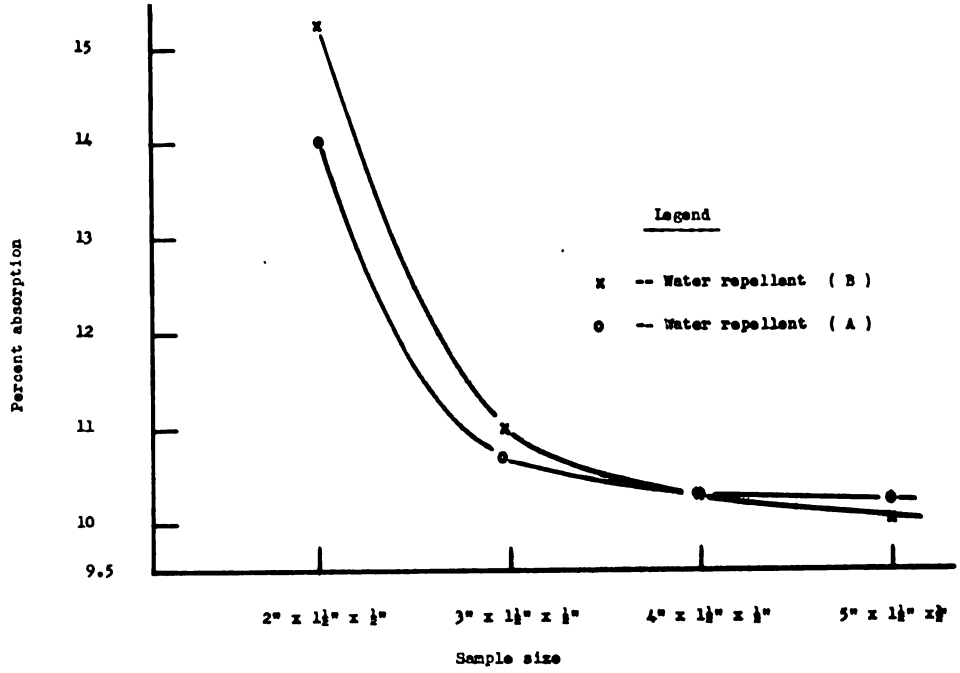

Figure 4 -- The effect of sample size on the percent absorption of water repellent (A) and (B) for all periods of dipping.

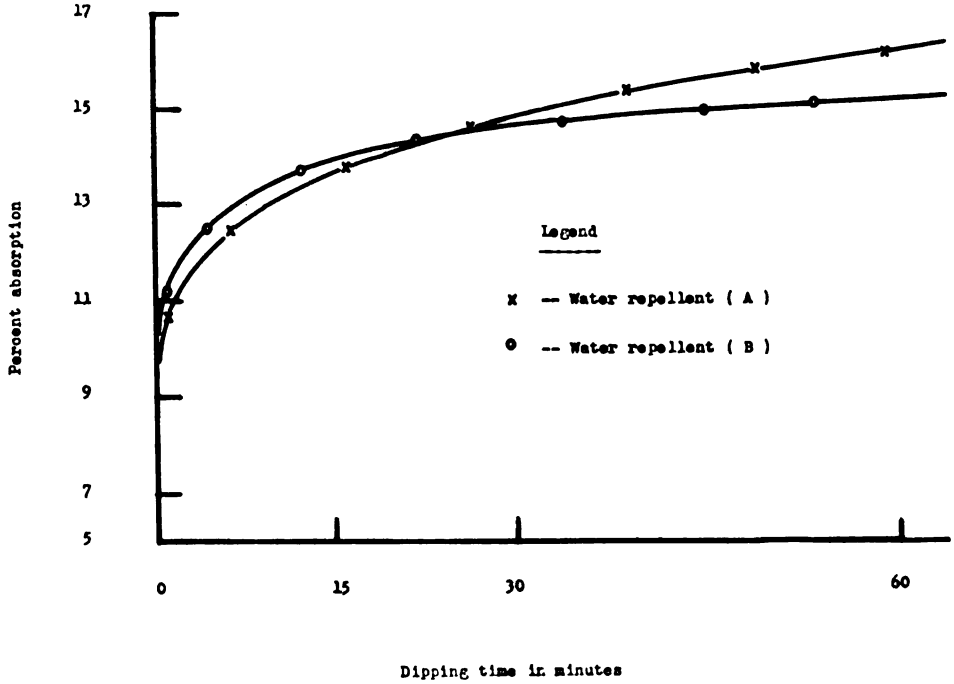

Figure 5 -- The effect of dipping time on the percent absorption of water repellent

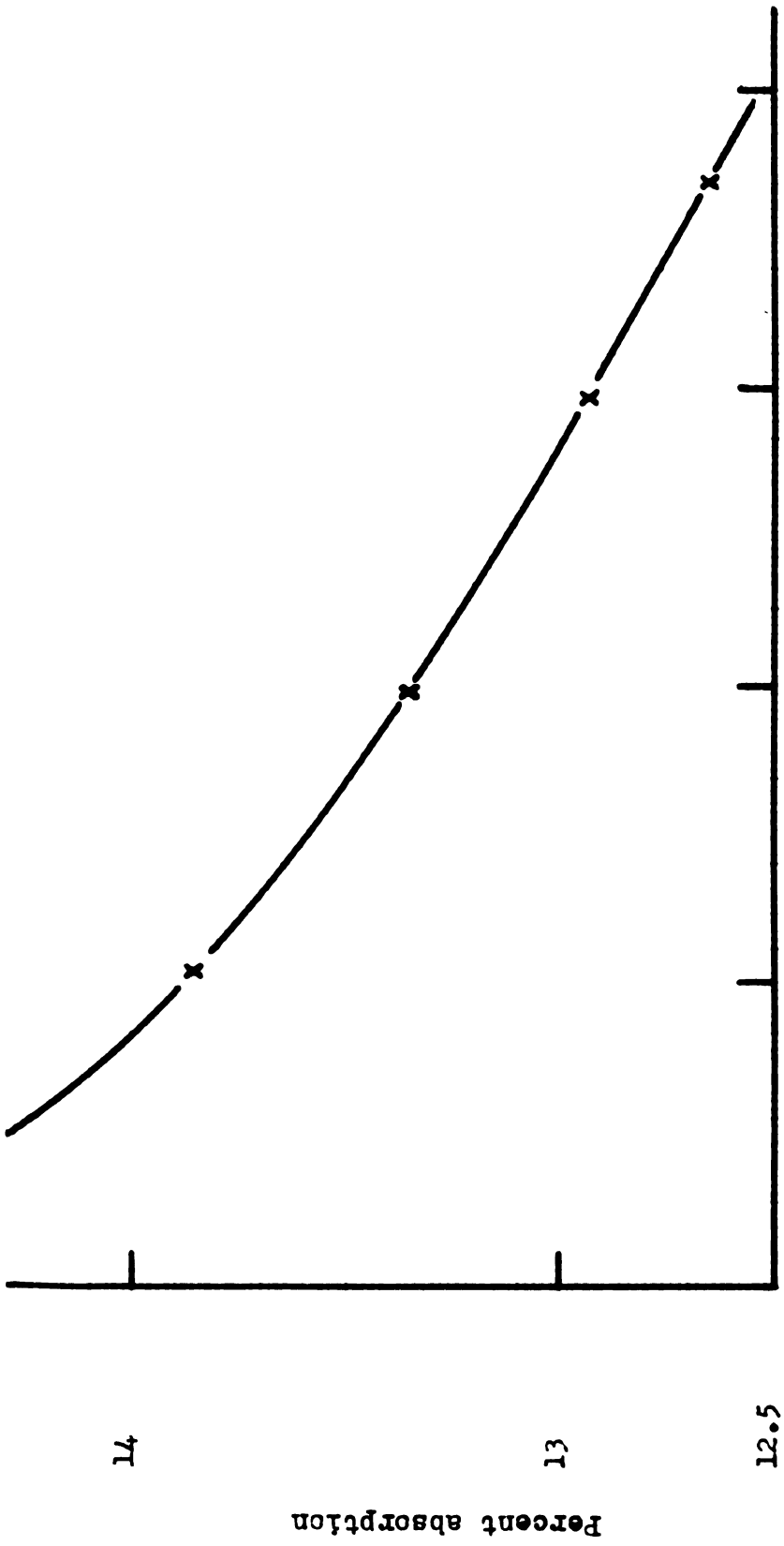

Figure 6 -- Effect of varying the specific gravity on the percent absorption of water repellent (B).

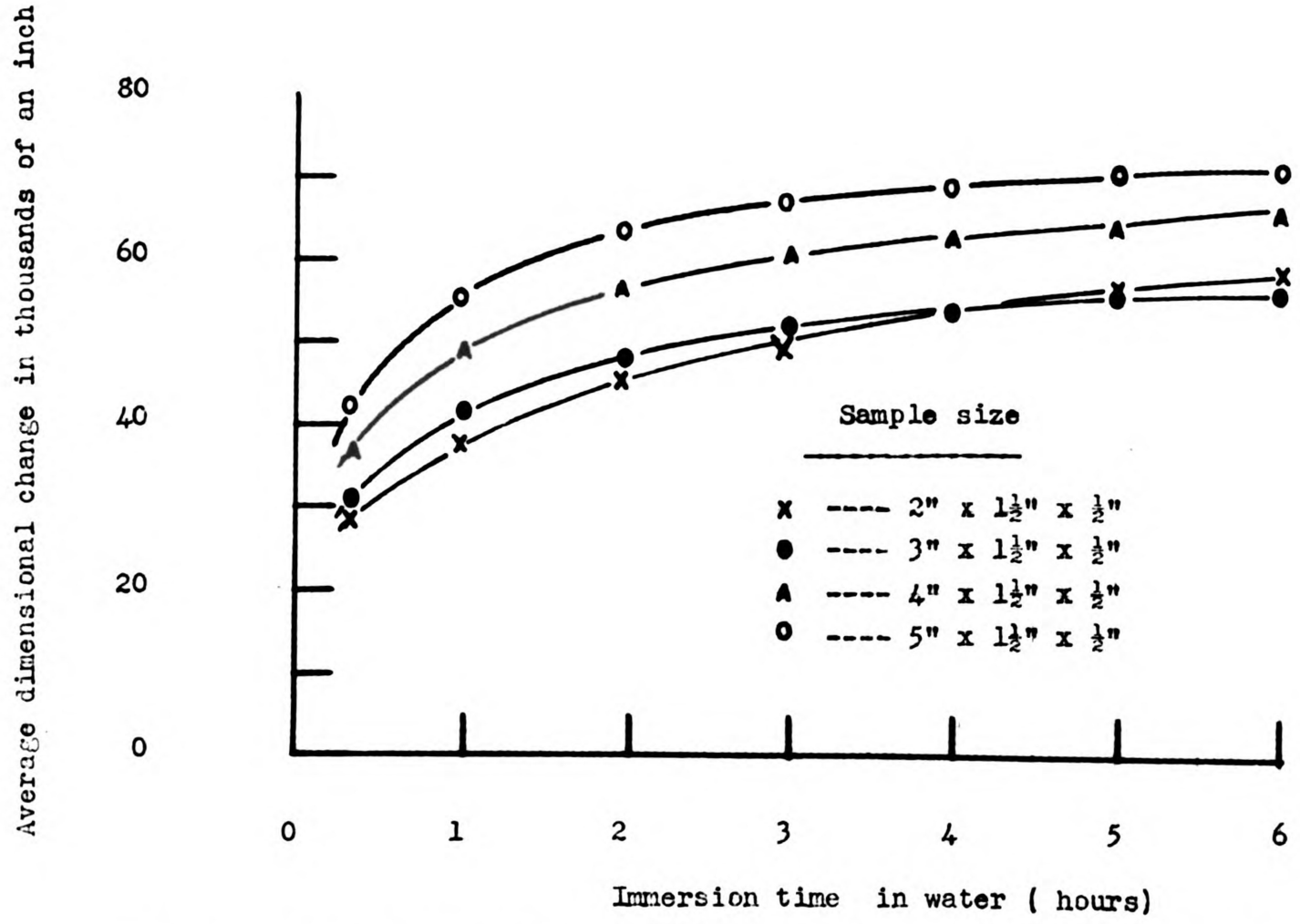

Figure 7 -- Average dimensional change of untreated control samples immersed in water for varying periods of time.

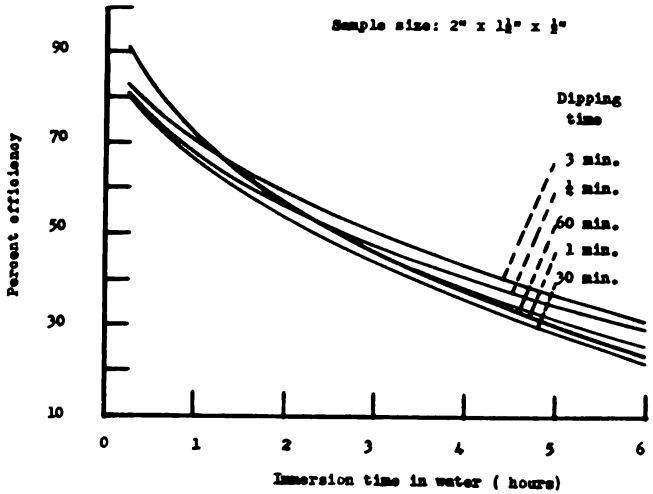

Figure 8 -- Average percent efficiency of water repellent (A).

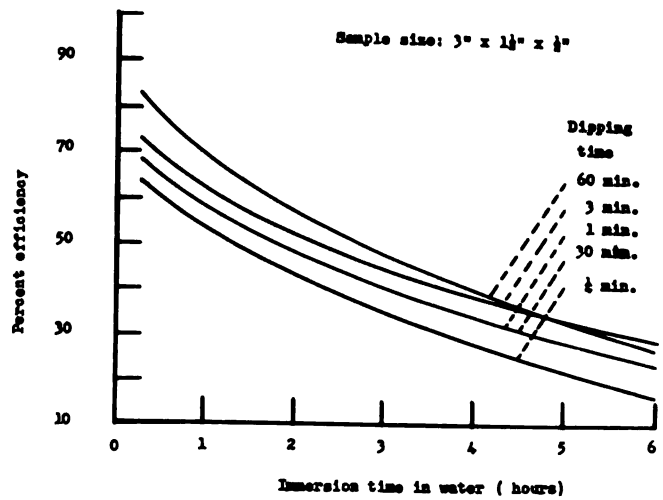

Figure 9 -- Average percent efficiency of water repellent (A).

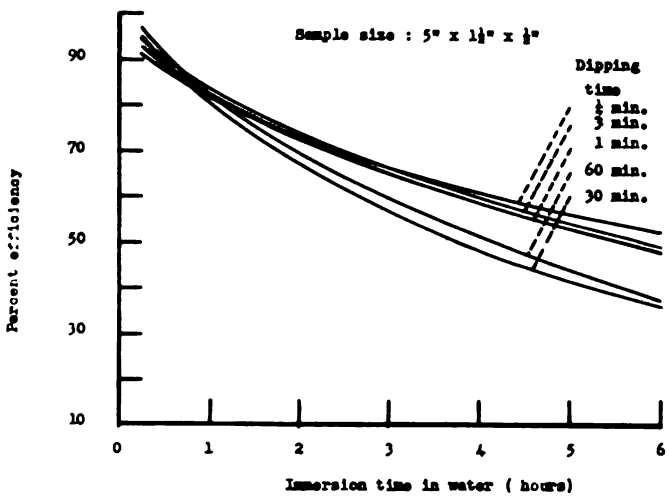

Figure 11 -- Average percent efficiency of water repellent (A).

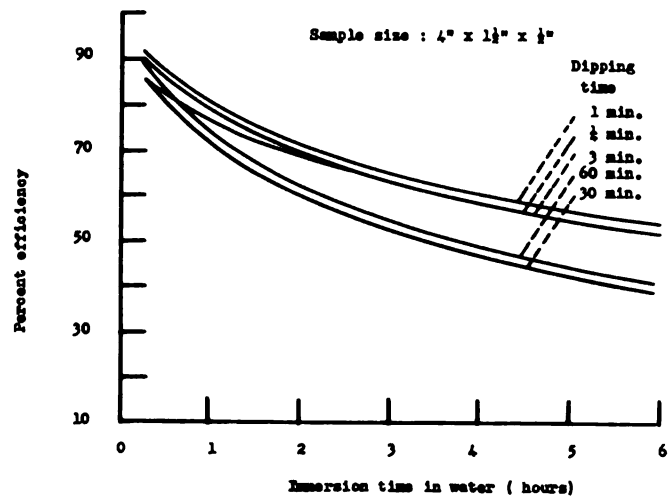

Figure 10 -- Average percent efficiency of water repellent (A).

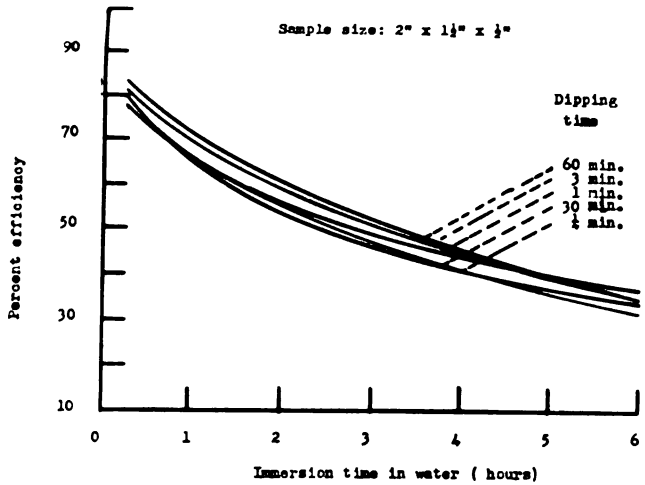

Figure 12 -- Average percent efficiency of water repellent (B).

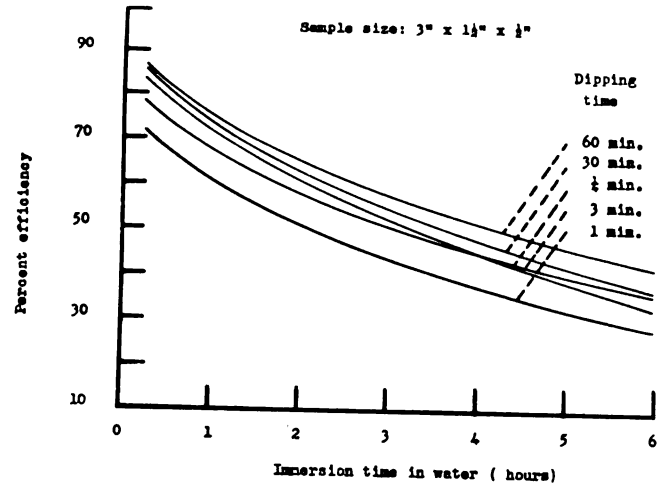

Figure 13 -- Average percent efficiency of water repellent (B).

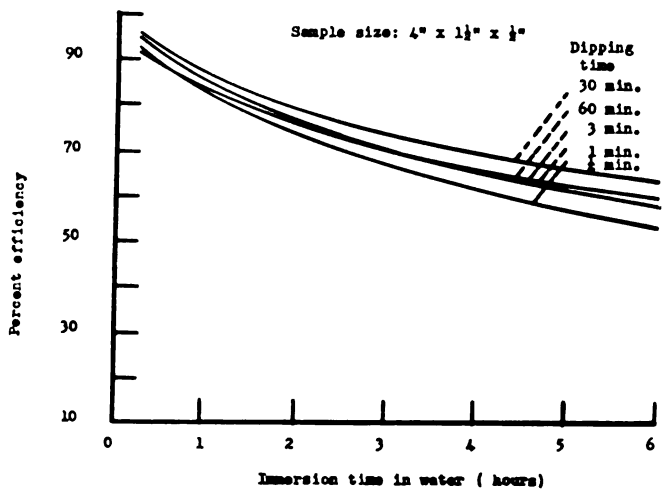

Figure 14 -- Average percent efficiency of water repellent (B).

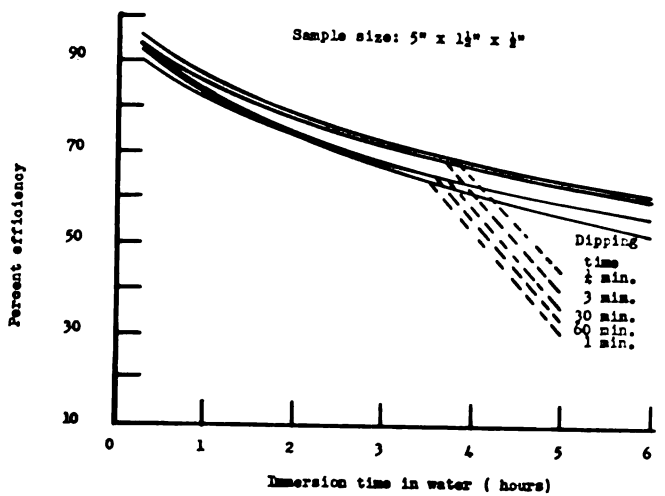

Figure 15 -- Average percent efficiency of water repellent (B).

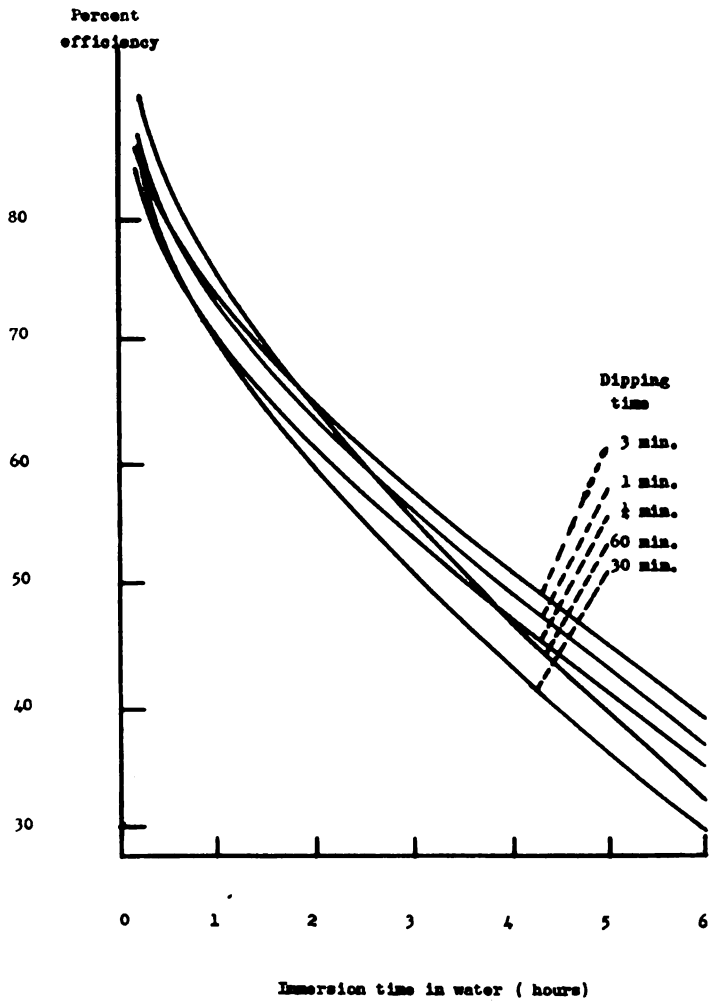

Figure 16 -- Results of varying the time of dipping on the percent efficiency of water repellent (A) for all sample sizes.

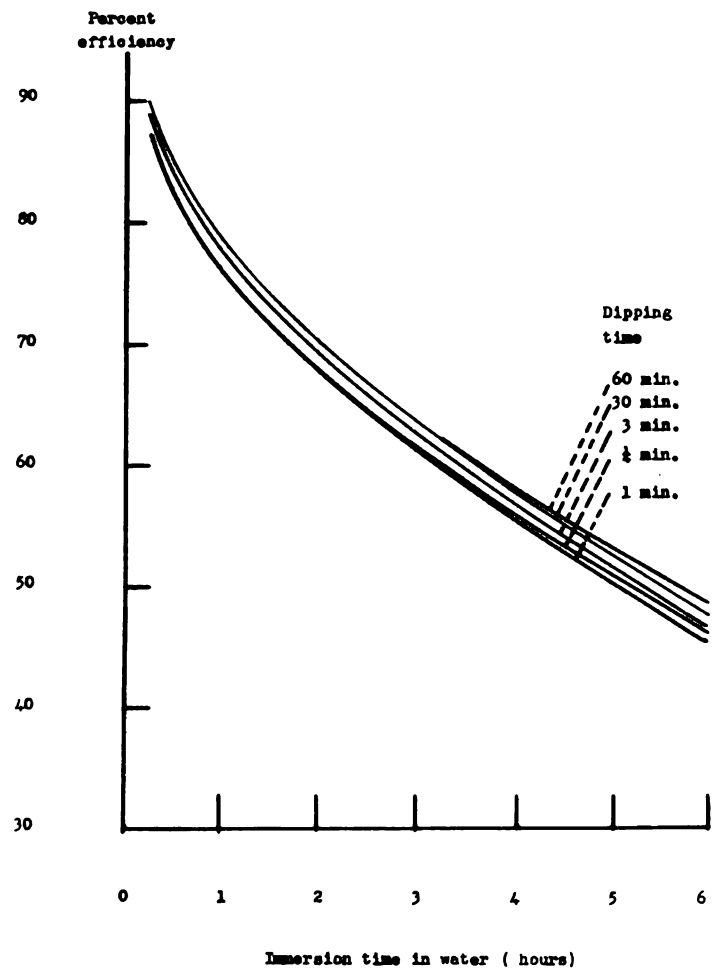

Figure 17 -- Results of varying the time of dipping on the percent efficiency of water repellent (B) for all sample sizes.

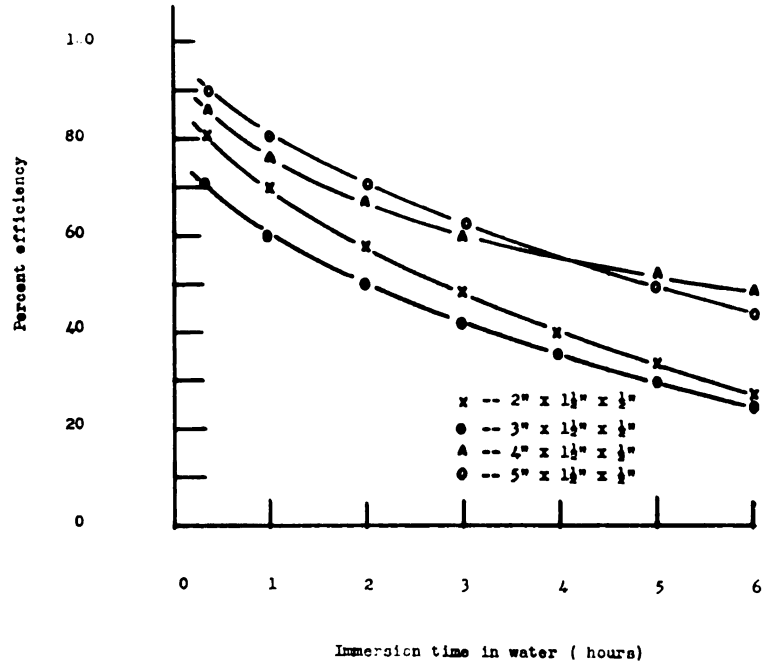

Figure 18 -- Influence of sample size on the percent efficiency of water repellent (A) for all times of dipping.

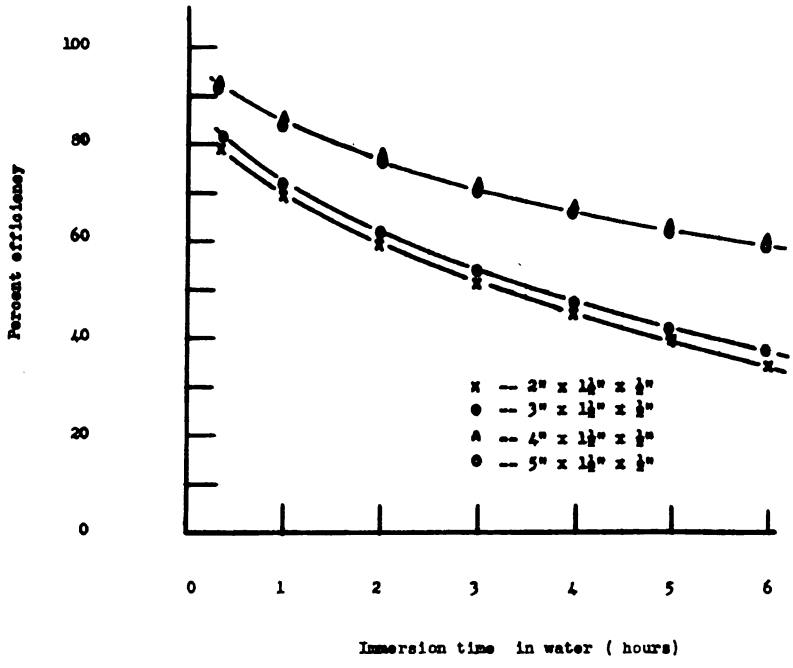

Figure 19 -- Influence of sample size on the percent efficiency of water repellent (B) for all times of dipping.

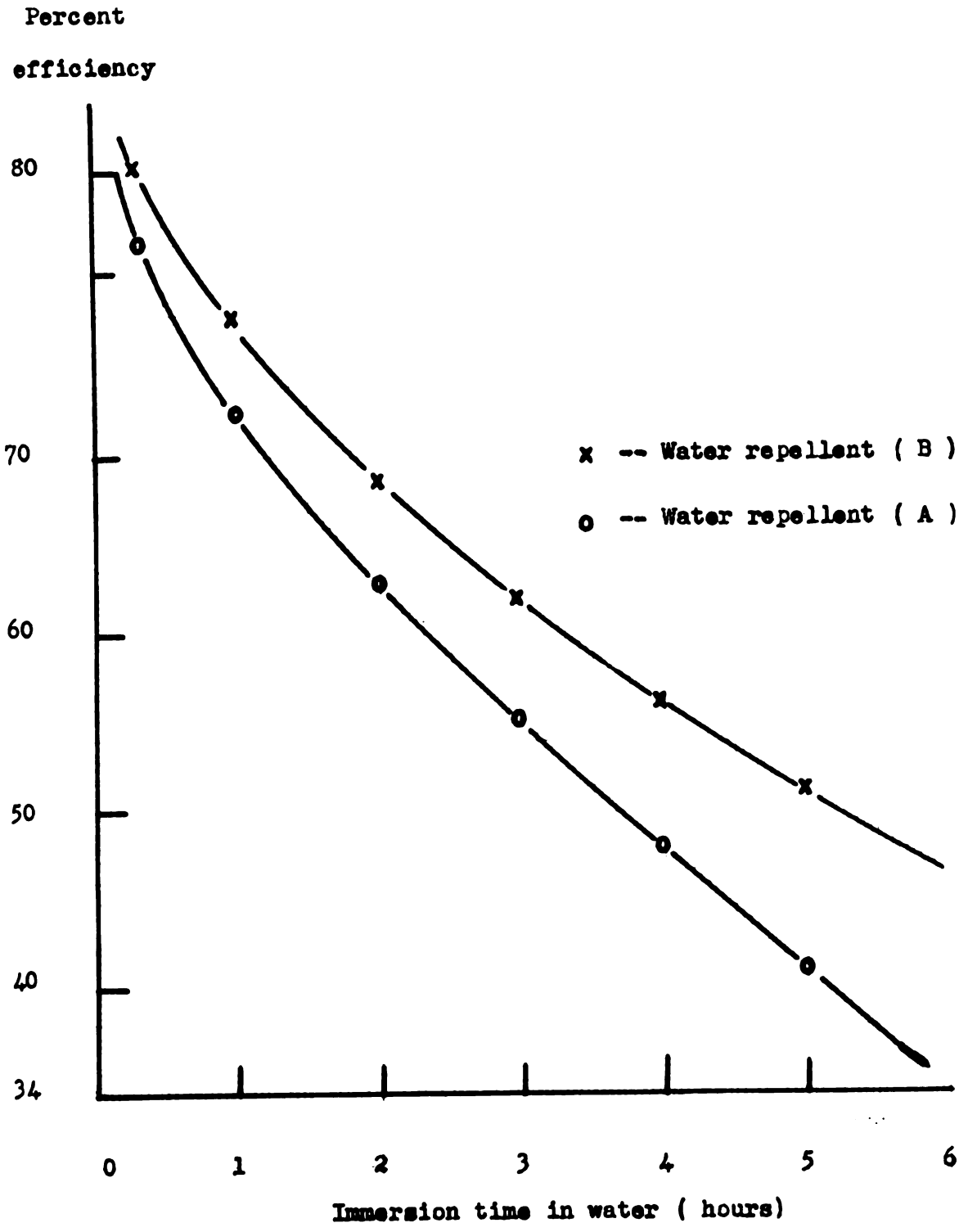

Figure 20 -- A comparison of the percent efficiency of water repellent (A) and (B) for all sizes and all dipping times.

TABLE NO. 1

Absorption data for (2'' x 1½'' x ½'') tangential ponderosa pine samples treated with water repellent (A).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	8.51	9.62	1.11	13.45
2	''	8.79	9.69	0.90	10.56
3	''	8.93	9.87	0.94	10.87
4	''	9.00	10.00	1.00	11.67
5	''	9.05	9.99	0.94	10.72
6	''	9.09	9.97	0.88	9.99
7	''	9.17	10.19	1.02	11.47
8	''	9.38	10.31	0.93	10.23
9	''	9.75	10.64	0.89	10.65
10	''	10.00	10.81	0.81	8.36
Ave:					10.80
11	1 minute	8.67	9.68	1.01	12.02
12	''	8.88	9.96	1.08	12.86
13	''	8.94	10.01	1.07	12.36
14	''	9.01	10.21	1.20	13.74
15	''	9.06	10.06	1.00	11.39
16	''	9.10	10.16	1.06	12.02
17	''	9.47	10.36	0.89	9.69
18	''	9.80	10.70	0.90	9.47
19	''	10.20	11.49	1.29	13.05
20	''	8.74	9.74	1.00	11.80
Ave:					11.84
21	3 minutes	8.71	9.90	1.19	14.09
22	''	8.90	9.95	1.05	12.18
23	''	8.98	10.14	1.16	13.33
24	''	9.19	10.44	1.25	14.03
25	''	9.07	10.31	1.24	14.10
26	''	9.10	10.19	1.09	12.36
27	''	9.19	10.22	1.03	11.56
28	''	9.56	10.88	1.32	14.25
29	''	9.94	11.04	1.10	11.42
30	''	10.35	11.75	1.40	13.96
Ave:					13.13
31	30 minutes	8.67	10.15	1.48	17.62
32	''	8.72	10.18	1.46	17.28
33	''	8.89	10.32	1.43	16.61
34	''	8.99	10.39	1.40	16.07
35	''	9.03	10.49	1.46	16.68
36	''	9.07	10.30	1.23	13.99
37	''	9.11	10.58	1.47	16.65
38	''	9.22	10.65	1.43	16.01
39	''	9.57	10.96	1.37	14.75
40	''	9.96	11.08	1.12	11.61
Ave:					15.73
41	1 hour	8.80	10.50	1.70	19.93
42	''	8.76	10.49	1.73	20.38
43	''	8.93	10.63	1.70	19.65
44	''	8.99	10.77	1.78	20.44
45	''	9.04	10.63	1.59	18.15
46	''	9.08	10.76	1.68	19.09
47	''	9.14	11.09	1.95	22.01
48	''	9.33	11.18	1.85	20.46
49	''	9.66	11.30	1.64	17.52
50	''	9.98	11.80	1.82	18.82
Ave:					19.64

TABLE NO. 2

Absorption data for (3" x 1½" x ½") tangential ponderosa pine samples treated with water repellent (A).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	12.85	13.93	1.08	8.67
2	"	13.37	14.56	1.19	9.18
3	"	13.55	14.80	1.25	9.52
4	"	14.23	15.11	0.88	6.38
5	"	14.65	15.69	1.04	7.32
6	"	15.19	16.38	1.19	8.08
7	"	14.26	15.38	1.12	8.10
8	"	14.42	15.54	1.12	8.02
9	"	14.60	15.75	1.15	8.13
10	"	14.78	15.90	1.12	7.82
Ave:					8.12
11	1 minute	13.15	14.30	1.15	9.03
12	"	13.44	14.78	1.34	10.29
13	"	13.58	14.92	1.34	10.18
14	"	14.43	15.56	1.10	7.87
15	"	14.80	15.86	1.06	7.39
16	"	15.33	16.92	1.59	10.71
17	"	14.27	15.47	1.20	8.68
18	"	14.42	15.82	1.40	10.02
19	"	14.64	15.85	1.21	8.46
20	"	14.74	15.88	1.14	7.98
Ave:					9.06
21	3 minutes	13.26	14.58	1.32	10.27
22	"	13.46	14.91	1.45	11.12
23	"	13.60	14.89	1.29	9.79
24	"	14.45	15.59	1.14	8,14
25	"	14.81	16.01	1.25	8.71
26	"	15.73	17.31	1.58	10.37
27	"	14.34	15.81	1.47	10.58
28	"	14.48	15.93	1.45	10.33
29	"	14.66	16.03	1.37	9.64
30	"	14.83	16.25	1.42	9.88
Ave:					9.88
31	30 minutes	13.29	14.83	1.54	11.96
32	"	13.49	15.29	1.80	13.77
33	"	13.68	15.66	1.98	14.93
34	"	14.52	16.06	1.54	10.95
35	"	15.40	16.95	1.55	10.39
36	"	15.95	17.89	1.94	12.55
37	"	14.35	16.06	1.71	12.30
38	"	14.56	16.43	1.87	13.26
39	"	14.73	16.41	1.68	11.77
40	"	14.89	17.00	2.11	14.62
Ave:					12.65
41	1 hour	13.34	15.46	2.12	16.40
42	"	13.51	15.46	1.95	14.90
43	"	13.76	15.91	2.15	16.13
44	"	14.65	16.47	1.82	12.82
45	"	16.34	18.41	2.07	13.08
46	"	16.00	18.00	2.00	12.90
47	"	14.39	16.33	1.94	13.92
48	"	14.59	16.47	1.88	13.30
49	"	14.76	16.56	1.80	12.59
50	"	14.96	16.84	1.88	12.97
Ave:					13.90

TABLE NO. 3

Absorption data for (4" x 1½" x ½") wood samples treated with water repellent (A).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	17.27	18.89	1.64	9.69
2	"	17.75	19.22	1.47	8.55
3	"	18.01	19.57	1.56	8.94
4	"	18.84	20.28	1.44	7.89
5	"	19.02	20.52	1.50	8.06
6	"	19.32	20.67	1.35	7.21
7	"	19.59	20.80	1.21	6.38
8	"	19.75	20.87	1.12	5.85
9	"	19.91	21.25	1.34	6.95
10	"	20.18	21.65	1.47	7.52
Ave:					7.70
11	1 minute	17.28	19.13	1.85	11.05
12	"	17.89	19.60	1.71	9.86
13	"	18.23	20.02	1.79	10.14
14	"	18.93	20.82	1.89	10.31
15	"	19.07	20.79	1.72	9.31
16	"	19.36	21.09	1.73	9.22
17	"	19.63	21.15	1.52	7.99
18	"	19.79	21.40	1.61	8.39
19	"	20.02	21.40	1.38	7.11
20	"	20.34	21.74	1.40	7.10
Ave:					9.05
21	3 minutes	17.46	14.92	1.96	11.58
22	"	17.92	19.80	1.88	10.83
23	"	18.65	20.61	1.96	10.85
24	"	18.96	20.90	1.94	10.56
25	"	19.16	21.22	2.06	11.09
26	"	19.43	21.38	1.95	10.36
27	"	19.67	21.28	1.61	8.45
28	"	19.83	21.30	1.47	7.83
29	"	20.03	21.59	1.56	8.04
30	"	20.39	21.94	1.55	7.84
Ave:					9.74
31	30 minutes	17.57	19.87	2.30	13.50
32	"	17.94	20.21	2.27	12.73
33	"	18.73	21.18	2.45	13.50
34	"	18.98	21.39	2.41	13.10
35	"	19.22	21.47	2.25	12.08
36	"	19.53	21.93	2.40	12.68
37	"	19.66	21.78	2.12	11.13
38	"	19.85	22.26	2.41	12.53
39	"	20.12	22.16	2.04	10.46
40	"	20.50	22.83	2.33	11.73
Ave:					12.34
41	1 hour	17.71	20.68	2.97	17.31
42	"	17.98	20.83	2.85	16.36
43	"	18.83	21.32	2.49	13.64
44	"	19.02	21.72	2.70	14.65
45	"	19.27	21.52	2.25	12.05
46	"	19.57	21.92	2.35	12.39
47	"	19.72	22.03	2.31	12.09
48	"	19.91	22.14	2.23	11.56
49	"	20.10	22.51	2.41	12.37
50	"	21.52	24.19	2.67	12.81
Ave:					13.52

TABLE NO. 4

Absorption data for (5'' x 1½'' x ½'') tangential ponderosa pine samples treated with water repellent (A).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	21.36	23.13	1.77	8.55
2	''	22.28	24.00	1.72	7.97
3	''	23.00	24.79	1.79	8.03
4	''	23.67	25.20	1.53	6.67
5	''	24.02	25.65	1.63	7.00
6	''	25.07	26.68	1.61	6.63
7	''	25.80	27.55	1.75	7.00
8	''	26.12	27.68	1.56	6.16
9	''	26.80	28.54	1.74	6.70
10	''	27.32	28.92	1.60	6.04
Ave:					7.07
11	1 minute	21.79	23.84	2.05	9.70
12	''	22.91	25.04	2.13	9.59
13	''	23.45	25.45	2.00	8.80
14	''	23.71	25.20	1.49	6.49
15	''	25.34	26.43	2.09	8.86
16	''	25.15	27.16	2.01	8.25
17	''	25.82	27.98	2.16	8.63
18	''	26.17	28.14	1.97	7.77
19	''	26.93	28.85	2.02	7.74
20	''	27.71	29.51	1.80	6.73
Ave:					8.26
21	3 minutes	21.84	24.12	2.28	10.78
22	''	22.97	25.09	2.12	9.52
23	''	23.44	25.53	2.09	9.20
24	''	23.79	26.10	2.31	10.02
25	''	24.40	26.72	2.32	9.81
26	''	25.25	27.69	2.44	9.97
27	''	25.98	28.13	2.15	8.54
28	''	26.27	28.55	2.28	8.96
29	''	27.00	29.23	2.23	8.52
30	''	27.85	30.10	2.25	8.34
Ave:					9.37
31	30 minutes	21.97	25.15	3.18	14.94
32	''	23.20	26.60	3.40	15.12
33	''	23.48	26.51	3.03	13.32
34	''	23.89	27.41	3.52	15.21
35	''	24.56	27.81	3.24	13.66
36	''	25.55	28.47	2.92	11.79
37	''	26.06	29.32	3.26	12.91
38	''	26.41	29.48	3.07	12.00
39	''	27.07	30.08	3.01	11.48
40	''	28.08	31.27	3.19	11.72
Ave:					13.22
41	1 hour	22.05	25.99	3.94	18.44
42	''	23.28	26.53	3.25	14.41
43	''	23.63	26.95	3.32	14.50
44	''	23.91	27.16	3.25	14.03
45	''	24.62	28.59	3.97	16.64
46	''	25.67	29.33	3.66	14.72
47	''	26.06	29.90	3.84	15.21
48	''	26.51	30.00	3.49	13.59
49	''	27.19	30.52	3.33	12.64
50	''	27.83	31.34	3.51	13.01
Ave:					14.76

TABLE NO. 5

Absorption data for (2" x 1½" x ½") tangential ponderosa pine samples treated with water repellent (B).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	8.55	10.09	1.55	18.71
2	"	8.85	10.17	1.32	15.38
3	"	8.94	9.80	0.86	9.71
4	"	9.00	10.16	1.16	13.30
5	"	9.05	10.07	1.02	11.63
6	"	9.10	10.15	1.05	11.90
7	"	9.19	10.30	1.11	12.47
8	"	9.45	10.52	1.07	11.68
9	"	9.78	10.84	1.06	11.18
10	"	10.09	11.63	1.54	15.75
Ave:					13.17
11	1 minute	8.70	9.81	1.11	13.17
12	"	8.89	10.28	1.39	16.14
13	"	8.96	10.01	1.05	12.10
14	"	9.01	9.98	0.97	11.11
15	"	9.06	10.28	1.22	13.89
16	"	9.10	10.23	1.13	12.81
17	"	9.18	10.26	1.08	12.13
18	"	9.49	10.52	1.03	11.20
19	"	9.89	10.90	1.01	10.54
20	"	8.72	10.74	2.02	23.91
Ave:					13.70
21	3 minutes	8.90	10.30	1.40	16.24
22	"	8.91	10.06	1.15	13.17
23	"	8.98	10.21	1.23	14.09
24	"	9.02	10.27	1.25	14.30
25	"	9.07	10.19	1.12	12.74
26	"	9.11	10.39	1.28	14.50
27	"	9.22	10.52	1.30	14.56
28	"	9.58	10.64	1.06	11.42
29	"	9.95	11.96	2.01	20.85
30	"	10.26	11.77	1.51	15.19
Ave:					14.70
31	30 minutes	8.85	10.25	1.40	16.32
32	"	8.94	10.28	1.34	15.47
33	"	8.92	10.23	1.31	15.16
34	"	8.99	10.33	1.34	15.38
35	"	9.04	10.42	1.38	15.75
36	"	9.08	10.41	1.33	15.11
37	"	9.13	10.68	1.55	17.06
38	"	9.21	10.72	1.51	16.93
39	"	9.67	10.98	1.31	13.98
40	"	9.97	11.24	1.27	13.15
Ave:					15.43
41	1 hour	8.63	10.25	1.62	19.38
42	"	8.78	10.66	1.88	22.09
43	"	8.93	10.91	1.98	22.89
44	"	9.00	11.08	2.08	23.82
45	"	9.04	10.76	1.72	19.63
46	"	9.08	10.67	1.59	18.07
47	"	9.17	10.73	1.56	17.55
48	"	9.36	11.12	1.76	19.40
49	"	9.66	11.13	1.47	15.70
50	"	9.99	11.90	1.91	19.73
Ave:					19.85

TABLE NO. 6

Absorption data for (3" x 1½" x ½") tangential ponderosa pine sample treated with water repellent (B).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	13.07	14.25	1.18	9.32
2	"	13.40	14.63	1.23	9.48
3	"	13.55	14.73	1.18	8.99
4	"	14.34	15.34	1.00	7.19
5	"	14.73	15.84	1.11	7.78
6	"	15.19	16.46	1.27	8.63
7	"	14.26	15.46	1.20	8.68
8	"	14.42	15.53	1.11	7.94
9	"	14.62	15.77	1.15	8.12
10	"	14.79	15.74	0.95	6.63
Ave:					8.28
11	1 minute	13.18	14.52	1.34	10.49
12	"	13.44	14.82	1.38	10.60
13	"	13.59	15.03	1.44	10.93
14	"	14.49	15.67	1.18	8.40
15	"	14.82	15.90	1.08	7.52
16	"	15.56	17.20	1.64	10.88
17	"	14.32	15.43	1.11	8.00
18	"	14.44	15.73	1.29	9.22
19	"	14.65	15.85	1.20	8.45
20	"	14.82	16.13	1.31	9.12
Ave:					9.36
21	3 minutes	13.27	14.92	1.65	12.83
22	"	13.47	15.02	1.55	11.88
23	"	13.67	15.32	1.65	12.45
24	"	14.50	15.79	1.20	8.54
25	"	14.49	16.15	1.18	8.13
26	"	15.77	17.43	1.66	10.86
27	"	14.34	15.81	1.47	10.58
28	"	14.52	15.86	1.34	9.52
29	"	14.70	16.32	1.62	11.38
30	"	14.87	16.29	1.42	9.85
Ave:					10.60
31	30 minutes	13.31	14.86	1.55	12.02
32	"	13.50	15.36	1.86	13.81
33	"	13.73	15.41	1.68	12.63
34	"	14.64	16.21	1.57	11.06
35	"	15.44	17.03	1.59	10.63
36	"	15.97	17.78	1.81	11.70
37	"	14.36	16.28	1.92	13.91
38	"	14.58	16.37	1.79	12.67
39	"	14.74	16.65	1.91	13.38
40	"	14.93	16.71	1.78	12.30
Ave:					12.41
41	1 hour	13.34	15.03	1.69	13.07
42	"	13.53	15.73	2.20	16.78
43	"	13.80	15.83	2.03	15.18
44	"	14.65	16.56	1.91	13.45
45	"	15.13	16.97	1.84	12.55
46	"	16.14	18.26	2.12	13.55
47	"	14.40	16.56	2.16	15.48
48	"	14.59	16.69	2.10	14.85
49	"	14.77	16.85	2.08	14.54
50	"	14.98	16.91	1.93	13.29
Ave:					14.27

TABLE NO. 7

Absorption data for (4" x 1½" x ½") tangential ponderosa pine samples treated with water repellent (B).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	17.27	18.91	1.64	9.80
2	"	17.35	19.47	1.62	9.36
3	"	18.09	19.77	1.68	9.58
4	"	18.84	20.52	1.68	9.20
5	"	19.06	20.49	1.43	7.74
6	"	19.34	20.80	1.46	7.79
7	"	19.61	21.02	1.41	7.42
8	"	19.76	21.01	1.25	6.53
9	"	20.00	21.34	1.34	6.91
10	"	20.26	21.96	1.70	8.66
Ave:					8.30
11	1 minute	17.35	19.26	1.91	11.36
12	"	17.87	19.75	1.88	10.85
13	"	18.29	20.30	2.01	11.34
14	"	19.07	20.73	1.66	8.98
15	"	19.14	21.05	1.91	10.30
16	"	19.43	20.90	1.47	7.81
17	"	19.63	21.21	1.58	8.31
18	"	19.74	21.32	1.58	8.26
19	"	20.03	21.52	1.49	7.68
20	"	20.37	22.25	1.88	9.57
Ave:					9.44
21	3 minutes	17.49	19.63	2.14	12.62
22	"	17.92	19.84	1.92	11.06
23	"	18.68	20.39	1.71	9.45
24	"	18.96	20.99	2.03	11.05
25	"	19.20	20.93	1.73	9.30
26	"	19.50	21.41	1.91	10.11
27	"	19.68	21.31	1.63	8.55
28	"	19.84	21.48	1.64	8.53
29	"	20.11	22.12	2.01	10.31
30	"	20.55	22.45	1.90	9.54
Ave:					10.05
31	30 minutes	17.61	19.85	2.24	13.13
32	"	17.98	20.45	2.47	14.18
33	"	18.79	21.02	2.23	12.25
34	"	18.97	21.70	2.73	14.85
35	"	19.27	21.40	2.13	11.41
36	"	19.55	21.73	2.18	11.51
37	"	19.67	22.12	2.45	12.85
38	"	19.89	22.22	2.33	12.09
39	"	20.14	22.16	2.02	10.35
40	"	20.54	22.71	1.63	8.19
Ave:					12.08
41	1 hour	17.74	20.35	2.61	15.18
42	"	18.01	20.69	2.68	15.36
43	"	18.83	21.35	2.52	13.81
44	"	19.02	21.64	2.62	14.22
45	"	19.29	21.68	2.39	12.79
46	"	19.59	21.84	2.25	11.85
47	"	19.75	21.99	2.24	11.70
48	"	19.94	22.11	2.17	11.23
49	"	20.18	22.35	2.17	11.10
50	"	20.65	23.11	2.46	12.29
Ave:					12.95

TABLE NO. 8

Absorption data for (5" x 1½" x ½") tangential ponderosa pine samples treated with water repellent (B).

Sample No.	Treatment time	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15 seconds	21.38	23.20	1.82	8.78
2	"	22.68	24.33	1.65	7.51
3	"	23.37	24.97	1.60	7.06
4	"	23.70	25.48	1.78	7.75
5	"	24.02	25.97	1.95	8.38
6	"	25.13	26.60	1.47	6.04
7	"	25.85	27.65	1.80	7.19
8	"	26.17	27.93	1.76	6.94
9	"	26.88	28.64	1.76	6.76
10	"	27.57	29.47	1.90	7.11
Ave:					7.35
11	1 minute	21.84	23.72	1.88	8.88
12	"	22.91	24.98	2.07	9.32
13	"	23.46	25.38	1.92	8.45
14	"	23.72	25.60	1.88	8.18
15	"	24.36	26.36	2.00	8.47
16	"	25.24	27.14	1.90	7.77
17	"	25.90	27.92	2.02	8.05
18	"	26.28	28.36	2.08	8.17
19	"	26.95	29.06	2.11	8.08
20	"	27.68	29.64	1.96	7.31
Ave:					8.27
21	3 minutes	21.93	24.16	2.23	10.49
22	"	22.99	25.39	2.40	10.77
23	"	23.47	25.68	2.21	9.71
24	"	23.81	25.99	2.18	9.45
25	"	24.56	27.11	2.55	10.71
26	"	25.47	27.63	2.16	8.75
27	"	25.98	28.43	2.45	9.73
28	"	26.31	28.50	2.19	8.59
29	"	27.03	29.24	2.21	8.44
30	"	28.14	20.44	2.30	8.43
Ave:					9.51
31	30 minutes	22.88	25.06	2.18	9.83
32	"	23.26	25.91	2.65	11.76
33	"	23.51	26.31	2.80	12.29
34	"	23.91	26.90	2.99	12.90
35	"	24.60	27.80	3.20	13.42
36	"	25.63	28.43	2.80	11.27
37	"	26.06	29.18	3.12	12.36
38	"	26.45	29.51	3.06	11.94
39	"	27.10	29.79	2.69	10.24
40	"	28.94	31.59	2.65	9.45
Ave:					11.55
41	1 hour	22.07	25.33	3.26	15.24
42	"	23.28	26.20	2.92	12.94
43	"	23.65	26.51	2.86	12.48
44	"	23.97	27.09	3.12	13.43
45	"	24.73	27.71	2.98	12.44
46	"	25.75	28.31	2.56	10.26
47	"	26.07	29.19	3.12	12.35
48	"	26.62	30.29	3.67	14.23
49	"	27.21	30.50	3.29	12.48
50	"	23.66	26.58	2.92	12.73
Ave:					12.86

TABLE NO. 9

Data showing the effect of specific gravity on the percent absorption for (3" x 1½" x ½") tangential ponderosa pine samples treated with water repellent (B).

Specific gravity range
0.3853 to 0.4128

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	14.00	15.83	1.83	13.48
2	14.07	16.01	1.94	14.23
3	14.08	16.27	2.19	16.06
4	14.13	15.95	1.82	13.29
5	14.14	16.25	2.11	15.40
6	14.16	16.40	2.24	16.33
7	14.21	16.15	1.94	14.09
8	14.29	16.49	2.20	15.88
9	14.31	16.07	1.76	12.69
10	14.39	16.19	1.80	12.91
11	14.42	16.57	2.15	15.39
12	14.46	16.51	2.05	14.63
13	14.52	16.66	2.14	15.21
14	14.52	16.55	2.03	14.43
15	14.54	16.30	1.76	12.49
16	14.54	16.39	1.85	13.13
17	14.55	16.72	2.17	15.39
18	14.56	16.36	1.80	12.76
19	14.59	16.70	2.11	14.92
20	14.60	16.85	2.25	15.90
21	14.60	16.69	2.09	14.77
22	14.65	16.70	2.05	14.44
23	14.65	16.61	1.96	13.80
24	14.69	16.67	1.98	13.91
25	14.70	16.61	1.91	13.41
26	14.75	16.67	2.20	15.40
27	14.76	16.61	1.84	12.87
28	14.78	16.95	2.25	15.71
29	14.79	16.60	2.18	15.21
30	14.80	17.03	2.12	14.78
31	14.80	16.97	2.23	15.55
32	14.81	16.76	1.95	13.59
33	14.82	16.90	2.08	14.48
34	14.84	17.03	2.19	15.23
35	14.92	17.00	2.08	14.38
36	14.95	16.77	1.82	12.56
37	14.97	16.94	1.97	13.59
38	14.98	17.01	2.03	13.98
39	14.98	16.94	1.96	13.50
40	14.99	16.91	1.92	13.22
Average:				14.32

TABLE NO. 10

Data showing the effect of specific gravity on the percent absorption of (3" x 1½" x ½") tangential ponderosa pine samples treated by dipping for 10 minutes in water repellent (B).

Specific gravity range 0.4128 to 0.4404

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	15.00	17.00	2.00	13.76
2	15.02	17.20	2.18	14.98
3	15.02	16.97	1.95	13.40
4	15.04	16.93	1.89	12.97
5	15.05	16.96	1.91	13.10
6	15.09	16.96	1.87	12.74
7	15.09	17.40	2.31	15.80
8	15.09	17.30	2.21	15.12
9	15.10	17.04	1.94	13.26
10	15.11	16.93	1.82	12.43
11	15.14	17.50	2.36	16.09
12	15.15	16.98	1.83	12.46
13	15.16	17.28	2.12	14.43
14	15.16	17.19	2.13	13.82
15	15.19	17.19	2.00	13.59
16	15.21	17.38	2.17	14.72
17	15.21	16.84	1.63	11.06
18	15.25	17.13	1.88	12.72
19	15.26	17.10	1.84	12.44
20	15.31	17.56	2.25	15.16
21	15.32	17.40	2.08	14.02
22	15.33	17.23	1.90	12.79
23	15.34	17.47	2.13	14.33
24	15.35	17.48	2.13	14.32
25	15.36	17.44	2.08	13.98
26	15.36	17.06	1.70	11.42
27	15.38	17.18	1.80	12.08
28	15.39	17.47	2.08	13.95
29	15.41	17.62	2.21	14.80
30	15.41	17.51	2.10	14.06
31	15.41	17.21	1.80	12.06
32	15.44	17.65	2.21	14.77
33	15.44	17.56	2.12	14.17
34	15.45	17.51	2.06	13.76
35	15.47	17.60	2.13	14.21

TABLE NO. 10 (cont.)

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
36	15.47	17.77	2.30	15.34
37	15.48	17.77	2.29	15.27
38	15.49	17.68	2.19	14.59
39	15.49	17.69	2.20	14.66
40	15.50	17.68	2.18	14.51
41	15.50	17.71	2.21	14.71
42	15.50	17.64	2.14	14.25
43	15.51	17.37	1.86	12.38
44	15.51	17.74	2.23	14.84
45	15.57	17.72	2.15	14.25
46	15.58	17.37	1.79	11.85
47	15.58	17.54	1.96	14.98
48	15.59	17.66	2.07	13.70
49	15.59	17.71	2.12	14.03
50	15.59	17.76	2.17	14.36
51	15.60	17.72	2.12	14.02
52	15.60	17.51	1.91	12.36
53	15.61	17.38	1.77	11.71
54	15.61	17.44	1.83	12.10
55	15.61	17.43	1.82	12.04
56	15.63	17.67	2.04	13.47
57	15.64	17.82	2.18	14.38
58	15.66	17.84	2.18	14.37
59	15.67	17.82	2.15	14.16
60	15.70	17.75	2.05	13.48
61	15.72	17.69	1.97	12.93
62	15.74	17.74	2.00	13.11
63	15.74	17.64	1.90	12.46
64	15.74	17.85	2.11	13.84
65	15.75	17.59	1.84	12.06
66	15.75	17.59	1.84	12.06
67	15.75	18.02	2.27	14.46
68	15.76	18.06	2.30	15.06
69	15.76	17.72	1.96	12.84
70	15.78	18.01	2.23	14.58
71	15.81	17.92	2.11	13.77
72	15.81	17.93	2.12	13.84
73	15.82	17.51	1.69	11.02
74	15.85	17.81	1.96	12.76
75	15.87	18.09	2.14	13.91
76	15.87	17.74	1.87	12.16
77	15.88	17.87	1.99	12.93

TABLE NO. 10 (cont.)

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
78	15.89	17.71	1.82	11.82
79	15.90	17.97	2.07	13.43
80	15.90	18.02	2.12	13.76
81	15.92	18.03	2.11	13.67
82	15.92	18.03	2.11	13.67
83	15.93	18.14	2.21	14.31
84	15.93	18.17	2.24	14.51
85	15.93	17.99	2.06	13.34
86	15.94	18.24	2.30	14.90
87	15.96	17.72	1.76	11.38
88	15.97	18.31	2.34	15.13
89	15.97	17.73	1.76	11.38
90	15.98	18.14	2.16	13.95
Average:				13.57

TABLE NO. 11

Data showing the effect of specific gravity on the percent absorption of (3" x 1½" x ½") tangential ponderosa pine samples treated by dipping for 10 minutes in water repellent (B).

Specific gravity range 0.4404 to 0.4679

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
1	16.00	17.99	1.99	12.84
2	16.00	18.13	2.13	13.74
3	16.01	17.98	1.97	12.70
4	16.03	18.18	2.15	13.84
5	16.03	18.21	2.18	14.04
6	16.06	18.15	2.09	13.43
7	16.06	18.24	2.18	14.01
8	16.07	18.12	2.05	13.17
9	16.08	17.77	1.69	10.85
10	16.08	18.00	1.92	12.32
11	16.09	18.13	2.04	13.08
12	16.11	17.86	1.75	11.21
13	16.12	18.29	2.17	13.89
14	16.13	17.85	1.72	11.00
15	16.15	17.97	1.82	11.63
16	16.18	17.84	1.66	10.59
17	16.21	18.02	1.81	11.52
18	16.22	17.92	1.70	10.81
19	16.23	18.02	1.79	11.38
20	16.24	18.32	2.08	13.21
21	16.24	18.37	2.13	13.53
22	16.25	18.05	1.80	11.43
23	16.26	18.67	2.41	15.30
24	16.26	18.22	1.96	12.44
25	16.29	18.24	1.95	15.49
26	16.30	18.43	2.13	13.49
27	16.30	18.73	2.43	15.39
28	16.30	18.49	2.19	13.87
29	16.30	18.51	2.21	14.00
30	16.31	18.31	2.00	12.66
31	16.31	18.31	2.00	12.66
32	16.32	18.52	2.20	13.92
33	16.33	18.10	1.77	11.19
34	16.33	18.52	2.19	13.84
35	16.33	18.63	2.30	14.54

TABLE NO. 11 (cont.)

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
36	16.33	18.33	2.00	12.64
37	16.35	18.52	2.17	13.70
38	16.36	18.46	2.10	13.25
39	16.36	18.62	2.26	14.26
40	16.36	18.53	2.17	13.69
41	16.36	18.49	2.13	13.44
42	16.37	18.41	2.04	12.86
43	16.38	18.36	1.98	12.48
44	16.38	18.61	2.23	14.05
45	16.39	18.41	2.02	12.72
46	16.40	18.56	2.16	13.59
47	16.40	18.73	2.33	14.66
48	16.40	17.77	1.37	8.62
49	16.40	18.69	2.29	14.41
50	16.41	18.80	2.39	15.03
51	16.41	18.45	2.04	12.83
52	16.41	18.64	2.23	14.02
53	16.42	18.53	2.11	13.26
54	16.42	18.73	2.31	14.52
55	16.42	18.42	2.00	12.57
56	16.43	18.50	2.07	13.00
57	16.43	18.69	2.26	14.20
58	16.43	18.79	2.36	14.82
59	16.45	18.67	2.12	13.30
60	16.46	18.64	2.18	13.67
61	16.46	18.75	2.29	14.36
62	16.46	18.54	2.08	13.04
63	16.46	18.03	1.57	9.84
64	16.48	18.55	2.07	12.96
65	16.51	18.50	1.99	12.44
66	16.53	18.66	2.13	13.30
67	16.54	18.66	2.12	13.23
68	16.59	18.76	2.17	13.50
69	16.61	18.53	1.92	11.93
70	16.61	18.02	1.41	8.76
71	16.61	18.45	1.84	11.44
72	16.61	18.62	2.01	12.49
73	16.65	18.84	2.19	13.58
74	16.67	19.17	2.50	15.48
75	16.68	18.78	2.10	13.00
76	16.68	18.83	2.15	13.30
77	16.69	18.87	2.28	14.10

TABLE NO. 11 (cont.)

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
78	16.72	19.08	2.36	14.67
79	16.74	19.52	2.78	17.14
80	16.74	18.83	2.09	12.88
81	16.74	18.99	2.25	13.87
82	16.78	18.95	2.17	13.34
83	16.82	19.09	2.27	13.93
84	16.86	19.15	2.29	14.01
85	16.87	19.05	2.18	13.33
86	16.87	19.14	2.27	13.88
87	16.88	19.23	2.35	14.36
88	16.88	18.72	1.84	11.25
89	16.89	18.98	2.09	12.77
90	16.89	19.20	2.31	14.11
91	16.90	18.94	1.74	10.62
92	16.91	19.33	2.42	14.77
93	16.95	19.37	2.42	14.74
94	16.97	19.18	2.21	13.44
Average:				13.17

TABLE NO. 12

Data showing the effect of specific gravity on the percent absorption of (3'' x $1\frac{1}{2}$'' x $\frac{1}{2}$'') tangential ponderosa pine samples treated by dipping for 10 minutes in water repellent (B).

Sample No.	Weight of sample before treatment	Weight of sample after treatment	Net absorption in grams	Percent absorption based on the bone dry weight
	Specific gravity range 0.4679 to 0.4954			
1	17.06	18.43	1.37	8.29
2	17.07	19.29	2.22	13.42
3	17.10	19.36	2.26	13.64
4	17.12	19.33	2.21	13.32
5	17.18	19.50	2.32	13.93
6	17.18	19.23	2.05	12.31
7	17.20	19.48	2.28	13.68
8	17.20	19.74	2.54	15.24
9	17.33	19.61	2.28	13.58
10	17.38	19.63	2.25	13.36
11	17.39	18.73	1.34	7.95
12	17.42	19.73	2.31	13.68
13	17.52	19.90	2.38	14.02
14	17.58	19.73	2.15	12.62
15	17.59	19.91	2.32	13.62
16	17.66	19.92	2.26	13.21
17	17.70	19.83	2.13	12.42
18	17.75	19.82	2.07	12.03
19	17.75	19.91	2.16	12.56
20	17.78	19.87	2.09	12.13
21	17.82	19.92	2.10	12.16
22	17.83	20.12	2.29	13.25
23	17.83	19.91	2.08	12.04
24	17.84	20.13	2.29	13.24
25	17.85	20.11	2.26	13.06
26	17.93	20.13	2.20	12.66
27	17.94	20.12	2.18	12.54
28	17.96	20.06	2.10	12.07
29	17.99	20.31	2.32	13.31
Average				12.73

TABLE NO. 13

Average Dimension Change of Untreated Tangential Ponderosa Pine Control Samples.

Immersion time in water hours : minutes	Average Dimensional Change in Thousands of an Inch			
	(2"x1½"x½")	(3"x1½"x½")	(4"x1½"x½")	(5"x1½"x½")
0 : 15	26	28	34	40
0 : 30	32	36	41	48
0 : 45	34	39	46	53
1 : 00	37	42	49	56
1 : 15	40	43	51	58
1 : 30	42	44	53	60
1 : 45	44	46	55	62
2 : 00	45	47	56	63
2 : 15	46	49	57	65
2 : 30	48	50	58	65
2 : 45	48	51	59	66
3 : 00	51	52	60	67
3 : 15	51	53	60	68
3 : 30	52	54	61	68
3 : 45	53	54	62	68
4 : 00	54	55	62	69
4 : 15	55	55	63	69
4 : 30	55	56	63	70
4 : 45	56	56	64	70
5 : 00	56	56	65	70
5 : 15	56	57	65	70
5 : 30	57	57	65	71
6 : 00	58	57	66	71

TABLE NO. 14

AVERAGE DIMENSIONAL CHANGE OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (A)

Sample Size: (2" x 1½" ½")						Sample Size: (3" x 1½" x ½")					
IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH					IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH				
	Immersion time in water repellent in minutes (A)						Immersion time in water repellent in minutes (A)				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	5	5	5	5	4	0 : 15	10	8	8	8	5
0 : 30	8	7	6	7	4	0 : 30	15	12	10	11	7
0 : 45	10	9	8	10	8	0 : 45	16	14	12	14	10
1 : 00	12	11	10	12	9	1 : 00	18	16	14	16	12
1 : 15	14	14	13	15	12	1 : 15	21	19	17	19	14
1 : 30	16	15	14	17	14	1 : 30	23	21	19	21	15
1 : 45	18	18	17	18	17	1 : 45	25	22	22	23	17
2 : 00	20	19	18	21	18	2 : 00	26	24	22	24	20
2 : 15	21	21	19	22	20	2 : 15	28	25	24	26	21
2 : 30	23	24	21	25	22	2 : 30	29	27	24	27	24
2 : 45	25	25	22	26	24	2 : 45	31	28	26	28	25
3 : 00	26	26	24	28	27	3 : 00	32	30	28	30	28
3 : 15	28	29	25	30	28	3 : 15	33	31	29	31	29
3 : 30	30	30	27	32	30	3 : 30	35	33	30	32	30
3 : 45	31	32	28	34	32	3 : 45	38	34	32	34	32
4 : 00	33	34	30	34	33	4 : 00	39	36	33	36	33
4 : 15	34	35	31	36	35	4 : 15	41	37	34	37	34
4 : 30	35	36	33	37	35	4 : 30	42	38	36	38	35
4 : 45	36	37	34	38	36	4 : 45	44	39	37	39	36
5 : 00	37	38	35	40	38	5 : 00	44	40	38	40	37
5 : 15	38	40	36	41	30	5 : 15	45	40	38	41	39
5 : 30	39	41	38	42	41	5 : 30	47	42	40	42	40
6 : 00	40	42	38	42	41	6 : 00	48	43	41	43	42

TABLE NO. 15

AVERAGE DIMENSIONAL CHANGE OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (A)

Sample Size: (4" x 1½" x ½")						Sample Size: (5" x 1½" x ½")					
IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH					IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH				
	Immersion time in water repellent in minutes (A)						Immersion time in water repellent in minutes (A)				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	4	3	5	4	5	0 : 15	3	3	3	3	4
0 : 30	6	5	7	7	7	0 : 30	6	5	4	6	6
0 : 45	8	7	9	10	10	0 : 45	7	7	6	8	9
1 : 00	10	9	10	13	11	1 : 00	9	9	7	10	10
1 : 15	12	11	12	16	14	1 : 15	11	11	9	12	13
1 : 30	14	12	13	17	16	1 : 30	13	12	11	14	15
1 : 45	15	14	14	20	18	1 : 45	14	14	13	17	16
2 : 00	17	15	16	21	20	2 : 00	16	16	15	19	18
2 : 15	18	17	18	23	22	2 : 15	17	18	17	21	21
2 : 30	19	18	19	25	24	2 : 30	18	19	19	24	22
2 : 45	20	19	20	26	25	2 : 45	19	21	21	26	24
3 : 00	22	21	21	28	26	3 : 00	21	23	22	28	26
3 : 15	22	21	22	29	28	3 : 15	22	25	24	30	28
3 : 30	24	22	23	31	29	3 : 30	23	25	25	32	29
3 : 45	25	23	24	32	30	3 : 45	24	26	26	34	32
4 : 00	25	24	25	33	31	4 : 00	26	28	28	36	33
4 : 15	27	25	26	34	32	4 : 15	27	29	29	37	34
4 : 30	27	26	27	35	33	4 : 30	28	30	30	38	36
4 : 45	28	27	27	36	34	4 : 45	30	31	32	39	37
5 : 00	29	27	28	37	35	5 : 00	30	32	32	41	39
5 : 15	30	28	29	38	36	5 : 15	31	33	33	42	40
5 : 30	31	29	30	39	37	5 : 30	32	34	33	43	41
6 : 00	31	30	30	40	38	6 : 00	33	36	34	44	42

TABLE NO. 16

AVERAGE DIMENSIONAL CHANGE OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (B)

Sample Size (2" x 1½" x ½")						Sample Size (3" x 1½" x ½")					
IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH					IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH				
	Immersion time in water repellent in minutes (B)						Immersion time in water repellent in minutes (B)				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	5	5	5	5	5	0 : 15	6	6	5	4	4
0 : 30	8	7	7	9	7	0 : 30	9	8	8	6	6
0 : 45	10	10	9	10	8	0 : 45	11	9	9	8	8
1 : 00	13	12	11	12	10	1 : 00	13	12	11	10	10
1 : 15	15	14	12	14	12	1 : 15	14	13	13	11	12
1 : 30	16	15	14	15	14	1 : 30	16	15	14	13	13
1 : 45	19	17	16	16	15	1 : 45	18	16	16	16	15
2 : 00	20	18	17	18	17	2 : 00	20	18	17	17	16
2 : 15	22	20	20	20	18	2 : 15	21	20	20	19	18
2 : 30	23	21	21	21	20	2 : 30	23	21	22	20	19
2 : 45	24	23	22	23	22	2 : 45	23	23	23	22	20
3 : 00	25	24	24	25	23	3 : 00	24	23	24	24	21
3 : 15	27	26	25	26	25	3 : 15	26	24	26	24	22
3 : 30	28	26	26	27	26	3 : 30	27	26	27	25	23
3 : 45	30	28	28	29	28	3 : 45	28	27	29	27	25
4 : 00	31	29	29	30	29	4 : 00	30	28	30	28	26
4 : 15	32	30	30	31	30	4 : 15	31	29	31	29	26
4 : 30	33	30	31	32	32	4 : 30	31	29	32	30	27
4 : 45	33	32	32	34	33	4 : 45	33	30	33	30	28
5 : 00	34	33	33	34	34	5 : 00	34	32	34	32	30
5 : 15	36	34	34	36	35	5 : 15	34	33	35	33	30
5 : 30	36	35	35	37	36	5 : 30	35	34	36	34	32
6 : 00	38	36	37	38	38	6 : 00	37	35	38	35	32

TABLE NO. 17

AVERAGE DIMENSIONAL CHANGE OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (B)

Sample Size: (4" x 1½" x ½")						Sample Size: (5" x 1½" x ½")					
IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH					IMMERSION TIME IN WATER	AVERAGE DIMENSIONAL CHANGE IN THOUSANDS OF AN INCH				
	Immersion time in water repellent in minutes (B)						Immersion time in water repellent in minutes (B)				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	3	2	3	2	3	0 : 15	2	4	3	4	4
0 : 30	4	4	5	4	5	0 : 30	3	6	5	5	6
0 : 45	6	5	6	5	6	0 : 45	5	8	6	7	8
1 : 00	8	7	8	6	8	1 : 00	7	10	8	8	9
1 : 15	10	8	9	8	9	1 : 15	8	11	9	10	10
1 : 30	11	9	10	8	10	1 : 30	9	13	10	12	12
1 : 45	13	11	12	10	11	1 : 45	11	15	11	13	13
2 : 00	14	12	12	11	13	2 : 00	12	16	12	15	15
2 : 15	16	13	14	12	14	2 : 15	13	17	14	16	16
2 : 30	17	15	15	13	14	2 : 30	14	19	15	18	17
2 : 45	18	16	16	14	16	2 : 45	16	20	16	18	18
3 : 00	19	17	17	15	17	3 : 00	17	21	17	20	19
3 : 15	20	18	18	16	18	3 : 15	18	23	18	21	20
3 : 30	21	19	19	17	19	3 : 30	19	24	19	22	20
3 : 45	22	20	20	17	19	3 : 45	20	25	20	23	22
4 : 00	23	21	21	18	20	4 : 00	21	26	21	24	22
4 : 15	24	22	21	19	21	4 : 15	22	27	22	25	24
4 : 30	25	22	22	20	23	4 : 30	22	28	23	26	25
4 : 45	26	24	24	21	23	4 : 45	24	30	24	27	26
5 : 00	27	24	24	21	24	5 : 00	25	30	25	28	26
5 : 15	29	25	25	22	24	5 : 15	25	31	26	28	28
5 : 30	29	26	26	23	25	5 : 30	26	32	27	29	28
6 : 00	29	26	26	24	26	6 : 00	27	33	27	30	29

TABLE NO. 18

AVERAGE WATER REPELLENT EFFICIENCY OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (A).

Sample Size: (2" x 1½" x ½")						Sample Size: (3" x 1½" x ½")					
IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (A) Immersion time in water repellent (A) in minutes					IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (A) Immersion time in water repellent (A) in minutes				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	80.8	80.8	80.8	80.8	84.6	0 : 15	64.3	71.4	71.4	71.4	82.1
0 : 30	75.0	78.1	81.2	78.1	87.5	0 : 30	58.3	66.7	72.2	69.5	80.6
0 : 45	70.6	73.5	76.5	70.6	76.5	0 : 45	59.0	60.5	69.2	60.5	74.4
1 : 00	67.6	70.3	73.0	67.6	75.7	1 : 00	57.2	61.9	66.7	61.9	71.4
1 : 15	65.0	65.0	67.5	62.5	70.0	1 : 15	51.2	55.8	60.5	55.8	67.5
1 : 30	62.0	64.3	66.7	59.5	66.7	1 : 30	47.7	52.3	56.8	52.3	65.9
1 : 45	59.1	59.1	61.4	59.1	61.4	1 : 45	45.7	52.2	52.2	50.0	63.1
2 : 00	55.6	57.8	60.0	53.3	60.0	2 : 00	44.7	48.9	53.2	48.9	57.5
2 : 15	54.4	54.4	58.7	52.2	56.5	2 : 15	42.9	49.0	51.0	46.9	57.2
2 : 30	52.1	50.0	56.2	47.9	54.2	2 : 30	42.0	46.0	52.0	46.0	52.0
2 : 45	48.0	48.0	54.2	45.8	50.0	2 : 45	39.3	45.1	49.0	45.1	51.0
3 : 00	49.1	49.1	53.0	45.1	47.1	3 : 00	38.5	42.3	56.2	42.3	46.2
3 : 15	45.1	43.1	51.0	41.2	45.1	3 : 15	37.7	41.6	45.3	41.6	45.3
3 : 00	42.4	42.4	48.1	38.5	42.4	3 : 30	35.2	38.9	45.0	40.8	45.0
3 : 45	41.5	39.7	47.2	35.8	39.7	3 : 45	29.6	37.0	40.8	37.0	40.8
4 : 00	38.9	37.0	45.0	37.0	38.9	4 : 00	29.1	35.5	40.0	35.5	40.0
4 : 15	38.2	36.4	43.6	34.6	36.4	4 : 15	25.5	32.7	38.2	32.7	38.2
4 : 30	36.4	34.6	40.0	32.7	36.4	4 : 30	25.0	32.2	35.7	32.2	37.5
4 : 45	35.8	33.9	39.3	32.1	35.8	4 : 45	21.4	30.4	33.9	30.4	35.7
5 : 00	33.9	32.2	37.5	28.6	32.2	5 : 00	21.4	28.6	32.2	28.6	33.9
5 : 15	32.2	28.6	35.7	26.8	30.4	5 : 15	21.1	29.8	33.3	28.1	31.6
5 : 30	31.6	28.1	33.3	26.3	28.1	5 : 30	17.6	26.3	29.8	26.3	29.8
6 : 00	31.0	27.6	34.5	27.6	29.3	6 : 00	15.8	24.6	28.1	24.6	26.3

TABLE NO. 19

AVERAGE WATER REPELLENT EFFICIENCY OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (A).

Sample Size: 4" x 1½" x ½"						Sample Size: (5" x 1½" x ½")					
IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (A) Immersion time in water repellent (A) in minutes					IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (A) Immersion time in water repellent (A) in minutes				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	88.2	91.2	85.3	88.2	85.3	0 : 15	92.5	92.5	92.5	92.5	90.0
0 : 30	85.4	88.8	82.9	82.9	82.9	0 : 30	87.5	89.6	91.7	87.5	87.5
0 : 45	82.6	84.8	80.4	78.3	78.3	0 : 45	86.8	86.8	88.7	84.9	83.0
1 : 00	79.6	81.6	79.6	73.5	77.6	1 : 00	83.9	83.9	87.5	82.2	82.2
1 : 15	76.4	78.4	76.4	68.7	72.4	1 : 15	81.0	81.0	84.5	79.3	77.6
1 : 30	75.6	77.4	75.5	68.0	69.9	1 : 30	78.3	80.0	81.7	76.7	75.0
1 : 45	72.8	74.6	74.6	63.6	67.3	1 : 45	76.4	76.4	79.0	72.6	74.2
2 : 00	69.6	73.2	71.4	62.5	64.3	2 : 00	74.6	74.6	76.2	69.9	71.4
2 : 15	68.4	70.2	68.4	59.6	61.4	2 : 15	73.8	72.3	73.8	67.7	67.7
2 : 30	67.2	69.0	67.2	56.9	58.6	2 : 30	72.3	70.8	70.8	63.1	66.2
2 : 45	66.1	67.8	66.1	55.9	57.7	2 : 45	71.2	68.2	68.2	60.6	63.6
3 : 00	63.3	65.0	65.0	53.4	56.7	3 : 00	68.7	65.7	67.2	58.2	61.2
3 : 15	63.3	65.0	63.3	51.7	53.4	3 : 15	67.6	63.3	64.7	55.9	58.8
3 : 30	60.7	63.9	62.3	49.2	52.5	3 : 30	66.2	63.3	63.3	53.0	57.4
3 : 45	59.7	62.9	61.3	48.4	51.7	3 : 45	64.7	61.8	61.8	50.0	53.0
4 : 00	59.7	61.3	59.7	46.8	50.0	4 : 00	62.3	59.4	59.4	47.8	52.2
4 : 15	57.2	60.3	58.7	46.0	49.2	4 : 15	60.9	58.0	58.0	46.4	50.7
4 : 30	57.2	58.7	57.2	44.5	47.6	4 : 30	60.0	57.2	57.2	45.7	48.6
4 : 45	56.2	57.9	57.9	43.7	46.9	4 : 45	57.2	55.7	54.3	42.3	47.2
5 : 00	55.4	48.5	56.9	43.1	46.2	5 : 00	57.2	54.3	54.3	41.5	42.3
5 : 15	53.8	56.9	55.4	41.6	44.6	5 : 15	55.7	52.9	52.9	40.0	42.9
5 : 30	52.3	56.9	53.8	40.0	43.1	5 : 30	55.0	52.1	53.5	39.4	42.3
6 : 00	53.0	54.6	54.6	39.4	42.4	6 : 00	53.5	49.3	52.1	38.0	40.9

TABLE NO. 20

AVERAGE WATER REPELLENT EFFICIENCY OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (B).

Sample Size: (2" x 1½" x ½")						Sample Size: (3" x 1½" x ½")					
IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (B) Immersion time in water repellent (B) in minutes					IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (B) Immersion time in water repellent (B) in minutes				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	80.8	80.8	80.8	80.8	80.8	0 : 15	78.6	78.6	82.1	85.7	85.7
0 : 30	75.0	78.1	78.1	75.0	78.1	0 : 30	75.0	77.8	77.8	83.4	83.4
0 : 45	70.6	70.6	73.5	70.6	76.5	0 : 45	71.8	77.0	77.0	79.5	79.5
1 : 00	64.9	67.6	70.3	67.6	73.5	1 : 00	69.1	71.4	73.8	76.2	76.2
1 : 15	62.5	65.0	70.0	65.0	70.0	1 : 15	67.5	69.8	69.8	74.2	72.1
1 : 30	62.0	64.3	66.7	64.3	66.7	1 : 30	63.7	65.9	68.2	70.4	70.4
1 : 45	56.8	61.4	63.6	63.6	65.9	1 : 45	60.9	65.2	65.2	65.2	67.4
2 : 00	55.6	60.0	62.2	60.0	62.2	2 : 00	57.4	61.7	63.8	63.8	65.9
2 : 15	52.2	56.5	56.5	56.5	60.9	2 : 15	57.2	59.2	59.2	61.2	63.3
2 : 30	52.1	56.2	56.2	56.2	58.3	2 : 30	54.0	58.0	56.0	60.0	62.0
2 : 45	50.0	47.9	54.2	47.9	54.2	2 : 45	54.2	54.2	54.2	56.8	60.2
3 : 00	51.0	53.0	53.0	51.0	54.9	3 : 00	53.8	55.7	53.8	53.8	59.7
3 : 15	47.1	49.0	51.0	49.0	51.0	3 : 15	52.0	54.7	52.0	54.7	59.5
3 : 30	46.2	50.0	50.0	48.1	50.0	3 : 30	50.0	51.8	50.0	53.7	57.4
3 : 45	43.4	47.2	47.2	45.3	47.2	3 : 45	48.2	50.0	46.3	50.0	53.7
4 : 00	42.6	46.3	46.3	45.0	46.3	4 : 00	45.4	49.1	45.4	49.1	52.7
4 : 15	41.8	45.5	45.5	43.6	45.5	4 : 15	43.6	47.3	43.6	47.3	52.7
4 : 30	40.0	45.5	43.7	41.8	41.8	4 : 30	44.7	48.2	42.9	46.5	51.2
4 : 45	41.1	42.9	42.9	39.3	41.1	4 : 45	41.1	46.5	41.1	46.5	50.0
5 : 00	39.3	41.1	41.1	39.3	39.3	5 : 00	39.3	42.8	39.3	42.8	46.5
5 : 15	35.7	39.9	39.3	35.7	37.5	5 : 15	40.4	42.2	38.6	42.2	47.4
5 : 30	36.8	38.6	38.6	35.1	36.8	5 : 30	39.3	40.4	36.8	40.4	43.9
6 : 00	34.5	37.9	36.2	34.5	34.5	6 : 00	35.2	39.3	33.4	39.3	43.9

TABLE NO. 21

AVERAGE WATER REPELLENT EFFICIENCY OF TANGENTIAL PONDEROSA PINE SAMPLES TREATED WITH WATER REPELLENT (B).

Sample Size: (4" x 1½" x ½")						Sample Size: (5" x 1½" x ½")					
IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (B) Immersion time in water repellent (B) in minutes					IMMERSION TIME IN WATER	PERCENT EFFICIENCY OF WATER REPELLENT (B) Immersion time in water repellent (B) in minutes				
Hours:minutes	1/4	1	3	30	60	Hours:minutes	1/4	1	3	30	60
0 : 15	91.2	94.1	91.2	94.1	91.2	0 : 15	95.0	90.0	92.5	90.0	90.0
0 : 30	90.2	90.2	88.8	90.2	88.8	0 : 30	93.8	87.5	89.6	89.6	87.5
0 : 45	87.0	89.2	87.0	89.2	87.0	0 : 45	90.6	84.9	88.7	86.8	84.9
1 : 00	83.7	85.7	83.7	87.8	83.7	1 : 00	87.5	82.2	86.2	86.2	83.9
1 : 15	80.4	83.3	82.4	83.3	82.4	1 : 15	86.7	81.0	84.5	83.3	83.3
1 : 30	79.2	83.0	81.1	84.9	81.1	1 : 30	85.5	78.3	83.9	80.0	80.0
1 : 45	76.4	80.0	78.2	81.2	80.0	1 : 45	82.5	76.2	82.5	79.0	79.0
2 : 00	75.0	78.6	78.6	80.4	76.8	2 : 00	81.0	74.6	81.0	76.2	76.2
2 : 15	71.1	77.2	75.4	79.0	75.4	2 : 15	80.0	73.8	78.5	75.4	75.4
2 : 30	70.7	74.1	74.1	77.6	75.9	2 : 30	78.5	70.8	76.9	72.3	73.8
2 : 45	69.5	72.9	72.9	76.3	72.9	2 : 45	75.8	69.7	75.8	72.3	72.3
3 : 00	68.4	71.7	71.7	75.0	71.7	3 : 00	74.6	68.7	74.6	70.2	71.7
3 : 15	66.3	70.0	70.0	73.3	70.0	3 : 15	73.5	66.2	73.5	69.1	70.6
3 : 30	67.9	68.9	68.9	72.1	68.9	3 : 30	72.1	64.7	72.1	67.6	70.6
3 : 45	62.1	66.1	66.1	72.6	67.8	3 : 45	70.6	63.2	70.6	66.2	67.6
4 : 00	63.0	66.2	66.2	71.0	67.7	4 : 00	69.6	62.3	69.6	65.2	68.1
4 : 15	61.9	65.1	66.7	69.9	66.7	4 : 15	68.1	60.9	68.1	63.8	65.2
4 : 30	60.3	65.1	65.1	68.3	63.5	4 : 30	68.6	60.0	67.2	62.9	64.3
4 : 45	59.4	62.5	62.5	67.2	64.1	4 : 45	65.7	57.2	65.7	61.4	62.9
5 : 00	58.5	63.1	63.1	67.7	63.1	5 : 00	64.3	57.2	64.3	60.0	62.9
5 : 15	55.4	61.5	61.5	66.2	63.1	5 : 15	64.3	55.8	62.9	60.0	60.0
5 : 30	55.4	60.0	60.0	64.7	61.5	5 : 30	63.4	54.9	62.0	59.2	60.6
6 : 00	56.1	60.6	60.6	63.6	60.6	6 : 00	62.0	53.5	62.0	57.8	59.2