The Treatment of Douglas-Fir Sawdust

With Water Repellants and Toxics

by

William Welch

A Thesis

Presented to the Faculty

of the

School of Forestry

Oregon State College

In Partial Fulfillment

of the Requirements for the Degree

Bachelor of Forestry

June 1942

Approved:

Professor of Forestry

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Mr. Glen Voorhies - Assistant Professor of Forestry
Oregon State College

Dr. Ernest Hubert - Laboratory Technician for the
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LIST OF TABLES

TEXT

To a large body of the mill operators in the Northwest, sawmilling is looked upon as a purely marginal business. That is, during periods of high prices and great demand for lumber a sawmill can make money; however, when prices and demand fall off, the fixed costs incident to the operation of a sawmill prevent it from operating at a profit. This fact is due largely to the inefficiency and waste prevalent in most small and many large sawmills of the west coast. Those firms which have made a conscious effort to reduce waste by more complete utilization of the by-products of lumber manufacture, and have increased efficiency by proper maintenance and the replacement of obsolete equipment have turned out to be permanent and profitable operations.

In this connection, Mr. Glen Voorhies' study of over forty sawmills of all sizes in Oregon shows the sawdust cut to be fully 11 percent of the volume of the logs cut. Also Mr. Allen H. Hodgson in a sawmill waste study in 1931 found that in the western sawmills which he studied, 13.39 percent of the volume of the logs cut was turned into sawdust. Sawdust, then, is a very important source of waste in Oregon sawmills.

The research which I have carried on is aimed at finding an economic use for part of the immense quantities of waste sawdust now being produced in the state. If such a use can be found many sawmills which under present conditions must shut down or operate at a loss during slack periods in the lumber market would be able to become permanent operations. The consequent benefits to labor, consumers, and producers of other commodities are, I believe, obvious.

The objective upon which the work was based was to make sawdust insensitive to changes in relative humidity thus preparing it for use as an insulating material for dwelling and other construction. Sawdust has been used in the past for insulating purposes of this kind but has been more or less unsatisfactory because here in the Northwest at least, it changed moisture content so readily with changes in the relative humidity. Consequently, after a period of high humidity, it was necessary to heat the water in the insulating material as well as the air in the house in order to bring the dwelling to a comfortable temperature. Such a condition defeats the purpose of insulation, and consequently untreated sawdust has not been widely used as an insulation material by those who understand its shortcomings.

Briefly, there are two objectives behind the research work: to find an economic use for part of the enormous amounts of waste sawdust produced in sawmills; and to develop a process that will render sawdust fairly insensitive to changes in relative humidity, thus rendering it satisfactory for use as an insulating material.

The total final importance of such an accomplishment as economically waterproffing sawdust is rather hard to forsee. It is very easy to become optomistic when one considers that a sawmill operator may be able to turn into cash 12 or 15 percent of his raw material that formerly was being wasted altogether or sold at a very low price for fuel; or when one thinks of the saving in fuel costs and the comfort that a low priced, efficient insulating material would offer to many home builders who cannot now afford insulation. Sawdust has several advantages in this field; it is in the top one-third, as far as insulating values go, of the various materials used for fill insulating purposes. And sources of raw materials for the processing are located, in the form of sawmills, in nearly every part of the United States. This fact alone gives it a merchandising advantage over products which have only a few sources of supply for their needed raw materials and must pay high freight rates in order to supply distant regions. Such materials as rock wool, lead slag, and sugar cane chips fall within this group.

Be this as it may, sawdust, on the other hand, is not the most efficient insulating material known, nor would it be without competition from local products in many parts of the country. Even in its own field such a product as I am trying to develop would have to meet with serious competition from other lumber mill by-products, such as, Fir-Tex, wood felt, and various other insulating and construction materials.

Taken on the whole though, processed sawdust has many and widely scattered sources of raw material; it is light in weight, thus increasing its insulating value and decreasing freight and handling costs; it has a higher insulating value than many of its competing products; and it should bear a very low price. All these factors would tend to give it an advantage over its competitors.

There is no doubt, however, that processed sawdust, even if widely accepted and used as an insulating material, would never be able to consume all the sawdust now going to waste in the country's sawmills. Its acceptance, however, would help quite a bit in the fight against waste in the lumber industry. As a trickle of water will eventually fill a large tank, so many comparatively small uses such as the one under consideration will eventually, if discovered, do away with all the sawdust waste in our country's mills. And when viewed in this light, each drop in the bucket is as important as the next.

The treatment of sawdust for the purposes and reasons for which this study is made seem to be rather a new idea. In a thorough search of several varied articles, books, and pamphlets on waste utilization and the processing of wood, I was unable to find any reference to work of this kind having been done in the past. A pamphlet entitled "Insulation" put out by the U. S. National Committee on Wood Utilization, while mentioning processing "fill" insulators to protect them against moisture, gave no details as to methods nor any references as to where such material might be found. The inference was, however, that mechanical means such as waterproof papers or metal sheetings between the fill-in material and the outer wall were the methods referred to. Material in this same pamphlet established that "fill" insulators lose much of their effectiveness when wet or damp, and therefore resistance to moisture is perhaps the primary requisite of this type of insulating material, a fact which helps to establish the importance of this study.

In view of the fact that precedent establishing investigations had never, to my knowledge at least, been carried on, I was somewhat at a loss as to how to begin. But with the help of Mr. Voorhies of the Wood Products department, I arrived at a plan of procedure.

I took a quantity of ordinary sawdust and heated it to a bone dryness at 212 degrees Farenheit in a small oven possessing an automatic temperature control. This process I felt, would insure a more complete penetration of the solutions into the wood. It is a commonly known fact that perfectly dry wood is much more receptive to the entrance of liquids than is wood with a relatively higher moisture content.

Then, in order to have similar samples with which to work, I measured out six samples of the bone-dry sawdust, each one of which weighed exactly twenty-five grams. One of these samples was left untreated to act as a control upon which to base the results of the experiment. The remaining five samples were each treated with one of the five substances described below.

1. Water Glass: a commercial product composed of an aqueous solution of sodium di-silicate. Its chemical formula is $NA_2SI_4O_9$. This substance was diluted with water in the ratio of one to four to make it more fluid and thus increase the ease with which it could be applied to the sawdust.

2. Wood-Fix: is a commercial water repellent composed largely of heat treated oils, the exact formula of which is not known. This product is manufactured by the Wood Treating Chemicals Company of St. Louis, Missouri. The only samples available of this product were already mixed with Stoddard Solvent in the ratio of one to seven. Feeling that the solvent would help to take the material into the wood, we used Wood-Fix in its diluted form.

3. Wood-Tox: is the trade name of a commercial toxic water repellent put out by the same firm that produces Wood-Fix. It has the same base of heat treated oils but contains in addition some poisonous substance such as arsenic. This substance has the advantage of protecting the material treated from insects, fungii, molds and stains. The Wood-Tox was muxed with Stoddard Solvent in the ratio of one to one and one-half.

4. Wood-Life: is a toxic water repellent produced by the Protection Products Manufacturing Company of Kalamazoo, Michigan. Though this material also possesses a heat treated oil base similar to that used in numbers two and three, I was interested in determining if there was any difference between the two products though the advertising of both firms claims about the same thing.

5. Wood-Youth: is a non-toxic water repellent manufactured by the producers of Wood-Life, and corresponds to Wood-Fix in the claims made for it. Numbers four and five were used full strength in the test to determine comparatively the effectiveness of the Stoddard Solvent which was used in numbers two and three.

The idea in using toxic water repellents was to determine what effect, if any, that the toxic material had on the water repelling qualities of the solutions. It is evident that if the toxic solution was as effective in keeping out the water as was the non-toxic solution and did not cost too much more, that it would certainly pay to use the material that would help protect insulating material from stain, molds, decays, and insects.

The samples were all treated as uniformly as possible. The sawdust was first put into a beaker and then was flooded with the solution for a period of three minutes; during this time it was agitated constantly to insure contact between the fluid and every grain of sawdust. A fine mesh cheese cloth was then stretched over the mouth of the beaker and the liquid allowed to drain off. The contents of the beaker were then weighed to determine the amount of the liquid absorbed by the sawdust. Results of this process are shown in Table I.

All the samples were then allowed to stand in a warm culture box for nearly three weeks; this was to allow the solvent to evaporate and for the samples to lose their excess moisture. While in this process, the samples were agitated frequently to insure complete contact of the sawdust particles with the air.

At the end of this period the samples were placed in individual flat glass containers which allowed a great deal of the sawdust surface to be exposed. These flats were then placed in a desicator containing flake Sodium Chloride, a dehydrating agent capable of producing relative humidities as low as 10 or 11 percent in closed containers. The samples were left in the desicator for one week to allow them to reach an equalized relatively low moisture content. With a relative humidity of perhaps eleven percent in the desicator, the wood should be at about three percent moisture content at the end of this period.

Again at the end of this stage twenty-five gram samples were weighed out of the original samples which now weighed more than at first due to the treatments they had received. These measurements were very carefully taken to one one-hundredth of a gram.

A desicator was then prepared containing Sodium Bromide, which is a powerful hydrating agent capable of producing a relative humidity as high as 60 percent in a closed container. In the absence of a controllable humidity chamber, it was felt that the desicator was a fairly reliable method of securing moderately high humidities. After a period of six days, during which the desicator had been kept in a warm room to increase its effectiveness and the samples were removed and immediately weighed. As indicated in Voorhies' table of moisture content of wood as affected by relative humidity, the moisture content of the control at this time should have been very close to 12 or 15 percent. The results of the weighing are indicated in Table II.

Following this test the samples were once again placed in the dehydrating desicator in an effort to more thoroughly set the substances precipitated by the liquid treatment. According to Mr. Voorhies, a seasoning process helps to increase the effectiveness of the treatment.

After seven days in the dehydrating desicator, the samples were again placed in the sealed jar containing the sodium bromide and left there at a temperature around 70° to 80° for two weeks. Again they were carefully weighed and the results tabulated.

Results:

The actual results of the tests are best shown by the tables of weighings included in this report; however, an interpretation of the figures may not be amiss.

In the first weighing, the untreated control after being dehydrated for two weeks, gained 1.81 grams of moisture when exposed to high humidities for one week. The other samples which had been treated, in all but three cases showed a slightly lower absorption of moisture than did the control. This was more or less in line with expectations. However, thinking that the seasoning had not been complete enough, I ran the second test explained in the procedure. This time results were a little more encouraging in all samples. Evidently my main error lay in using water glass, a water soluble substance, in solution number two. Apparently the effect achieved was that the chemical absorbed more moisture than did the wood itself, thus making it entirely unfit for this use. Another discrepancy in the difference between the third and fourth reading on sample six is evidently due to an error in procedure. Because of limited facilities, this test was run separately and some chance for error might have crept in.

Conclusions:

After considering the results of this experiment as applied to mass production of waterproof sawdust for insulating purposes, I have come to the following conclusions.

Since in no instance with the substances used and under the test conditions present was it possible to reduce the absorption of moisture more than $2\frac{1}{2}$ percent; and since this amount is not sufficient to appreciably increase the efficiency of sawdust as an insulator, I cannot recommend the employment of these substances for the use in question. Even if the insulating quality were improved slightly by this reduction in absorption, the initial cost of equipment and materials and the cost of labor and fuel would prevent the economical production of sawdust treated by this method.

TABLE I

The Absorption by Weight and Percent of the Agents Used in this Treatment.

Sample # Agent	Weight in Grams	Percent of Weight of Sawdust
2	43.66	174
3	29.00	116
4	32.00	128
5	32.55	130
6	45.13	180

TABLE II

The Changes in Moisture Content of Treated Samples by Weight and Percent Due to Changes in Relative Humidity. Weight in Grams.

Test #	Sample Numbers					
	1	2	3	4	5	6
1	25.00	25.00	25.00	25.00	25.00	25.00
2	26.81	27.63	26.74	26.57	26.56	26.59
3	24.88	25.07	25.14	25.26	24.84	24.88
4	26.54	27.22	26.14	26.47	26.34	26.63
Diff.						
1-2	1.81	2.63	1.74	1.57	1.56	1.59
3-4	1.66	2.15	1.00	1.21	1.50	1.75
% of 25	6.6	8.6	4.0	4.8	6.0	7.0