POSSIBILITIES OF WOOD PRESERVATION

IN THE BITUMINOUS MINES OF ILLINOIS.

Thesis for Degree of M. of For.

Edmund Carl Mandenberg

1921

THESIS

"Enormous quantities of valuable timbers are being placed in the coal and metal mines of this country without any preservative treatment against decay. That the life of these timbers might be greatly lengthened by the injection of certain chemicals has been proved by the U. S. Forest Products Laboratory in numerous service lists. In 1910 the laboratory installed in an Alabama mine untreated and timbers which had been treated with coal tar creosote. Ten years later all the untreated timbers had been removed because of decay, while 80 per cent of the creosoted timbers were still sound and none had decayed to a point where removal was necessary. This is only one of the many records obtained by the laboratory which should induce every mining company to install some sort of a wood treating plant."**

The purpose of the following study is an attempt to show briefly the possibilities and savings which are possible through the practice of wood preservation in the mines of lower Illinois.

The study is based on the personal investigation of the writer in 18 mines located in the vicinity of Marion, Illinois. The field work was carried on during the months of April and May of 1920. Naturally, many points in the Illinois field were not visited, but the Marion field was well covered and this field is representative of the coal producing areas of Illinois.

**Forest Products Technical Notes #110.

In the bulletins and papers so far published, the surface has only been scratched. There is not a panic in timber but the actual condition of our standing timber supply has become so alarming that it is time something is undertaken to awaken public interest in this important matter. It is a fact that we are destroying our forest supplies more rapidly than they are being reproduced.

In 1905, four hundred mines* in Illinois used 10,342,000 cubic feet of round timber and 7,025,000 board feet of sawed timbers. In that year eight mining states spent over $500,000 each for mine timbers, three of these spent over one million dollars each and Illinois ranked fourth with a total expenditure for mine timbers of $778,186.

The condition of the timbers going into the mines varies from green, fresh from the axe, to thoroughly seasoned timber which has been cut several years. Where the timbers going into the mines are sound, and are placed where water trickles over them, there is apparently no difference in the life of a seasoned timber or a green one; but in a dry or damp entry, the seasoned timber is preferable because of its greater strength and partly on account of less cost in handling and setting in place; and because it is not so quickly attacked by dry rot. The writer has seen green timber in place in

*Forest Service Circular No. 49, "Timber Used in Mines of United States in 1905", R. S. Kellogg.

damp situations attacked by fungus in two weeks time.

Various agencies destroy mine timbers and the following percentages show the relative importance as observed in the mines visited:

5% Wear

15% Breakage and Fire

20% Waste from all causes

60% Decay and Insect Attack

The position of the timber in the mine relative to air currents and the purity of the air itself, has a great deal to do with the period of service it gives.

Mines in this section are usually equipped with a "main haul" shaft and a "ventilating shaft". The air goes down the first named or "down-cast"; the fresh air enters the mine through this opening. The second is the "up-cast" and the foul air leaves the mine bottom through this shaft. Timbers in the "down-cast" and on the "mine bottom" adjacent, give a longer period of service than the timbers in the "up-cast" or those timbers in the workings on the "mine bottom" adjacent to the "up-cast" shaft. Warm moist air in a mine will rot timbers more quickly than dry and comparatively cool air.

The indirect advantages, due to the practice of preservation of mine timbers, are numerous and carry considerable weight. Local timbers, grown on properties or furnished by farmers in the immediate vicinity of the mine operations can be utilized with economy. Also, a very considerable saving in freight is possible because

usually the more durable timbers used are shipped greater distances. Timbers can be peeled in the woods at the time of cutting and considerable saving in freight effected because of the added weight of the bark which is approximately 10 per cent of the green weight. The peeling of timber at the mines has been unsatisfactory as a rule, and is generally not practiced because of the expense and because space in the timber storage areas is limited. However, if the timber is to be treated, it must be peeled thoroughly, and this can best be accomplished in the woods when the material is cut and where the labor cost is cheaper. It prevents the attacks of the insects which work directly under the bark and which, to some extent, naturally, weaken the timbers.

The practice of timber preservation also cuts down the delays in coal production and "shut downs" caused by the failure of timbers due to premature and preventable decay. In the main entries, which are heavily timbered, preservation makes possible great savings because the treated timbers retard decay and prevent excessive falling of the rocks from the roof of these entries. It also lessens the "cave ins" which result from collapse and weakening of decayed timbers. Outside appearances are deceiving. Timber may seem sound but when closer inspection is made they are found to be in an advanced stage of decay. Such "cave ins" frequently cause mines to cease operations for several days because of the great quantity of rock which comes down, haulage through these entires is stopped be-

cause all mine cars must be used to move fallen rock to the surface of the ground before the production of coal can start.

It further prevents derailments of coal trains caused usually when spikes lose hold in decayed ties. When such accidents occur, mine operations are suspended until the wreckage has been cleared away.

These factors are costly enough but occasionally lives are lost and preventable decay is the primary cause.

Most Illinois mines wish to use white oak wherever possible. The local supply is practically exhausted and the practice of wood preservation makes it possible to use the locally grown perishable timbers which, when creosoted, give better service than the more durable timbers formerly did. These had to be shipped to the mines from distant sources of supply. This is a material saving in excessive freight charges which have been advanced just recently upwards to 40%.

The use of creosoted timbers results, also, in a material saving in the annual cost of maintenance of the mine workings, a reduction in the amount of timber required yearly because of prolonged period of service and makes possible the utilization of inferior species of wood, which is so essential and further aids the big conservation movement which is of vital interest to the country at large and to all users of timber products, especially the mine operators.

A number of the mining companies of Illinois

have experimented and are convinced that timber preservation is practical and economical, but in order to practice wood preservation on a larger scale certain changes in the present methods in vogue are necessary. First, timber cannot be rushed directly from the woods to the mines; there must be time for seasoning it and for treating it. This necessitates the storing of a large supply of peeled timber at one or more points. Second, the timber should be peeled in the woods immediately upon being felled, and allowed to partially season while waiting on the cars for shipment to the mines. This saves the producers freight charges on the bark and a portion of the water present in green wood. Bark retards the seasoning of timbers. "In a peeling and seasoning test the total loss of green weight by peeling was 8.1 per cent and the total loss of green weight by seasoning was 35.1 per cent in a period of 112 days"*; and "the total loss of green weight by seasoning red oak for 50 days was 17 per cent in a tie 5" x 5" x 5'4"."** It also decreases the durability because it makes excellent breeding places available for wood destroying insects. The bark also flakes off the mine bottom timbers soon after they are set, causing an accumulation of rubbish in the workings which is readily

*Forest Service Circular #111, "Prolonging Life of Mine Timbers".

**Forest Service Bulletin #107, "The Preservation of Mine Timbers".

inflammable and which causes additional expenditures of money to remove it to the surface. Third, a careful and thorough inspection should be made of all timbers and those showing evidence of fungus growth should be discarded as it would be poor economy to apply preservative to these infected materials.

The following tabulations serve to give an idea of the species of timber used for various construction in mining operations:

Main Haul Ties

Quercus rubra

Quercus coccinea

Quercus velutina

Fagus americana

Hicorea ovata

Betula papyrifera

Ulmus americana

Fraxinus americana

Platinus occidentalis

Acer saccharum

Acer saccharinum

Entry Timbers

Quercus alba

Quercus rubra

Quercus celutina

Hicoria ovata

Laggings

Quercus alba

Pinus palustris

Pinus echinata

Pinus taeda

Tipples

Pinus palustris

Pseudotsuga taxifolia

All the above timbers are readily impregnated by the non-pressure process and are recommended for treatment. Room ties, props, caps, and car timbers are not included because of their short mechanical life or because these materials are seldom reclaimed in operations.

Mine timbers are bought on specification and the common sizes for various classes are as below:

Main haul ties. Hewed two or four sides, sizes 5" x 6" x 6'; 6" x 6" x 5.5'; and 6" x 8" x 5.5'.

Legs and crossbars. All timbers are round with top in inches one half of the length in feet. In sizes, 5" diameter, 10' long; 6" diameter, 12' long; 7" diameter, 14' long; 8" diameter, 16' long; and 9" diameter, 18' long.

Laggings, cribbings, buntings, and shaft casings. In dimension 3" x 12"; 4" x 12"; 5" x 12"; and 6" x 8".

Tipple timbers all dimension stock for braces, caps, legs, sheave timbers, etc.

The type of treating plant suggested is the non-pressure process, Open Tank system. This simple, inexpensive plant is easy to operate, and gives satisfactory

impregnation to all common mine timbers. The cost of treating timbers by the pressure process is greater than the cost of application by the non-pressure process. The saving secured by the open tank process is due to elimination of all expensive machinery necessary in pressure processes, permits of much lighter construction of treating tanks because no great strains are put on the sides of the tanks, smaller amount of labor is necessary to operate the plant and the cost of construction and maintenance of the open tank plant is much less than that of the pressure plant.

The theory of the Open Tank process is that the heat of the preservative expands the air and moisture in the cells of the wood and in the intercellular spaces and when the wood is submerged in the cold bath there is a contraction which takes place, creating a vacuum and the preservative is forced into the wood by atmospheric pressure.

An all around plant which will take care of all mine requirements is shown in the blue print. Special attention is necessary in locating the plant with reference to the storage yard, since the efficient handling of the timber before and after treatment cuts the operating costs materially.

An ideal simple plant for Illinois mines is one with tanks 36 inches wide, 40 inches deep and 21 feet long. This will handle from 36 to 60 ties per

charge, depending upon the size, 20 to 32 pieces of cribbing, depending upon the thickness and 6 to 50 legs or cross bars, varying in size and length. All material is handled in racks and the tanks will accommodate one to three racks in every charge.

The following is a list of the main items of equipment necessary:-

Two wood shell, metal lined tanks equipped with 1-1/2" pipe coils on the bottom, with rests for racks and overflows.

One drain board covered with metal

Nine to twleve 2" angle iron frames as racks

One chain block hoist or derrick

One 10,000 gallon storage tank

Six levers to submerge timbers

All timbers should be thoroughly seasoned before treatment and where framing of timbers is necessary attempts should be made to standardize sets so that the timbers can be framed above the ground.

All timbers should be seasoned to an air dry condition before treatment is attempted.

The main objects of seasoning are to increase the durability of the wood, to prevent excessive checking, to increase its strength and stiffness, to facillitate treating operations and to decrease its weight.

The rate of drying varies with the time of the year, size and form of piece, species and method of piling.

Records show that certain species of ties lost 10 pounds in twenty-four hours. Mine timbers should be seasoned in open piles. The top layer of ties in each pile should be placed close together and serve as a roof to shed rain water.

When treating, the timbers are piled in racks separated by thin strips of wood or iron to permit the oil to readily come in contact with all surfaces.

The time of treatment required in the two baths varies with the species of timber, the cross section dimension and whether it is round or square. Round timbers with one-half inch or more of sap require submersion of timbers in each bath of from thirty minutes to one hour. Square timbers are treated by rule of thumb and experience and require one hour treatment in each bath for each inch in thickness. The temperature of the hot bath should be maintained between 175°F. and 200°F., and the cold bath at less than 100°F. and not less than 50°F. In lieu of the hot and cold baths for timbers naturally resistant to penetration of creosote, a hot and cooling treatment will give good results, i.e., the timbers are treated in the hot bath and when the time has elapsed the steam is shut off and the timbers remain submerged until the oil cools to air temperature, minimum of 50°F.

A standard specification for non-pressure treatments follows:

1. Oil must be a pure distillate from coal-tar.

2. The specific gravity at 15°C. shall be at least 1.08.

3. Water must not exceed 1%.

4. The Flash Point shall not be lower than 100°C.

5. The matter insoluble in hot benzol shall not exceed 0.5%.

6. Upon distilling by the Standard American Ry. Engineering Ass'n Method, the oil on a dry basis must give

A. Not more than 1% up to 210°C.

B. Not more than 10% up to 235°C.

C. Not less than 25% nor more than 60% up to 300°C.

Liquid at 41°F.

A comparison of the following tables 1 and 2 will show the savings possible through the practice of wood preservation. The annual charges were computed from the following formula:

$$A = R \frac{1.op^n \quad .op}{1.op - 1}$$

in which A = Annual charge

R = Amount of initial investment

n = Number of years in recurring period

.op = Rate of interest taken at .06

Table 1 - Annual cost of untreated timbers in place.

1	2	3	4**	5	6
Ties					
1.	5"x6"x6'0"	$0.35	$0.50	4 yrs.	$0.246
2.	6"x6"x5.5'	0.40	0.50	4 "	0.260
3.	6"x8"x5.5'	0.50	0.50	6 "	0.204
Entry Timbers					
4.	5" 10'0"	0.85	0.50	5 yrs.	0.321
5.	6' 12'0"	1.20	1.20	5 "	0.570
6.	7' 14'0"	2.00	2.10	5 "	0.974
7.	8' 16'0"	2.50	3.20	5 "	1.355
8.	9' 18'0"	4.25	4.50	5 "	2.080
Shaft Timbers*					
9.	3" x 12" Oak	$150.00	$50.00	8 yrs.	32.30
10.	4" x 12" Pine	74.00	50.00	6 "	25.25
11.	5" x 12" Oak	150.00	50.00	5 "	47.50
12.	6" x 8" Oak	95.00	50.00	10 "	19.70
13.	3" x 12" Pine	72.00	50.00	5 "	29.00

* All figures based on M ft. B. M.
** Includes cost of hauling underground, framing and erection.

Note: The following legend applies to the above table.

1. Index
2. Dimensions of timbers
3. Cost per piece at mine, summer 1920.
4. Cost to place in mine
5. Reported average life
6. Annual cost in place

Table 2 - Annual cost of treated timbers in place.

1.	2.	3.	4.	5.	6.	7.	8.
1.	$ 0.85	0 .504	$ 0.254	8 yrs.	$ 0.178	$ 0.068	27.7
2.	0.90	0.503	0.251	10 "	0.156	0.104	40.0
3.	1.00	0.588	0.285	12 "	0.153	0.051	25.0
4.	1.45	0.34	0.594	10 "	0.276	0.043	13.4
5.	2.40	0.512	0.805	10 "	0.456	0.134	23.5
6.	4.10	0.619	0.997	10 "	0.692	0.282	29.0
7.	5.70	0.925	1.319	10 "	0.953	0.402	29.6
8.	8.75	1.18	1.622	10 "	1.405	0.675	32.4
9.	200.00	21.00	11.90	16 "	20.98	11.58	55.1
10.	124.00	17.00	10.80	12 "	16.10	9.15	36.5
11.	200.00	15.00	10.25	15 "	21.65	25.85	54.5
12.	145.00	16.00	10.90	20 "	13.60	6.10	31.0
13.	122.00	21.00	11.90	10 "	18.15	10.65	37.5

Note: The following legends apply to the above table:

1. Index
2. Cost in Place Untreated
3. Gallons of Preservative*
4. Cost of Treated Material**
5. Reported or Estimated Average Life
6. Annual Cost in Place
7. Saving per Piece
8. Saving--per cent.

* Based on using Carbosota Liquid Creosote Oil manufactured by The Barrett Company.

** Includes labor to handle--incidentals and depreciation. In case of round entry timbers it includes the cost to peel, season (two handlings) and interest on investment while seasoning.

A study of the tables 1 and 2 shows that while the cost of creosoting is quite an item it is only a small portion of the timber and placing cost.

The tables also show that the savings possible by creosoting timbers in the Open Tank process are great enough that it will pay mine operators to adopt the practice of wood preservation on all permanently located mine timbers.

The ordinary mine operation will require several carloads of main haul ties per year and when a saving of $0.05 per tie per year can be madea considerable yearly saving results.

The saving when main entry timbers are cresoted is approximately $0.33 per piece per year. Mines in Illinois have on the average two miles of heavily timbered main entry and these usually require about 3500 sets of timber, three pieces to a set. This item alone effects a considerable saving and should be of particular interest to mine operators.

The savings due to the practice of creosoting shaft timbers are higher than the other two classes because there is usually less mechanical wear on these timbers and there are no great numbers of squeezes and crushes which materially shorten the mechanical life of mine timbers. If decay can be prevented or retarded the period of service of shaft timbers can be at least doubled and in most cases trebled.

Experience has shown us that creosoted timbers will not only last longer than untreated timbers but the increase in the life will be such that the ultimate annual cost of maintaining the creosoted timbers will be much less than that of the natural untreated timbers.

The tables clearly show that appreciable amounts of money can be saved in a comparatively short time by the practice of wood preservation.

Wood preservation is economical, practical and available to every mine operator.

Appendix

Figure 1- Fungus fruiting bodies

" 2- Decay oh surface structures

" 3- Poor piling

" 4- Decay on coal tipple timbers

" 5- Dry rot fungus fruiting bodies

" 6- Storage yard of mine

" 7- Mine timber yard

" 8- Loading ties into racks for treatment

" 9- Lowering rack of ties into tank

" 10- Hot and cold treating tanks

" 11- Two creosoting tanks at Indiana mine

" 12- View of mine yard

Perspective of Open Tank Process Plant

Detail of Plant

Figure 1.- Fungus fruiting bodies on cross bar timbers in timber storage yard. (Courtesy The Barrett Company)

Figure 2.- Decay on surface mine structures above ground. (Courtesy The Barrett Company)

Figure 3.- Poorly piled leg and cross bar timbers of mixed hardwoods. Fungi growing on several timbers. Better inspection is necessary. (Courtesy The Barrett Company)

Figure 4.- Decay on coal tipple timbers at points of contact. (Courtesy The Barrett Company)

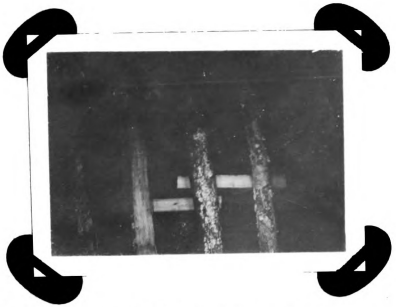


Figure 5.- Dry rot fungus fruiting bodies on cross bar timbers in main entry of mine 250 feet below ground. (Courtesy The Barrett Company)

Figure 6.- Some mines do carry a great amount of timber on hand. In order to practice wood preservation this is necessary and in addition all timbers should be peeled thoroughly. (Courtesy The Barrett Company)

Figure 7.- A mine timber yard. Shows supply carried on hand and also shows men loading a mine car with timbers to be used in timbering operations in the mine entries. (Courtesy The Barrett Company)

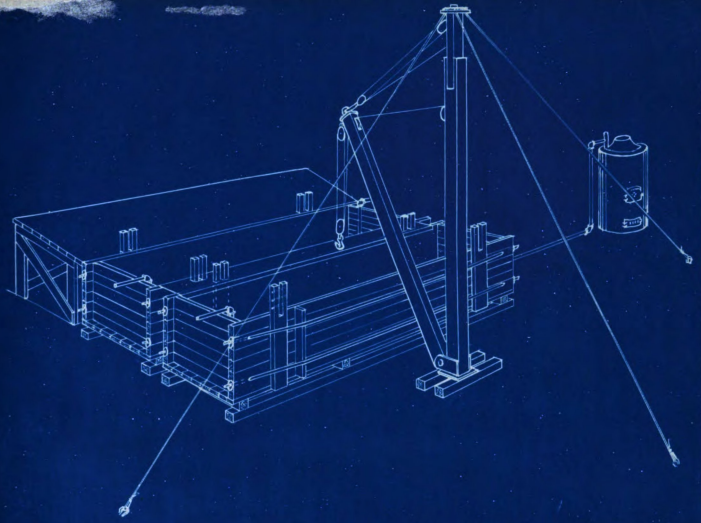
Figure 8.- Loading ties into racks prior to giving treatment. (Courtesy The Barrett Company)

Figure 9.- Lowering rack of ties into the tank containing hot creosote. (Courtesy The Barrett Company)

Figure 10.- Hot and cold treating tanks built of wood lined with metal. A good type for mines. (Courtesy The Barrett Company)

Figure 11.- Two creosoting tanks at an Indiana mine, West of Vandalia. Built of concrete and equipped with coils to give hot and cooling treatment. (Courtesy The Barrett Company)

Figure 12.- View of yard near mine showing treating tanks in the distance. (Courtesy The Barrett Company)



TANK

HOIST

BOILER

RACK

DRAIN-BOARD

COILS

STORAGE

For Details See Dwg A-2488
For Assembly this Dwg.

The Barrett Company
17 BATTERY PLACE, NEW YORK

CARBOSOTA OPEN TANK PROCESS
SEMI PORTABLE CREOSOTING PLANT

DESIGNED CM	DRAWN JS	TRACED JS	CHKD
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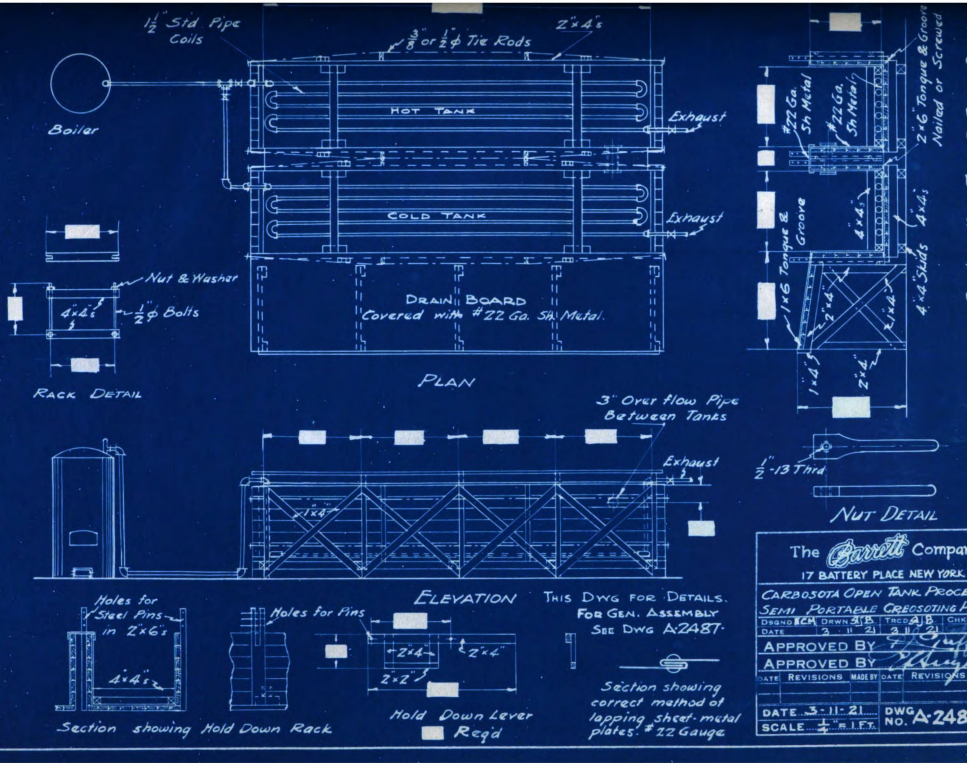

THIS DWG FOR DETAILS. FOR GEN. ASSEMBLY SEE DWG A-2487.

The Barrett Company
17 BATTERY PLACE NEW YORK.

CARBOSOTA OPEN TANK PROCESS
SEMI PORTABLE CREOSOTING PLANT

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DATE 3-11-21 DWG NO. A-2488
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