WOOD PRESERVATION¹

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INTRODUCTION

During the Second World War the natural resources of this earth were drained to an extent which has yet to be equalled in history. Throughout those seven years of combat, men and machines worked furiously to extract materials.

Today, Canadians are becoming conscious of the necessity for conserving natural resources. This new phase of thinking is exemplified by the large institutions which contribute to—or directly perform—scientific research whereby new and better methods of conservation might be investigated.

This research is a prerequisite to a dynamic forest industry. What with an influx of substitutes such as plastics, tile, concrete, and metal infringing on our forest industries, we must be prepared to execute two things: (a) produce a finished product which will serve the consumer to a greater extent and which can also be merchandised in an attractive fashion; or (b) prolong the normal life span of a forest product so that the consumer will receive more for his money in the light of competing commodities.

It is the second requirement with which I am interested, and this can be accomplished quite economically by the preservation of wood.

WOOD PRESERVATION

The preservation of wood is not new to our generation; it originated in Europe a few centuries ago. Amongst the requirements for an effective wood preservative are the following:

- (a) toxicity to wood-destroying fungi and insects
- (b) insolubility in water
- (c) low volatility
- (d) ease of application
- (e) depth of penetration
- (f) relative low cost
- (g) no chemical effect on the strength of the wood
- (h) availability

Also, for special purposes, it might be advantageous to have the following qualities:

- (i) clean
- (j) colorless
- (k) odorless
- (l) paintable
- (m) non-swelling
- (n) fire-resistant

Although there is no one preservative which will meet all these requirements, there are several available which have superior qualities

Wood preservatives can be classified as to:

- (A) Oil borne
- (B) Water borne

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Both types of wood preservatives can be further subdivided as to whether they are applied through a pressure method or a non-pressure method.

(A) Oil Borne Wood Preservatives

In 1836, Franz Moll first patented the use of coal-tar creosote but the method of treatment proved impractical, resulting in a very limited use. Two years later John Bethell was granted a patent for injecting creosote into wood under pressure. This departure from the non-pressure, steeping process—popular prior to 1838—met with outstanding success and has served as the basis for most of the present-day methods of wood preservation. (1)

In 1865 the first Bethell processing plant was established at Somerset, Massachusetts, for the treatment of railway timbers. Two years later Seeley patented a hot and cold bath treatment. This non-pressure oil-borne preservation method did not materialize into common usage until H. Von Schrenk revived it in 1904. From then on it has been used extensively for the treatment of poles and posts. My personal experience with this method has been that, unless the wood to be treated is extremely dry, the penetration of coal-tar creosote is negligible and the post will not last more than four or five years without having to be re-treated or replaced.

To counteract this deficiency, Boulton patented a boiling-under-vacuum method in 1881, thereby inaugurating a pressure process for green lumber. This method is known as the "full-cell" treatment. The cost of the Boulton process is relatively high although the retention of creosote is correspondingly high.

Realizing the expense of such a technique, Max Reuping, in 1902, patented his "empty-cell" process whereby the wood is impregnated with a large amount of creosote followed by a subsequent draining off of a quantity of oil. Several years later, in 1906, C. B. Lowry patented a second "empty-cell" process. At times, the attributes of both methods are combined into one and known as the "Lowry-Reuping" process.

The further demand for economy has led to the use of a 50% coal-tar creosote and 50% petroleum mixture, especially in the treatment of railway ties. Other mixtures include carbolineum, coal tar, and water-gas tar in any ratio of one to another. Wood-tar creosote is also used to a limited degree in Canada.

During either the "full-cell" or "empty-cell" process, an over-abundance of creosote is usually administered to the wood. Therefore, it is the custom to allow the wood to remain in the treating cylinder under vacuum until such time as the required quantity of creosote per cubic foot of wood is obtained.

Coal-tar creosote is a derivative of soft coal. Here in the Maritimes the steel company uses the coal in the production of coke and this coke is used to feed the blast furnaces and open hearths. One of the by-products of this reduction is tar. The tar is then cracked into water, intermediate oils, roofing pitch, electrode pitch, and tar coke. The intermediate oils are then further distilled into water, benzophenols, tar acids, naphthalene, and creosote.

There are 162 known compounds comprising coal-tar creosote, and they range in boiling points of 175° C (Coumarone (C₉H₆O)) to 450° C (Triphenylene (C₁₈ H₁₂)). (2)

Investigators have developed substantial evidence to show that each component in creosote has proved either injurious or fatal to one species of wood-destroying fungi or another. Also, that these compounds, when mixed together, form a more effective preservative than when used singly.

OIL TYPE SEALER PRESERVATIVES

Of more recent discovery are pentachlorophenol and copper naphthenate. These oil-type sealer preservatives are recommended for kiln dried wood or wood which has been well-seasoned naturally. These preservatives found a large application during the Second World War for such varied uses as on life rafts, wooden ammunition boxes, and packing crates.

The dipping of sashes and frames into sealer preservatives is progressing in popularity in the woodworking industry. At the request of certain Maritime sash interests, a pigmented sash dip has been introduced to the Canadian market. The sashes and frames can now be finished with a white or gray coating thereby enhancing the merchantability of the consumer product. If the practice of sash dipping is not followed with more enthusiasm, I regret to state that this phase of the forest products industry will have to cede to a competing metallic sash and frame product.

The above-mentioned sealer preservatives, together with zinc naphthenate, are valuable ingredients designed expressly for the preservation of seasoned wood, boats, nets, and fabrics.

(B) Water Borne Wood Preservatives

Water borne wood preservatives have been used in Europe since a much earlier date than in North America. In 1705, Homberg used mercuric chloride as a protection against decay. In 1767, DeBoisseau and Bordenave both recommended copper sulphate. But it was Kyan, in 1832, who obtained a patent for the treatment of wood with mercuric chloride while Margary followed in 1837 with a patent for copper sulphate. Both these patents call for an immersion in the respective solution. Later, in 1839, Boucherie patented the unique method of treating the living tree with certain chemicals. Similar adaptations are still in use with more research being executed every year.

Sir William Burnett is credited with the use of zinc chloride for wood preservation. He patented the use of that salt in 1838. His method adopted open tanks resulting in a limited penetration. Later, in 1847, a new method was devised by Burnett employing the use of pressure. This technique is in use to this day. One disadvantage of the Burnett patent is that the water-soluble salt leaches out quite readily when subjected to exposed, humid conditions. From 1922-1927 a Burnett treatment with a mixture of zinc chloride and creosote hit a peak in popularity but it has not been in use since 1934.

Through extensive research the average life for zinc chloride treated lumber was greatly increased by the development of chromated zinc chloride in 1937.

Another salt, sodium fluoride, was found favorable for wood preservation around 1850 but it—like zinc chloride—is soluble in water if used alone. After many years of experimentation, a mixture of sodium fluoride and dinitrophenol proved quite successful.

Apart from being highly toxic (approximately forty times as toxic as coal-tar creosote), dinitrophenol is extremely stable in water.

To the fluoride-phenol combination described, valuable additions were made around 1920 by the introduction of fluoride-potassium bichromate-phenol and fluoride-potassium bichromate-phenol-disodium hydrogen arsenate mixtures. These new preservatives have properties much superior to the older products in that they are extremely insoluble in water and after penetration into the wood, they become permanently affixed to the wood fibres thereby preventing leaching. (3)

TABLE I
WOOD PRESERVATIVE RATING

Preservative	Solubility	Toxicity
Common Salt	35.7	1
Copper Sulphate	31.6	5
Zinc Chloride	209.0	20
Wood Tar	0	20
Borax	2.8	20
Coal-Tar Creosote	0	50
Sodium Fluoride	4.4	100
Dinitrophenol	0.07	2000

OSMOTIC PRESSURE TREATMENT

The techniques of introducing these various preservatives into the wood without the use of applied pressure has been the subject of research for the past number of years. About twenty-five years ago a revolutionary method of penetration was discovered. It is known as the "Osmotic Pressure Treatment". As its name implies, it is based upon the natural Law of Osmotic Pressure. This osmotic pressure causes the passing of a solution of high concentration into the solution of lower concentration when the two are separated by a semi-permeable membrane. This osmotic pressure—a physical law as well established as the Law of Gravity—drives the preservatives into the wood. It is this identical pressure which is responsible for the penetration of the toxic chemicals to a depth equal to the existing moisture. In green pine and spruce poles, this means a depth of penetration of $1\frac{3}{4}$ inches to 2 inches.

The discovery of osmotic pressure is credited to Van't Hoff. He developed the theory—around 1880—that soluble substances obey the gas laws. Hence, osmotic pressure is defined by Hoff as the hydrostatic pressure which brings two solutions of different concentration into equilibrium when separated by a semi-permeable membrane. The existence of osmotic pressure is revealed to us through many natural appearances. Osmotic pressure in wood cells, actually measured, has registered over three hundred and twenty-five pounds per square inch. This is higher than that of the average steam boiler. Under ordinary circumstances, it is sufficiently powerful to enable plants and trees to split rocks and cement and to lift houses. It is this same power-packed action which forces the wood preservatives into the wood cells.

The wood preservatives are supplied in powder form. This powder has to

be mixed with water thereby forming a viscous paste of predetermined density. Most treatments with this method are performed right on the job. Thus, the expenses of shipping the wood to a centralized treating plant as well as the cost of the return freight are eliminated.

The concentrated paste is then applied to the surfaces of green wood which is clear of inner and outer bark. Then the coated wood is stacked in a very close pile and covered with waterproof paper or plastic covering material. This covering is to prevent the rain washing off the paste and to retain the moisture in the pile until the preservatives have penetrated beneath the surface of the wood. This usually takes from two to three weeks.

When this paste is applied, the Law of Osmotic Pressure immediately begins to function. Soon the toxic salts are carried through the wood cells as far in as there is moisture. In green wood this can be two inches or more. The sodium fluoride penetrates the farthest while the insoluble dinitrophenol affixes to the wood fibres in the outer areas of the wood. The potassium bichromate combines with a portion of the sodium fluoride to form a non-leachable chromation layer which also affixes to the wood fibres.

In this manner two insoluble, toxic compounds are formed around the outer reaches of the treated wood. In doing so they afford a water-repelling coating on the outside of the wood while the sodium fluoride remains in the inner extremity of the preserved portion to insure adequate toxicity from the inside. As most of these chemicals are colorless, the depth of penetration must be calculated with the aid of chemical coloring reagents.

The osmotic pressure technique combines a superior capacity to destroy fungi and insects while retaining complete neutrality to metals. Included in these wood preservatives are such chemicals as sodium fluoride, dinitrophenol, potassium bichromate, and disodium hydrogen arsenate.

TABLE II
COMPARISON OF METHODS OF WOOD PRESERVATION

	Water Borne	Oil Borne
Toxic.....	X	X
Insoluble.....	X	X
Non-volatile.....	X	X
Ease of application.....	X	
Depth of penetration for all species.....	X	
Low cost.....	X	
No effect on strength of wood treated.....	X	X
Availability.....	X	
Clean.....	X	
Colorless.....	X	
Odorless.....	X	
Paintable.....	X	
Non-swelling.....	X	X
Fire-resistant.....	X	X
Moisture repelling.....	X	X

William Chapman in his *Treatise on the Preservation of Timber* published in London, England, in 1817, states:

"Almost every chemical principle or compound of any plausibility has been suggested in the course of the last five years, and submitted either to the Admiralty or Navy Boards; but the multiplicity and contradiction of opinions formed nearly an inextricable labyrinth."

In the 140-odd years since Chapman's treatise, I have no reason to believe that times have changed. Contradictions and differences of opinion will be with us always, but practical field results go a long way toward dispelling any reticence anyone might feel toward the osmotic pressure technique.

Millions of board feet of all Canadian species of wood have been treated by this process from Newfoundland to British Columbia. Many important fields of use have proven that wood preservation offers a profitable return on a small investment.

A practical example can be given to demonstrate the value to our Canadian lumber and timber resources of the process I have the pleasure to represent in my home field—the Maritime Provinces.

In looking over our record since 1936, my company has preserved more than 650,000,000 board feet of lumber and in addition, millions of poles and fence posts.

If it is calculated that the life of the wood is increased from 3 to 5 times from the application of wood preservatives, it may be estimated that more than 2,000,000,000 board feet have been saved or a total of 66,000,000 trees of average pulpwood size which would require approximately 650 square miles of forest area and 30 to 40 years to grow.

Gentlemen, I think you will agree with me that this is a substantial contribution toward conservation.

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