# WOOD PRESERVATION - HOW THE EUROPEANS MEET THE CHALLENGE?

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## Summary

Health and safety aspects, environmental pollution and the disposal of treated wood after use are of increasing importance for chemical wood preservation. In various European countries, mainly in Scandinavia, The Netherlands, Germany and Switzerland, numerous restrictions up to a total ban of certain chemicals involve serious problems for the future of wood preservation. This concerns mainly the classical types of wood preservatives like CCA and other chromium containing salts, PCP and other chlorinated hydrocarbons and even creosote. Intensive research work has been started in the respective countries to meet these challenge and a special COST project shall co-ordinate the research work within EC and associated countries. European standardization tries to give the basis for harmonizing wood protection, and a second symposium on health and safety aspects 1993 in Cannes gives a good platform for discussion.

To meet the multiple problems associated with wood preservation, it will be most important to concentrate and to co-ordinate research work and all actions to promote wood protection in its broadest sense and to learn more about the service impact. This concerns the use of traditional chemicals including improvement of existing technologies, the promotion of new preservatives as well as the development of new principles of wood preservation, such as chemical modification of the wood substance itself. But it concerns also the broader use of traditional methods of wood protection without the application of chemicals as well as the promotion of biocontrol.

## 1. Introduction

For more than 150 years for many fields of timber application industrial wood preservation was more or less self understanding. In recent times, however, in an increasing amount of countries, legislative restrictions involve serious problems for the use of chemical wood preservatives. At present an EC-directive is under discussion to regulate the use of all kinds of biocides within the European Community. Due to health and safety aspects an increasing fear appears in the population, and as a consequence certain people do not accept chemical wood preservatives at all. The term of so-called "environmental friendly" wood protection measurements as well as of "environmental friendly" wood preservatives is more and more in use.

In this paper, after an overall view on the challenge of wood preservation, a brief characteristic is given on the actual situation in Europe. Ways shall be outlined, how to meet this challenge, some of them being so far only a wish but they are under discussion by responsible persons.

## 2. Wood preservation - a challenge

### 2.0 General

Wood preservation in its proper sense is against the basic principle of nature to decompose all organic materials. The challenge is the necessity to interrupt the decomposition only for the service time of wood and wood-based materials, whereas after use decomposition would be an ideal mean of recycling. The two principles of long-term use of wood and its decomposition after use are contradictory.

A further serious problem is the broad effect of biocides. Their efficacy is not restricted to wood destroying organisms but they will also affect many non-target organisms including human beings. Thus the application of chemical wood preservatives always involves a potential danger for the environment in its broadest sense.

### 2.1 Wood preservation or wood protection

The English language has the chance to differentiate between wood preservation, which predominantly means application of chemicals, and wood protection as an overall term for any kind of measurement to avoid deterioration or discoloration of wood.

Over centuries wood protection without using chemicals mainly by a proper design and construction, was the major principle to achieve long service life. Since the middle of the last century, however, chemical wood preservatives gained increasing importance and other ways of wood protection were often forgotten.

In recent times the picture has completely changed and various environmentally engaged persons try to protect all kinds of wood without using any chemicals. Of course, this view is unrealistic. Modern wood preservation has to include both, chemical wood preservation **and** wood protection without chemicals in such a way that they will complement each other to the highest extend possible. It is one of the challenges we have to meet: to reach the goal of a comprehensive wood protection. As a matter of fact the consequence cannot be doing wood preservation by using chemicals **or** wood protection without chemicals, but to take benefit of both simultaneously.

The principle of an over-all concept of wood protection including wood preservation becomes obvious in a guideline published in Switzerland already in 1987 (Anonym 1987)

### 2.2 Health and safety aspects

Health and safety aspects of wood preservation have been considered since long. However, in the last decade they got outstanding importance. There is no need to present details on this challenge. A survey on the principles is given by Coggins (1990).

In Europe, in February 1990, a symposium took place in Cannes/France on "The Challenge - Safety and Environment" where 28 papers were presented, 5 of which came from Canada ("Cannes" 1990). For 8-9 February 1993 a second respective Symposium is organized in Cannes.

## 2.3 Ban of chemical wood preservatives

As a consequence of health and safety problems many highly effective biocides have been banned. This involves the need to promote new types for replacing the banned ones. However, as biocides have to act against living organisms, they always may apply some undesired side effects and sooner or later also new developments will be discussed for being banned. A good example for this continuous replacement is the insecticide DDT being replaced by Lindane, this being replaced by the pyrethroids, which are now under discussion for possible harmful impact on nerves. The period during which biocides may be used becomes shorter and shorter. At the same the requirements of health and safety authorities on wood preservatives increase rapidly, and it becomes more and more difficult to get the agreement for a new biocide.

## 2.4 Disposal

The disposal of treated wood will be a most important challenge for the further use of any kind of treated wood. In Europe partly a tendency starts to buy treated wood only if the guarantee is given to take it back after use. Furthermore, various customers demand from the treating plant to take the timber out of use if it shall be replaced by a newly treated one.

However, so far no generally accepted concept exists, how to handle the wood containing dangerous chemicals, such as chlorinated hydrocarbons, arsenate or mercury compounds. Even for less harmful wood preservatives, such as boron, disposal may be a problem in some European countries, e.g. Germany.

## 2.5 Need of chemical wood preservation?

A further challenge to be mentioned is the question on the need of chemical wood preservation as such. Alternative materials other than wood may be used which are not subject to rapid deterioration by organisms, if a short service life is not acceptable.

There is no need to mention for the members of the CWPA the many-fold advantages of timber utilization and the benefits of chemical wood preservation. However, all persons, who are not aware of these advantages and benefits have to be convinced of them (see also 6.3).

# 3. Actual situation in Europe

The situation in Europe is very complex and fluent and no real actual state can be given. However, things constantly develop towards increasing restrictions for the use of chemicals and of treated wood as well as towards increasing difficulties for the disposal of treated wood after its use. Legislation and administration so far are not harmonized, and almost every country has its own regulations. The problems in Germany in 1988 were summarized by the author (Willeitner 1988), but the situation is now even worse.

At present, only a few countries like Belgium, have no specific restrictions for certain wood preservatives.

Restrictions regarding chromium and arsenic are mainly under discussion in Scandinavia and Germany.

Creosote is under discussion to minimize its content of Benzo(a)pyrene. Some countries, like Finland, intend to forbid creosote-oil and tar-oil containing preservatives in the near future. Other countries, like Germany or Sweden, have restrictions for the application of creosoted timber.

Organic hydrocarbons are restricted in most of the European countries, some of them having a total ban for certain compounds. But also TBTO and even boron are under discussion for a re-evaluation regarding their further use.

In general there is a tendency, mainly in Scandinavia, to re-evaluate all of the traditional wood preservatives, mainly in Scandinavia. This re-evaluation does necessarily not imply restrictions, however, it demonstrates the sensitivity of authorities regarding chemical wood preservatives.

On the basis of the European Community so-called directives are established, which have to be transferred into national law by every member country. Concerning wood preservatives, so far only for PCP an EC directive exists restricting its use. The regulation in Germany goes further, and deviating from this EC directive the use of PCP including sodium-PCP and the trade with PCP-treated wood is forbidden in total. For creosote an EC directive is in preparation. Again in Germany a regulation for creosote is already existing, which restricts the amount of benzo(a)pyrene and which forbids the use of creosoted wood for private purposes.

Most important will be a European directive on non-agricultural pesticides (NAP), which is under preparation. It concerns all kinds of biocides to be applied outside agriculture including wood preservatives. This directive will give general guidelines on the administrative handling of biocides and will involve restrictions for certain chemicals.

## 4. Elaboration of data to meet the challenge

### 4.0 General

Despite of the long tradition of international research work in the field of wood deterioration and wood preservation, many data are missing which are needed for improving the various methods of wood protection. To proof this statement, only a few examples may be outlined in this paper. Most of these examples have been discussed end of 1992 as basis for co-ordination of research programs within the European Community within the so called "COST" program.

### 4.1 Degradation mechanism

Improved knowledge on degradation mechanisms will provide means to block the activity of wood attacking organisms. Modern laboratory techniques, e.g. in electron-microscopy or in biochemistry, provide instruments for new fields of research. In recent times plenty of profound papers have been published and discussed mainly at the annual meetings of the International Research Group on Wood Preservation. From Europe as an example two Senior Scientists may be mentioned: Thomas Nilsson from Sweden and Kurt Messner from Austria. Despite their impressing results, the lack of knowledge is still significant, and intensive further research work is needed.

## 4.2 Service life of untreated wood

It may be surprising, that there is also a lack of knowledge on the service life of untreated wood, as experience exists on the use of timber for centuries. However, all these experiences are more or less empirical. Basic scientific research work is missing. It is essential to know more on the behaviour of untreated wood in various risks of attack depending on specific service conditions to find the best way for wood protection with a minimum of chemical wood preservatives.

A few examples shall confirm this statement.

- Insufficient knowledge exists on the influence of artificial drying at elevated temperature on the susceptibility of wood towards attack by wood-destroying insects.
- What about the reduction of blue-stain and insect attack in floated wood? It is said this will diminish the risk of attack, however, so far no real scientific proof has been given.
- Almost nothing is known on the minimum time of elevated humidity necessary for the germination of spores from dry-rot and other wood destroying fungi on constructional timber.

## 4.3 In service impact analysis of chemicals

More knowledge is needed on all aspects of protected wood, mainly chemically treated wood, regarding its impact in service. This concerns not only the requirements to be achieved for a suitable durability. Also more detailed information is missing on the side effects of wood preservatives, may be by in-door evaporation of dangerous substances, may be by leaching during service in outside use. For harmonized test procedures to proof the performance of biocides in treated wood - or to put it reverse, for the emission of biocides from treated wood - European standards are under preparation.

## 4.4 Recovery and disposal

The importance of the disposal of treated wood after its use has already been mentioned, and there is no need to go into details in a country where everybody concerned with wood preservation is well aware of this problem. Unfortunately, only limited or even no data are available, how to reuse wood, how to recover chemicals, what happens during incineration, how to reach a proper composting etc.

In this connection the last sentence in the paper presented by Paul A. Cooper in Cannes in 1990 may be cited:

> "There is a need for extensive research into ways of reducing, reusing, recycling and disposing of this material in environmentally acceptable ways" (Cooper 1990).

## 5. Change of protection methods to meet the challenge

### 5.0 General

For the future of wood protection it is necessary to overcome some of the traditional principles of industrial wood preservation. Methods of wood protection have to be directed as far as possible towards the individual risk in service. As a result things will become more complicated than so far. Some basic principle shall be mentioned in this paper without being able to go into details.

### 5.1 To avoid harmful chemicals

It seems to be almost self understanding to avoid harmful chemicals. However, what means "harmful"? Many aspects have to be considered starting with the production of the substance, its handling during application, its possible effects during use of treated timber, and last not least the problem of disposal. Chemicals may be harmful for human beings, animals, plants or for the environment. So far, no chemical wood preservative exists, which can be regarded for being harmless in its proper sense. Only the degree of undesired side effects varies to a high extent.

To avoid chemicals regarded as harmful in Europe, to some extent hydrochlorinated fungicides are being replaced by triazole-compounds (Wüstenhöfer, Wegen, Metzner 1992). On specific triazoles like Azaconazole, Propiconazole, and Tebuconazole, various detailed information has been given in papers presented during the annual meetings of the International Research Group on Wood Preservation (e.g. Gründlinger, Exner 1990; Valcke, van Leemput 1990; Valcke, Stevens 1991).

In Germany, in recent times two organic based water borne fungicides have been developed free of chromium compounds which are to be used for wood in ground contact: Cu-HDO = bis-n-cyclohexyldiazeniumdioxy)-copper (Göttsche, Borck 1990; Hettler, Breyne, Maier 1992) and Betain = Oligomere {[Didecyl (2-hydr-oxy-ethyl-poly-2-oxidoethyl)-(poly-2-oxidoethyl)-(N-hydroxy-poly
-ethoxy) ammonium. 0,0]} borate. (Härtner, Barth 1992).

For creosote a new type has been developed containing less PAH including benzo(a)pyrene, and having less intense smell, to be achieved by a condensed boiling range (Hillner, Streckert 1992).

### 5.2 To develop softer chemicals

If harmful chemicals shall be avoided, there is a need for softer chemicals which have to be developed.

Like for "harmful chemicals" again the question arises what means "softer". Very often only in the course of time one could recognize harms involved by chemicals, which originally have been regarded for being relatively safe.

A major point for developing new wood preservatives will be the high costs for doing all the tests necessary to verify the side effects.

An impressive survey on the enormous problems involved with the development of new preservatives has been given in Cannes 1990 by Connell, Cornfield, Williams (1990).

### 5.3 To minimize the use of chemicals

To minimize the use of chemicals it is necessary to make a proper distinction between the necessity for using chemicals: There may be

- the essential need to apply biocides -
  the alternative would be, not to use wood at all;

- the recommendation of applying chemicals, if for various reasons an early deterioration shall be prevented -
  the alternative would be to accept only a short service life for untreated wood;

- the condition, where wood preservatives are not needed, due to a minimized risk of attack or deterioration.

In Europe in early 1993 a new standard EN 460 will be published, where these various possibilities are fixed, giving 5 options depending on the natural durability of wood in relation to the various hazard classes in which the wood shall be used (Table 1-3).

This "classification" of the need of chemical wood preservation
is mainly based on the service expectations.

With respect to minimize chemicals so far only limited experience exists on the combination of the principles of wood preservation with those of wood protection, that is by using biocides along with other supporting methods of wood protection. As a matter of fact the use of biocides may often be diminished by changing the design or by an improved fabrication or by the application of coatings or shelters (see also 2.1 and Anonym 1987).

The tendency for the future of wood protection should be

- to support non-chemical wood protection by adding some chemicals (applying small amounts which as such would be insufficient), thus improving the protective effect of design, natural durability etc.

or, to put it in reverse,

- to reduce the amount of chemicals needed by applying assisting non-chemical protective methods.

### 5.4 To improve treating processes

Treating processes have to be improved mainly to avoid harm for the laborers as well as to avoid environmental pollution. As an example accelerated fixation of chromium by steaming of freshly treated wood shall be mentioned (Peek, Willeitner 1988; Willeitner, Peek 1988).

Treating plants involve many ways of pollution. In some countries of Europe a whole set of regulations concerns health and safety aspects during handling wood preservatives. As a consequence, for example, in treating plants parts of the operation place and of the storage

places for treated wood have to be under cover. Moldrup (1990) summarizes new requirements in Scandinavia.

### 5.5 To consider natural durability

The natural durability of wood towards the various biological agents varies to a high extent. So far, only limited benefit is taken of the increased durability of specific wood species. Of course, the well-known species of high durability, such as Western Red Cedar, are broadly used. However, consequent combination of more or less increased durability with the aim of limiting the use of biocides is missing. With this respect it may be referred to the regulation given in the European Standard EN 460 (see above, table 3).

### 5.6 To give preference to design/fabrication

The importance of design and fabrication has already been mentioned earlier. Out of ground contact often the use of chemicals can be markedly reduced if by constructional means water is restrained from the wood and high moisture content will be avoided (see 5.3).

As to the amelioration of fabrication, many ways are possible to improve the whole manufacturing chain from felling to end-use. Often it is simply a question of proper organization to avoid blue-stain, mould or insect attack etc. during storage and transportation. Thus prophylactic treatment will be reduced.

### 5.7 To extend methods of moisture regulation

Ways to extend methods of moisture regulation are immediately connected to proper design and fabrication. Moisture regulation, however, is also of high importance for the storage of wood. In this kind both rapid drying and water storage have to be mentioned as important methods of wood protection.

### 5.8 To promote chemical modification of wood

It is necessary to promote new methodologies of wood protection by modifying the wood substance as such in a away that organisms will not be able to attack it. In Europe, so far, only limited research work took place in this field (e.g. Militz 1991; Codd, Banks, Cornfield, Williams 1992), however, in the recent meetings of IRG interesting results have been presented mainly by colleagues from Japan, where an international symposium took place in Kyoto in 1991.

### 5.9 To take benefit of biocontrol

Biocontrol may be based on the competition between different organisms including enzymes, pheromones and biotechnology. As to research work in Europe, mainly Kurt Messner from Vienna and Riana Benko from Ljubljana have to be mentioned. At the 23rd Annual Meeting

of the International Research Group on Wood Preservation at Harrogate a series of papers has been presented to this subject (e.g. Bruce 1992; Morris, Dickinson, Calver 1992).

## 6. Co-operation to meet the challenge

### 6.0 General

As the challenge of wood preservation is enormous it needs a broad national and international co-operation of everybody engaged in this field. Again only a few highlights can be outlined.

### 6.1 Scientific co-operation

Scientific co-operation has a long tradition; nevertheless, it has to be improved by co-ordinated research programmes as well as by exchange of scientists. In the past, this co-operation concerned mainly those, who were immediately engaged in wood preservation as such. The challenge of the future, however, needs a much broader interdisciplinary co-operation. A few examples will make this obvious: The behaviour of leachates of wood preservatives in the ground can only be investigated along with soil scientists; for chemical modification chemists are needed and incineration demands the know-how of running respective plants.

### 6.2 Co-operated development

The development of wood preservatives and wood protection methods can hardly be done by a single company. Requirements on health and safety aspects are enormous and need tremendous efforts. Co-operated development, however, also needs to be prepared to share the profit as well.

### 6.3 Co-operation to bring the message over

Public relation is very important for wood protection and in particular for chemical wood preservation. Its image in the public is rather bad, and it is an essential for the future to convince everybody concerned on the needs and the benefits of wood preservation. Ecological analysis of the advantages and disadvantages of competitive materials from cradle to grave as given by Erlandsson, Ödeen and Edlund (1992) for utility poles are rare.

So far, the efforts of various organisms, associations, companies, manufacturers of preservatives and producers of treated wood often are not on the same line and may confuse the customer. Co-operation is one step to bring the message over.

### 6.4 Co-operation with authorities

Most important is an intensive co-operation with all authorities concerned with regulations regarding wood preservatives, starting with the approval of new formulations up to the disposal of treated wood. This co-operation in Europe is sometimes difficult, due to high

political pressure. As a basis for an open-minded co-operation with authorities it is essential to be honest and to provide all facts including those which seem to be unpleasant.

### 6.5 International co-operation

It is obvious to have any co-operation on an international basis. In Europe, the Nordic Countries Denmark, Finland, Iceland, Norway, and Sweden founded already in 1969 the Nordic Wood Preservation Council. Manufacturers of wood preservatives in EC and EFTA are organized in the European Wood Preservers Manufacturer Group since the early 80's. Research work is co-ordinated to a high extent by the International Research Group on Wood Preservation.

Regarding European Standardization, Dr. Bravery gave an overall view on the actual situation within CEN during the 1991 CWPA Annual Meeting. Some research work on fundamentals of testing is done within ad-hoc groups of the IRG.

Research work in Europe is sponsored to some extent within various programmes of the European Community, like FOREST (Forestry Sectorial Research and Technology), AAIR (Agriculture and Agro-Industry including Fisheries) or COST (European Co-operation in the Field of Scientific and Technical Research).

## 7. Conclusions

To conclude, the contents of this paper may be summarized as follows:

- Wood preservation is a challenge especially due to its possible impact on health and environment.
- To improve the situation, more detailed data have to be elaborated regarding the various aspects of deterioration and of wood protection, the latter including both non-chemical methods and chemical wood preservation.
- Non-chemical means of wood protection including design and fabrication have to be promoted.
- New chemicals are needed which are less harmful. Methods of application have to be improved with respect to less environmental pollution. Parallel, the use of chemicals has to be minimized as far as possible. Nevertheless, chemical wood preservatives are an essential in certain fields of wood utilization.
- Recovery of chemicals and disposal of treated wood needs realistic concepts based on profound data which are so far missing and which have to be elaborated urgently.
- Co-operation in the various fields of research work, development, and public relation is essential.

Altogether it is a tremendous program to meet the challenge which needs strong efforts by everybody related to wood preservation.

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Table 1: General service situations and hazard classes as detailed in the European Standard EN 335-1

| **Hazard class** | **General service situations** |
|---|---|
| 1 | - Above ground,<br>- Covered, (dry) |
| 2 | - Above ground,<br>- Covered, (risk of wetting) |
| 3 | - Above ground<br>- Not covered |
| 4 | In contact with ground or fresh water |
| 5 | In salt water |

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Table 2: Classes of natural durability of wood to fungal attack as detailed in the European Standard EN 350-1 using field tests based on EN 252

| Durability Class | Description | Multiple of average life of test stakes relative to the most durable set of reference stakes * | | |
|---|---|---|---|---|
| 1 | Very durable | 5 | < | x |
| 2 | Durable | 3 | < | x - 5 |
| 3 | Moderately durable | 2 | < | x - 3 |
| 4 | Slightly durable | 1.2 | < | x - 2 |
| 5 | Not durable | | | x - 1.2 |

* value x = $\frac{\text{average life of test stakes}}{\text{average life of the most durable set of reference stakes}}$

Table 3: Guidance on the natural durability class of wood species which are appropriate for use in various hazard classes with respect to fungal attack as detailed in the European Standard EN 460

| Hazard class | Durability class | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1 | o | o | o | o | o |
| 2 | o | o | o | (o) | (o) |
| 3 | o | o | (o) | (o) - (x) | (o) - (x) |
| 4 | o | (o) | (x) | x | x |
| 5 | o | (x) | (x) | x | x |

Key:

| | |
|---|---|
| o | natural durability sufficient |
| (o) | natural durability is normally sufficient but for certain end uses treatment may be advisable |
| (o)-(x) | natural durability may be sufficient but depending on the combination of wood species, its permeability and end use, treatment may be necessary |
| (x) | preservative treatment is normally advisable but for certain end uses natural durability may be sufficient |
| x | preservative treatment necessary |