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MOVING FROM CCA TO ALTERNATIVE WOOD PRESERVATIVES – THE SWEDISH SCENE

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Summary

This paper presents the experiences from Sweden when restrictions against the CCA type wood preservatives were introduced in 1992-1993. The use of CCA-treated wood on the domestic market decreased from 85 % to 40 % in only one year and the use of arsenic and chromium free alternatives increased from about 10 % to approximately 60 %.

The move from CCA to arsenic and chromium free alternatives caused a lot of problems for the wood treaters. In addition to technical problems at the treating plants, the most significant problem was to comply with the treatment specifications. Although the situation is better today, this is still a major problem for the treaters. The restrictions have not had any major impact on the total market for treated wood, but there has been an increased use of larch heartwood as a replacement for treated wood in recent years.

In 2004 further restrictions on CCA will be implemented in the European Union. The use of CCA-treated wood will decrease on all markets where it appears today, but it is expected to have a market for commodities such as poles, fence posts and load-bearing constructions outdoors. For other commodities it is expected that arsenic and chromium free preservatives will replace CCA, although CCB and CC type preservatives still may be used.

Keywords: CCA, Europe, EU, Sweden, restrictions, preservative-treated wood, performance, specifications

1. Introduction

On 30 June 2004 extensive restrictions against the use of CCA-treated wood will be introduced in the European Union. For a number of countries, where CCA has been the predominant wood preservative since the early 1950s this will mean a major move for the wood preserving industry which then will have to start using arsenic free types preservatives.

In Sweden severe restrictions against arsenic and chromium containing preservatives were introduced already during the period 1992-1993. Since then Sweden has been the largest "test field" in Europe, and probably also in the world, with respect to the introduction and large scale use of different types of arsenic and chromium free wood preservatives.

2. The Chemical Inspectorate's restrictions

With the aim of reducing the use and distribution of potentially environmentally dangerous substances, the Swedish Chemicals Inspectorate (KemI) in 1992 introduced restrictions for the use of wood treated with arsenic and chromium containing wood preservatives. In the

Code of Statutes KIFS 1990:10 it was stated that such treated wood was restricted for use accordingly:

- When the wood is buried in, or otherwise in permanent contact with damp soil or water;
- When the wood is used for the construction of jetties or other marine applications;
- When the wood is permanently installed as safety devices to protect against accidents;
- When the wood is used for the interior of constructions where it is difficult to replace and where there is a risk of accidental wetting, e.g. ground plates on plinths and concrete slabs, ground-floor joists, etc
- All other use of such treated wood is prohibited.

During a transition period 1992-1993 wood treated with chromium-based preservatives was allowed also for other end-uses than the ones mentioned above.

The KemI restrictions had a dramatic influence on the use of CCA-treated sawn timber on the domestic market. It decreased from approximately 85 % in 1991 to below 40 % in 1994, whereas the arsenic and chromium free preservatives increased their market share from about 10 % to nearly 60 % during the same period, see Figure 1. Since 1994 the percentage of CCA-treated sawn timber on the domestic market has been fairly constant around or just below 40 %. During the transition period 1992-1993 the use of CCP-preservatives, i.e. those containing copper, chromium and phosphorous compounds, had a remarkable peak as can be seen from Figure 1.

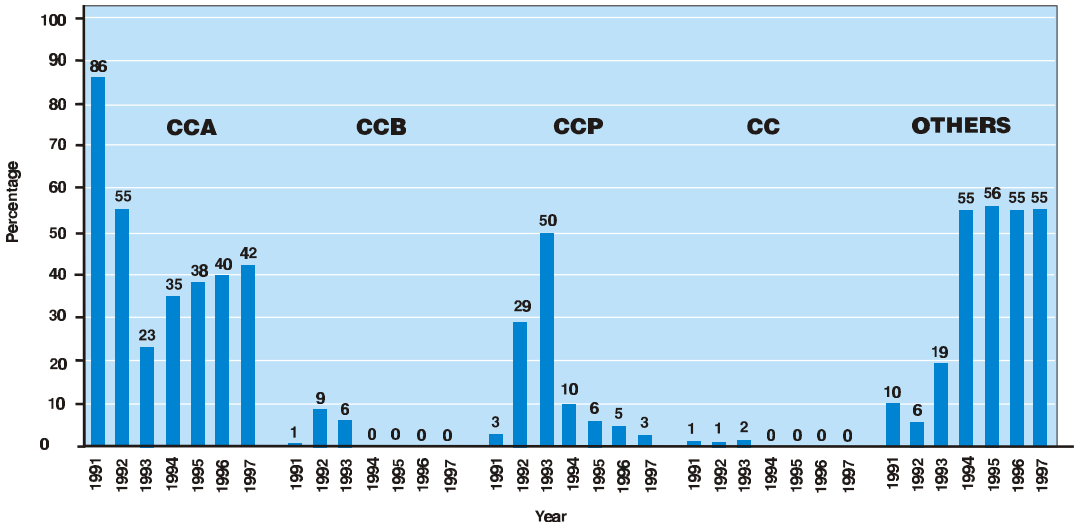


Figure 1. Percentage production of preservative-treated sawn timber with different water-borne preservative types in Sweden 1991-1997 for the domestic market.

3. Arsenic and chromium containing wood preservatives

At present 29 arsenic and chromium free wood preservatives are approved by the Nordic Wood Preservation Council (NWPC), a joint association for the Nordic wood preserving industry which has established a voluntary approval scheme for industrial wood preservatives. Most of the arsenic and chromium free preservatives are based on copper as the major active ingredient, and one or more organic actives, e.g. copper-azole and copper-quats, but combinations of boron and an organic compound as well as metal free alternatives exist.

An excerpt of the NWPC list of approved preservatives is presented in Table 1.

Table 1. Excerpt from list of wood preservatives approved by the Nordic Wood Preservation Council (June 2003)

Wood preservative	Retention requirement* in *Pinus* spp sapwood, kg/m³ Class**	
	A	AB
CB products		
Celcure ACB	-	32,0
CBA products		
Tanalith E/Tanalith E 3491	18,0	13,0
Tanalith E7/Tanalith E 3492	-	9,0
Wolmanit CT	18,0	13,0
ACQ products		
Kemwood ACQ 1900	36,0	19,0
Celcure AC 800	36,0	19,0
ACQ 2200	-	12,0
Celcure AC 500	-	12,0
Quaternary ammonium products		
Basilit KD	-	12,0
Mitrol C 800	-	8,0
Triazole products		
Gori pres 10	-	3,0
Scanimp KF	-	5,2
Wolsit KD-10	-	11,0
Cu-HDO products		
Wolmanit CX-8	-	12,0
Wolmanit CX-10	-	10,0
Wolmanit CX-E	21,0	-
Other water-borne products		
Impralit-KDS 4	-	12,0
Sinesto B	-	18,0
Tim-bor[1]	-	1,0***

* The retention figure refers to the formulation specified by the preservative manufacturer.
** The Nordic wood preservation classes A and AB correspond to the hazard classes 4 and 3 respectively according to EN 335.
*** The retention is based on total wood volume.
[1] The treated wood must be surface-coated according to the manufacturer's recommendation before delivery to the user.

The arsenic and chromium free products are approved for the Nordic wood preservation class AB, corresponding to hazard (use) class 3 in the European Standard EN 335, and thus intended for commodities above ground. A few arsenic and chromium free preservatives are also approved for Nordic wood preservation class A, corresponding to hazard (use) class 4 of EN 335, and intended for commodities in contact with the ground or fresh water.

The retentions for the respective wood preservation classes are expressed in kg per m^3 sapwood of *Pinus sylvestris.* For approval in class AB a laboratory method EN 113 has been required so far. From 2005 the lap-joint field trial (CEN/TS 12037) method will be required. It is not an easy task to establish retention levels for treated wood to be used above ground. Relying on a laboratory test only is not at all satisfying. A reliable field test is better, but it is difficult to find a good method for above ground testing that actually will give conclusive

results within a reasonable time. There are severe doubts about the lap-joint method. At least in the Nordic climate, any attack of decay proceeds very slowly.

In Sweden the wood treaters have so far used mainly the following arsenic and chromium free wood preservatives: Tanalith E (3491), Tanalith E 7 (3492), Kemwood ACQ 1900, Celcure AC 800 and Wolmanit CX-8. The market shares have varied during the last 10 years. The ACQ type product dominated in the beginning of the period, but today the copper-HDO products have the biggest market share.

4. Experiences from industry

As many treaters had a quite important export of CCA-treated wood to the United Kingdom, Norway and France, they decided to maintain the CCA production when the restrictions came into force, but also commence a production with one or more of the arsenic and chromium alternatives. For treaters with more than one plant this was no problem. Treaters with only one plant had to choose between installing a second storage tank or another complete plant.

Moving from CCA to the copper-based alternatives proceeded as a whole quite well. However, many plants reported various problems related to the chemical properties of the new preservatives. All new alternatives have been reported to be more aggressive to metals than CCA. Considerable sludge formation and problems with plugging of pipelines and valves have been significant problems with the ACQ-type preservatives as well as complaints about the smell of ammonia. Foaming is another major problem with all new preservatives. Today, the technical problems experienced in the beginning seem to be less frequent.

The most alarming problem with the new preservatives has been the difficulties for the treaters to comply with the quality requirements of the treated timber, and in particular to achieve full penetration of the pine sapwood. This was extremely obvious during the first couple of years after the major move to arsenic and chromium free alternatives. Although there is a tolerance allowed, which means that 10 % of the units (boards, poles etc) of a batch may not conform to the full sapwood penetration requirement, there are still problems with some wood preservatives to comply with the requirements according to statistics compiled by the SP Swedish National Testing and Research Institute, see Figure 2.

There are many explanations to the poor penetration. The wood preservative, the timber and the treating process all have an influence. The role of each of them and how they interact, in particular for the new preservatives, is not entirely known. The knowledge in this field is mainly related to the old generation type preservatives, such as CCA, CCB etc.

Apparently, it is more difficult to comply with the penetration requirements with the new preservatives and the chemical formulation probably plays a major role. Features such as fairly large organic molecules, emulsion type treating solutions and use of certain additives (pH stabilizers, anti-foam additives, waxes etc) are all critical.

The properties of the timber are also of importance. Whereas a too high moisture content used to be the reason for poor penetration, today the problem is rather that the wood is too dry, and the problem seems to be more critical for the arsenic and chromium free preservatives than for CCA. A lower limit seems to be around 12 %. The way the timber has been dried also affects the treatability but exactly to what extent is not fully understood. The treating process is of

course also of importance, which is often neglected. The process must be adapted to the preservative used, the timber to be treated and the specification to be achieved.

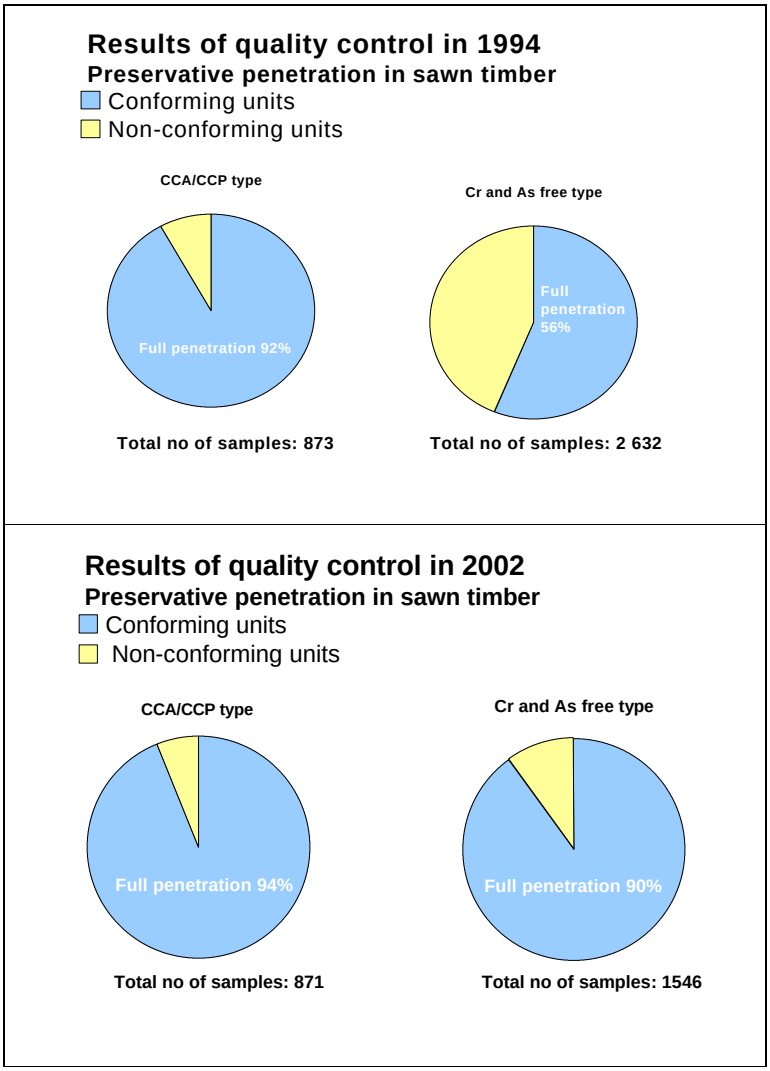


Figure 2. Compilation of results from SP's quality control scheme in 1994 and 2002 for CCA/CCP and arsenic and chromium free preservatives respectively.

To get a better understanding of the problems related to the treatment with the arsenic and chromium free preservatives more research and investigations are necessary. Bearing in mind that the present knowledge of the properties of CCA and some other of the old generation type wood preservatives is the result of five decades of research activities around the world, this is easy to understand. A systematic approach is needed to understand the complex relationships between different factors that influence the treatability.

In this connection it is also important to point out that for some of the new preservatives it is difficult to check the penetration even with the help of a copper reagent such as ammonium hydroxide and rubeanic acid. One often cannot establish a sharp difference between the treated and untreated zone, Figure 4. One reason for that is probably because the penetration gradient for copper is much steeper, at least for some of the new copper-based preservatives,

compared to CCA, Figure 5. Additionally, if the copper content is low this will make it even more difficult to detect the penetration depth.

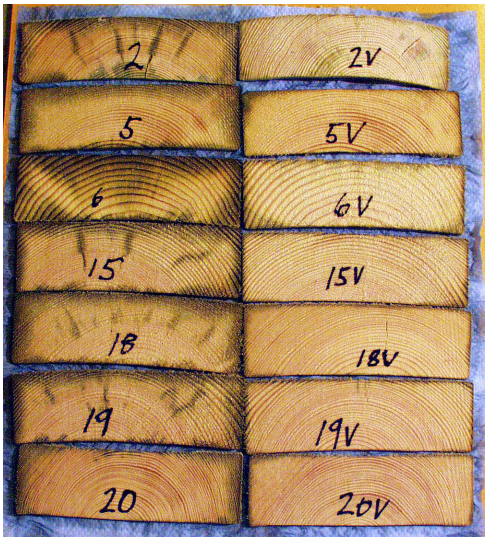


Figure 3. Samples treated with an arsenic and chromium free preservative with (V) and without wax additive.

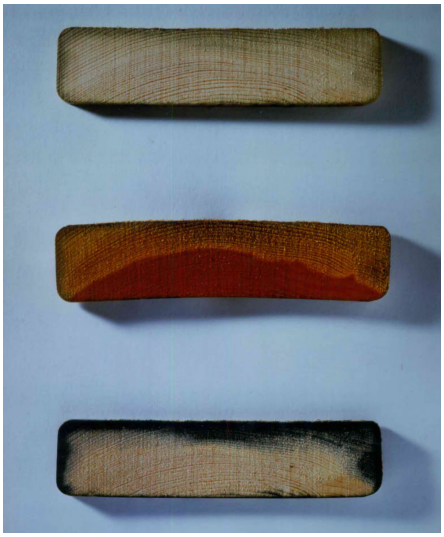
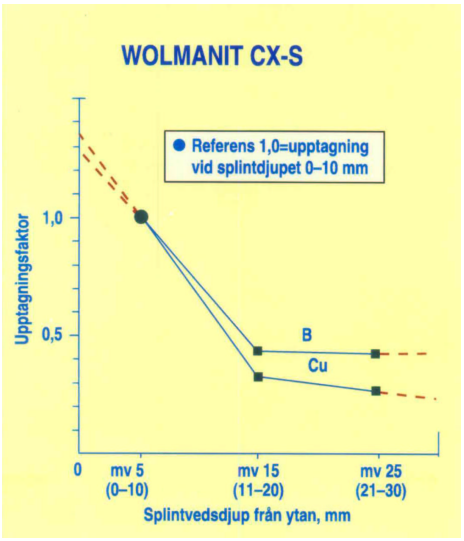


Figure 4. Cross-sections from the same board.
Top: without any copper reagent
Middle: with heartwood reagent
Bottom: with copper reagent but still not easy to judge the penetration.



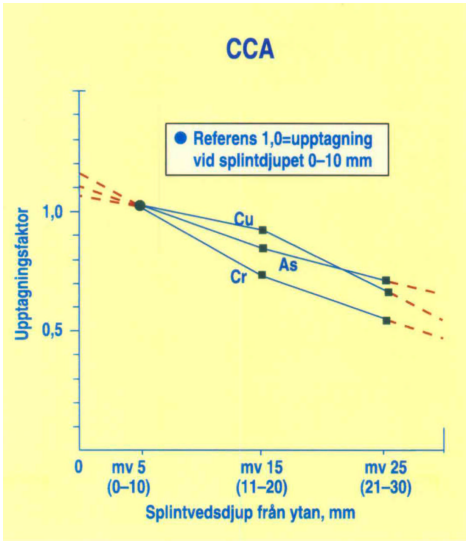


Figure 5. Penetration gradients for active ingredients in Wolmanit CX-S and CCA.

With the introduction of the copper-based preservatives there was also a need for reliable methods of chemical analysis for the active ingredients. During the last ten years there has

been a fruitful collaboration between SP and other Nordic institutes and the wood preservative manufacturers to further develop the methods recommended.

Figure 6. Characteristic attack by mould on the surface of wood treated with an arsenic and chromium free wood preservative.

The general appearance of timber treated with the arsenic and chromium free is somewhat different from that of CCA-treated wood. There have been some problems with deposits on the surface for most arsenic and chromium free preservatives. For the Tanalith E type preservatives and ACQ 1900 in particular, one has also had embarrasing attacks by white mould on the surface, see Figure 6, even though the treaters have added a lot of anti-mould agents. Thus, the effect of the anti-mould agents has been disputed by the treaters. The mould problems vary from plant to plant. It has been claimed that the problem is worse for timber that has been stored with <10 mm stickers and poor air circulation than for timber that has been stored without any stickers at all. With thicker stickers and good air circulation ensured at the storage area there is a good chance of avoiding mould problems.

5. The market

How has the market reacted to timber treated with the new preservatives? Well, it has not reacted or changed in any dramatic way, besides the move from CCA to arsenic and chromium free preservatives. The sales and use of treated timber on the Swedish domestic market has remained stable and no attention has been paid to the argument that timber treated with the new preservatives is more environmentally friendly that CCA. Since the 1970s the use of sawn and profiled treated wood has constituted between 5 and 8 % of the total market of sawn and profiled timber in Sweden, Figure 7. In recent years major building contractors and municipalities have introduced environmental policies where the use of treated wood, irrespective of wood preservative used, has been banned or severely restricted. Larch has

become a favourite material for these categories as well as for architects and has replaced treated wood in many constructions where it traditionally has been used, such as noise

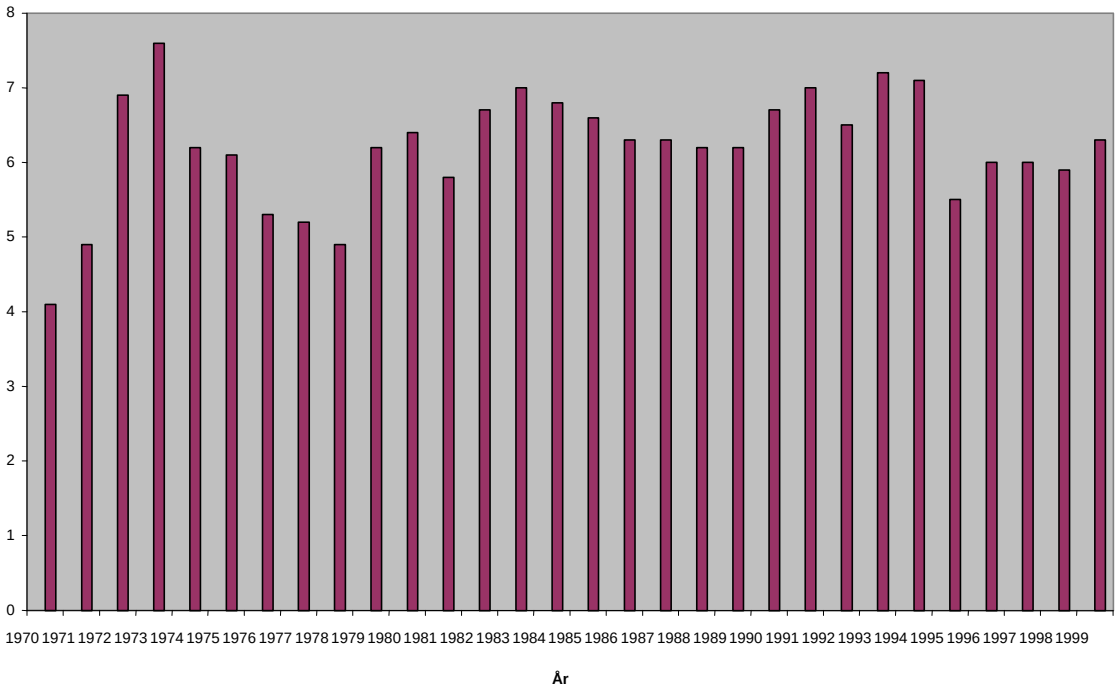


Figure 7. Percentage of preservative-treated sawn timber used in relation to total consumption of sawn timber in Sweden during the period 1970-1999.

barriers, playgrounds and decking, Figure 8. Fortunately for the treaters, the home owners still have confidence in treated wood as has been shown in a study recently carried by SP in collaboration with a major Gallup institute, SIFO Research and Consulting.

Figure 8. Typical use of larch.

A disputable consequence of the move to arsenic and chromium free preservatives has been that the Swedish timber yards have chosen to offer treated wood in dimensions above 40 mm in wood preservation class A, i.e. in principle treated with CCA, and wood thinner than 40 mm in wood preservation class AB, i.e. treated with arsenic and chromium free preservatives. The reason for this is said to be that the timber yards do not want to keep in stock the same dimension treated to different specifications. As some common dimensions, e.g. 22x95 mm and 28x120, are used frequently in outdoor constructions in ground or near ground, there is an obvious risk for misuse. Insufficiently treated class AB-timber will be used in the ground and "over-treated" CCA-treated timber will be used above ground in conflict with the restrictions from the Chemicals Inspectorate. It will be interesting to see how the timber trade will deal with this issue next year when the new EU directive will come into force.

6. New restrictions for CCA-treated wood

In the beginning of 2003 the EU presented a revised directive 76/769/EEC with respect to the sales and marketing of arsenic compounds. Among other things the directive concerns CCA-treated timber. The revised directive comes into force on 30 June 2004 and states:

- CCA-treated wood may be used in industrial installations and may be placed on the market for professional and industrial use provided the structural integrity of the wood is required for human or livestock safety and skin contact by the general public during its service life is unlikely.

Examples of approved end-uses are:

- As structural timber in public and agricultural buildings, office buildings and industrial premises
- In bridges and bridgework
- As constructional timber in freshwater areas and brackish waters, e.g. jetties and bridges
- As noise barriers,
- In avalanche control
- In highway safety fencing and barriers
- As debarked round conifer livestock fence posts
- In earth retaining structures
- As electric power transmission and telecommunication poles
- As underground railway sleepers.

All CCA-treated timber must then be branded with the text "For professional and industrial installation and use only, contains arsenic".

How will then the new restrictions affect the wood preserving industry and the use of treated timber in Europe? Clearly, the use of CCA will decrease substantially. A question raised within the European wood preserving industry is whether the end-uses allowed will be sufficient in volume and economically interesting for keeping the CCA market alive. For several end-uses, outdoor and above ground, the arsenic and chromium free wood preservatives may offer sufficient performance of the treated wood. But what about treated wood for use in ground contact? Will arsenic free, but chromium containing preservatives, such as CCB and CC type, be used? Or will the arsenic and chromium free preservatives also be used for commodities in ground contact, although we still have limited experience of the

performance in such situations? Do we even have to give up the use of wood in ground contact? There are many questions awaiting an answer.

7. Performance

Ever since the arsenic and chromium free preservatives were introduced on a large scale in Sweden there has been doubts about the performance. It seems reasonable to expect that it cannot compete with that of CCA. But will it be “fit for purpose” for the end-uses intended? It will probably take some time before we know for sure. With the help of biological tests in the laboratory and field as well as evaluation of treated timber in service one will get at least some information.

In 1996 SP established an extensive field trial with arsenic and chromium free preservatives. Samples treated according to wood preservation class AB (above ground) are exposed above ground and in the ground, the latter because one will get interesting results earlier than for the above ground testing.

Results after 7 years’ exposure in ground contact show significant differences between different preservatives, see Figure 9.

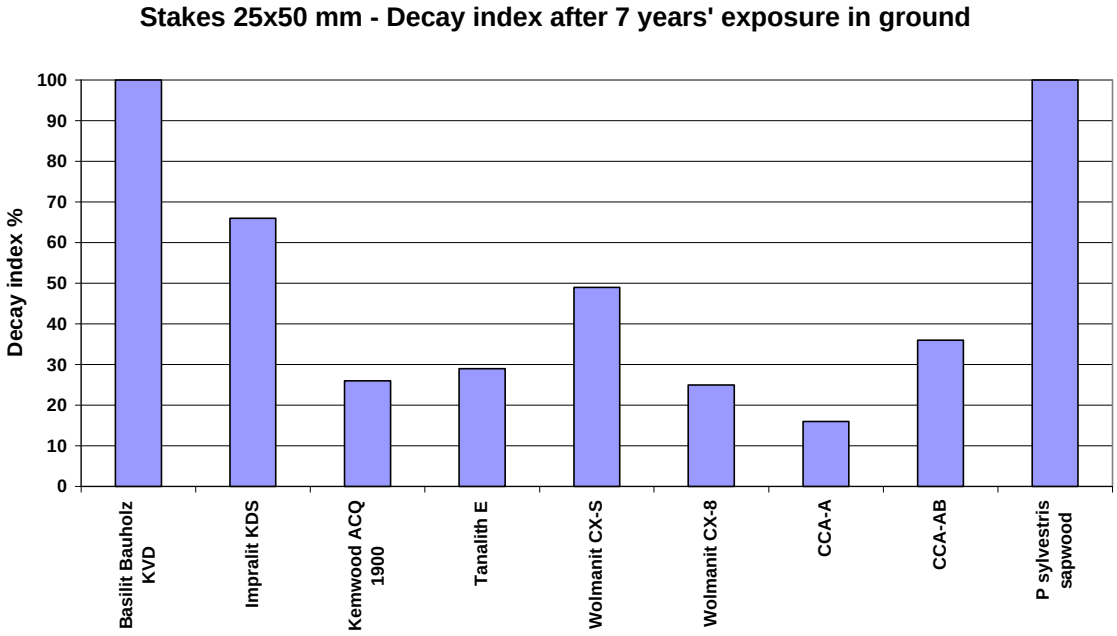


Figure 9. Results from SP’s field trial with stakes according to EN 252 after 7 years’ exposure

Basilit KVD, Impralit KDS and Wolmanit CX-S treated samples are severely attacked by decay fungi. Basilit KVD is a metal free preservative with tebuconazole as the main active ingredient, while Wolmanit CX-S and Impralit KDS both are based on copper and an organic compound. The copper content in the treated wood for these two preservatives is rather low, about one-third and one-half respectively, compared to the copper content of CCA-A (for in ground use), and there is a correlation between the degree of decay and the amount of copper retained in the wood. A high copper content is not solely determining, but the combination with the organic active ingredient also seems to play a role, at least in the short term.

Even if the test in ground contact is not entirely relevant to evaluate the performance of Basilit KVD treated wood, the result indicates that it will be a challenge to find metal free wood preservatives with a performance comparable to copper-based preservatives. This statement is supported by evidence from practice where timber treated with a benzalkonium-boron product during 1993-1995 has decayed after only 5-8 years' use in above ground applications such as decking and fences, Figure 10.

Figure 10. Severe decay in decking after approximately 8 years' in service.

In order to get more data about the performance of arsenic and chromium free wood preservatives but also alternative materials such as heat-treated wood, untreated larch and pine heartwood, acetylated wood, linseed oil-treated wood, further field trials have been established in Sweden. Interesting data can be expected within the next few years. A full scale service test has also been established. The performance of timber treated with different arsenic and chromium free preservatives is compared with CCA-treated wood and untreated pine, spruce and larch in a noise barrier near Stockholm, see Figure 11.

8. Discussion and conclusions

With 10 years's experience of the use of arsenic and chromium free wood preservatives in Sweden one can conclude as follows:

- Before any new preservative is released on the market it has to be better tested and evaluated than has been the case for the preservatives introduced in Sweden. This is particularly important with respect to the possibilities to achieve penetration and retention requirements. As a consequence, the Nordic Wood Preservation Council has introduced a new requirement in the approval procedure for wood preservatives (NWPC Document No 2-1998); the applicant has to demonstrate that the wood preservative can comply with the penetration requirement in question.
- Moreover the documentation of performance and technical properties must be much better. Concerning the latter hardly any information has been presented.
- Metal free wood preservatives have not yet succeeded to establish themselves on the market.

- There have been practical and technical problems related to the plants and operation of the plants, such as corrosion, foaming etc, but the situation has improved a lot during the last couple of years. In this connection one has to mention that the service and backup provided by the wood preservative manufacturers have varied considerably.

Figure 11. Noise barrier of larch with test sections of pine (*Pinus sylvestris*) treated with different arsenic and chromium free wood preservatives. Test sections with untreated spruce (*Picea abies*) and pine (*P sylvestris*) are also included in the trial.

- During the last 10-year period major building contractors as well as those responsible for buildings and infrastructure of municipalities have been more and more reluctant to use preservative-treated wood, irrespective of the preservative used. Even if the new preservatives demonstrate a better environmental profile, those categories have had a preference for untreated larch heartwood.
- When the arsenic and chromium free preservatives were introduced one would assume "a fit for the purpose" approach to be adopted by the market, i.e. selecting arsenic and chromium free alternatives for above ground end uses and CCA for in ground. This did not materialize in practice, mainly due to the fact that the timber trade did not keep a full range of dimensions treated to different end-use specifications.

It is still an open question what will happen after 30 June next year when the revised European directive will come into force. The CCA restrictions will probably not have any influence on the total market for preservative-treated wood in Europe in the short term. We will of course see a major move to arsenic and chromium free preservatives all over Europe. The restrictions will not have any major effect in countries where CCA is banned or restricted already, e.g. Austria, Denmark and Germany. For France and the United Kingdom, where CCA has been extensively used, the restrictions will have a major impact on the wood preserving industry and an even more dramatic move than that we had in Sweden in 1992-1993 is expected.

CCA will probably survive in Europe for certain commodities, such as poles and fence posts, for some time. The future role for the chromium-based preservatives CCB, CC and CCP is still not clear. Will they replace CCA for commodities in ground contact and sea-water or will the arsenic and chromium free alternatives be used also for those commodities?

It is apparent that wood preservatives and treated wood have received more attention and caused more activities amongst the regulators than can be justified. But perception is just as important as facts. The upcoming restrictions against CCA might be just another step forward to further restrictions and bans against wood preservatives and preservative-treated wood. One should not be surprised if the copper-based preservatives will be subject to EU restrictions within the next ten years or so. Norway has already decided to phase out copper in wood preservatives by 2010.

There are already a number of metal free wood preservatives on the market, but so far they have a modest share of the market for industrially treated wood. It is partly a price issue but without support from the regulators and restrictions for the copper-based preservatives it is not likely they will increase their market share in the near future. No new preservative types have yet succeeded to break new ground and get into the market without regulators' support.

Whatever happens to CCA and the other "old generation" products, one can conclude that new wood preservatives and alternative products such as heat-treated wood will have more specific end-uses than CCA owing to narrower mode of action. This means that the selection of a proper wood protection will be more complicated and the need for proper guidance will be more urgent than ever.

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