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Dimensional Changes of Wood Immersed in Different Consolidant Agents

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Abstract

Treatment of deteriorated wooden objects can include immersion in consolidant solutions of synthetic resins and organic solvents — a procedure that may provoke dimensional change. This paper examines the response of eastern white pine and white oak to immersion in ethanol, isopropanol, n-butanol, toluene, and pentane, and in consolidant solutions of 5% Aquazol 50 in ethanol, 5% Aquazol 50 in isopropanol, 5% Acryloid B-72 in toluene, 5% poly (vinyl butyral) Butvar B-79 in n-butanol, and 5% poly (vinyl acetate) AYAC in toluene. Samples demonstrated characteristic behaviours to specific solvents. Ethanol caused an increase in dimension, isopropanol and n-butanol an initial shrinkage followed by swelling, and toluene and pentane a small shrinkage in the wood. Behaviour of the oak and pine differed in rate and degree of response. Although the response of wood to organic solvents is likely multi-variable, molecular diameter and solvent polarity are important factors. The addition of consolidants to the solvents caused an amplification of dimensional change. For most samples immersed in consolidant solutions, original dimensions are not fully recovered after 4 months of drying. The samples showing the most change are those immersed in Butvar B-79 in toluene, and pine samples immersed in Aquazol 50 in ethanol.

Titre et Résumé

Examen des variations dimensionnelles du bois immergé dans divers agents de consolidation

Le traitement des objets en bois détériorés peut comporter l'immersion dans des solutions d'agents de consolidation à base de résines synthétiques et de solvants organiques, mais cette méthode peut toutefois entraîner des variations dimensionnelles des objets. Le présent article porte sur l'étude de la réaction de deux essences de bois (le pin blanc et le chêne blanc) dont des échantillons ont été immergés dans des solvants purs (éthanol, isopropanol, n-butanol, toluène et pentane) et dans différentes solutions d'agents de consolidation [solution à 5 % d'Aquazol 50 dans l'éthanol, solution à 5 % d'Aquazol 50 dans l'isopropanol, solution à 5 % d'Acryloid B-72 dans le toluène, solution à 5 % de Butvar B-79 {à base de poly(butyral de vinyle)} dans le n-butanol, et solution à 5 % d'AYAC {à base de poly(acétate de vinyle)} dans le toluène]. Les réactions des échantillons sont caractéristiques pour des solvants particuliers. L'immersion dans l'éthanol provoque une augmentation des dimensions du bois, tandis que le toluène et le pentane entraînent un léger retrait des échantillons; quant à l'isopropanol et au n-butanol, ils provoquent un retrait initial, suivi d'un gonflement. Les échantillons de chêne blanc et de pin blanc ont des comportements différents, notamment au chapitre de la vitesse et de l'importance de la réaction. L'ajout d'agents de consolidation aux solvants purs entraîne un accroissement des variations dimensionnelles observées. Bien que la réaction du bois aux solvants organiques dépend probablement de plusieurs variables, le diamètre moléculaire et la polarité du solvant constituent des facteurs importants. La plupart des échantillons ne

reprentent pas leurs dimensions initiales, et ce, même après quatre mois de séchage. Les échantillons qui présentent les variations dimensionnelles les plus importantes sont ceux immergés dans une solution de Butvar B-79 dissous dans le toluène et les échantillons de pin blanc immergés dans une solution d'Aquazol 50 dissous dans l'éthanol.

Introduction

Examination of the short- and long-term effects of bulk consolidation on the dimensional stability of wood was initiated by several works of art brought to the Canadian Conservation Institute (CCI) for treatment. A fragment from one object (Figure 1) showed severe damage to the wood from boring insects. Bulk consolidation, although a radical treatment option, was considered necessary as structural integrity was severely compromised. There are several treatment approaches that deliver consolidants into wood (Grattan 1980); the present study focuses on thermoplastic resins dissolved in organic solvents.



Figure 1. A broken fragment of polychrome sculpture showing extensive damage to the wood.

Dimensional stability is one of the requirements of an ideal consolidant (Werner 1978) because changes in dimension can have a devastating effect on an object, e.g. causing warping of the wood and buckling or tenting of decorative layers in the case of shrinkage, and crack development or widening and lengthening of existing cracks in the case of swelling. Cracks in the radial axis in paint and ground layers of a panel painting can be seen in Figure 2. These cracks result from the wood's swelling response to increases in humidity that exceeds that of paint and ground layers.

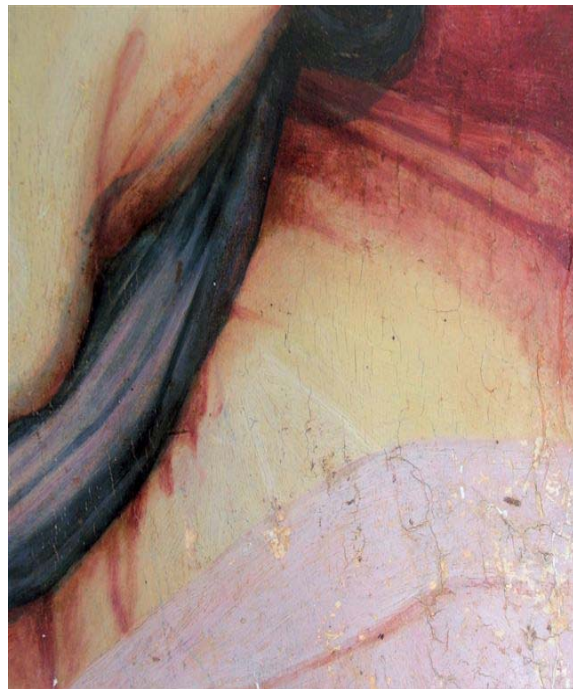


Figure 2. Cracking in the radial axis is caused by hygroscopic swelling of wood.

The impregnation of degraded wood by organic liquids and consolidants is an ongoing preoccupation of the wood science industry. Volumetric change, in particular, has been examined by Stamm (1934, 1935), de Bruyne (1939), and Mantanis et al. (1994, 1995). Conservation scientists have addressed volumetric changes in studies by Wang and Schniewind (1985) and Schniewind (1990, 1998). Schniewind (1990) noted that wood swells during consolidation in an amount proportional to the swelling potential of the solvent. The swelling potential is not defined except in relationship to the polarity of the

solvent and consolidant: the greater the polarity, the greater the swelling. As for predictors of swelling, molecular weight and solvent polarity were first proposed by Stamm (1935) and de Bruyne (1939). Other predictive theories followed: cohesive energy density of the solvent, or Hildebrand's parameter as well as solvent donor number (Mantanis et al. 1994, 1995). A number of theories advanced by researchers for the calculation of volumetric change based on properties of wood and solvents were explored by the authors. However, with the exception of Stamm's observation that swelling is proportional to molecular weight for alcohols, published theories to predict wood swelling are not entirely reliable.

A phased project was undertaken to evaluate the short- and long-term dimensional effects of exposing wood (eastern white pine and white oak) to pure solvents (phase 1) (Baker and Grattan 2009; Baker and Grattan 2010), and to consolidant solutions (phase 2). Can questions such as the predictability of dimensional change be answered or behaviour of wood characterized; and if dimensional change takes place, is this a temporary or a permanent change of state?

Methods and Procedures

Wood samples

Samples were obtained from air-dried planks of quarter-sawn white oak and eastern white pine. Samples were cut with the long axis oriented in the radial direction. Size was determined largely by the width of each plank; oak samples were cut to 1.7 cm height \times 2.0 cm width \times 19.2 cm length and pine samples to 1.6 cm height \times 2.0 cm width \times 13.2 cm length (where height = tangential; width = longitudinal; and length = radial axis). Two stainless steel "T" pins were pushed into predrilled holes on the top surface and close to the ends of each sample (Figure 3). Measurements, recorded in millimetres to two decimal places, were taken between sets of pins using digital calipers. Samples were equilibrated to 50% relative humidity (RH) at 20°C prior to and after immersion. Measurements and weights were recorded prior to treatment and at multiple intervals during and post immersion. Two samples each of oak and of pine were used for each experiment. Samples were immersed in glass pans containing 600 mL of solvent (phase 1) and consolidant solution (phase 2). Pans were covered with Mylar sheet, followed by a layer of expanded polyethylene foam and a glass cover to seal the opening. Samples were removed from solvents and consolidant solutions after reaching maximum (in most cases) dimensional change. Following immersion, samples were dried on metal screen racks.



Figure 3. Sample of white oak with measuring pins.

Consolidants

Four consolidants were chosen. The first three are among consolidants cited in the research and review literature (Schniewind and Kronkright 1984; Wang and Schniewind 1985; Schniewind 1990; Unger et al. 2001), and from among those identified in published treatments (Barclay 1981; Payton 1984): poly(vinyl butyral) (PVB) Butvar B-79, poly(vinyl acetate) (PVAC) resin AYAC, and acrylic co-polymer Acryloid B-72. The fourth consolidant tested was Aquazol 50, one of a series of homopolymers of 2-ethyl-oxazoline. Where the consolidant is one in a series, the resin with a low or lowest molecular weight was chosen for testing. Butvar B-79 has the lowest molecular weight in the PVB series: 50,000 – 80,000 g mol⁻¹. Ethyl methacrylate/methyl acrylate (70:30), Acryloid B-72, has a molecular weight of 30,000 – 34,000 g/mol⁻¹. AYAC, at 12,000 g/mol⁻¹, has the lowest molecular weight of all of the PVAC resins, and of our test consolidants. Aquazol 50 has a molecular weight of 50,000 g/mol⁻¹. Each solution was made up of 5% solids to liquid (weight to volume).

Solvents

Five solvents were chosen: anhydrous ethanol, isopropanol, n-butanol, toluene, and pentane. Selection of the solvents for phase 1 of the testing was predicated on differences in critical molecular diameters (CMD) as well as range of polarities expressed here as dielectric constants (see Table 1). Water is included in Table 1 as a comparison. A study carried out on waterlogged wood (Jensen 1997) shows that a solvent's ability to swell wood falls off sharply after the CMD reaches and exceeds 5.5 Å, and once adsorbed into the cell wall, for swelling to take place, the solvent molecules must be polar (Jensen 1997).

Table 1. Polarity (dielectric constant) and critical molecular diameter of test solvents.

	water	ethanol	n-butanol	isopropanol	toluene	pentane
Polarity	9	5.2	4	3.9	2.4	0
CMD (Å)	2.8	4.4	4.5	4.3	6.7	4.96

If this is the case, then ethanol, n-butanol, isopropanol, and pentane should be adsorbed into the cell wall, but not toluene. Ethanol should produce the most swelling followed next by n-butanol and isopropanol. Toluene and pentane should not cause swelling.

Results

Phase 1. Exposure to pure solvents

Percentage changes from pretreatment radial measurements as a result of immersion in solvents are shown in Figure 4 for oak samples and in Figure 5 for pine samples. Each data point reflects an average value for two samples.

Oak, All Solvents: Change Dimension

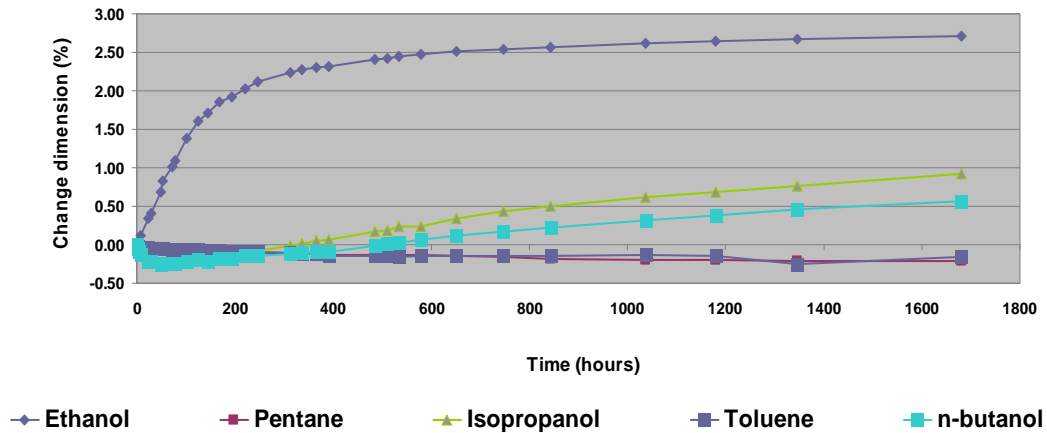


Figure 4. Percentage change in the radial dimension for white oak immersed in pure solvents.

Pine, All Solvents: Change Dimension

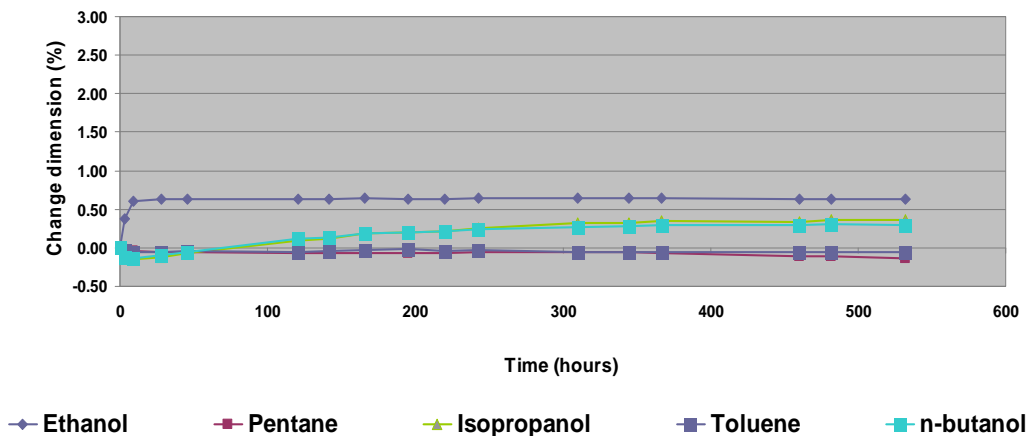


Figure 5. Percentage change in the radial dimension for eastern white pine immersed in pure solvents

Given small sample size, the data per se is not statistically significant; however, when examined as a whole (Figures 4 and 5), characteristic behaviours associated with particular solvents can be identified. Differences in dimensional response between oak and pine samples were in rate and magnitude; rate of response was faster for pine, but greater for oak. Increase in dimension was most pronounced for those samples immersed in ethanol. A maximum swelling in oak samples of over 2.5% was reached at between 600 to 800 hours of exposure to ethanol while pine samples immersed in ethanol reached their maximum swelling of 0.6% in less than 10 hours of exposure. Isopropanol and n-butanol provoked, in both oak and pine samples, an initial

shrinkage followed by swelling. With oak samples immersed in isopropanol and n-butanol, this shrinkage reached 0.25% at approximately 50 hours. Subsequent swelling of oak samples reached just under 1% for isopropanol and just over 0.5% for oak immersed in n-butanol at the end of the test period (1700 hours). Pine samples show an initial shrinkage when immersed in both isopropanol and n-butanol of approximately 0.2% reached in under 10 hours of immersion. Subsequent swelling of the pine was almost identical for the two solvents with a maximum value of 0.3% attained in 300 hours. Toluene and pentane had an almost identical effect on the wood: both oak and pine samples showed an immediate shrinkage that continued slowly over the test period. For the oak samples this resulted in reduction of volume in the radial axis of 0.3% at the end of the test period (1700 hours) and for the pine samples a reduction in volume of 0.15% after 550 hours of immersion.

Phase 2. Exposure to consolidant solutions

The following figures are based on averages of two samples each of pine and oak immersed in different consolidant solutions. Figures 6 to 10 show dimensional change between consolidant solutions and solvents alone for both oak (A) and pine (B). Samples immersed in consolidant solutions were removed from solution for drying, and results of this drying phase are also shown in Figures 6 to 10.

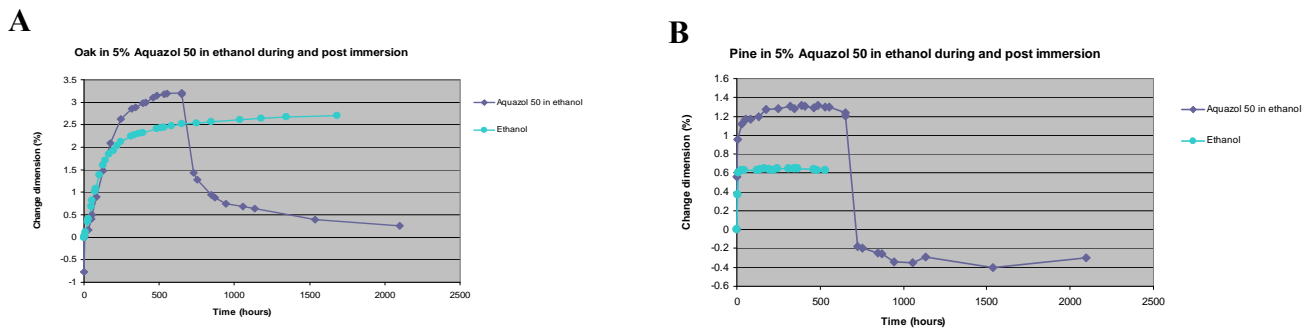


Figure 6. Percentage change in radial dimension for white oak and eastern white pine immersed in 5% Aquazol 50 in ethanol compared to pure ethanol. Drying curves, post immersion, for samples exposed to consolidant solution only are also shown.

Figure 6 shows the percentage change in dimension for oak samples (A) and pine samples (B) immersed in 5% Aquazol 50/ethanol compared to the change in dimension for samples exposed to ethanol alone. Samples of both oak and pine were removed from the Aquazol 50/ethanol solution at 650 hours and allowed to air dry (1450 hours). The swelling of the wood in the consolidant solution mirrors the response of wood to the solvent. However, Aquazol 50 causes an amplitude in swelling for both woods. In the oak samples (A), this reaches approximately 3.25% with the consolidant added to the solvent compared to approximately 2.5% for the solvent alone. In the pine samples (B), the addition of Aquazol 50 almost doubles the swelling:

1.3% as opposed to a maximum increase for exposure to ethanol alone of 0.6%. After 1450 hours of drying, neither the oak nor the pine samples have returned to original dimensions. The oak samples retain a swelling of 0.26%, and the pine samples a shrinkage of 0.3% from their pretreatment state.

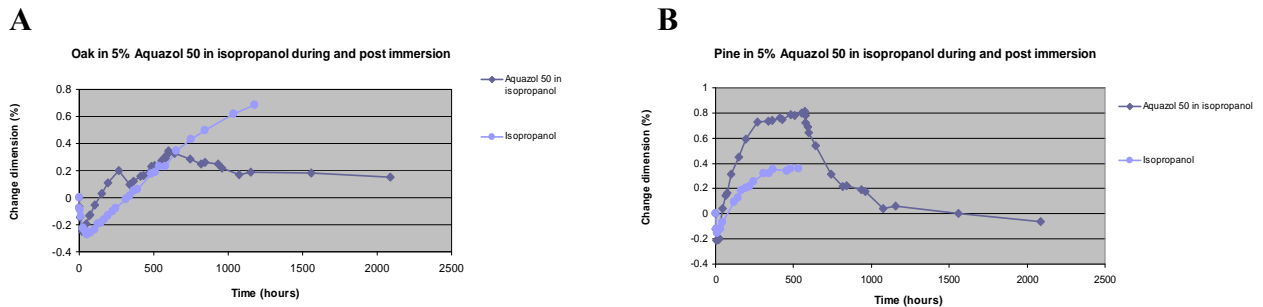


Figure 7. Percentage change in radial dimension for white oak and eastern white pine immersed in 5% Aquazol 50 in isopropanol compared to pure isopropanol. Drying curves post immersion for samples exposed to consolidant solution only are also shown.

Figure 7 shows results for oak samples (A) and pine samples (B) immersed in 5% Aquazol 50/isopropanol compared to immersion results for isopropanol alone. Oak and pine samples were removed from the consolidant solution at 575 hours, and drying results are shown for 1525 hours of drying. Samples immersed in consolidant solutions show similar patterns of behaviour to those immersed in solvent alone. Oak and pine exhibit an initial shrinkage followed by a swelling. Subsequent swelling of the wood is amplified by the presence of the consolidant. This is especially so for the pine samples (B) where maximum swelling with the consolidant solution reaches 0.8% as opposed to 0.3% for the solvent alone. The smaller percentage swelling of the oak (A) is anomalous, and more testing is required for oak. After drying, the oak samples have not returned to their pretreatment state, and exhibit a 0.15% increase in dimension. The pine samples have largely returned to their original dimensions.

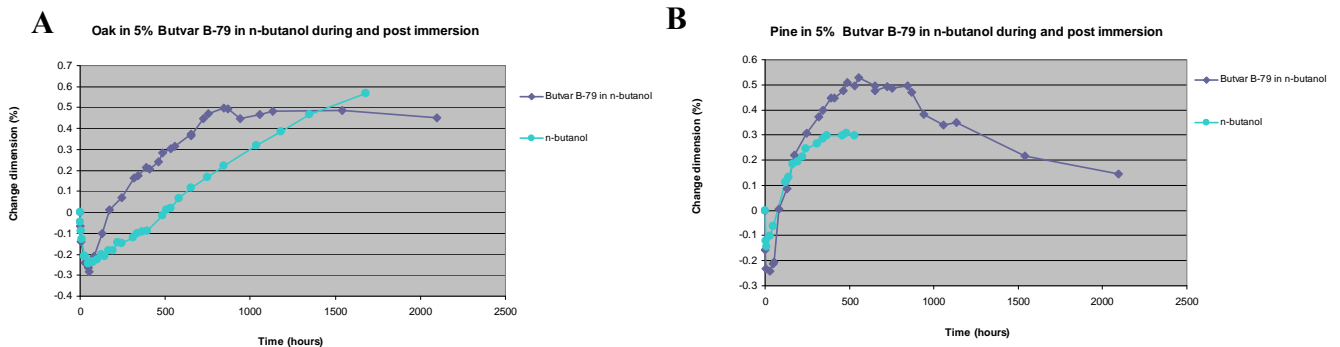


Figure 8. Percentage change in radial dimension for white oak and eastern white pine immersed in 5% Butvar B-79 in n-butanol compared to pure n-butanol. Drying curves post immersion for samples exposed to consolidant solution only are also shown.

Figure 8 shows the response of oak samples (A) and pine samples (B) exposed to a consolidant solution of 5% Butvar B-79/n-butanol compared to immersion results from n-butanol. Samples of oak and pine were removed from the consolidant solution for drying at 650 hours. Drying time shown in Figure 8 is 1450 hours. Both oak and pine show similar behaviour in the consolidant solution and solvent alone with an initial shrinkage followed by swelling. The presence of the consolidant causes an amplification of the swelling. This reaches a maximum for oak (A) of just under 0.5% at 650 hours compared to a swelling of 0.25% for the solvent alone. Pine samples (B) show an increase in dimension of slightly over 0.5% at 650 hours of exposure to the consolidant solution compared to 0.3% for a comparable exposure time to n-butanol alone. After 1450 hours of drying, neither the oak nor the pine samples have returned to their original dimensions; the oak retains a 0.45% increase in dimension, and the pine 0.15%.

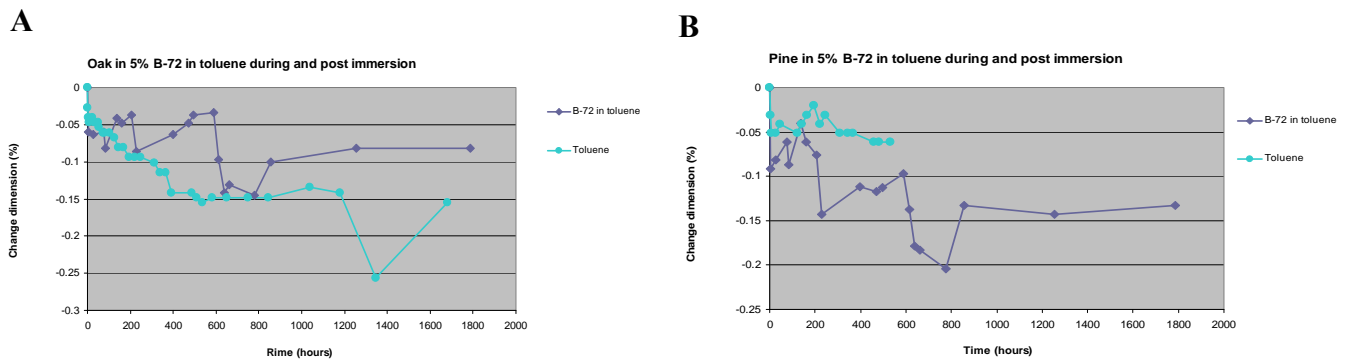


Figure 9. Percentage change in radial dimension for white oak and eastern white pine immersed in 5% B-72 in toluene compared to pure toluene. Drying curves post immersion for samples exposed to consolidant solution only are also shown.

Figure 9 shows the results of oak samples (A) and pine samples (B) immersed in a consolidant solution of 5% B-72/toluene compared to toluene alone. Samples were removed from the consolidant solution at 600 hours, and drying times, as given in Figure 9, are 1200 hours. As with all previous tests, the solvent plays a predominant role in the behaviour of the wood. In this case, oak and pine shrink from exposure to both the solvent alone and the consolidant solution. The presence of the consolidant in solution appears to provoke non-ideal behaviour in oak samples (A) with some mitigation then a worsening of shrinkage, whereas the consolidant appears only to worsen the shrinking of pine samples (B), with a 0.1% shrinkage on exposure to the consolidant solution as opposed to 0.06% for toluene alone. After 1200 hours of drying, the oak samples retain a shrinkage of 0.08%, and the pine a shrinkage of approximately 0.13%.

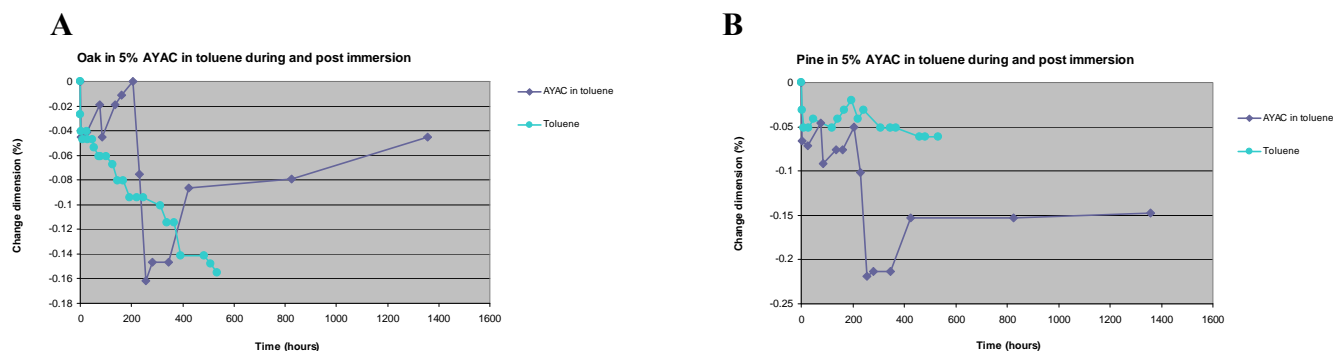


Figure 10. Percentage change in radial dimension for white oak and eastern white pine immersed in 5% AYAC in toluene compared to pure toluene. Drying curves post immersion for samples exposed to consolidant solution only are also shown.

Figure 10 shows the results of oak samples (A) and pine samples (B) immersed in a consolidant solution of 5% AYAC/toluene compared to pure toluene. Samples were removed from the consolidant solution after 250 hours of immersion. Drying time given in Figure 10 is 1150 hours. Again, the solvent affects the reaction of both oak and pine. In this case, the predominant response is shrinkage. There is a similarity in behaviour to samples immersed in toluene and B-72 (Figure 9A, B) with oak samples (Figure 10A) showing non-ideal behaviour: some mitigation in shrinkage followed by increased shrinkage, and an overall increase in shrinkage of the pine samples (Figure 10B). After drying, the oak samples gradually regain most of their original dimension, but fall short at slightly over 0.04% loss after 1150 hours of drying. Pine samples show a loss in dimension of 1.5%.

Long-term effects

Measurements and weights taken after 4 months of air drying are shown in Table 2 for samples immersed in consolidant solutions. Negative numbers reflect loss of dimension. In almost every test, some dimensional change is retained. Generally, pine samples show the larger response both in retained swelling and shrinkage. Pine samples immersed in Aquazol 50/ethanol demonstrate a large loss from original dimension on drying (-0.39%) as do, to a much lesser extent, the pine samples immersed in Aquazol 50/isopropanol (-0.05%). Samples immersed in Butvar B-79/n-butanol show the greatest change in state upon long-term drying with retained swelling of 0.44% for oak and 0.65% for pine. Following immersion in AYAC/toluene and B-72/toluene, oak samples have virtually returned to pretreatment state, but pine samples show retained shrinkage. In terms of retained consolidant, the smallest weight gains are for samples immersed in Butvar B-79/n-butanol and Acryloid B-72/toluene. The greatest weight gain is by oak and pine immersed in AYAC/ toluene. AYAC has the smallest molecular weight of all of the test consolidants, and it is likely that uptake through the wood structure and into voids is more successful than that of consolidants with larger molecular structures. Samples of wood immersed in Aquazol 50/ethanol show a greater weight gain for both pine and oak than do samples immersed in Aquazol 50/isopropanol. In this case, the increased solvent swelling of the wood by ethanol may be responsible for the more effective uptake of consolidant.

Table 2. Percentage change in dimension after 4 months of drying/ weight gains.

Solvents and consolidant solutions	Percentage change after 4 months drying		Weight gain	
	Oak	Pine	Oak	Pine
Ethanol + Aquazol 50	0.19	-0.39	2.29	5.60
Isopropanol + Aquazol 50	0.08	-0.05	1.58	2.30
n-Butanol + Butvar B-79	0.44	0.65	1.88	1.57
Toluene + Acryloid B-72	-0.04	-0.13	0.89	3.65
Toluene + AYAC	0	-0.15	2.66	11.90

Discussion

Role of the solvents

Results show a correlation between dimensional change and exposure to solvents — the nature of the change depending on the solvent. Polarity, as described by Schniewind (1990), as well as molecular weight or volume (Stamm 1935; de Bruyne 1939; Jensen 1997) have a significant role. The more polar the solvent the greater the swelling potential, and the smaller the molecule the more likely the penetration into the cell wall where swelling takes place. For solvents to swell wood they must follow the same physical-chemical pathways as water. Water exists in wood in two forms: adsorbed into cell walls, and free water present in cell voids. Once absorbed into voids, water diffuses, below the fibre saturation point, into the cell structure, prompted by moisture gradients set up across the cell walls (Kollmann 1968, p. 220). This diffusion happens through a molecular jump phenomenon where molecules of polar vapour (water) are adsorbed on the hydroxyl groups of the cellulose, hemicellulose, and lignin at the solid void interfaces (Stamm 1975, pp. 104–106). When adsorbed, the water will swell the cell walls through an interaction with the hydroxyl groups of cellulose and hemicelluloses (Unger et al. 2001, p. 21). Swelling is not related to the uptake of liquid in the cell lumen or voids (Siau 1971, p. 5). Dense hardwoods (oak) have a greater ratio of cell wall to voids than softwoods (pine), and, as swelling is proportional to the volume of water adsorbed in the cell wall, the denser the wood the greater the dimensional change (Kollmann 1968, p. 162). This correlation is confirmed with the results for immersion of the hard and softwoods in pure solvents.

A solvent with a small CMD and high polarity such as ethanol can rapidly replace water in the cell wall, causing this to swell as the wood is flooded with the solvent. The larger and less polar solvents, isopropanol and n-butanol, will penetrate cell walls, forcing water out, but will not replace water as readily as the more polar ethanol. This may explain the initial shrinkage followed by the gradual swelling of wood exposed to these solvents. In the case of toluene, the CMD of these molecules is too large to allow for penetration and, even if the molecules could pass into the walls, as is the case for the smaller pentane molecules, reactive hydroxyl groups cannot be accessed by these low to non-polar solvents for swelling to occur. As water is drawn out of the cells, the wood shrinks.

Consolidant solutions

Solvents drive the dimensional response, and consolidants, present in swelling solvents such as ethanol, isopropanol, and n-butanol, will amplify the solvent swelling. Consolidants dissolved in a solvent that causes shrinkage, such as toluene, have a more complex influence that could be related to density of the wood. With denser wood, the consolidant in the toluene inhibits, to a small degree, shrinkage, but conversely amplifies this in the softwood samples. Schniewind (1990) reports that, in a number of consolidant solutions, tangential swelling of Douglas fir samples is largely recovered after a 4-week period. Results for samples dried for 4 months show some recovery, notably samples of oak immersed in AYAC in toluene and Acryloid B-72 in toluene. However, long-term changes are apparent in most of the other samples, especially the pine where, in each case, either swelling or shrinkage was more pronounced after 4 months of drying than in their oak counterparts. This is not due to quantity of consolidant retained by the wood, as weight gain does not correlate to dimensional change. In most cases the pine samples show a lingering, if not permanent reduction in dimension, especially in the case of samples immersed in Aquazol 50/ethanol. This shrinkage may be due to cell collapse as a result of pressure gradients that develop within the cell wall and between the cell wall and voids during loss of solvent in the drying phase. Retained consolidant within the voids may prevent dimensional recovery on drying.

Conclusion

Dimensional change can take place within the span of normal treatment times. Swelling of wood will cause cracking, and shrinkage: warping of the wood and compression and delamination of decorative layers. Although testing was carried out on undamaged wood, historic wood will still respond to the influence of solvents (Buck 1952; Erhardt et al. 1996; Unger et al. 2001). The purpose of this research was to better understand the response of wood immersed in common solvents and consolidants, and to begin to characterize these responses. The best treatment method may not yet be clear, but some interesting results on swelling and shrinkage provoked by solvents and consolidant solutions are presented. More work is required to characterize the behaviour of different species of wood to particular solvents and consolidants in order to identify appropriate combinations that will cause the least change in dimension.

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Materials and Suppliers

Acryloid B-72 (Paraloid B-72)

Rohm and Haas Canada
2 Manse Road
Scarborough ON Canada
Tel.: 416-284-4711

AYAC

Union Carbide (Dow Chemical Company)
Resins for this experiment were obtained in 2002 from Conservation Emporium, Sparks, Nevada, USA, and were manufactured by Union Carbide (Dow Chemical Company). PVACs are no longer made by Union Carbide. Currently available PVACs (manufacturer unknown) are not direct equivalents to the Union Carbide products. Glass transition temperatures and molecular weights differ.

Aquazol 50

Polymer Chemistry Innovations Inc.
4231 South Fremont Avenue
Tucson AZ USA
Tel.: 520-746-8876

Butvar B-79

Monsanto Company
5054 W. Jefferson Avenue
Trenton MI USA
Tel.: 313-675-5444

Ethanol (anhydrous ethyl alcohol, water content 0.1%)

Commercial Alcohols Inc.
98 Walker Drive
Brampton ON Canada
Tel.: 905-790-7500

Isopropanol (isopropyl alcohol, water content 0.2%, certified ACS)

Canada Wide Scientific
2300 Walkley Road
Ottawa ON Canada
Tel.: 1-800-267-2362

n-Butanol (1-butanol, certified ACS)

Thermo Fisher Scientific
112 Colonnade Road
Nepean ON Canada
Tel.: 613-226-8874

Toluene (certified ACS, water content 0.006%)

Thermo Fisher Scientific
112 Colonnade Road
Nepean ON Canada
Tel.: 613-226-8874

Author Biographies and Contact Information

Wendy A. Baker is a graduate of the Art Conservation Program at Queen's University, Kingston, Ontario (1977–1979). After working for a number of years in the private sector where she maintained a studio specializing in the conservation of paintings, she joined the Fine Arts Laboratory of the Canadian Conservation Institute in 2002. Her duties now include conservation treatments of paintings, research into conservation techniques and materials, and the training of interns.

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David W. Grattan earned a degree in Chemistry from Imperial College, University of London in 1968, and spent the next 2 years in industrial research at the International Synthetic Rubber Company. He continued his education with a PhD in Polymer Chemistry from the University of Keele (1973) followed by 4 years of postdoctoral research at the National Research Council of Canada, involving gas kinetics and then the light stability of polymers. David joined the Canadian Conservation Institute (CCI) in 1977, where he began his conservation career immersed in the problems of waterlogged wood. He maintains an active research interest in the application of science to the conservation of wood. David was Chair of the International Council of Museums – Committee for Conservation (ICOM-CC) for two successive terms from 1996 to 2002, and also served on the board of Abstracts of International Conservation Literature (AATA) for a number of years. He retired as Manager of Conservation Research at CCI in February 2011.

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E-mail: dwgrattan@gmail.com

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Wendy A. Baker est diplômée du programme de conservation-restauration de l'Université Queen's, à Kingston en Ontario (1977 à 1979). Après avoir travaillé un certain temps dans le secteur privé, où elle avait ouvert un studio spécialisé en restauration de tableaux, elle fait son entrée en 2002 au laboratoire des beaux-arts de l'Institut canadien de conservation. Dans le cadre de ses fonctions, elle effectue des traitements de restauration de peintures, réalise des travaux de recherche sur les techniques et les matériaux de restauration et veille à l'apprentissage des stagiaires.

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David W. Grattan a obtenu un diplôme en chimie à l'Imperial College de l'Université de Londres en 1968, et il a consacré les deux années subséquentes à des travaux de recherche industrielle à l'International Synthetic Rubber Company. Il poursuit ses études et obtient un doctorat en chimie des polymères à l'Université de Keele (1973), puis il passe quatre ans à mener des travaux de recherche au niveau postdoctoral au Conseil national de recherches du Canada sur la cinétique des gaz, puis sur la stabilité à la lumière des polymères. M. Grattan commence à travailler à l'Institut canadien de conservation (ICC) en 1977, où il s'est d'abord attaqué aux problèmes des bois gorgés d'eau. Il continue de mener des recherches sur les applications scientifiques utiles pour la restauration du bois. Il a occupé la présidence du Comité pour la conservation du Conseil international des musées (ICOM-CC) durant deux mandats consécutifs, de 1996 à 2002; il a également siégé plusieurs années au conseil d'administration de l'Abstracts of International Conservation Literature (AATA). En février 2011, il a quitté son poste de directeur de la recherche en conservation à l'ICC pour prendre sa retraite.

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