Supercritical CO_2 dewatering of *E. nitens*. Results of Scion's core funded experiments

Bernie Dawson, Hamish Pearson, Rosie Sargent

Report information sheet

Report title	Supercritical CO_2 dewatering of *E. nitens.* Results of Scion's core funded experiments
Authors	Bernie Dawson, Hamish Pearson, Rosie Sargent Scion
Client	Specialty Wood Products Partnership
Client contract number	
MBIE contract number	
SIDNEY output number	
Signed off by	Doug Gaunt
Date	August 2018
Confidentiality requirement	Confidential (for client use only)
Intellectual property	© New Zealand Forest Research Institute Limited. All rights reserved. Unless permitted by contract or law, no part of this work may be reproduced, stored or copied in any form or by any means without the express permission of the New Zealand Forest Research Institute Limited (trading as Scion).
Disclaimer	The information and opinions provided in the Report have been prepared for the Client and its specified purposes. Accordingly, any person other than the Client uses the information and opinions in this report entirely at its own risk. The Report has been provided in good faith and on the basis that reasonable endeavours have been made to be accurate and not misleading and to exercise reasonable care, skill and judgment in providing such information and opinions. Neither Scion, nor any of its employees, officers, contractors, agents or other persons acting on its behalf or under its control accepts any responsibility or liability in respect of any information or opinions provided in this Report.

Published by: Scion, 49 Sala Street, Private Bag 3020, Rotorua 3046, New Zealand. www.scionresearch.com

Executive summary

The problem

The objective of this study was to see if removing sap from *Eucalyptus nitens* via supercritical CO_2 dewatering reduces the level of checking and collapse

This project

Eucalyptus nitens was sourced from Southwood Exports in Southland, and small boards were either air dried from green to ~12% moisture content, or dewatered with supercritical CO_2 to remove sap from the lumens prior to air drying to 12%. Levels of collapse, and numbers of checks were measured following drying.

Key results

The dewatered boards had significantly lower levels of collapse compared to the air dried boards. The average depth of collapse was reduced from 1 mm per board face to 0.25 mm per board face.

The number of checks on the faces and ends of the dewatered boards were higher than in the air dried boards.

Implications of results for the client

Dewatering with supercritical CO_2 has potential to reduce levels of collapse in *E. nitens*. Levels of end checking are increased, but these may not necessarily correlate with the presence of internal checking.

Further work

As a next step, it is recommended that the economics of the dewatering process be compared to that of air drying from green.

Supercritical CO2 dewatering of *E. nitens*. Results of Scion's core funded experiments

Table of contents

Introduction

A significant component of drying degrade in *E. nitens* is often caused by water tension forces which form early in the drying phase, when the cell lumens are substantially filled with sap. If this lumen filling liquid can be removed by mechanical means, rather than via evaporation, checking and collapse may not form during subsequent drying. Scion has developed a supercritical CO_2 dewatering treatment (Dawson & Pearson, 2017; Franich, et al., 2014) as a means of removing lumen water from green radiata wood. The final moisture content is typically close to the fibre saturation point (~30% MC). To date, this treatment has been primarily used with radiata pine, but there is potential for its use in collapse prone species such as *E. nitens*. In this work this dewatering was used as a pre-treatment prior to drying *E. nitens*. Levels of cross sectional shrinkage (a measure of collapse) and visible surface checks were compared between treated (dewatered) and air-dried boards, and untreated and air-dried boards.

Materials and methods

Billets from approximately 15 year-old plantation grown *E. nitens* trees were obtained from SouthWood Exports Ltd. The billets were cut from around 2.5m up the tree. The cut faces of each billet were sealed with Logshield, and sent to Rotorua via refrigerated freight. Ten billets were chosen for this study (based on absence of defects, high proportion of heartwood etc.). Each billet was milled to produce green flat/quarter sawn 37x37x550 mm^3 boards (Figure 1). Care was taken to ensure all boards are positioned in the same growth rings of the outer heartwood.

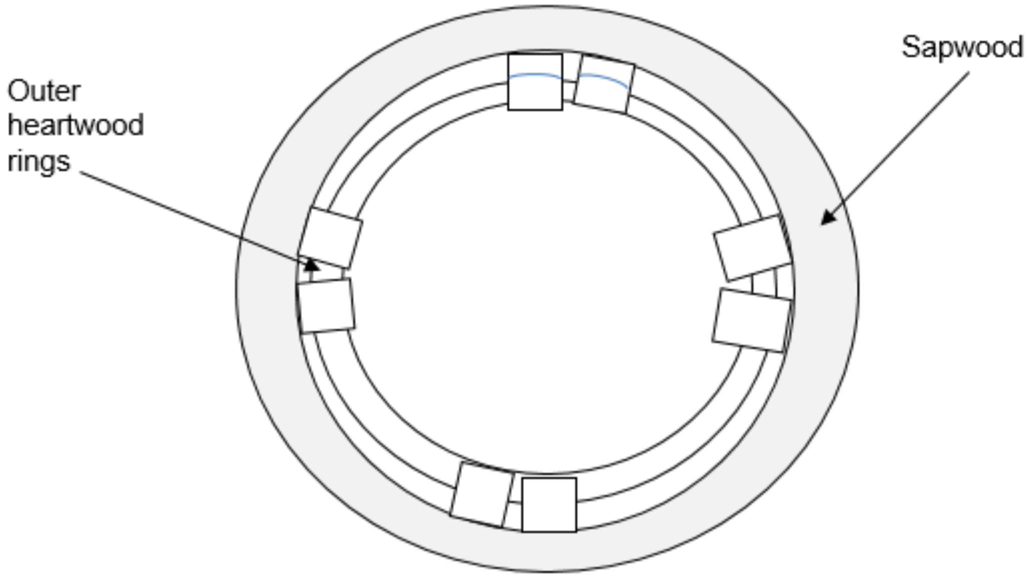

Figure 1 Approximate position of boards cut from *E. nitens* billets

Each board was cut into two 200 mm long boards, carefully avoiding defects, plus an offcut (taken from between the two 200 mm long samples) for MC and density determination.

37x37x200 mm^3 specimens from each pair were randomised and assigned to the treated (dewatered) and untreated group.

Water removal

Dewatering

The dewatering treatment was performed in the Scion 1L SCF (supercritical fluid) plant, using the standard dewatering schedule developed at Scion for radiata pine (Dawson & Pearson, 2017). Sap expelled from the wood was collected periodically during the treatment cycles before being weighed and recorded. Boards were weighed before and after treatment. Following treatment, boards were air dried.

Air drying

Air drying was performed under constant conditions: 25°C / 65% RH. Boards were weighed prior to being placed in the room. Board weights were monitored periodically, and drying continued until board weights have stabilised (~12% MC). Their final weights were recorded.

Measurements

Collapse

AS/NZS 4787 (2000) Timber - Assessment of Drying Quality quantifies collapse in terms of the material that needs to be removed to give two parallel straight faces on the widest dimension (Figures 2&3). Collapse was measured on the two radial faces as the sum of the largest cross-section depressions from the original green surface.

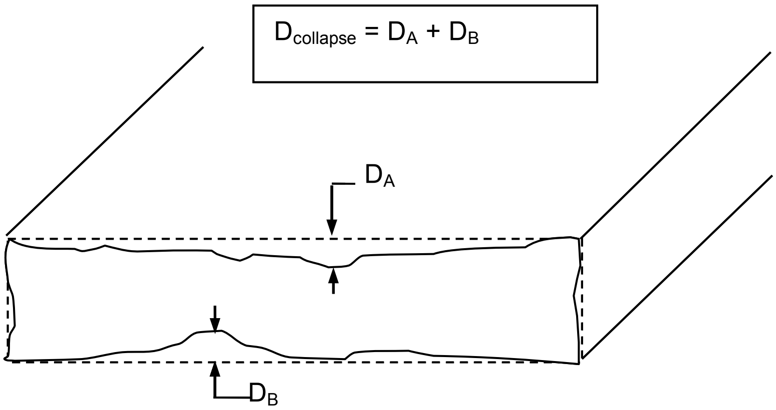

Figure 2 AS/NZS 4787:2001 degree of collapse

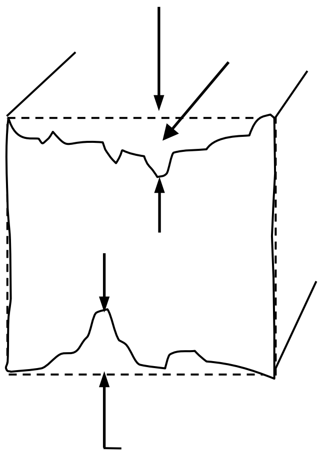

Figure 3 With a square cross section, measure the two deepest depressions on opposite radial faces and quantify collapse as their sum in millimetres.

Checking

Visible checks were measured on the *two ends* of each specimen as both the number of checks and their total width (mm), and on the *four faces* as the number of checks and their total length (mm).

Results and discussion

The level of collapse following dewatering or air drying is shown in Figure 4. The dewatered boards had significantly lower levels of collapse compared to the air dried boards.

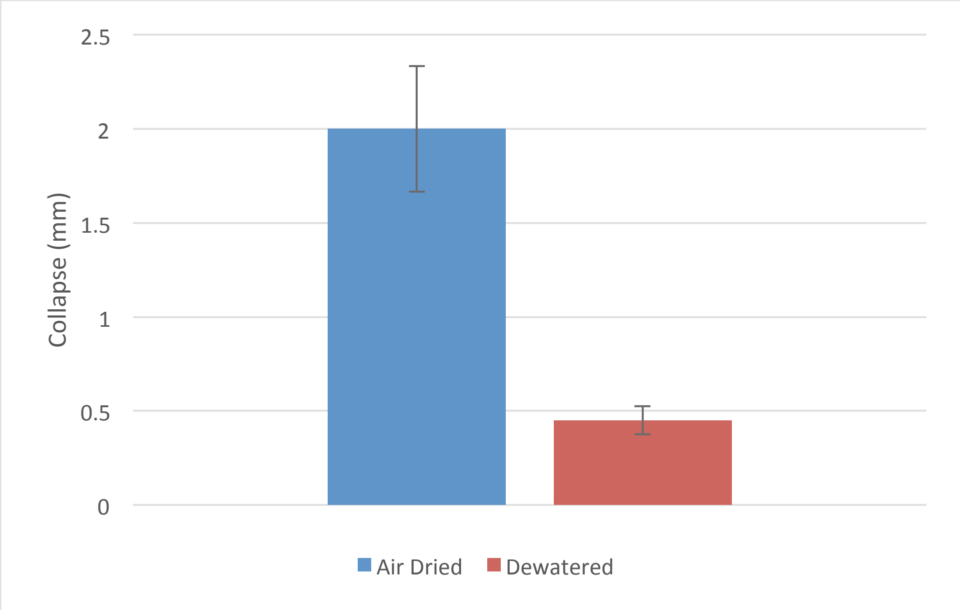

Figure 4 Maximum depth of collapse following drying to 12% MC

The number of checks on the faces and ends of the boards are shown in Figure 5. The numbers of surface checks are very low in both the air dried and dewatered boards. The air dried boards had an average of two end checks per board, but the dewatered boards had an average of eight end checks per board. End checking is not necessarily an indication of internal (within-ring) checking, and levels of within ring checking would need to be confirmed in a separate study.

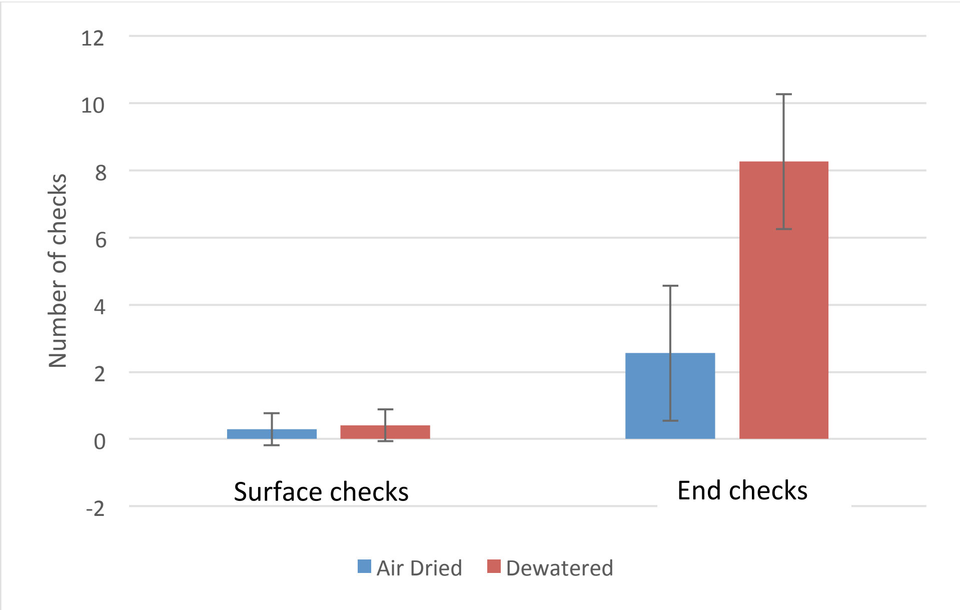

Figure 5 Number of checks on the faces and ends of specimens following drying to 12% MC

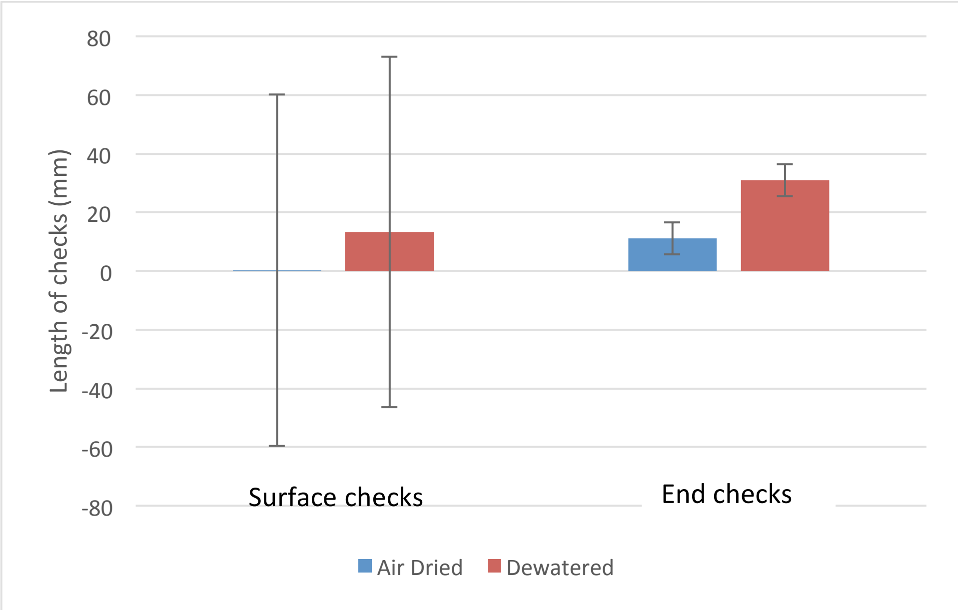

Figure 6 Total length of checks on the faces and ends of specimens following drying to 12% MC. The large standard errors for surface checks are from outliers in the data.

The lengths of surface and face checks was highly variable (Figure 6). The majority of specimens had no surface checks but a few specimens had many surface checks giving a total length of checks up to 1000 mm. This leads to a large standard deviation, and thus a large standard error relative to the mean check length.

Recommendations and conclusions

Supercritical CO_2 dewatering reduced levels of collapse compared with air drying from green. Levels of end checking were higher following dewatering. End checking may not necessarily be a good predictor of internal checks in larger boards, so this result would need to be confirmed.

It is planned to evaluate the economics of dewatering *E. nitens* and to compare this with air drying from green.

Acknowledgements

Logs used in this study were supplied free of charge by Graeme Manley at SouthWood Exports Ltd.

John Lee and Jamie Agnew (Scion) assisted with sawing of the logs and small boards. Bruce Davy assisted with the dewatering treatments.

References

AS/NZS 4787. (2000). Timber - Assessment of Drying Quality.

Dawson, B. S. W., & Pearson, H. (2017). Effect of supercritical CO2 dewatering followed by oven-drying of softwood and hardwood timbers. *Wood Science and Technology, 51*(4), 771-784. doi:10.1007/s00226-017-0895-8

Franich, R. A., Gallagher, S., & Kroese, H. (2014). Dewatering green sapwood using carbon dioxide cycled between supercritical fluid and gas phase. *Journal of Supercritical Fluids, 89*, 113-118. doi:10.1016/j.supflu.2014.02.019