Drying development on Chilean hardwoods

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Plan

• Introduction
• Current status in drying of Chilean hardwoods
• Challenges in drying of Chilean hardwoods
• Chilean research in drying of Chilean hardwoods
• Conclusions
High interest in Chile for increasing the amount of hardwood coming from fast sustainable managed plantations, processed into solid wood products, like Eucalyptus species.

Radiata pine are decreasing

Eucalyptus are increasing

Plantation 1967: 200,000 ha
Eucalyptus 1967: 31,000 ha
Plantation 2017: 3,100,000 ha

Eucalyptus globulus 2017: 590,000 ha
Eucalyptus nitens 2017: 270,000 ha

Pinus radiata 2017: 1,400,000 ha
Radiata pine production: Very important
Crises internationals: Down production
1982 and 2009
Industrial uses of radiata pine is around 50% in solid wood.

Only about 1% of the harvested hardwoods is transformed into solid wood products.
Introduction

Hardwood production 1967: 350,000 m$^3$
Hardwood production 2017: 125,000 m$^3$
Decreases: 60%

Because of *Nothofagus* species:
Coigüé, lenga, raulí
Expensive
Environmentally damaging
Long rotation
Drying problems

Softwood production 1967: 500,000 m$^3$
Softwood production 2017: 8,000,000 m$^3$
Increases: 16 times

Due to *Pinus* specie:
Radiata pine
Less costly
Sustainably managed
Short rotation
Easy to dry

There is a great opportunity for developing the drying of Chilean hardwoods, using species of short rotation, managed sustainably and less costly.
CURRENT STATUS OF CHILEAN HARDWOODS

Nothofagus species:
- Coigüe
- Lenga
- Raulí
- Roble
- Expensive
- Environmentally damaging
CURRENT STATUS OF CHILEAN HARDWOODS

Pre-heating for color homogenisation of Chilean *Nothofagus*

Coigüe and lenga
T = 100°C
HR = 100%
t = 12-24 h
Current Status of Chilean Hardwoods

Air-drying of Chilean coigüe

Long drying times:
- 6 months to 2-years
- High costly
Air drying of raúlí: 50-mm: Effect of year-period
CURRENT STATUS OF CHILEAN HARDWOODS

Pre-drying of Chilean coigüe

Reduce drying time: 2/3
Best wood quality
CURRENT STATUS OF CHILEAN HARDWOODS

Low temperature KD of Chilean coigüe

$T=40-70 \, ^\circ C$
$t= 30-90 \, \text{days}$
After predrying
CURRENT STATUS OF CHILEAN HARDWOODS

- Low temperature KD of coigüe: 30-mm
CURRENT STATUS OF CHILEAN HARDWOODS

• Low temperature KD of coigüe: 30-mm
CURRENT STATUS OF CHILEAN HARDWOODS

Vacuum drying of Chilean hardwoods

T = 40-60 °C
P = 0.4-0.8 at
t = 15-30 days
After predrying
CURRENT STATUS OF CHILEAN HARDWOODS

- Vacuum drying of lenga: 50-mm
Using fast growing hardwoods
Higher than 40 m³/ha/year.
Low costly

Environmentally friendly hardwoods species can be certified as sustainable managed forest

New solid wood products from eucalyptus wood could be replace the used of native hardwood species as Nothofagus
Material
Juvenile wood
Age < 20 years old
Diameter < 40 cm
Growth-stresses
Sawnwood
Sawn-wood prepared using band-saw.

Optimized production.
Compensated sawing to alleviate growth-stresses.
Juvenile wood

Vessels: Tylosis, great diameter
Parenchyma paratraqueal abundant
High variability of anatomical features
CHALLENGES IN DRYING OF CHILEAN HARDWOODS

- Low density
- High growth-ring width
- High radial variability
CHALLENGES IN DRYING OF CHILEAN HARDWOODS

High collapse

BR: Before reaconditioning, AR: After reaconditioning, CO: Collapse

Tangential Shrinkage (%)

Core  Transition  Lateral
CHALLENGES IN DRYING OF CHILEAN HARDWOODS

High deformation during drying

Week 1

Week 8
High drying stress on the wood surface at the beginning of drying process. Inducing surface checking.
Highest values of drying stress are induced during convective drying of juvenile wood.
- Intensify internal checks.
- Limited the collapse recuperation.
RESEARCH IN DRYING OF CHILEAN HARDWOODS

Drying schedules

Low T
Very low air-velocity
- Drying low T
- Using a global mass-transfer coefficient
- Performing of drying schedules
- To control MC

Simple drying simulation of MC
Simulation of the drying stresses

- Drying low T
- Performing drying schedules
- To reduce drying checks
- Drying low T
- Performing drying schedules
- Recovering collapse
- To relieve drying-stresses
RESEARCH IN DRYING OF CHILEAN HARDWOODS

E. nitens 25-mm

a) Before drying RFV  
b) After drying RFV (150 h)
RESEARCH IN DRYING OF CHILEAN HARDWOODS

E. nitens 25-mm

c) After reaconditioning (12h)
RESEARCH IN DRYING OF CHILEAN HARDWOODS

Drying RFV nitens 25-mm
RESEARCH IN DRYING OF CHILEAN HARDWOODS

E. nitens 50-mm

a) Before drying RFV

b) After drying RFV
c) Before reaconditioning

c) After reaconditioning (12 h)
RESEARCH IN DRYING OF CHILEAN HARDWOODS

E. nitens 50-mm
RESEARCH IN DRYING OF CHILEAN HARDWOODS

RFV drying of E. regnans 25 mm

a) Before RFV drying

a) After RFV drying
RESEARCH IN DRYING OF CHILEAN HARDWOODS

E. regnans 25-mm
RESEARCH IN DRYING OF CHILEAN HARDWOODS

Thermal wood modification of E. nitens 25 mm

a) Before TWM

a) After TWM
Thermal wood modification E. nitens 25-mm

**Drying-etape:**
- Drying time: 44 h
- Td= 70 °C
- Tw= 50 °C
- MC from 12 to 4 %.

**TWM-etape:**
- TWM time: 3h
- Td= 190 °C
- Tw= 100 °C
- Cooling stage Tw < 100 °C
- Conditioning stage
- Final MC 6-8%
Conclusions

Drying development of Chilean hardwoods will enable wood producers to begin replacing expensive and often environmentally damaging hardwoods species with less costly and sustainably managed eucalyptus wood for solid wood products.

Once the technological problem of drying Eucalyptus is solved, then the produced wood will seek to substitute other more expensive and less sustainable native hardwood species both internally and in the international market.

RFV drying can be applied successfully in some Chilean hardwoods, as well Eucalyptus.

Thermal wood modification is another development for some Chilean hardwoods as well Eucalyptus, for solid wood products.
“...Yo llevo por el mundo en mi cuerpo, en mi ropa, aroma de aserradero, olor de tabla roja...”

(Oda a la madera, Pablo Neruda)

Thank you for your attention