DRYTECH 2008
Timber Drying Kiln Specifications:
Performance vs. Prescriptive

Steve Riley
Outline

• How kilns are specified by purchasers/vendors
• Prescriptive approach
• Things to consider
• Performance based approach
• Combining the two
• Recommendations
Good drying is a balance

Lots of kilns

↓ Slow drying

↓ Low degrade

Hi capital cost +

Hi running cost
Evolution
Kiln Design evolution

Air Dry FAD
- Low air flow
- Narrow walkways
- Influenced by hardwood experience
- Limit extremes
- Uncontrolled

Conv KD
- Control humidity and temperature

HT
- High temps, fast heat up,
- Driven by 'plasticizing' wood to reduce twist
- High air flows arrive later

ACT
- Toning down HT for appearance grade
- High production driven
- Wide walkways, design detail
- High air flows arrive later
Emphasis is on

• Temperature
• Heat –up rates
• Velocity
• i.e a description of the process

PRESCRIPTIVE SPECIFICATION
Prescriptive Based Specification

• Must be complete !!!
• Drying rate depends on
  – Temperature  AND
  – Humidity     AND
  – Air Velocity
• Productivity depends on how all three and how they are achieved
Currently common specification

- Kiln will operate at given DB and WB
- Will reach DB in given time
- Minimum air velocity.
- With luck, variability of DB, WB and V.
- Reco step - time to reach DB
Supplier A
- Meets spec but heat exchanger is small
- When vents open DB control is lost
- Extended dry times - more variability
- Cheaper price

Supplier B
- Meets spec but heat exchanger is larger
- When vents open DB control is not lost
- Needs more expensive fans as well
- Cheapest price
Things to consider when specifying a kiln

Ability to reach DB

• Currently a common attempt to define heat input.
• Historically from HT drying, plasticization
• Obviously important for high production.
• Evidence of quality benefit of drying fast early then slowing
Things to consider when specifying a kiln

Ability to reach WB

- Currently routinely ignored
- Only specifying DB with closed vents is insufficient
- Soon as vents open, max air heat load coincides with max evaporation load
- This invariably effects the DB
- Thus must specify time to reach WB also
Kiln with insufficient heating to maintain WB depression

(1) WB set point dropped quickly
- DB struggles while WB maintained

(2) WB set point ramped down
- DB maintained while WB slowly ramped down

A solution:
- Can be improved with WB ramp but drying time still extended

- Drying is time extended
- No Zonal control

DryTech 08
Air Velocity is Important

- New WPP Newsletter Article
- Dry time $\propto V^{-B}$, $0.5 < B < 0.8$
- But $kW \propto V^3$
- Thus selection of air velocity $V$ is critical

Experimental and Industrial ACT charges dried to "similar" final MC

Things to consider when specifying a kiln

DryTech 08
Things to consider when specifying a kiln

**Fan electricity use**

- Fans operate 24/7
- Fan kW = Total Pressure Drop x Volume Delivered /Efficiency
  - No. fans
  - Fan diameter
  - Heat exchanger

Bypass

- 0.3-0.75
- reversibility
- motor, drives
## Effect of Bypass

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2a</th>
<th>2b</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>Stack air velocity m/s</td>
<td>2.7</td>
<td>3.7</td>
<td>5.0</td>
<td>4.7</td>
<td>3.3</td>
<td>2.0</td>
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<tr>
<td>Stack air vol m³/s</td>
<td>31.7</td>
<td>36.4</td>
<td>48.7</td>
<td>52.1</td>
<td>33.6</td>
<td>20.1</td>
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<tr>
<td>Bypass air vol m³/s</td>
<td>18.1</td>
<td>19.0</td>
<td>0</td>
<td>28.0</td>
<td>16.8</td>
<td>18.5</td>
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<tr>
<td>Bypass $(\frac{Bypass\ Vol}{Stack\ Vol})$</td>
<td>57</td>
<td>53</td>
<td>0</td>
<td>54</td>
<td>50</td>
<td>92</td>
</tr>
<tr>
<td>Comments</td>
<td>Full stack</td>
<td>Full stack</td>
<td>2a fully baffled</td>
<td>Full stack</td>
<td>Full stack</td>
<td>Packet loaded</td>
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</table>

High values- 50% not uncommon
### Bypass – Accommodated

<table>
<thead>
<tr>
<th>Bypass %</th>
<th>Pressure drop Pa</th>
<th>Vol/fan m3/s</th>
<th>kW for 10 fans</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>261</td>
<td>9.2</td>
<td>34.2</td>
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<tr>
<td>10</td>
<td>302</td>
<td>10.1</td>
<td>43.5</td>
</tr>
<tr>
<td>20</td>
<td>347</td>
<td>11.0</td>
<td>54.5</td>
</tr>
<tr>
<td>50</td>
<td>502</td>
<td>13.7</td>
<td>98.5</td>
</tr>
<tr>
<td>100</td>
<td>829</td>
<td>18.3</td>
<td>216.8</td>
</tr>
</tbody>
</table>

### Bypass – Ignored

<table>
<thead>
<tr>
<th>Bypass</th>
<th>P</th>
<th>Volume/fan</th>
<th>Stack air velocity</th>
<th>Drying time decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>Pa</td>
<td>m3/s</td>
<td>m/s</td>
<td>%</td>
</tr>
<tr>
<td>0</td>
<td>261.9</td>
<td>9.17</td>
<td>5.00</td>
<td>0.0</td>
</tr>
<tr>
<td>10</td>
<td>257.5</td>
<td>9.27</td>
<td>4.60</td>
<td>4.3</td>
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<tr>
<td>20</td>
<td>254.2</td>
<td>9.35</td>
<td>4.25</td>
<td>8.5</td>
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<tr>
<td>50</td>
<td>247.6</td>
<td>9.50</td>
<td>3.46</td>
<td>20.3</td>
</tr>
<tr>
<td>100</td>
<td>242.1</td>
<td>9.63</td>
<td>2.63</td>
<td>38.0</td>
</tr>
</tbody>
</table>
Another example of poor prescriptive thinking

- 1990’s vacuum kilns arrived in NZ for radiata
- They were compared with steam/vent kilns at same DB and RH…. But was air velocity ignored
- Conclusion – significant drop in drying time
- BUT if equivalent fan kW’s had been used, drying times would have been similar.
Things to consider when specifying a kiln

Cooling

• Most reco-ing is improved by cooling after drying
• If cooling is carried out in-kiln, its rate should be specified
• Multi-Step steaming
• Can heat generator/transfer system handle it?
Things to consider when specifying a kiln

Reco Baths

- Ability to reach DB set pt very important
- It all happens in the first hour
- Huge range of water use. Depends on:-
  - Bath size/exchanger size
  - Location of sensor
  - Boil strategy (minCv etc).
Things to consider when specifying a kiln

Emissions

**Gaseous**
- Increasing issue
- Will be required for every new kiln
- New features – centralised stacks, condensers etc

**Liquid**
- Disposal could be part of spec

**Noise**
- Whisper kits, time-based fan speed
Prescriptive approach to specifying a kiln:-

• The commonly used approach

• If used it must be complete.
Performance based approach

- Specify annual throughput i.e. drying time
- Specify Quality requirement
- Statement of running cost

- Leave kiln details to supplier
Performance based specifying

• Appears straightforward but isn’t
• Practically proving throughput and quality is not easy
• No kiln vendor wants to be held hostage to resource variability
Performance Specs

Drying time:-

• Drying time test charge must be completely specified
  – Fresh material (less than fresh = more variable)
  – Thickness, width, grade
  – Stacking, loading factor
  – Weighting
  – Baffling
  – End point
Performance specs

Drying Quality:-

- Final quality intimately connected to MC end point
- Realistic (skewed) MC distribution expected/
- Specify how MC will be measured, calibration etc
- Residual stress is a measure of steaming effectiveness and end point (transverse only)
- Recommend rip cup as stress measure
- Surface checking is material/handling issue
Performance specs

Running Cost:-

- **Electricity cost** - manufacturer should state kWs
- **Heat cost** – doesn’t vary much with kiln types..yet.
- **Maintenance** – can effect throughput, thus should be considered
Performance spec recommendation

Emmissions

• Will one day have to be specified and measured
• Lack of good data for HT drying
• Future-proofing?
## Confirmation that specs are met

<table>
<thead>
<tr>
<th>Prescriptively</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy - specific parameters to measure and doesn’t depend on material</td>
<td>Difficult - dependant on variability and on end point system performance</td>
</tr>
</tbody>
</table>

## Risk to buyer

<table>
<thead>
<tr>
<th>Prescriptively</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>High - poor performing kilns can be bought unless prescription is complete</td>
<td>Low - final price paid on actual kiln performance</td>
</tr>
</tbody>
</table>

## Risk to vendor

<table>
<thead>
<tr>
<th>Prescriptively</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
</tr>
</tbody>
</table>

## Approach Favours

<table>
<thead>
<tr>
<th>Prescriptively</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Vendor</td>
<td>The Buyer</td>
</tr>
</tbody>
</table>
Recommendations

• If Prescriptive approach is used
  – **it must be complete**
  – please include time to reach WB set point as well
  – Consider energy, steaming, emissions

• If Performance approach
  – Specify duration and quality
  – Agree on test charge
  – Include energy costs

• Combine both approaches
  – Performance specs in terms of throughput and quality +…
  – A prescriptive test which will form a benchmark for future comparison
Future Perspective

• Trends is towards
  – minimising energy, emissions, environmental footprint
  – Higher expectations of product performance
  – Greater competition with other materials
• Kilns
  – Consume a lot of energy and water
  – Highly implicated in wood performance/behaviour
  – Last 20+ years
• Thus a holistic view of kiln design at purchase time is warranted
Thanks