Core Blending Efficiency Improvements Achieved in Continuous Pressing of Particleboard
HOW TO SAVE MONEY

A report on 3 large scale plant trials

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Experts. Chemically speaking...

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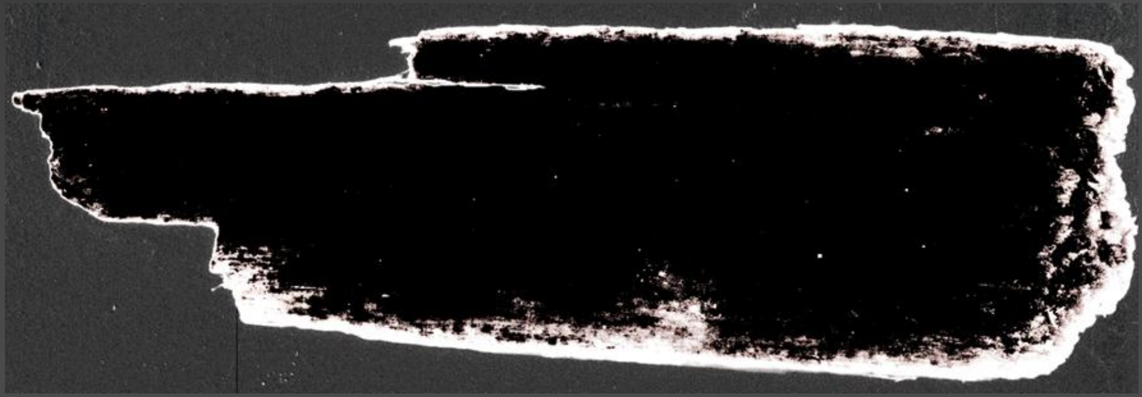
Characteristics of high speed blenders

- Blending is a trade off between the spreading of resin on flake and it's destruction
  - Longer dwell times result in more flake destruction
  - Longer dwell times do not necessarily result in more effective resin spreading
- Poorly resinated flake tends to be preferentially resinated on edges rather than on the faces

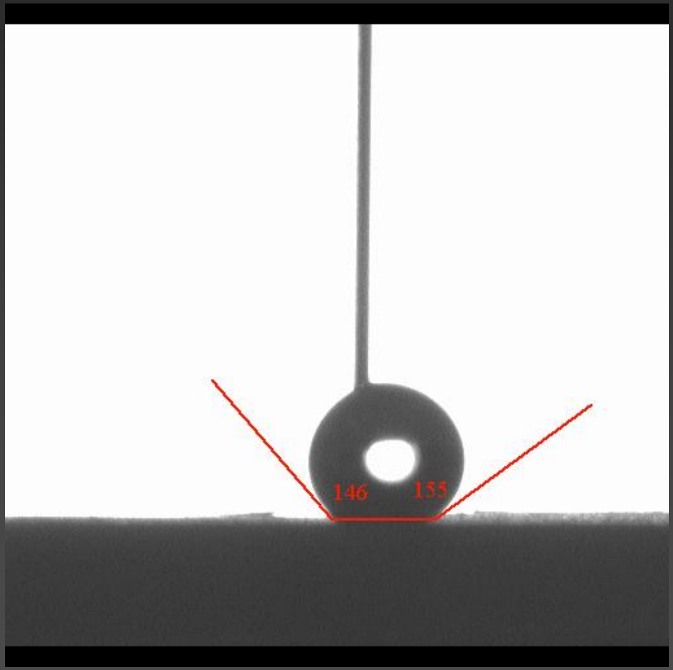


Core blending "efficiency"

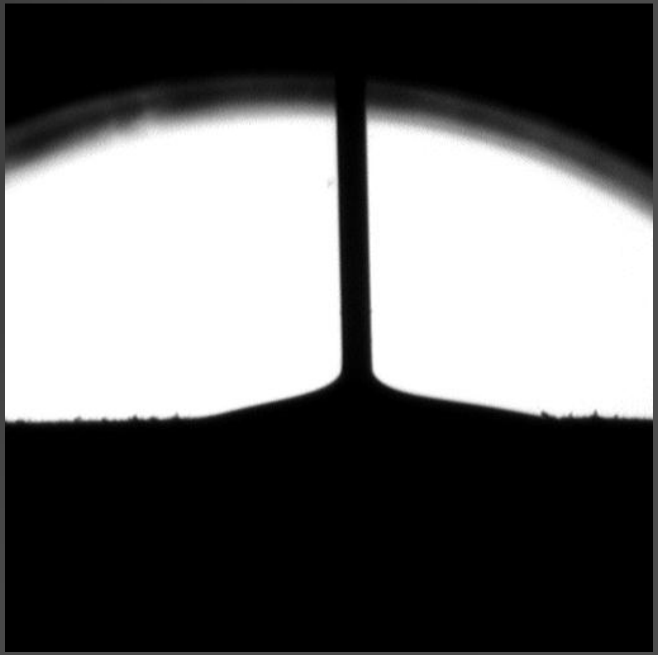
- It was shown that dry flake has very low surface free energy and resins have high surface tension therefore the interfacial energy between the two is large impeding transfer of resins in high speed blenders
- It was shown that the larger flake which is most important for board properties is the least well resinated
- It was also shown that larger flake had the most variation in resin coverage
- It was also shown that during blending the important larger flake is broken up during blending
- This larger flake with the high surface to volume (aspect) ratio that is fundamentally important for the bending properties of particleboard
- High speed blending is a very inefficient way to spread resin and a very efficient way to destroy flake geometry
- Resin is unevenly distributed over large flake and most of the resin is spread over the smallest flake Roberts 2011

Effect of Rezex A

- A multi-phase wetting system Rezex A was developed to reduce the surface tension of the MUF resin while being compatible with resin/wax/hardener mix



Resin without Rezex A™ wetting slash pine



0.2% Rezex A™ in MUF resin wetting slash pine

Improving core blending efficiency

- It was shown that with the use of Rezex A and with blender modifications that the average resin coverage increased
- In addition variation in resin coverage significantly decreased
- In conjunction with this the proportion of larger flake increased as did the average size of the larger flake.
- It was therefore postulated that if the effective resination of this flake was improved by increasing the average area of resin coverage and by reducing the variability of resin coverage between flake and that the average size and proportion of the larger flake increased then bending properties should improve
- It was further postulated that this being the case there were opportunities to reduce density and or resin loading.
- What follows is proof through three large scale plant trials at three particleboard plants what was postulated in fact turned out to be absolutely correct.

Experimental design

- Trials were conducted at 3 plants each with PAL blenders and large continuous presses, capacity up to 2,000m3 per day
- The design was similar in each and a statistical inference could be drawn based on effects of density and resin reduction on properties
- The design was based around the following blender setups:

  Day 1. Horns normal/Flap closed
  Day 2. Horns normal/Flap open
  Day 3. Horns advanced/Flap closed
  Day 4. Horns advanced/Flap open

- No additional equipment was needed in the glue kitchens to add the Rezex A to the core resin mix

Experimental design resin reduction

	Blender	Rezex Dose	Resin reduction
N1	Flap closed/Horns Normal	0	0%
N2	Flap open/Horns Normal	0	0
N3	Flap closed/Horns Advanced	0	0
N4	Flap open/Horns Advanced	0	0
R1	Flap closed/Horns Normal	0.2	0
R2	Flap closed/Horns Normal	0.1	0
R3	Flap closed/Horns Normal	0.2	5%
R4	Flap closed/Horns Normal	0.1	5%
R5	Flap closed/Horns Normal	0.2	10
R6	Flap closed/Horns Normal	0.1	10
R7	Flap closed/Horns advanced	0.2	0
R8	Flap closed/Horns advanced	0.1	0
R9	Flap closed/Horns advanced	0.2	5%
R10	Flap closed/Horns advanced	0.1	5
R11	Flap closed/Horns advanced	0.2	10
R12	Flap closed/Horns advanced	0.1	10
R13	Flap open/Horns advanced	0.2	0
R14	Flap open/Horns advanced	0.1	0
R15	Flap open/Horns advanced	0.2	5%
R16	Flap open/Horns advanced	0.1	5%
R17	Flap open/Horns advanced	0.2	10
R18	Flap open/Horns advanced	0.1	10
R19	Flap open/Horns normal	0.2	0
R20	Flap open/Horns normal	0.1	0
R21	Flap open/Horns normal	0.2	5%
R22	Flap open/Horns normal	0.1	5%
R23	Flap open/Horns normal	0.2	10
R24	Flap open/Horns normal	0.1	10

Experimental design density reduction

	Blender	Rezex Dose	Density reduction
N1	Flap closed/Horns Normal	0	0%
N2	Flap open/Horns Normal	0	0
N3	Flap closed/Horns Advanced	0	0
N4	Flap open/Horns Advanced	0	0
D1	Flap closed/Horns Normal	0.2	0
D2	Flap closed/Horns Normal	0.1	0
D3	Flap closed/Horns Normal	0.2	5%
D4	Flap closed/Horns Normal	0.1	5%
D5	Flap closed/Horns Normal	0.2	10
D6	Flap closed/Horns Normal	0.1	10
D7	Flap closed/Horns advanced	0.2	0
D8	Flap closed/Horns advanced	0.1	0
D9	Flap closed/Horns advanced	0.2	5%
D10	Flap closed/Horns advanced	0.1	5
D11	Flap closed/Horns advanced	0.2	10
D12	Flap closed/Horns advanced	0.1	10
D13	Flap open/Horns advanced	0.2	0
D14	Flap open/Horns advanced	0.1	0
D15	Flap open/Horns advanced	0.2	5%
D16	Flap open/Horns advanced	0.1	5%
D17	Flap open/Horns advanced	0.2	10
D18	Flap open/Horns advanced	0.1	10
D19	Flap open/Horns normal	0.2	0
D20	Flap open/Horns normal	0.1	0
D21	Flap open/Horns normal	0.2	5%
D22	Flap open/Horns normal	0.1	5%
D23	Flap open/Horns normal	0.2	10
D24	Flap open/Horns normal	0.1	10

Blender horn and paddle positions

Blender zone	Horn position normal	Horn position (Advanced)
Inlet paddles	+40°	+40°
Injection zone	0°	0°
Mixing zone 1	0°	+α°
Mixing zone 2	0°	+α °
Outlet zone 1	-10°	+α °
Outlet zone 2	-10°	-10°

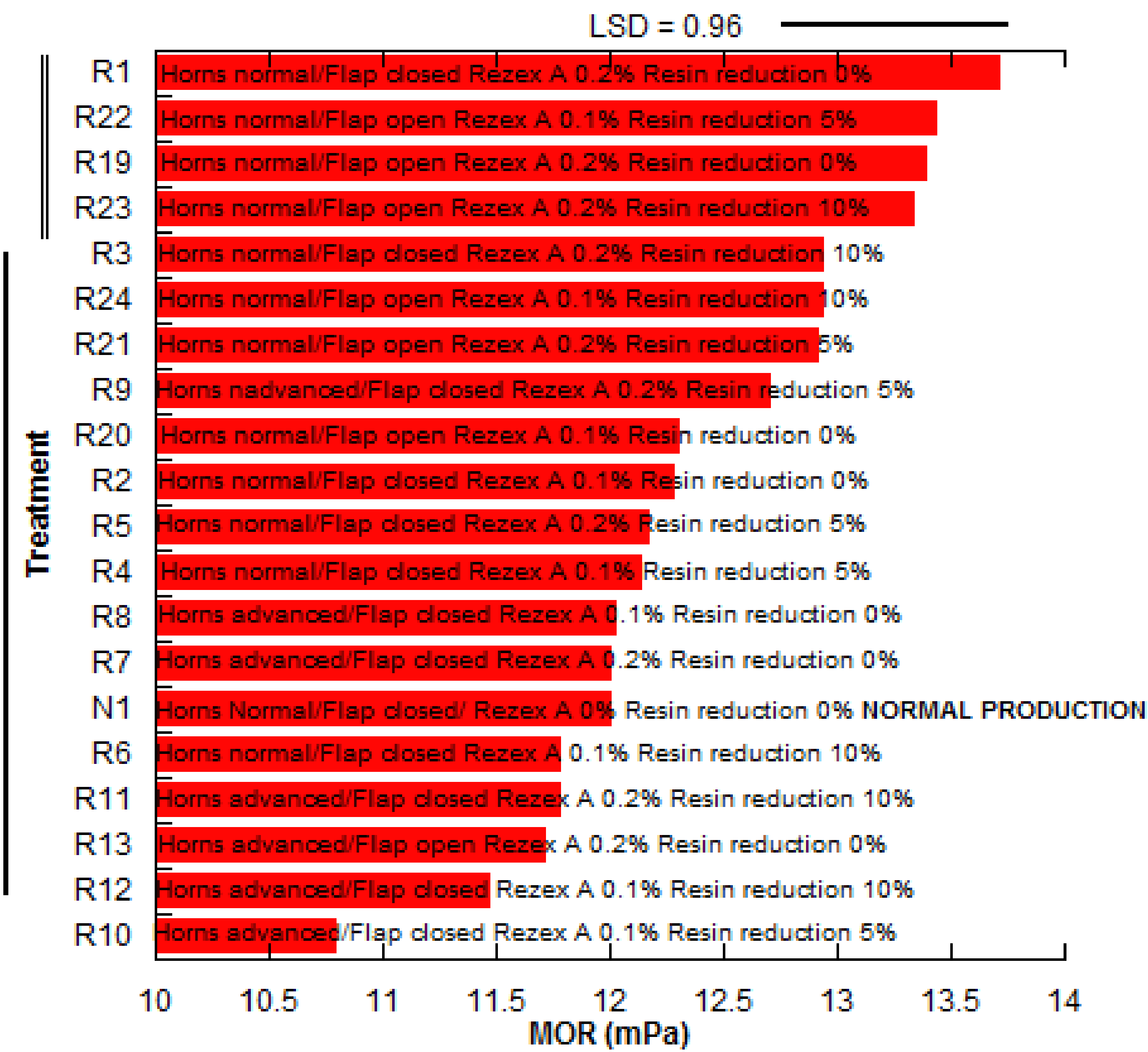
Treatments for Day 1

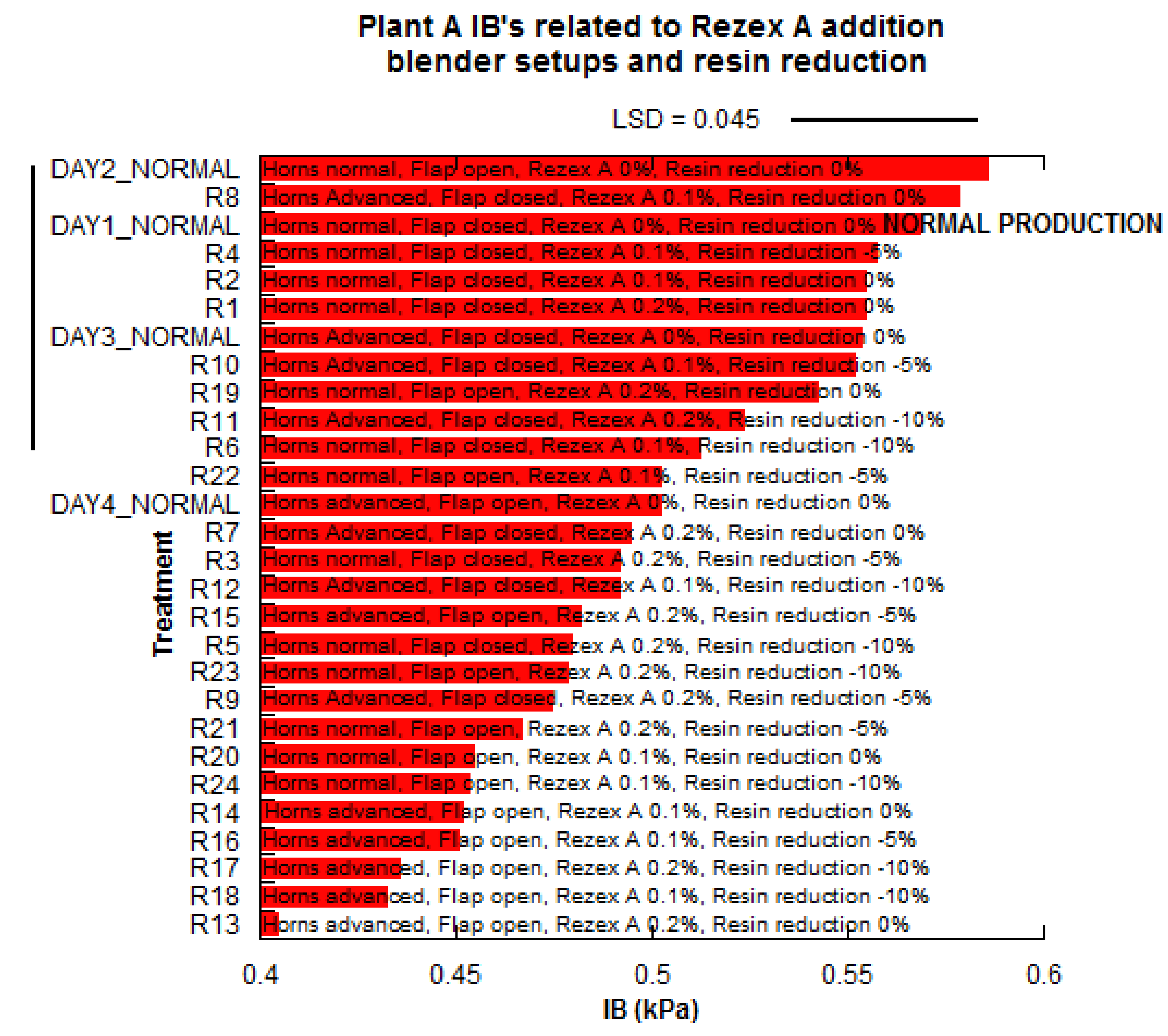
	Treatments Day 1	Resin	Density	Rezex A %
Normal		Normal	Normal	0
R1	Horns Normal/ Flap closed	Normal	Normal	0.2
D3	Horns Normal/ Flap closed	Normal	-5%	0.2
R3	Horns Normal/ Flap closed	-5%	Normal	0.2
R5	Horns Normal/ Flap closed	-10%	Normal	0.2
D4	Horns Normal/ Flap closed	Normal	-5%	0.1
R2	Horns Normal/ Flap closed	Normal	Normal	0.1
R4	Horns Normal/ Flap closed	-5%	Normal	0.1
R6	Horns Normal/ Flap closed	-10%	Normal	0.1

Results: resin reduction

- With no change in resin loading there were significant improvements in MOR (>10%) in Plants B & C with the use of Rezex A and with blender modifications, however no change in Plant A
- In Plant C there was a significant improvement in IB’s whereas in Plants A & B there was no significant change with the addition of Rezex A with no resin reduction
- In Plant B with a 10% resin reduction the value of MOR increased by 12% with the addition of 0.1% Rezex A and with blender modifications
- In all plants it was possible to reduce resin loading by 10% with the addition of Rezex A and manipulating blender settings with no statistical change in MOR.
- With resin reduction IB’s were plant specific A & C it was possible to reduce resin loading by 10% with no statistical effect on IB’s. IB’s were reduced however still well above specification limits in C

Plant B MOR related to Rezex A, blender and resin reduction



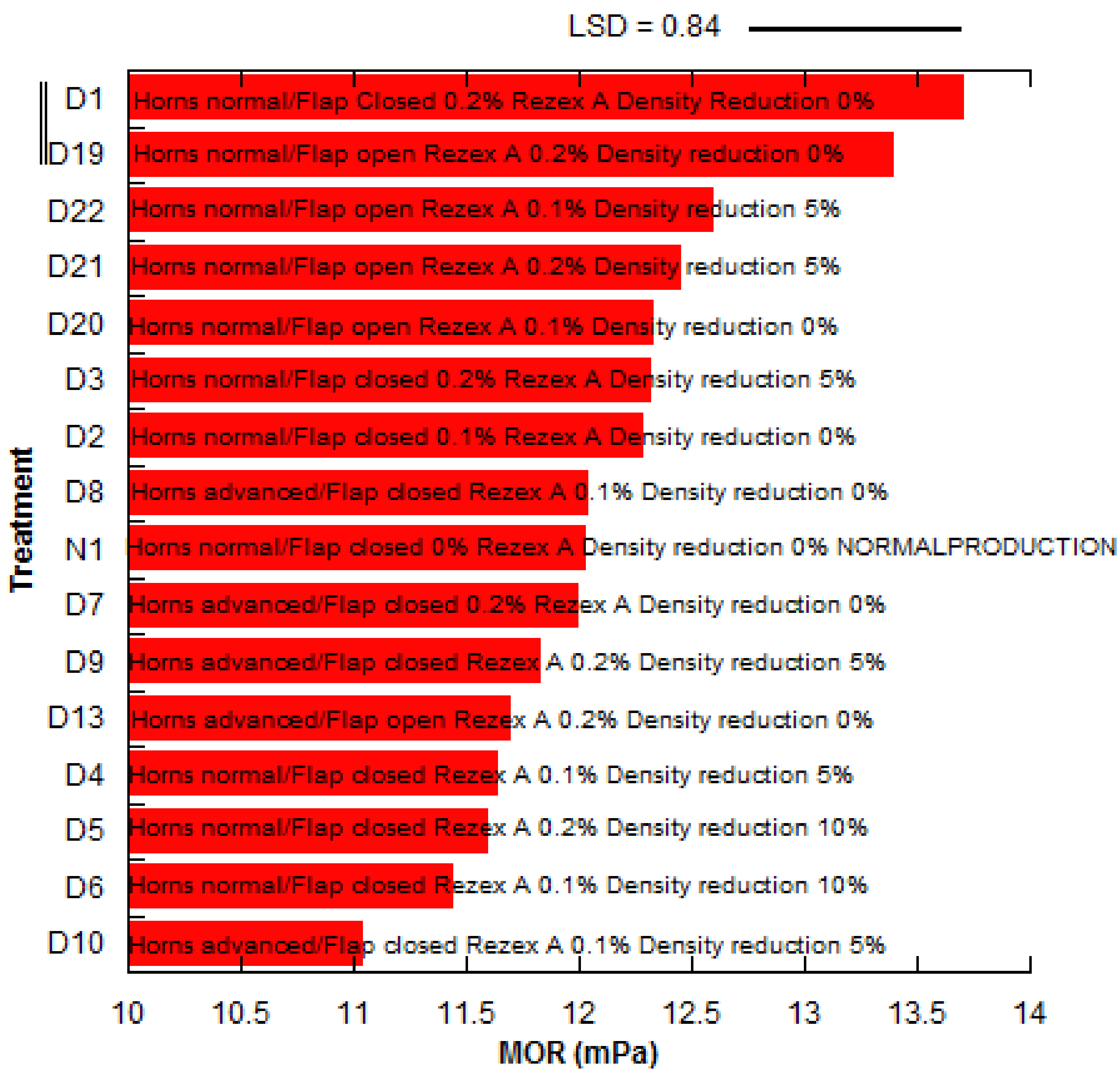


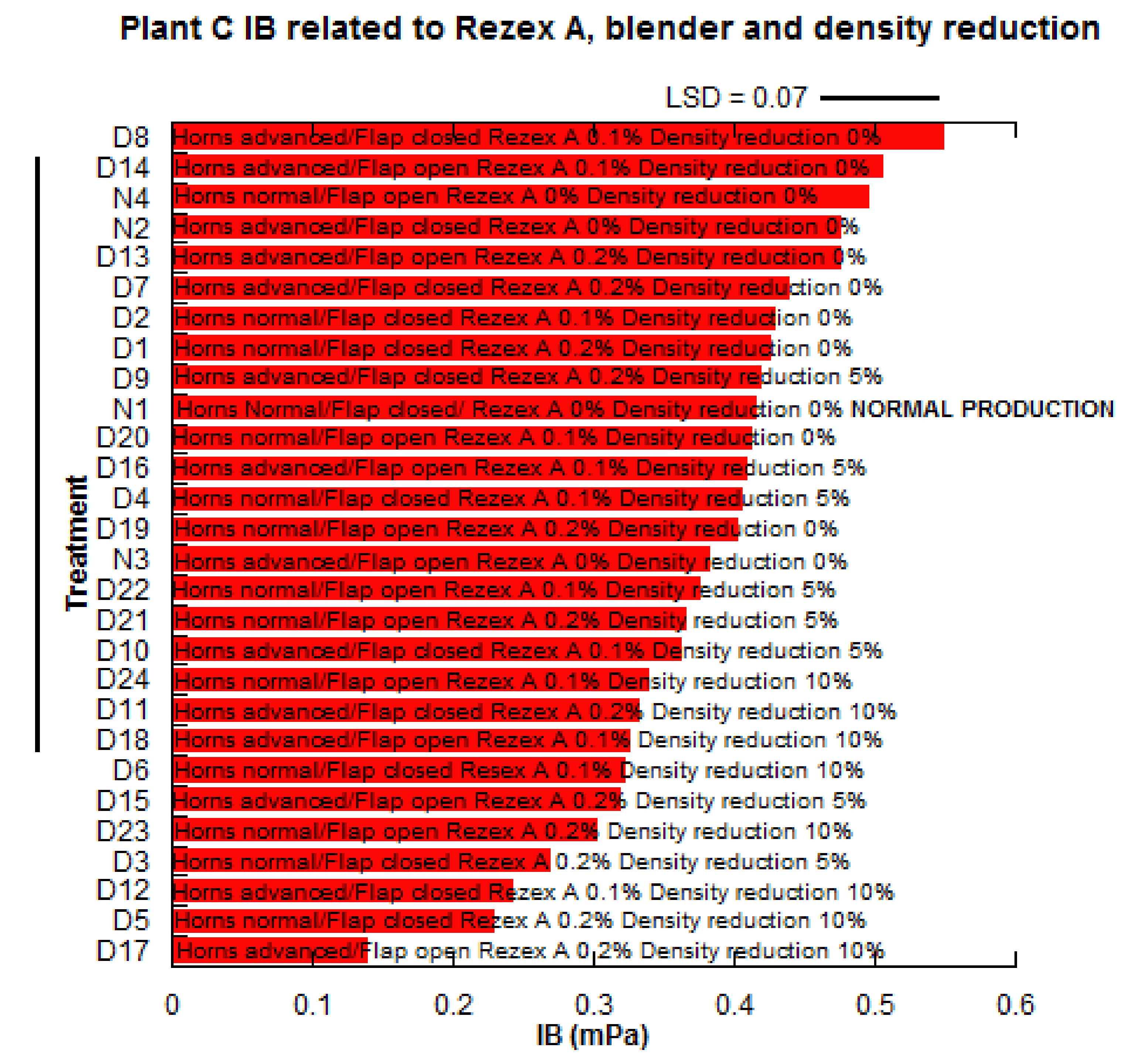
Plant A IB's related to Rezex A addition
blender setups and resin reduction
LSD = 0.045
NORMAL PRODUCTION
Treatment
DAY2_NORMAL Horns normal, Flap open, Rezex A 0%, Resin reduction 0%
R8 Horns Advanced, Flap closed, Rezex A 0.1%, Resin reduction 0%
DAY1_NORMAL Horns normal, Flap closed, Rezex A 0%, Resin reduction 0%
R4 Horns normal, Flap closed, Rezex A 0.1%, Resin reduction -5%
R2 Horns normal, Flap closed, Rezex A 0.1%, Resin reduction 0%
R1 Horns normal, Flap closed, Rezex A 0.2%, Resin reduction 0%
DAY3_NORMAL Horns Advanced, Flap closed, Rezex A 0%, Resin reduction 0%
R10 Horns Advanced, Flap closed, Rezex A 0.1%, Resin reduction -5%
R19 Horns normal, Flap open, Rezex A 0.2%, Resin reduction 0%
R11 Horns Advanced, Flap closed, Rezex A 0.2%, Resin reduction -10%
R6 Horns normal, Flap closed, Rezex A 0.1%, Resin reduction -10%
R22 Horns normal, Flap open, Rezex A 0.1%, Resin reduction -5%
DAY4_NORMAL Horns advanced, Flap open, Rezex A 0%, Resin reduction 0%
R7 Horns Advanced, Flap closed, Rezex A 0.2%, Resin reduction 0%
R3 Horns normal, Flap closed, Rezex A 0.2%, Resin reduction -5%
R12 Horns Advanced, Flap closed, Rezex A 0.1%, Resin reduction -10%
R15 Horns advanced, Flap open, Rezex A 0.2%, Resin reduction -5%
R5 Horns normal, Flap closed, Rezex A 0.2%, Resin reduction -10%
R23 Horns normal, Flap open, Rezex A 0.2%, Resin reduction -10%
R9 Horns Advanced, Flap closed, Rezex A 0.2%, Resin reduction -5%
R21 Horns normal, Flap open, Rezex A 0.2%, Resin reduction -5%
R20 Horns normal, Flap open, Rezex A 0.1%, Resin reduction 0%
R24 Horns normal, Flap open, Rezex A 0.1%, Resin reduction -10%
R14 Horns advanced, Flap open, Rezex A 0.1%, Resin reduction 0%
R16 Horns advanced, Flap open, Rezex A 0.1%, Resin reduction -5%
R17 Horns advanced, Flap open, Rezex A 0.2%, Resin reduction -10%
R18 Horns advanced, Flap open, Rezex A 0.1%, Resin reduction -10%
R13 Horns advanced, Flap open, Rezex A 0.2%, Resin reduction 0%
0.4
0.45
0.5
0.55
0.6
IB (kPa)

Results: density reduction

- It was not possible to reduce the density of Plant A with any treatment.
- It was possible to reduce density in Plants B & C by 5% with the addition of 0.1% Rezex A and with blender modifications and get statistically similar MOR values to normal treatments
- With Plant B it was possible to reduce density by 10% with the addition of 0.2% Rezex A with no effect on MOR.
- With Plants A & B reducing density by 5% did result in statistically lower IB values however they were still well above any specification limit
- With Plant C even though it was possible to reduce density by 10% without any statistical affect on IB values a 5% net reduction was only possible due to MOR values.

Plant B MOR related to density reduction





Plant C IB related to Rezex A, blender and density reduction
LSD = 0.07
Treatment
D8 Horns advanced/Flap closed Rezex A 0.1% Density reduction 0%
D14 Horns advanced/Flap open Rezex A 0.1% Density reduction 0%
N4 Horns normal/Flap open Rezex A 0% Density reduction 0%
N2 Horns advanced/Flap closed Rezex A 0% Density reduction 0%
D13 Horns advanced/Flap open Rezex A 0.2% Density reduction 0%
D7 Horns advanced/Flap closed Rezex A 0.2% Density reduction 0%
D2 Horns normal/Flap closed Rezex A 0.1% Density reduction 0%
D1 Horns normal/Flap closed Rezex A 0.2% Density reduction 0%
D9 Horns advanced/Flap closed Rezex A 0.2% Density reduction 5%
N1 Horns Normal/Flap closed/ Rezex A 0% Density reduction 0% NORMAL PRODUCTION
D20 Horns normal/Flap open Rezex A 0.1% Density reduction 0%
D16 Horns advanced/Flap open Rezex A 0.1% Density reduction 5%
D4 Horns normal/Flap closed Rezex A 0.1% Density reduction 5%
D19 Horns normal/Flap open Rezex A 0.2% Density reduction 0%
N3 Horns advanced/Flap open Rezex A 0% Density reduction 0%
D22 Horns normal/Flap open Rezex A 0.1% Density reduction 5%
D21 Horns normal/Flap open Rezex A 0.2% Density reduction 5%
D10 Horns advanced/Flap closed Rezex A 0.1% Density reduction 5%
D24 Horns normal/Flap open Rezex A 0.1% Density reduction 10%
D11 Horns advanced/Flap closed Rezex A 0.2% Density reduction 10%
D18 Horns advanced/Flap open Rezex A 0.1% Density reduction 10%
D6 Horns normal/Flap closed Resex A 0.1% Density reduction 10%
D15 Horns advanced/Flap open Rezex A 0.2% Density reduction 5%
D23 Horns normal/Flap open Rezex A 0.2% Density reduction 10%
D3 Horns normal/Flap closed Rezex A 0.2% Density reduction 5%
D12 Horns advanced/Flap closed Rezex A 0.1% Density reduction 10%
D5 Horns normal/Flap closed Rezex A 0.2% Density reduction 10%
D17 Horns advanced/Flap open Rezex A 0.2% Density reduction 10%
0
0.1
0.2
0.3
0.4
0.5
0.6
IB (mPa)

Results: summary

- All 3 plants were able to achieve 10% reduction in resin loadings while making adequate board with various blender settings and the addition of 0.1% Rezex A
- Larger improvements in MOR were achieved where flake quality was poor which is most particleboard plants these days
- The proof and efficacy of the technology is in the fact that there were 5 treatments that were successful *at all three plants*

Plant	Treatment	Horn position	Flap position	Rezex A dose	Resin reduction
A	R12	Advanced	Closed	0.10%	10%
B	R12	Advanced	Closed	0.10%	10%
C	R12	Advanced	Closed	0.10%	10%
C	R11	Advanced	Closed	0.20%	10%
A	R10	Advanced	Closed	0.10%	5%
B	R10	Advanced	Closed	0.10%	5%
C	R10	Advanced	Closed	0.10%	5%
B	R9	Advanced	Closed	0.20%	5%
C	R9	Advanced	Closed	0.20%	5%
C	R18	Advanced	Open	0.10%	10%
C	R17	Advanced	Open	0.20%	10%
C	R16	Advanced	Open	0.10%	5%
A	R6	Normal	Closed	0.10%	10%
B	R6	Normal	Closed	0.10%	10%
C	R6	Normal	Closed	0.10%	10%
A	R5	Normal	Closed	0.20%	10%
B	R5	Normal	Closed	0.20%	10%
C	R5	Normal	Closed	0.20%	10%
A	R4	Normal	Closed	0.10%	5%
B	R4	Normal	Closed	0.10%	5%
C	R4	Normal	Closed	0.10%	5%
B	R3	Normal	Closed	0.20%	5%
C	R3	Normal	Closed	0.20%	5%
C	R24	Normal	Open	0.10%	10%
A	R23	Normal	Open	0.20%	10%
B	R22	Normal	Open	0.10%	5%
C	R22	Normal	Open	0.10%	5%
A	R21	Normal	Open	0.20%	5%
B	R21	Normal	Open	0.20%	5%

Plant	Treatment	Horn position	Flap position	Rezex A dose	Density reduction
B	D3	Normal	Closed	0.2%	5%
B	D4	Normal	Closed	0.1%	5%
B	D5	Normal	Closed	0.2%	10%
C	D10	Advanced	Closed	0.1%	5%
C	D16	Advanced	Open	0.1%	5%
C	D21	Normal	Open	0.2%	5%
C	D22	Normal	Open	0.1%	5%

Plant	Treatment	Horn position	Flap position	Rezex A dose	Resin reduction
A	R12	Advanced	Closed	0.10%	10%
B	R12	Advanced	Closed	0.10%	10%
C	R12	Advanced	Closed	0.10%	10%
A	R10	Advanced	Closed	0.10%	5%
B	R10	Advanced	Closed	0.10%	5%
C	R10	Advanced	Closed	0.10%	5%
A	R6	Normal	Closed	0.10%	10%
B	R6	Normal	Closed	0.10%	10%
C	R6	Normal	Closed	0.10%	10%
A	R5	Normal	Closed	0.20%	10%
B	R5	Normal	Closed	0.20%	10%
C	R5	Normal	Closed	0.20%	10%
A	R4	Normal	Closed	0.10%	5%
B	R4	Normal	Closed	0.10%	5%
C	R4	Normal	Closed	0.10%	5%

Conclusions

- It was hypothesised that if resin distribution was improved along with flake geometry with the use of Rezex A, bending modulus properties would increase.
- These plant trials proved the hypothesis that by improving flake resin coverage, distribution and geometry with the use of Rezex A can result in significant cost savings in particleboard manufacture
- Blending improvements can be made without the cost of new or additional blenders.
- All 3 plants achieved 10% resin reduction with 0.1% Rezex A with both Horns advanced/Flap closed & Horns normal/Flap closed
- In two cases where resin was reduced by 10% MOR values actually *increased*
- IB's generally were lower however still well above specification limits.

Conclusions

- Usually MOR is the limiting property due to poor flake quality and as long as tensile properties are above specs then this is all that is required
- The biggest gains in MOR came with the two plants that had the poorest quality recycled flake.
- Most plants use poor quality flake therefore with the technologies proposed above there are significant opportunities for cost savings
- There were 29 successful treatments resulting in either resin or density reduction
- These successful treatments make obsolete the complex instructions that blender manufactures say are essential
- The technologies proposed are a much more successful, practical and above all cost effective way of improving blending efficiency rather than the purchase of new or second blenders.


Thank you
Contact me here at
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