

# **LEACHABILITY OF BORATE-MODIFIED OSB:**

**A Comparison of Zinc and Calcium Borate**

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# Engineered Wood Products



# FST Infestation



States with  
Formosan Subterranean Termite  
Infestations



Hawaii, California, Texas, Louisiana, Mississippi,  
Alabama, Tennessee, Georgia, Florida,  
North Carolina and South Carolina

# Borate Chemicals

- **Water Soluble Type**

Sodium Borate

Boric Oxide ( $B_2O_3$ )

Boric Acid ( $H_3BO_3$ )

- **Water Insoluble Type**

Zinc Borate ( $2ZnO_3B_2O_3 \cdot 3.5H_2O$ )

Calcium Borate ( $Ca_2B_6O_{11} \cdot 5H_2O$ )

# Work At LSU

- **Comparative study between zinc and calcium borate treated OSB**
- **Structural safety (strength) and serviceability (modulus) analysis with borate modified OSB**

# Work At LSU

## Comparative Properties on

- Swelling
- Strength/modulus
- **Leaching**
- Termite Resistance
- Decay Resistance
- Long-term Creep



# **BORON LEACHABILITY**

**Practical  
Construction  
Practice  
With OSB**



# Objectives

**To study effects of borate type, initial borate content, wood species, and other processing variables on leachability of borate-modified OSB**



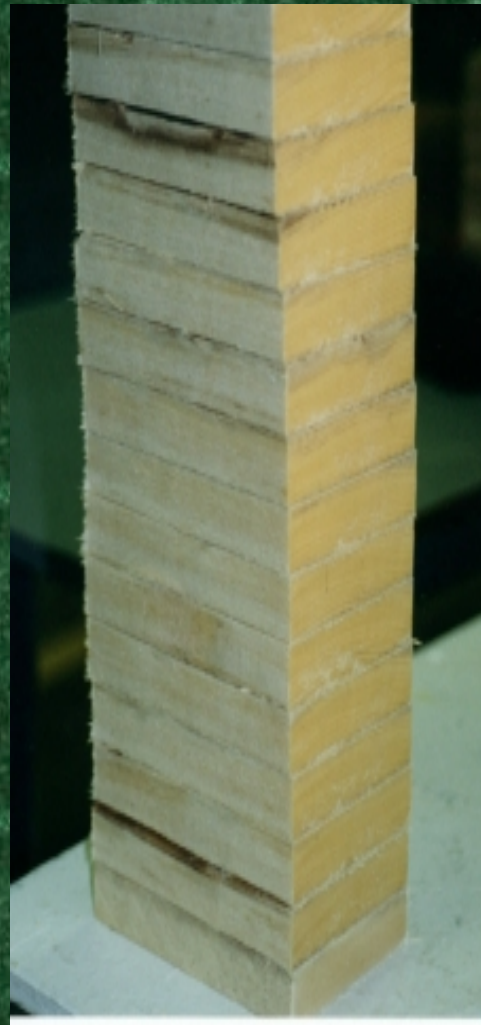
# Material Selection

**Wood** (Eleven Southern Species: Ash, Cottonwood, Cypress, Elm, Hackberry, Locust, Pecan, Red Oak, Southern Pine, White Oak, and Willow)

**Resin** (Liquid PF – Face/Core and pMDI)

**Borate** (Zinc and Calcium Borate)

# Flake Manufacturing



# Panel Fabrication - Blending

**Borate**

**Resin**

**Wax**

**Wood**



# Panel Fabrication

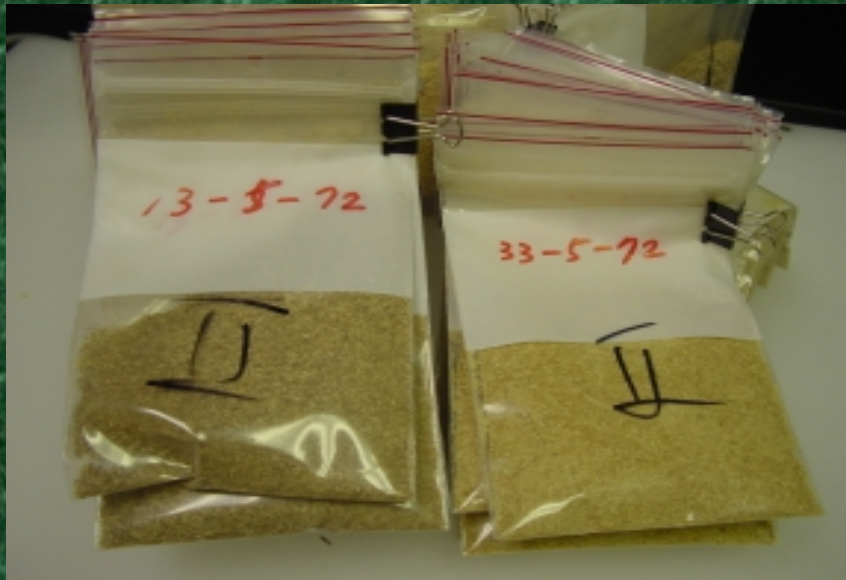


# OSB Water Leaching Test



**Wanted: A standardized leaching test method for treated wood composites!!**

# Panel **B**oric **A**cid **E**quivalent **A**nalysis



# RESULTS

- **Borate Particle Size Distribution**
- **Zinc Borate Leaching**
- **Calcium Borate Leaching**

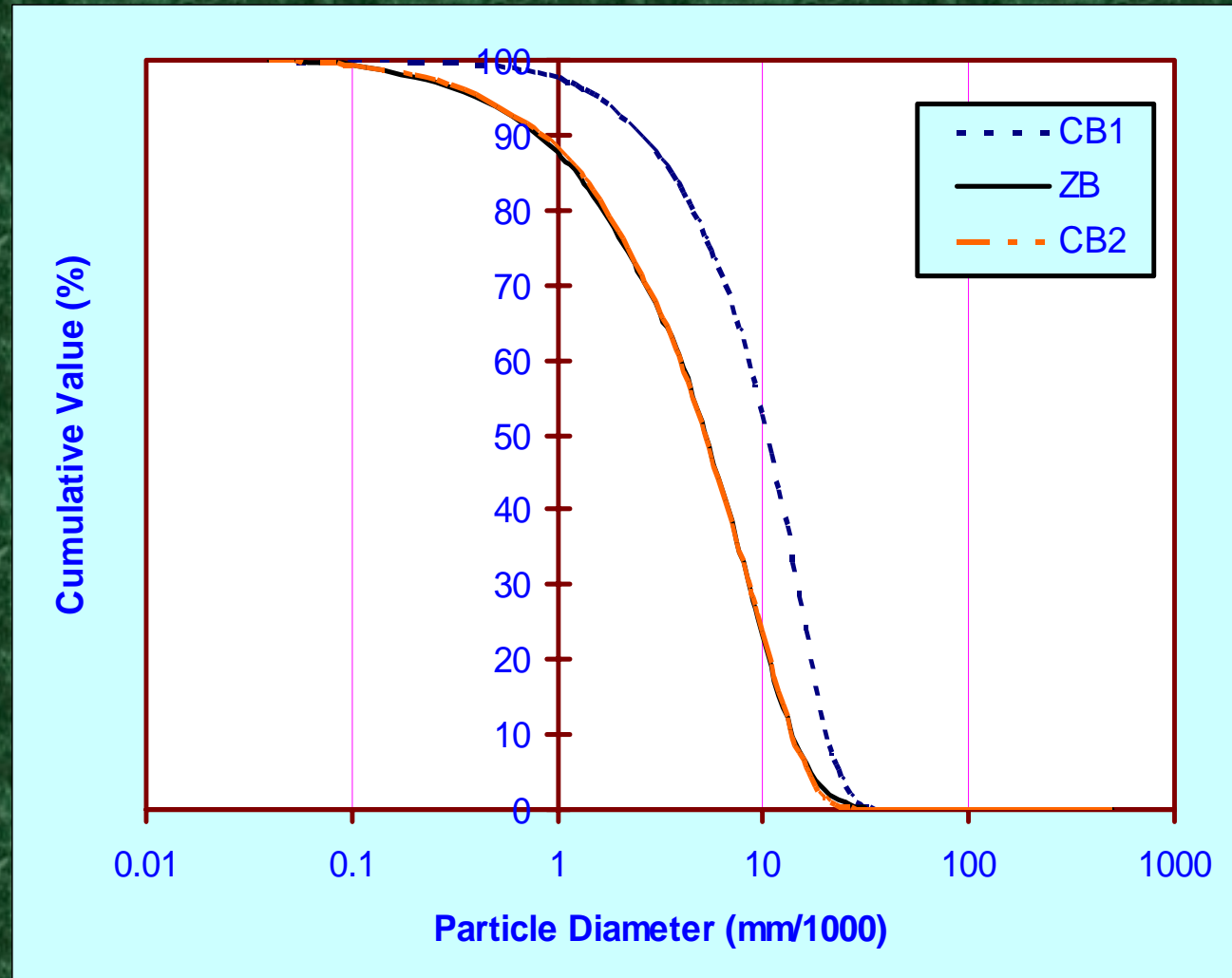
# Borate Particle Size Distribution

**Mean  
Particle  
Diameter**

**CB1: 11.09  $\mu\text{m}$**

**ZB : 6.61  $\mu\text{m}$**

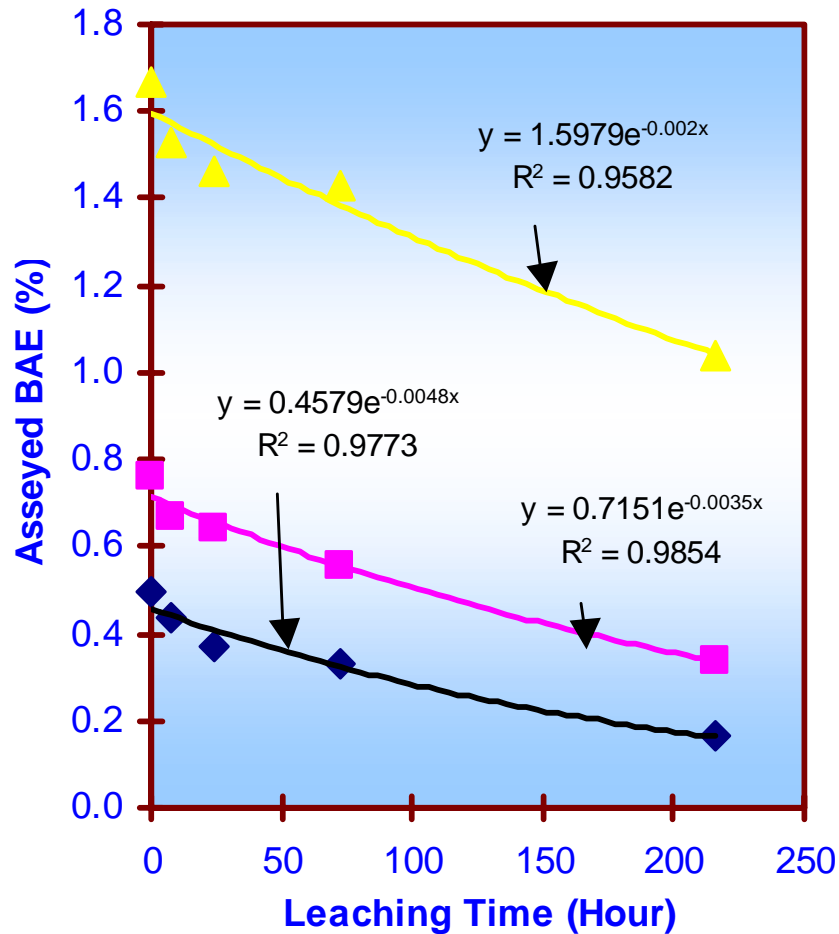
**CB2: 6.43  $\mu\text{m}$**



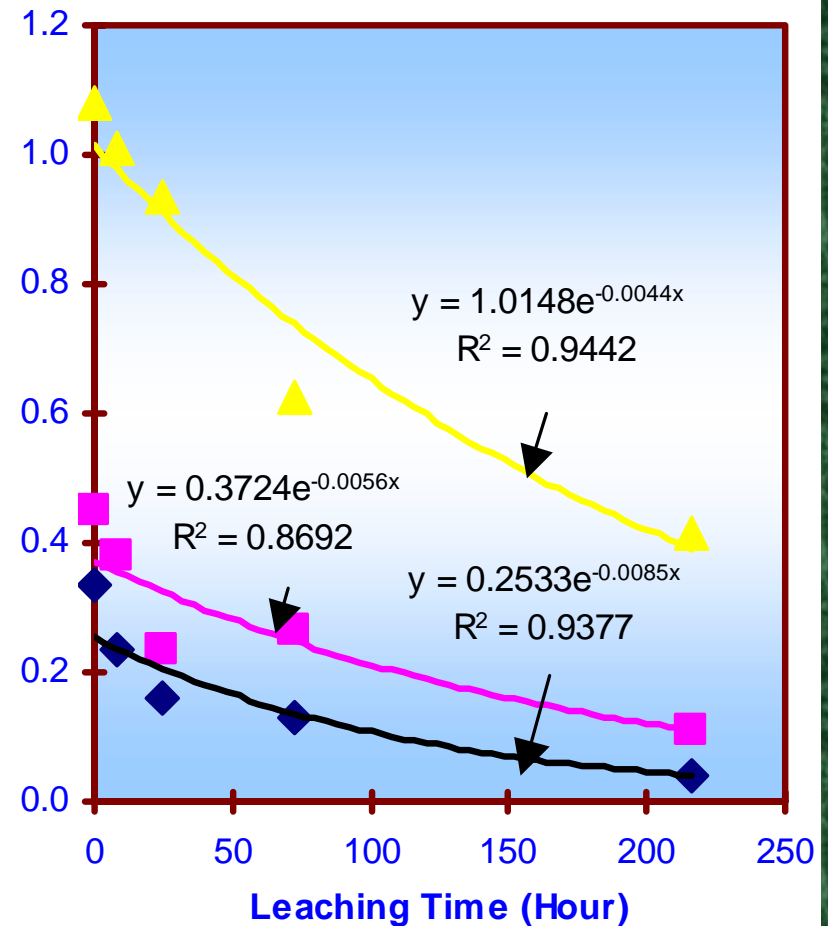


# Zinc Borate Leaching - BAE

## Southern Pine OSB

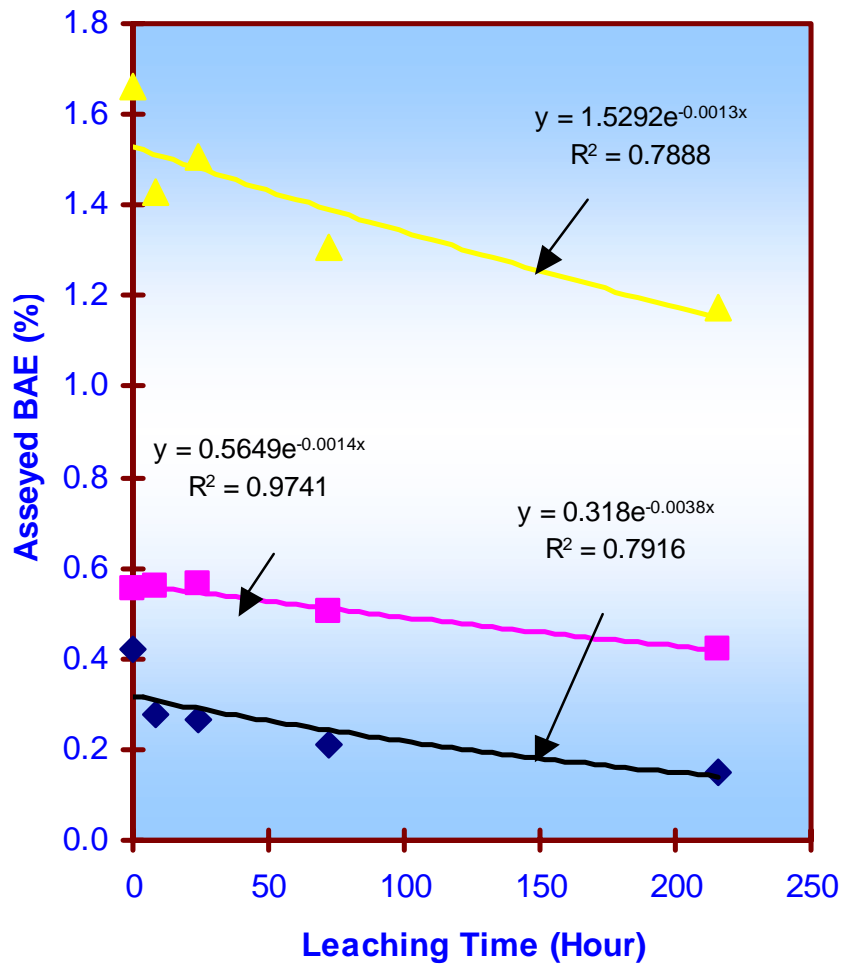


## Red Oak OSB

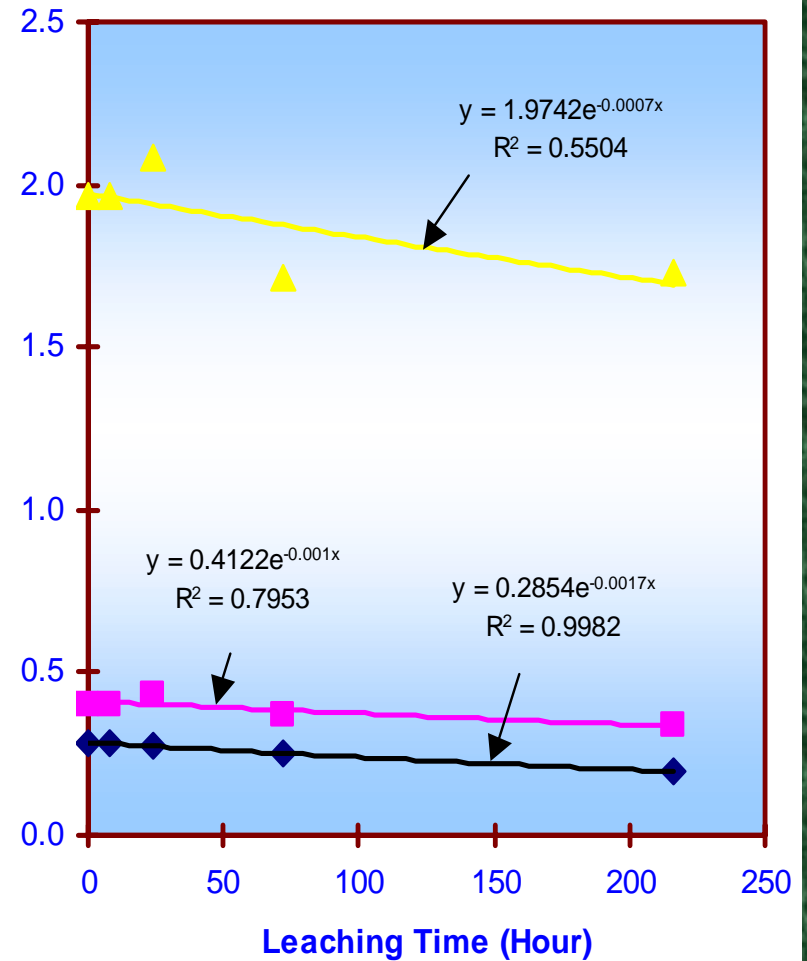


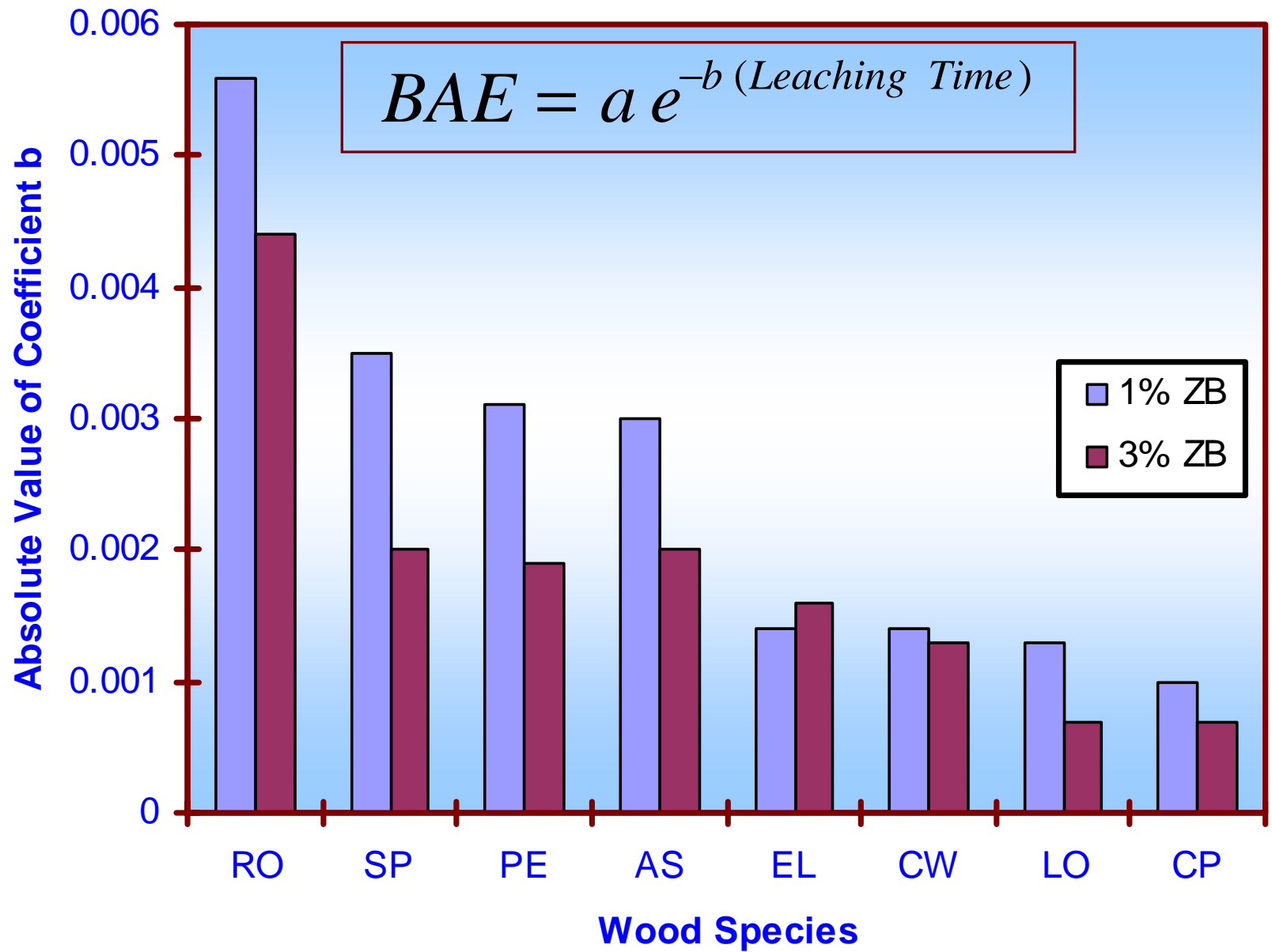
# Zinc Borate Leaching - BAE

## Cottonwood OSB

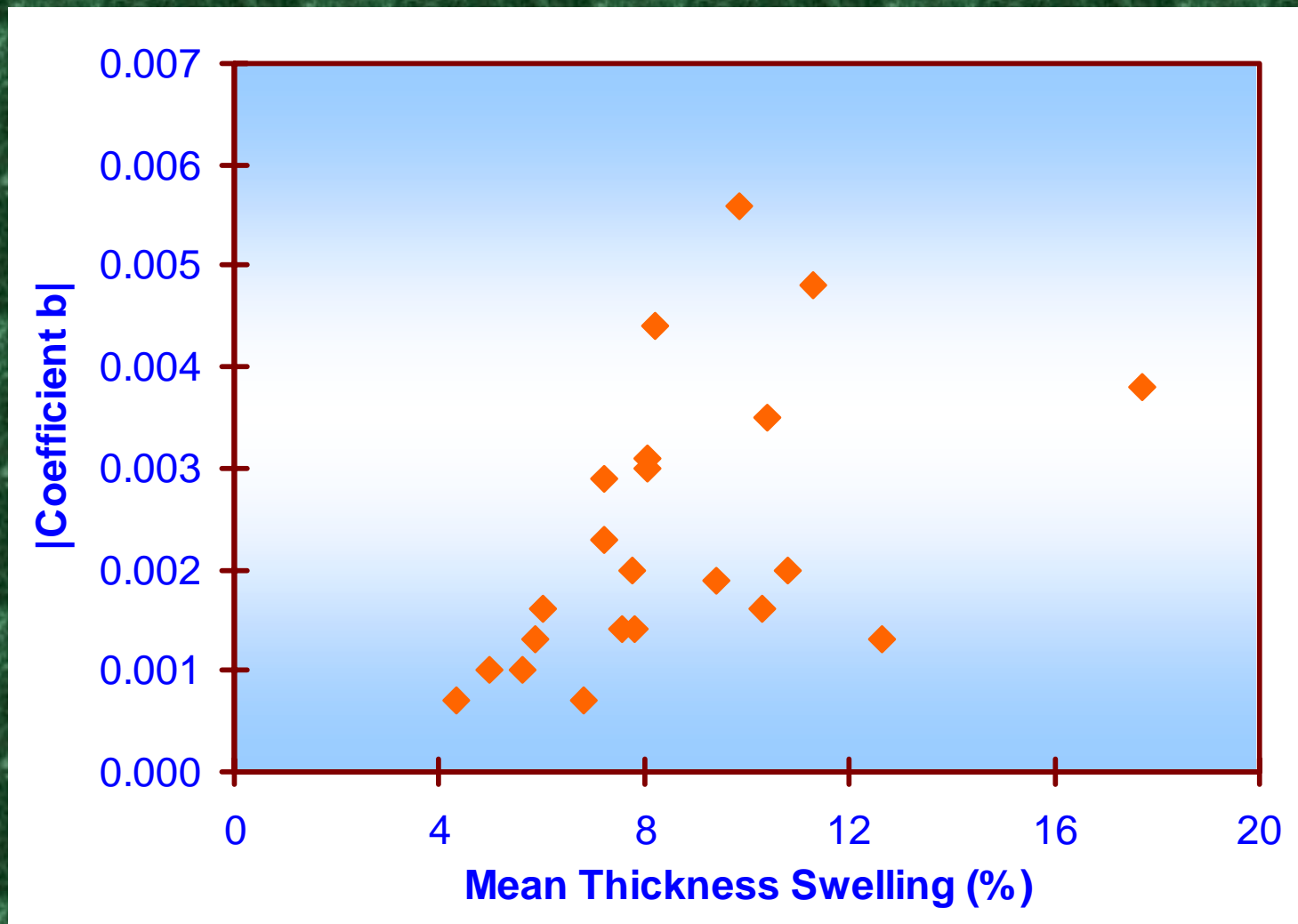


## Cypress OSB



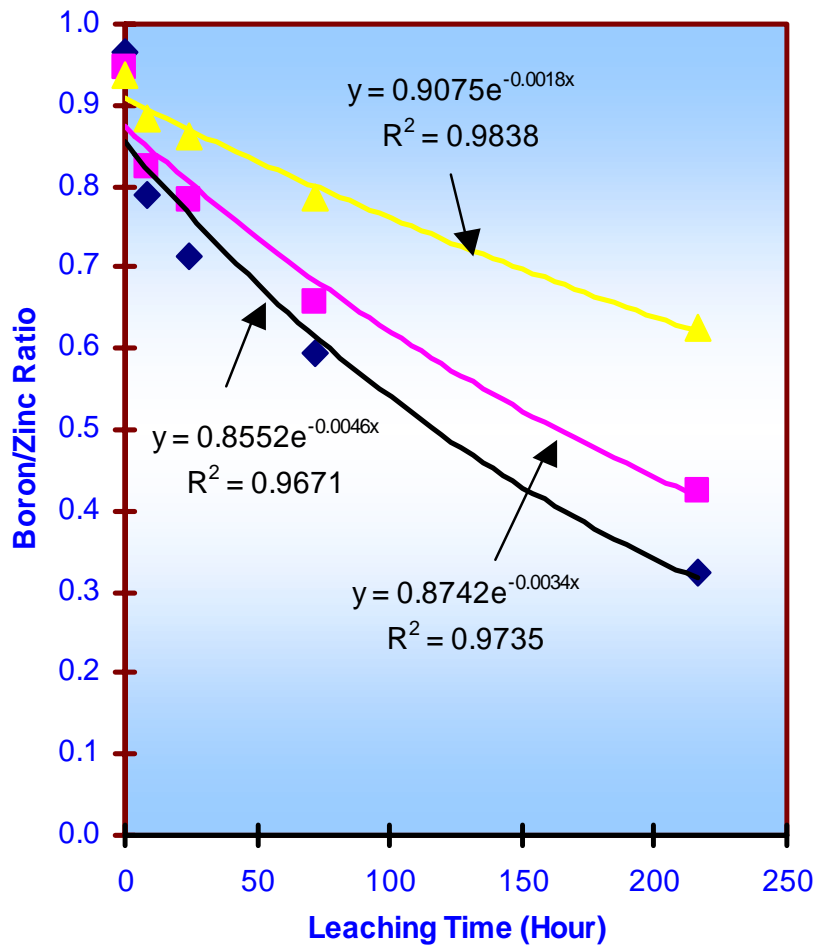


# ZB Leaching Coefficient v.s. TS

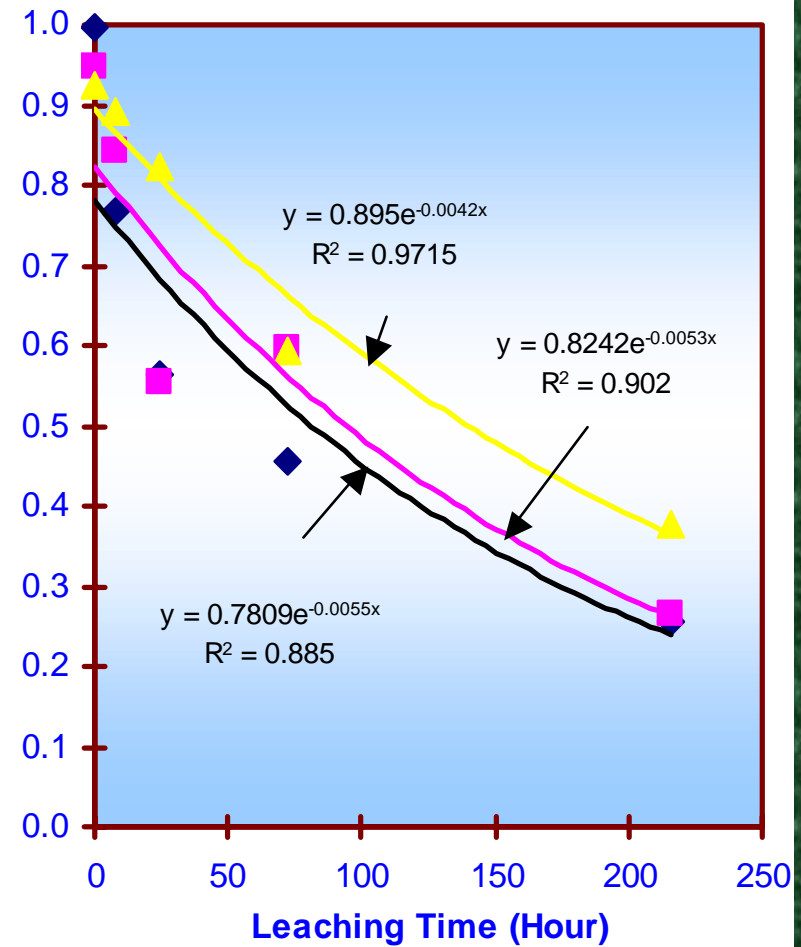


# Zinc Borate Leaching -B/Z Ratio

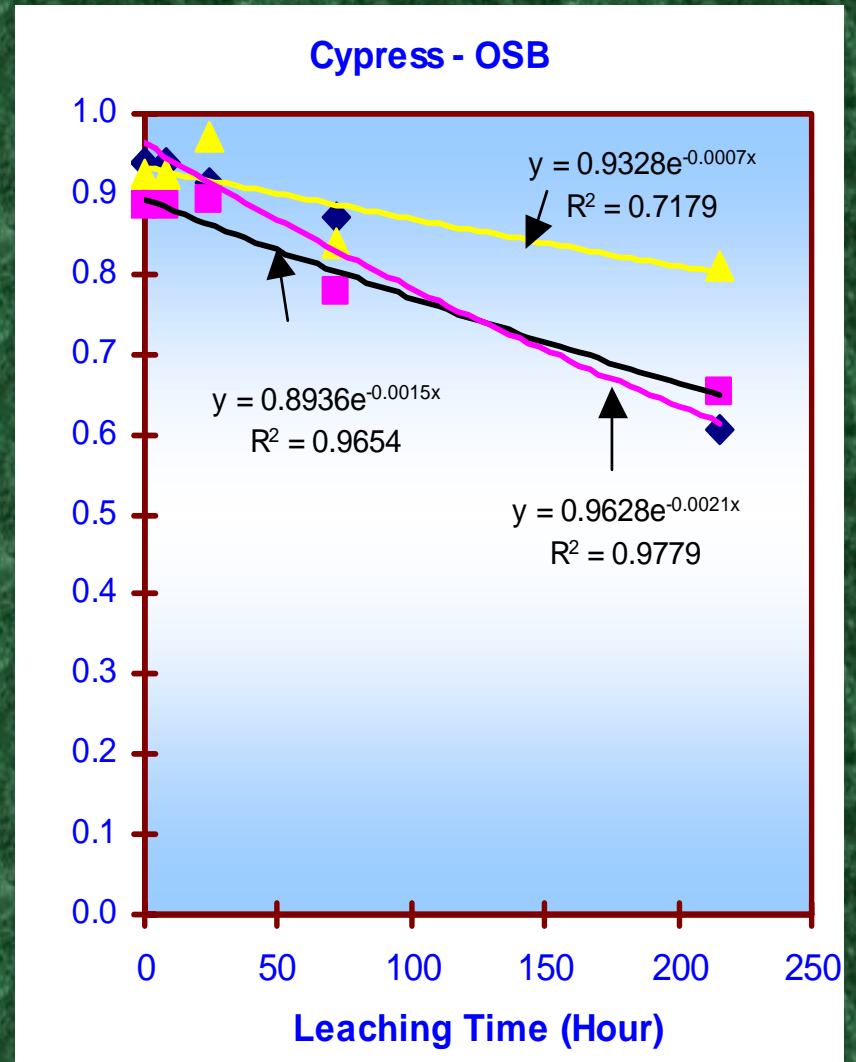
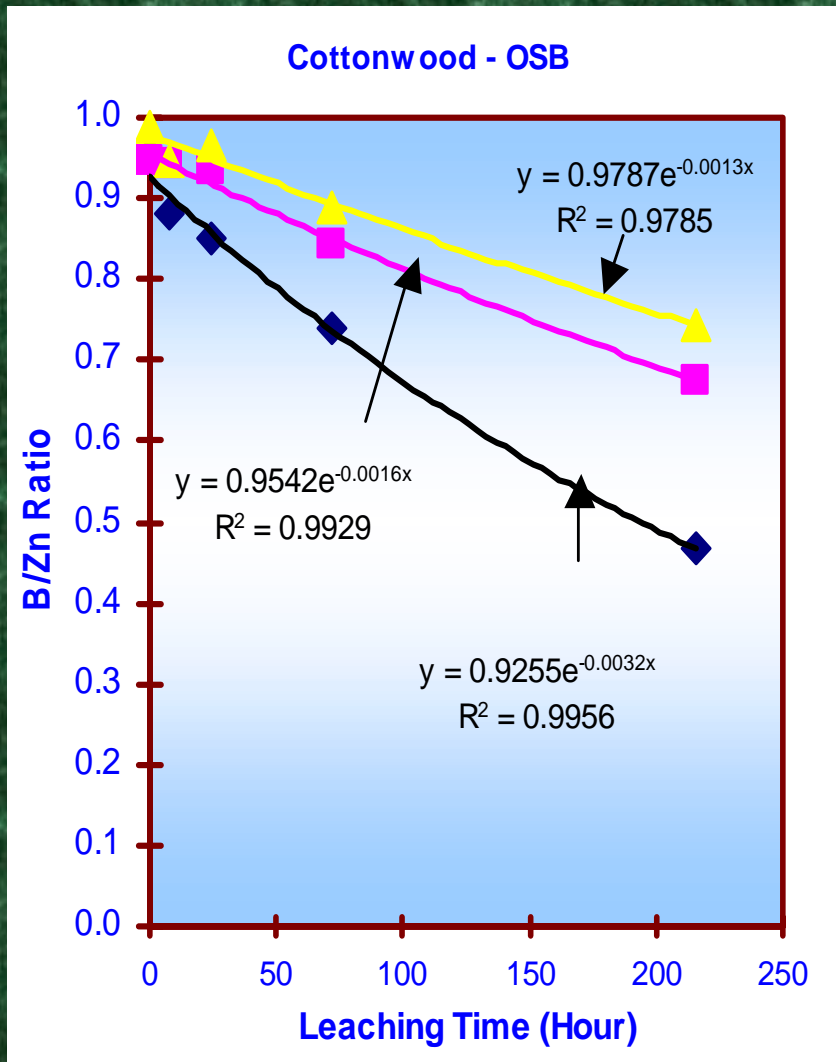
Southern Pine OSB



Red Oak OSB



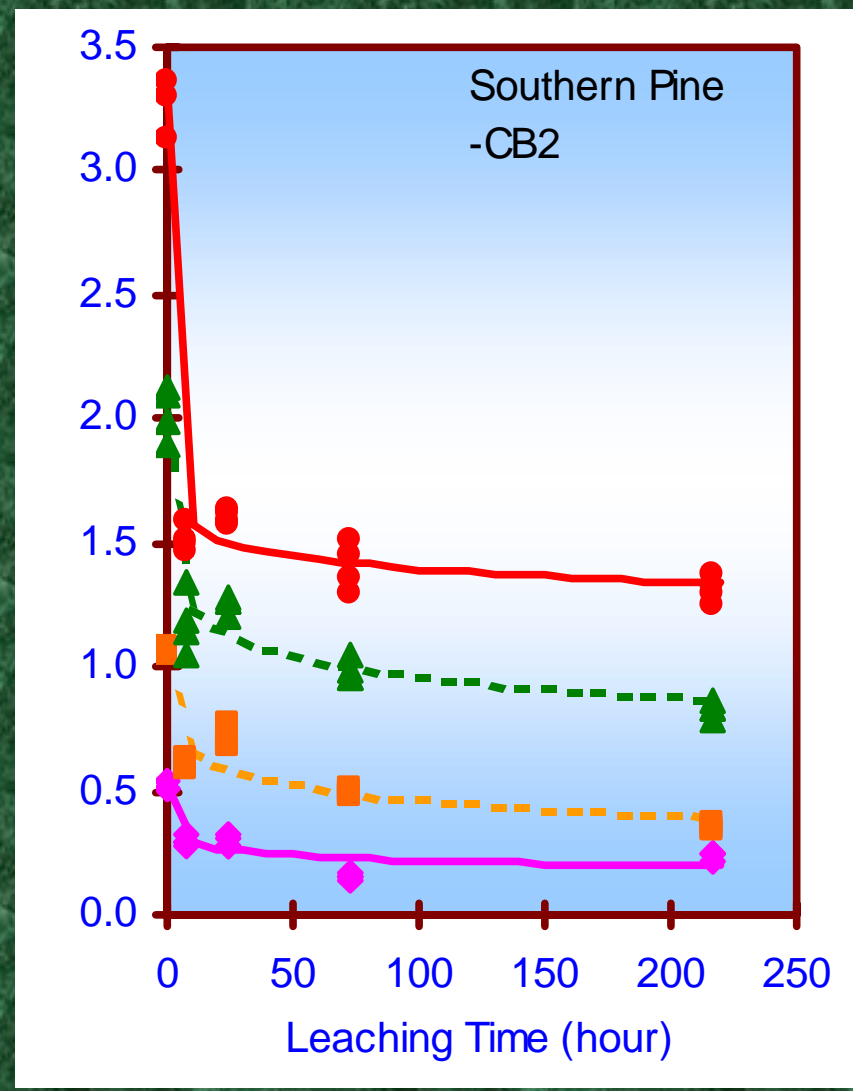
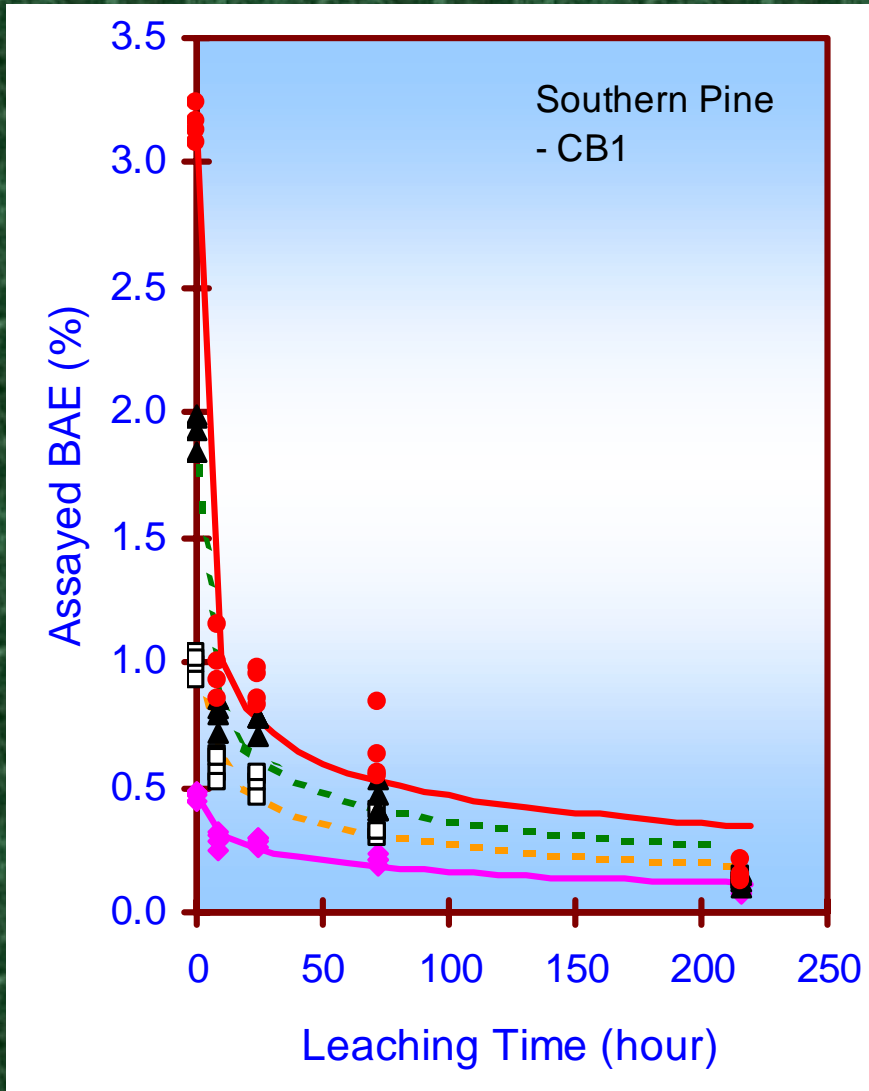
# Zinc Borate Leaching -B/Z Ratio



# Fixation Effect of PEG

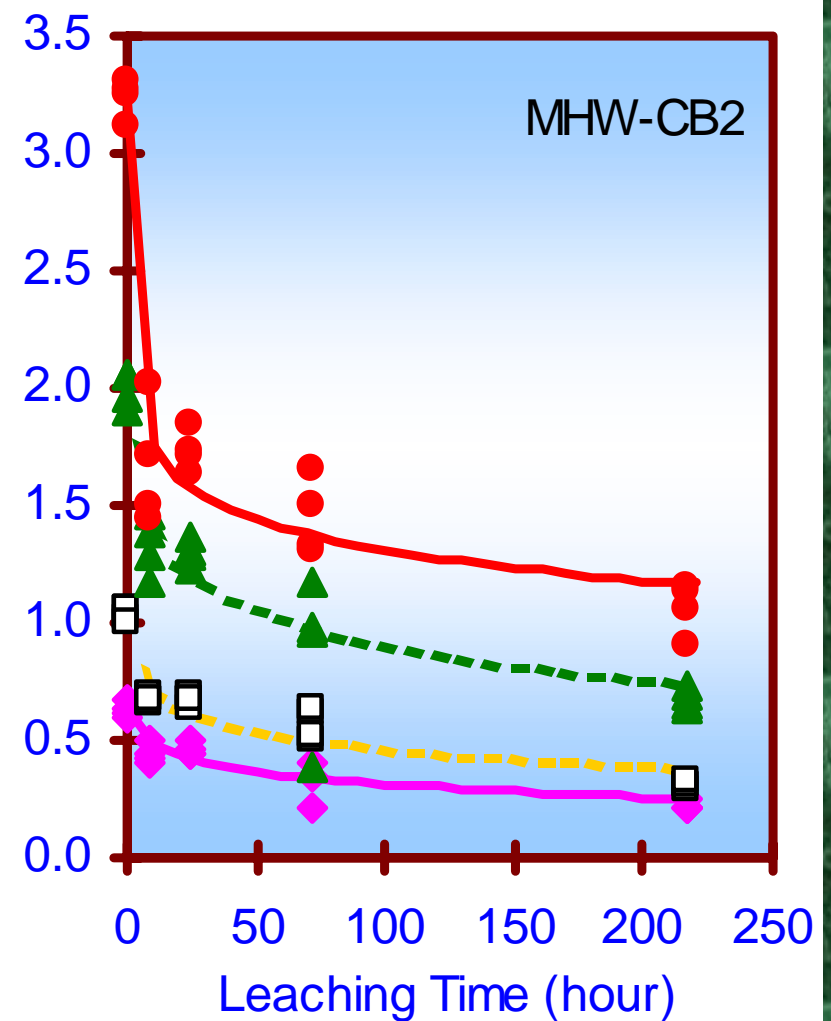
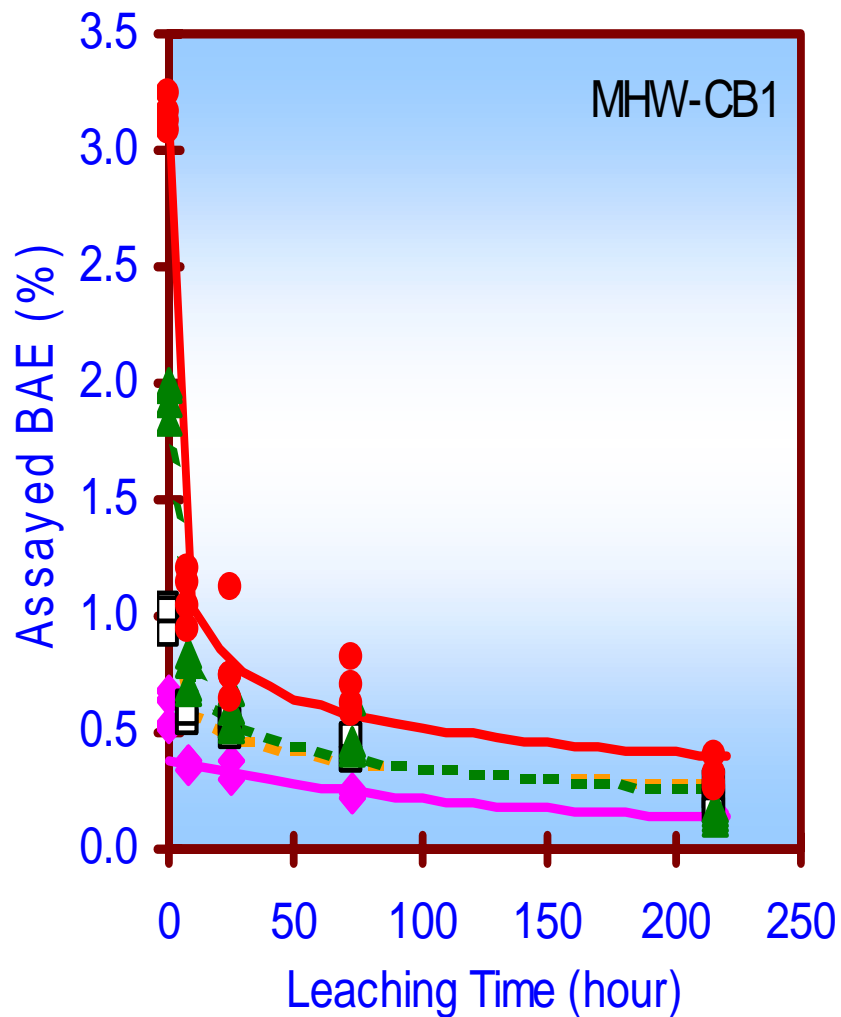
BAE Level	Source	DF	Sum of Squares	Mean Squares	F Value	Pr>F
1% ZB	Model	29	1.56325129	0.05390522	10.49	0.0001
	Species	2	0.11868290	0.05934145	11.55	0.0002
	Time	4	0.74324988	0.18581247	36.16	0.0001
	PEG	1	0.21348666	0.21348666	41.54	0.0001
	Species*Time	8	0.11271083	0.01408885	2.74	0.0213
	Species*PEG	2	0.15899769	0.07949884	15.47	0.0001
	Time*PEG	4	0.14681902	0.03670475	7.14	0.0004
	Species*Time*PEG	8	0.06930431	0.00866304	1.69	0.1430
3% ZB	Model	29	2.88358571	0.09943399	6.08	0.0001
	Species	2	0.62078738	0.31039369	18.98	0.0001
	Time	4	1.74581154	0.43645289	26.69	0.0001
	PEG	1	0.02485469	0.02485469	1.52	0.2272
	Species*Time	8	0.05376998	0.00672125	0.41	0.9052
	Species*PEG	2	0.00812933	0.00406466	0.25	0.7815
	Time*PEG	4	0.25335025	0.06333756	3.87	0.0118
	Species*Time*PEG	8	0.17688255	0.02211032	1.35	0.2571

# Calcium Borate Leaching -BAE

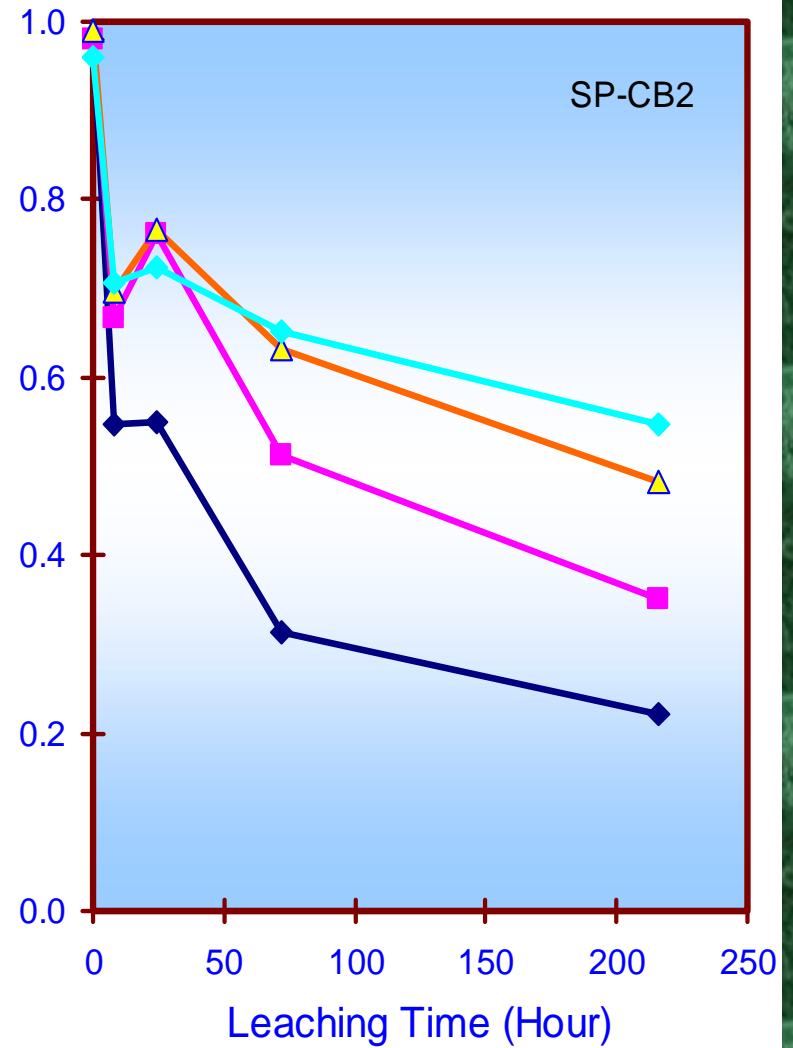
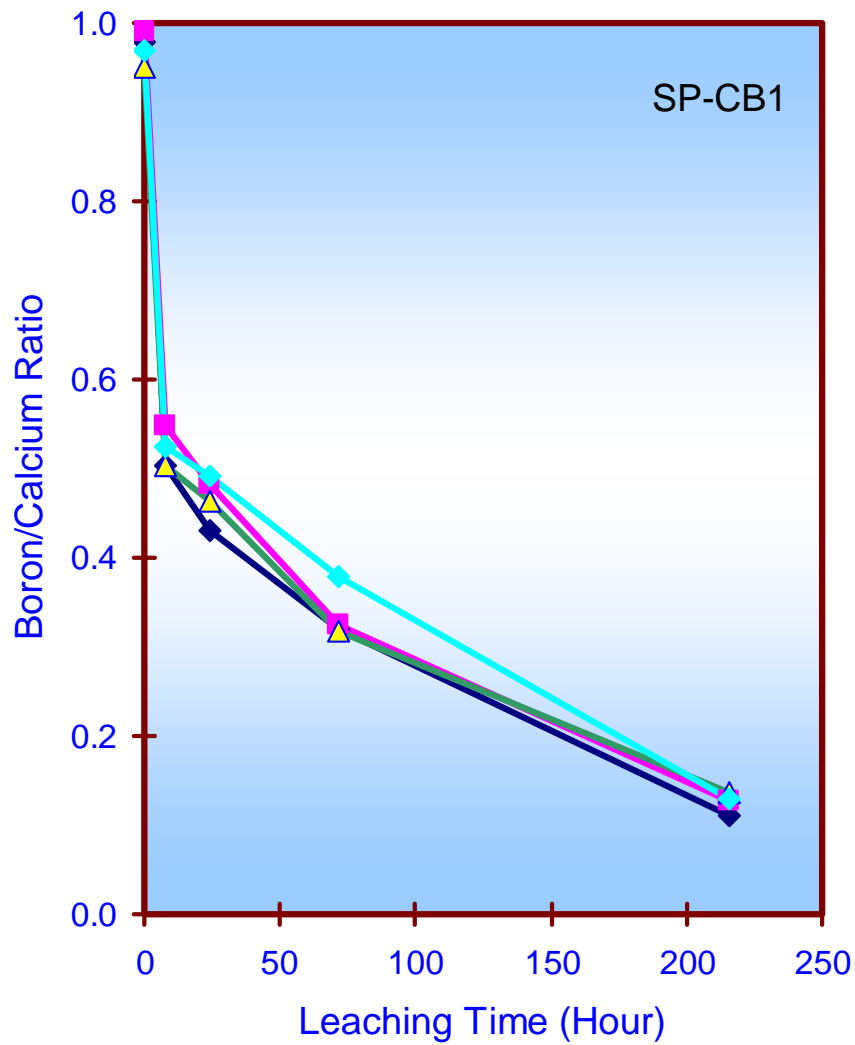




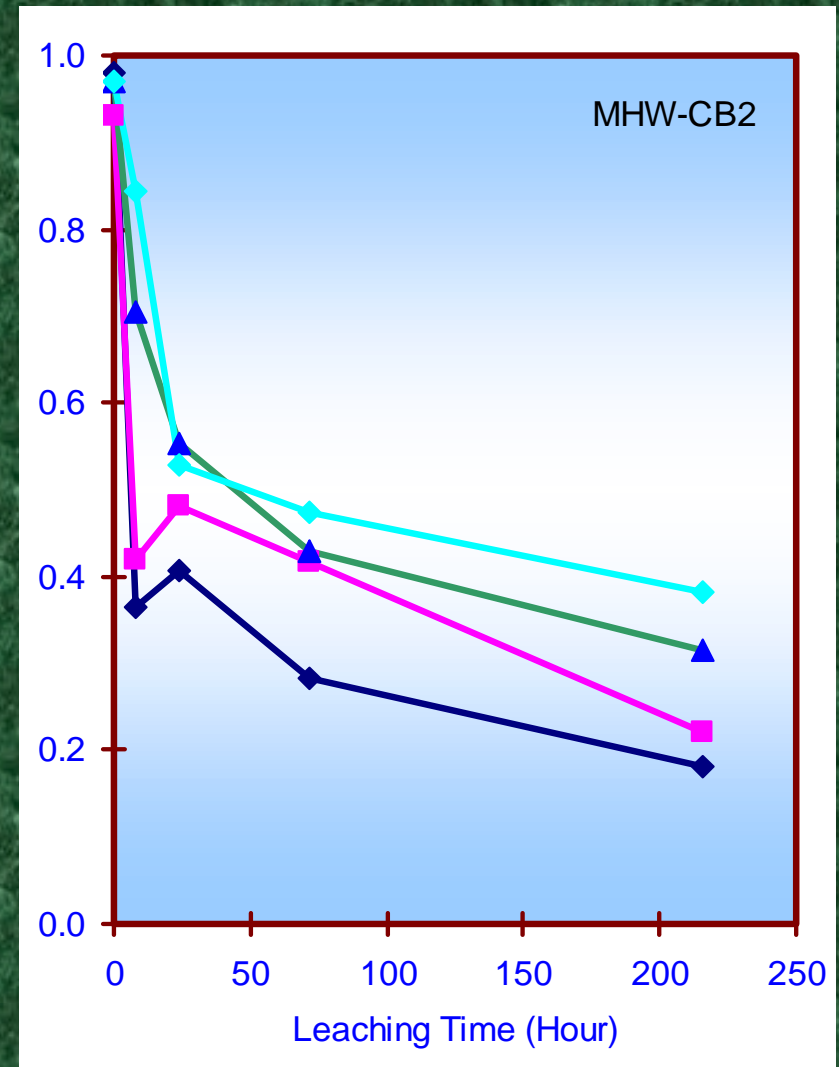
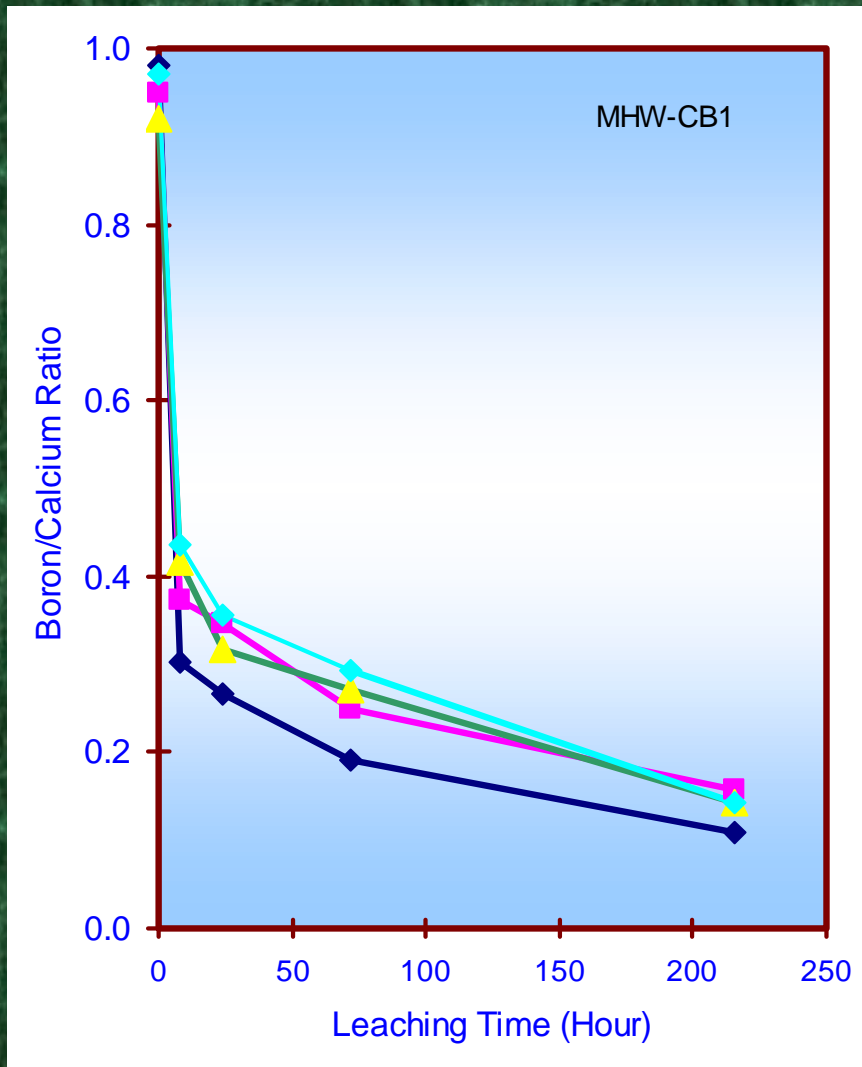
# Calcium Borate Leaching -BAE



# Calcium Borate Leaching – B/C Ratio



# Calcium Borate Leaching –B/C Ratio



# Calcium Borate OSB Leaching

<b>BAE Level</b>	<b>Source</b>	<b>DF</b>	<b>Sum of Squares</b>	<b>Mean Squares</b>	<b>F Value</b>	<b>Pr&gt;F</b>
<b>1% CB</b>	<b>Model</b>	<b>19</b>	<b>5.12105708</b>	<b>0.26952932</b>	<b>225.54</b>	<b>0.0001</b>
	<b>Species</b>	<b>1</b>	<b>0.03295468</b>	<b>0.03295486</b>	<b>27.58</b>	<b>0.0001</b>
	<b>Time</b>	<b>4</b>	<b>4.82675578</b>	<b>1.20668895</b>	<b>1009.77</b>	<b>0.0001</b>
	<b>Species*Time</b>	<b>4</b>	<b>0.02500909</b>	<b>0.00625227</b>	<b>5.23</b>	<b>0.0011</b>
	<b>CB</b>	<b>1</b>	<b>0.17238151</b>	<b>0.17238151</b>	<b>144.25</b>	<b>0.0001</b>
	<b>Species*CB</b>	<b>1</b>	<b>0.00002110</b>	<b>0.00002110</b>	<b>0.02</b>	<b>0.8947</b>
	<b>Time*CB</b>	<b>4</b>	<b>0.04170006</b>	<b>0.01042501</b>	<b>8.72</b>	<b>0.0001</b>
	<b>Species*Time*CB</b>	<b>4</b>	<b>0.02223486</b>	<b>0.00555871</b>	<b>4.65</b>	<b>0.0025</b>
<b>3% CB</b>	<b>Model</b>	<b>19</b>	<b>25.14148952</b>	<b>1.32323629</b>	<b>144.72</b>	<b>0.0001</b>
	<b>Species</b>	<b>1</b>	<b>0.00344379</b>	<b>0.00344379</b>	<b>0.38</b>	<b>0.5417</b>
	<b>Time</b>	<b>4</b>	<b>20.7166484</b>	<b>5.17916210</b>	<b>566.45</b>	<b>0.0001</b>
	<b>Species*Time</b>	<b>4</b>	<b>0.07803875</b>	<b>0.01950969</b>	<b>2.13</b>	<b>0.0876</b>
	<b>CB</b>	<b>1</b>	<b>2.93861283</b>	<b>2.93861283</b>	<b>321.4</b>	<b>0.0001</b>
	<b>Species*CB</b>	<b>1</b>	<b>0.01445484</b>	<b>0.01445484</b>	<b>1.58</b>	<b>0.2135</b>
	<b>Time*CB</b>	<b>4</b>	<b>1.23521265</b>	<b>0.30880316</b>	<b>33.77</b>	<b>0.0001</b>
	<b>Species*Time*CB</b>	<b>4</b>	<b>0.15507826</b>	<b>0.03876956</b>	<b>4.24</b>	<b>0.0043</b>

# Summary and Conclusions

- Boron leaching from ZB- and CB-modified OSB occurred upon initial water exposure.
- Borate type, initial BAE level, and sample thickness swelling significantly influenced boron leachability.
- Glue-line washing and decomposition of the borate to form less water-soluble boric acid are two possible causes.
- The relationship between assayed BAE and leaching time followed a decaying exponential function for ZB and a Harris decaying power function for CB.
- The results provide a relative measure of the leachability of the OSB panels treated with different types of borate.
- A standardized leaching method for treated composite materials is needed.