New Approach to Remove Metals from Chromated Copper Arsenate (CCA)-Treated Wood

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Current Disposal Options for Preservative-Treated Wood

- Landfill
  - Metals may leach into the soil and ground water
  - Tipping fees and disposal cost are rising
- Combustion/Incineration
  - Heavy metals exist in the ash

Waterborne Preservatives (2007)

Million Pounds Consumed

- #1 CCA: 53.9 (oxide lbs)*
- #2 ACQ: 45.9 (active lbs)
- #3 MCQ: 37.11 (active lbs)

*29% of total water borne (was 35% in 2004)

Vlosky 2009

Current Recycling Methods

- Reuse without chemical treatment
- Bioremediation
- Solvent extraction
- Thermochemical conversion "Pyrolysis"
- Hydrothermal (Super- and Sub- Critical Water) treatment

Solvent Extraction Problems

- Large amount of chemical solvents needed
- Long duration of the acid extraction process
- Not economically viable

The Bottom Line

- Previous recycling methods are too costly and/or too slow to be commercially viable.

CCA Fixation

- The major components of CCA fixed wood are thought to be $CrAsO_4$-lignin complexes, $CuCrO_4$-lignin complexes, Cu^{2+}-lignin and Cu^{+}-cellulose complexes, and $Cr(OH)^3$ precipitates (Dahlgren and Hartford 1972).

Reduction = Fixation

Lebow and Kartal (1999) pointed out that the essence of CCA fixation is the reduction of Cr from hexavalent to the trivalent state, and the subsequent precipitation or adsorption of Cu (e.g., wood carboxylate-copper(II) complexes), Cr(III) hydroxide, Cr(III) As complexes, etc. in the wood (Bull 2001), where the role of Cr is a co-precipitant for As.

Objectives

- **1. Recover Cu, Cr, and As metals effectively and quickly from CCA-treated wood samples with three different kinds of acids (acetic, oxalic and phosphoric acid)**

- **2. Optimize the recycling conditions in a microwave oven (reaction time, temperature, acid type and concentration)**

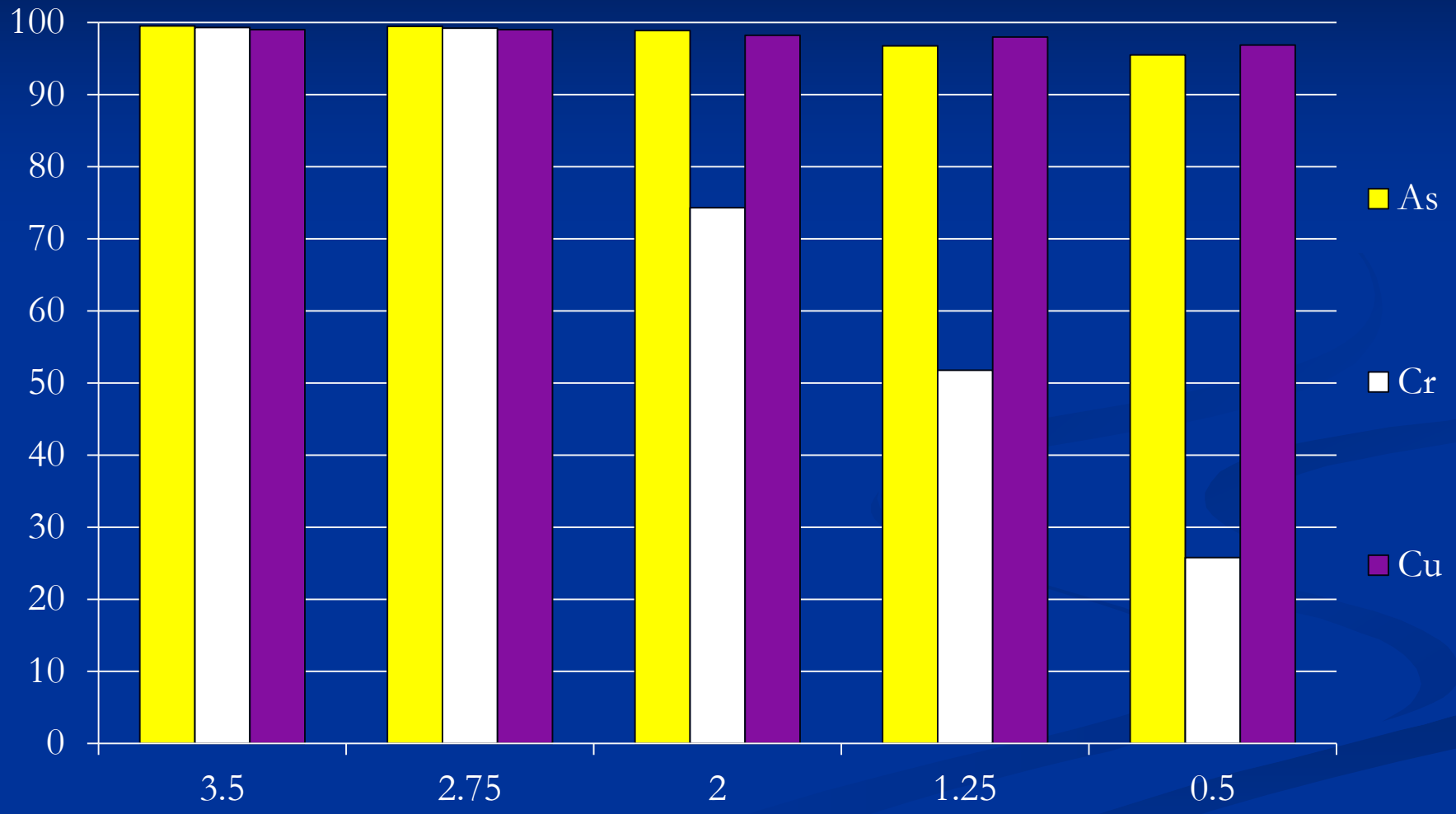
Materials and Methods

- 1.0g CCA treated Southern Pine chips (>40mesh) mixed with 20ml acid in a 100ml sealed vessel.
- The acid solutions were prepared in percentage concentration by weight of acid in g per vol of deionization water (g/v).
- Binary acid solutions of acetic/oxalic, acetic/phosphoric, or phosphoric/oxalic acids
- Milestone MEGA 1200 laboratory microwave oven: **160ºC/30min** unless otherwise noted

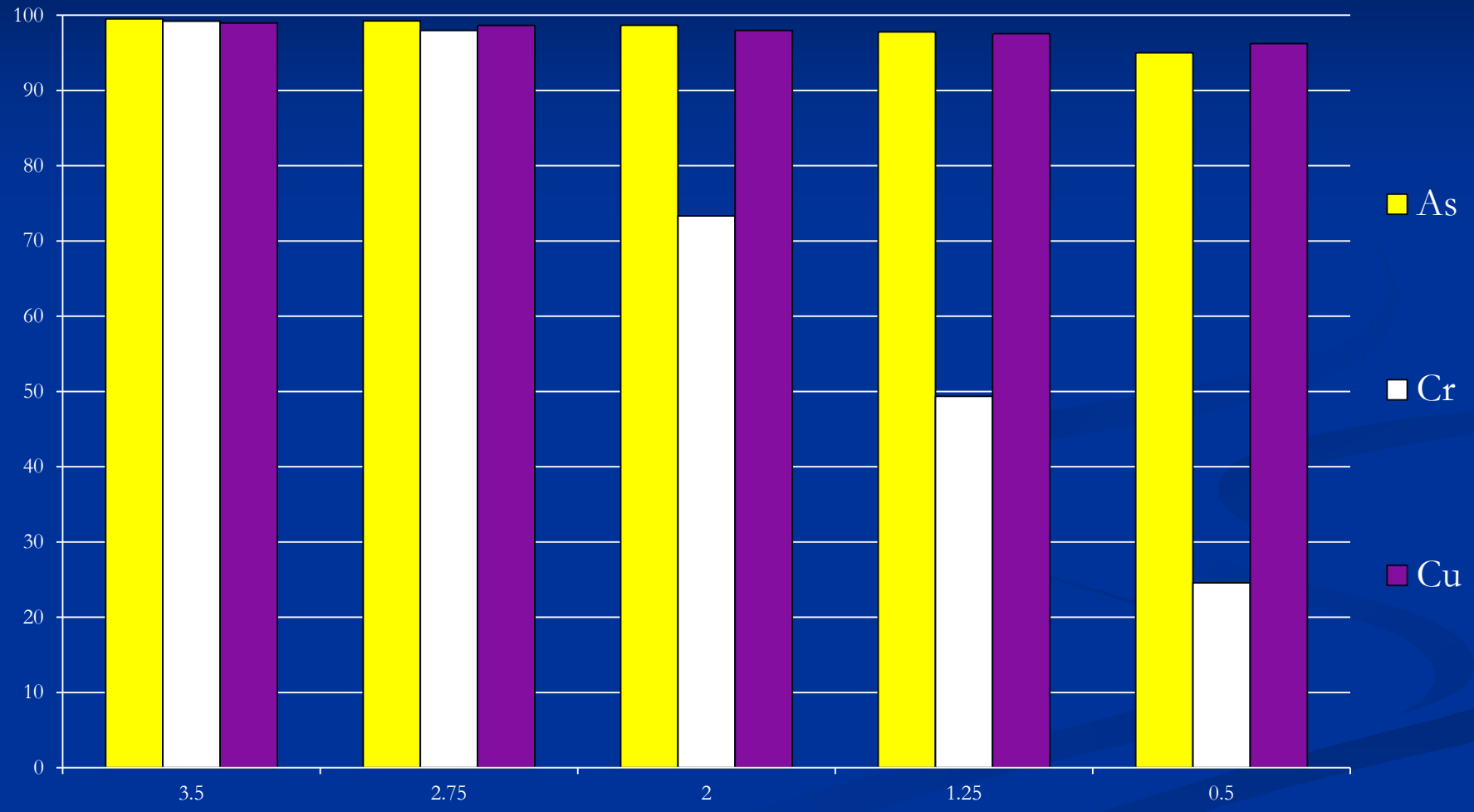
Analytical Methods

- Extracted liquids were vacuum-filtered through Whatman No. 4 filter paper and diluted to 100 ml for determination of the CCA elements.
- Solid wood residue retained on the filter paper was oven-dried and then subjected to acid digestion prior to ICP (AWPA A21-00). Samples were digested in accordance with AWPA A7-93.

CCA Removal, AA=2.0 (wt%)

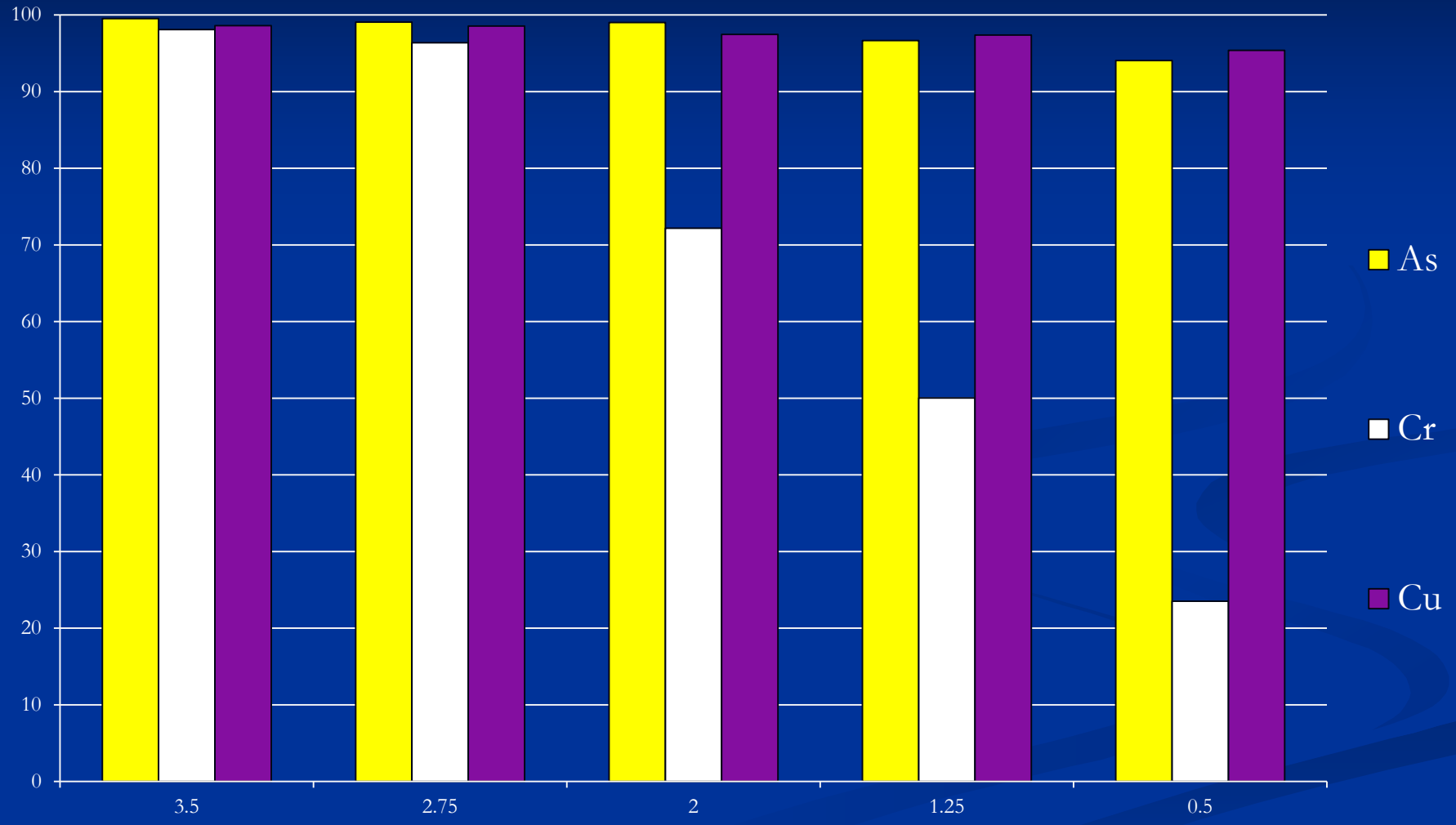


CCA Removal, AA=1.5 (wt%)



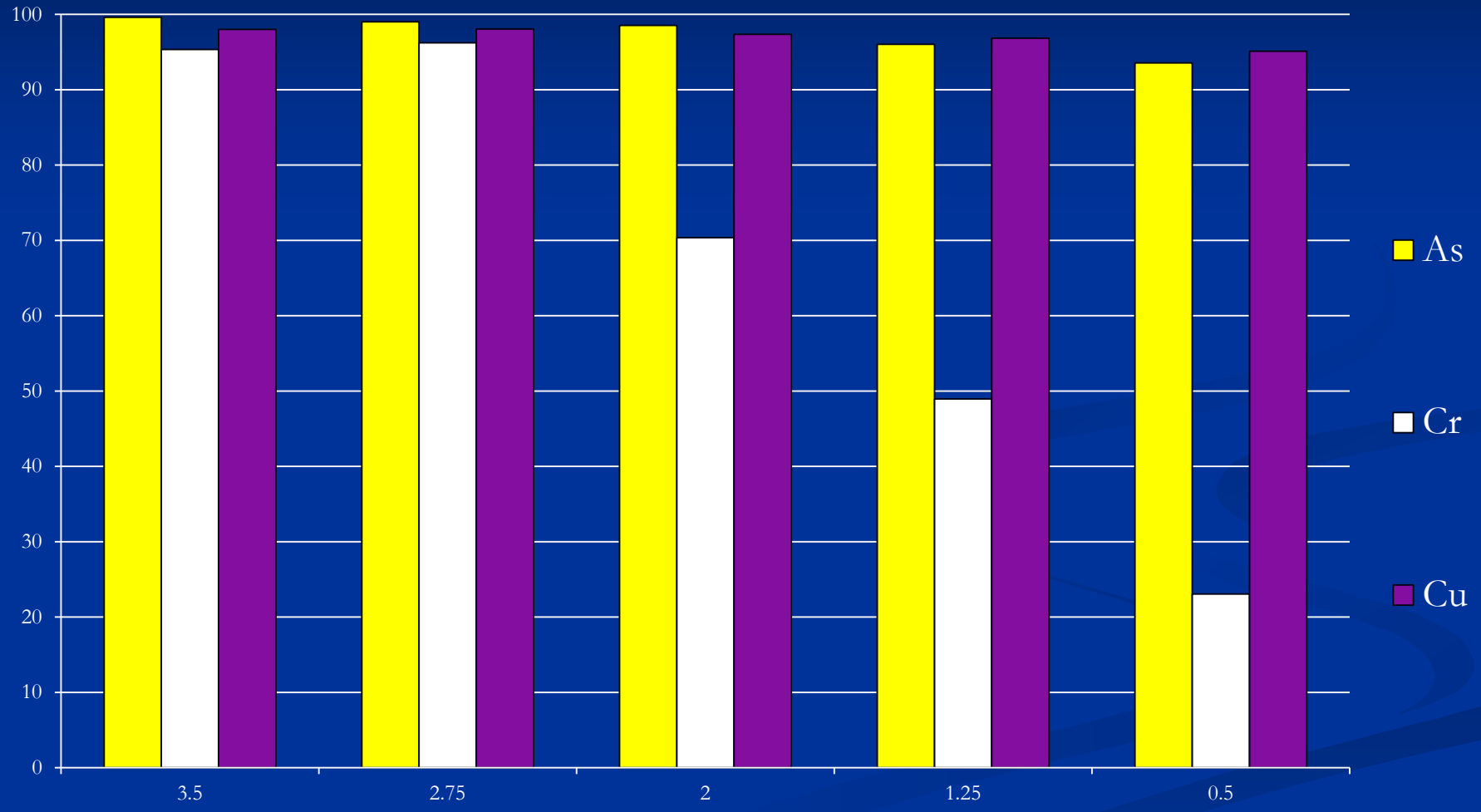
Phosphoric Acid (wt.%)

CCA Removal, AA=1.0 (wt%)



Phosphoric Acid (wt.%)

CCA Removal, AA=0.5 (wt%)



Phosphoric Acid (wt.%)

Conclusions

- The results show that diluted phosphoric acid mixed with acetic acid is very effective to recover CCA elements in a microwave reactor in a short period. The advantage of this method is a shorter extraction time and a one step process to achieve the complete recovery of CCA elements.

Conclusions

- The concentration of phosphoric acid and temperature of the microwave reactor were two important factors. A binary acid solution consisting of 2.75% phosphoric acid and 0.5% acetic acid, reaction time of 10 min., and temperature of 130 ^{0}C is the minimal reaction condition to achieve the maximum recovery rate of all CCA elements.

Future Research

- Further research such as the acetic acid concentration, reaction time, and temperature should be studied. Also, research on larger sized wood chips should be done to enhance the practical application of this method.


参数设置
1# 阳极电流 0
2# 阳极电流 21280
3# 阳极电流 12579
Kinco

For More Information

Hse, C.Y., T.F. Shupe, B. Yu, H. Pan, and Z. Zheng. 2011. Process for rapid microwave-enhanced detoxification of CCA-treated wood. US Patent # 8,043,399.

GEAUX TIGERS!!!!!