

Wood Chemistry

---

# Wood Chemistry

PSE 406/Chem E 470

Autumn Quarter Introduction  
2005

PSE 406 - Lecture 1 1

Wood Chemistry

---

# Agenda

- Introductions
- Course syllabus
  - » Web site
  - » Expectations
- Rice Krispies Treats

PSE 406 - Lecture 1 2

Wood Chemistry

---

## Your Instructor: Bill McKean

- B.S., 1960, University of Colorado, Chemical Engineering
- Ph.D., 1967, University of Washington, Chemical Engineering
- 1967-70, Battle Northwest, Frankfort, Geneva, Contract Research
- 1970-76 North Carolina State University, Professor, Paper Science and Engineering
- 1976-79 Senior Design Engineer, Weyerhaeuser
- 1979, present Professor, Paper Science and Engineering
- Consulting for multiple government and private organizations on pulping, bleaching, papermaking, power and recovery and marketing
- Married with 2 grown children

PSE 406 - Lecture 1 3

Wood Chemistry

---

## Course Web Site

- All the information about this course can be found on the course web site:
  - » <http://courses.washington.edu/pse406>
  - » Syllabus
  - » Class Schedule
  - » Lecture notes
  - » Reading assignments
  - » Announcements
  - » References

PSE 406 - Lecture 1 4

Wood Chemistry

## How is Wood like a Kellogs™ Rice Krispies Treat?

- A warped instructor needed some sort of an analogy to assist people in understanding wood.
- This is it.




Image borrowed from Kellogs™ web site for academic purposes

PSE 406 - Lecture 1 5

Wood Chemistry

## Rice Krispies Alone

- In a house with kids, a box of Rice Krispies consists of 2 things: Rice Krispies and Rice Krispies dust (especially true if there is a prize involved).
- You can pour this mixture into a bowl but you cannot stand it up or make a bar.





Image borrowed from Kellogs™ web site for academic purposes

PSE 406 - Lecture 1 6

Wood Chemistry

## Formation of the Bar

- In order to make a solid bar, you need something to glue together the Rice Krispies and the Rice Krispies dust.
- Marshmallow cooked over an open flame works great.
- You also need something to preserve the bars....A variety of preservatives can be used.



PSE 406 - Lecture 1 7

Wood Chemistry

## Rice Krispies Treats

Ingredient	Amount	Wood Equivalent
Big Rice Krispies	1 3/4 cups	Cellulose
Rice Krispies Dust	1 cup	Hemicelluloses
Marshmallow	1 1/8 cup	Lignin
Butter	3 tablespoons	Lignin
Preservatives	~ 1-5 tablespoons	Extractives

The butter and the marshmallows are heated together forming a sticky glue type material. This is applied to the Rice Krispies and dust forming a bar which is solid when cooled.

PSE 406 - Lecture 1 8

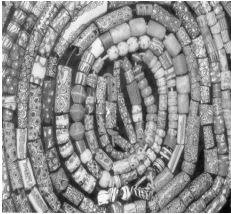
Wood Chemistry **What is Cellulose?**

- Cellulose is a large molecule made from glucose molecules (dextrose) strung together like beads on a string.
- The glucose molecules are known as monomers and the cellulose chain is known as a polymer.
  - » 1 glucose molecule= monomer
  - » 2 linked glucose molecules= dimer
  - » 3 linked glucose molecules= trimer
  - » lots of linked glucose molecules = polymer

PSE 406 - Lecture 1 9

Wood Chemistry **What is Cellulose?**

- Cellulose is a straight chain polymer. In bead terms, imagine a very long straight string of beads with 2 ends and no branching points.
- In wood, cellulose chains contain typically 10,000 glucose molecules...quite a long string of beads.



Source: World Book Encyclopedia

PSE 406 - Lecture 1 10


Wood Chemistry **What are Hemicelluloses?**

- Hemicelluloses are also sugar polymers but different from cellulose because they are:
  - » Made up glucose and other sugars.
  - » Contain some molecules other than sugars.
  - » Branched little polymers
    - The beads have Y's in them
  - » Much smaller than cellulose as they are made up of between 50-300 sugars (Rice Krispies Dust)
- There are lots of varieties of hemicelluloses.

PSE 406 - Lecture 1 11

Wood Chemistry **What is Lignin?**

- Lignin is a polymer like cellulose and hemicelluloses but is made with phenolic compounds (aromatic rings) instead of sugars.
- Lignins are large 3 dimensional polymers that form the glue that holds the cellulose and hemicelluloses together.
- Lignin has been described as 3 dimensional chicken wire.



Picture taken from Katy's chicken page

PSE 406 - Lecture 1 12

## What are Extractives?

- In the Rice Krispies model, extractives compounds were represented by preservatives added to the treats. This is a very good representation of the role of a good portion of the extractives in trees.
- The term extractives refers to a large variety of different chemicals produced by the tree for a variety of reasons (protection, food storage, formation of membranes, color, etc.)
- Examples: what sticks to your hand when you pick up your Christmas tree, what comes out of your tea bag with hot water, what you taste when you brush your teeth.

## Putting it All Together

- Putting all of the components together and you get wood. The cellulose and the hemicelluloses held together with lignin.



Picture from Focus Forest Products Web Site



- Taking the lignin away through chemical processes (pulping and bleaching) leaves these fibers of cellulose and hemicelluloses