ENZYMES
and
PITCH CONTROL

OUTLINE OF PRESENTATION

- Problems from Pitch
- Technical Information on Pitch
- Pitch Deposits
- Pitch & Defoamers
- Pitch Control
- Enzymes for Pitch Control

PITCH - ONE OF THE COSTLIEST PRODUCTION PROBLEMS

- Lost Production
- Diminished Clothing Life
- Sheet Defects - Spots and Holes
- Breaks
- Reduced Refiner Life
- Greatly Increased Production Costs

WOOD

- Cellulose
- Hemicelluloses
- Lignin
- Extractives / Resins

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- Hemicelluloses
- Lignin
- Extractives / Resins

WOOD RESINS

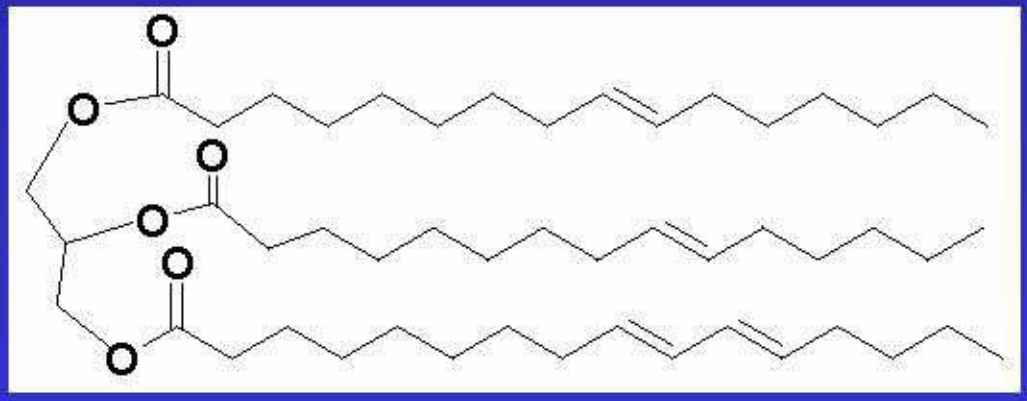
- Typically 2 - 4 percent of wood by weight
- Can range from 1 - 8 percent
- Much higher levels in the Bark
- Complex chemistry

WOOD RESINS CHEMISTRY

- Triglycerides
- Fatty acids
- Resin acids (softwoods only)
- Higher alcohols, waxes
- Minor components

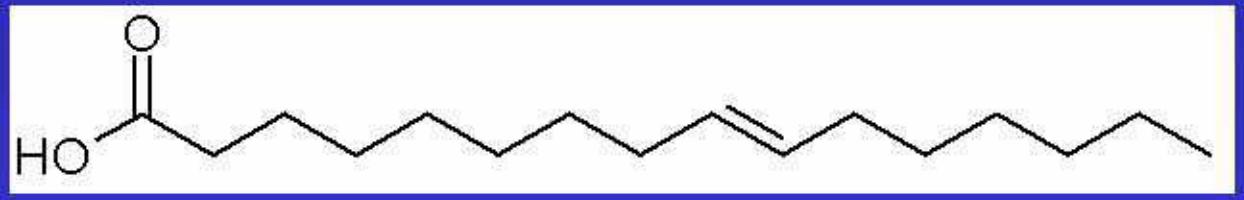
WOOD RESINS CHEMISTRY

- Triglycerides are fats
- Un-charged, but can be *saponified* in a kraft process
- Probably the major problem component



WOOD RESINS CHEMISTRY

- Fatty acids
- Have an anionic charge as pH rises
- Help disperse other resin components
- Can react with Ca^{++} to give a deposit



WOOD RESINS CHEMISTRY

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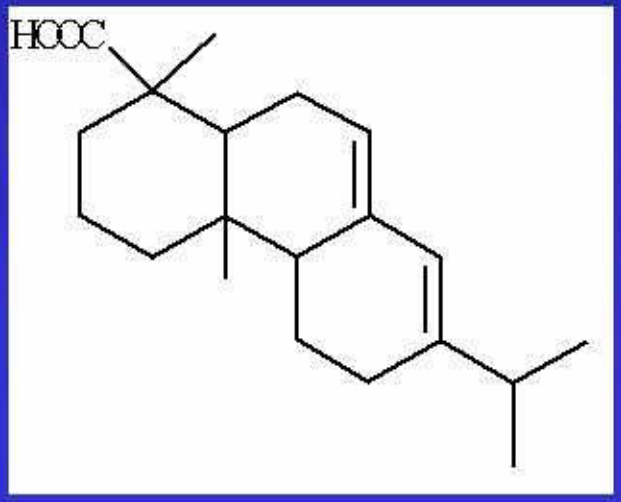
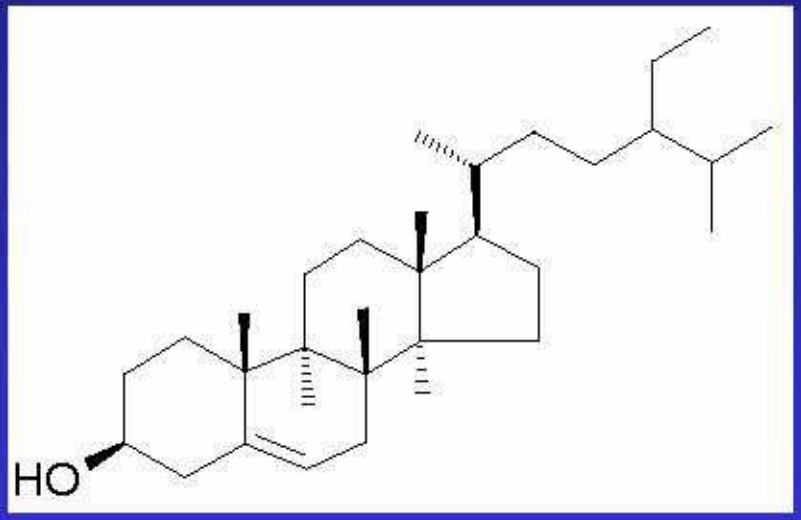


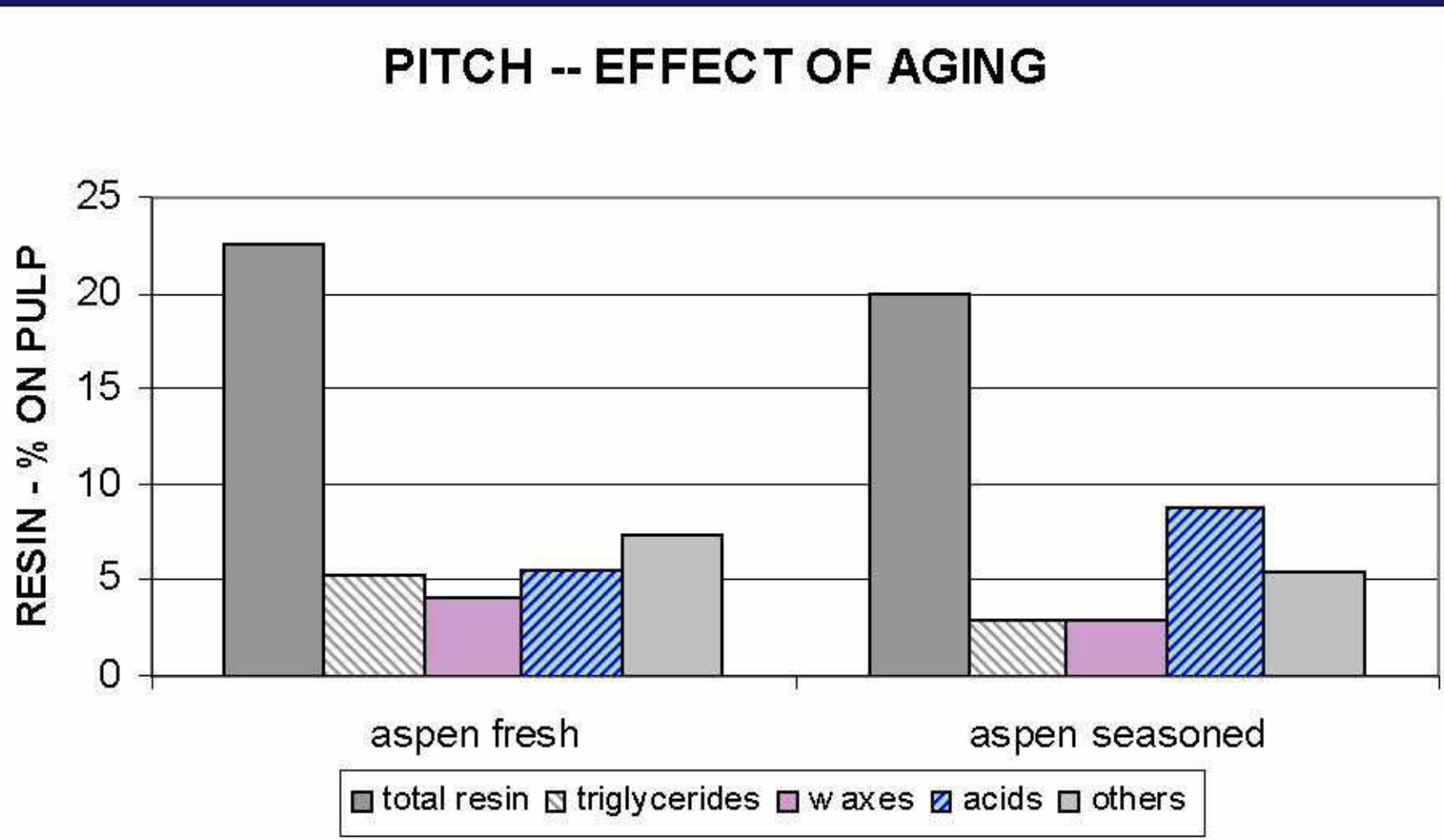
WOOD RESINS CHEMISTRY

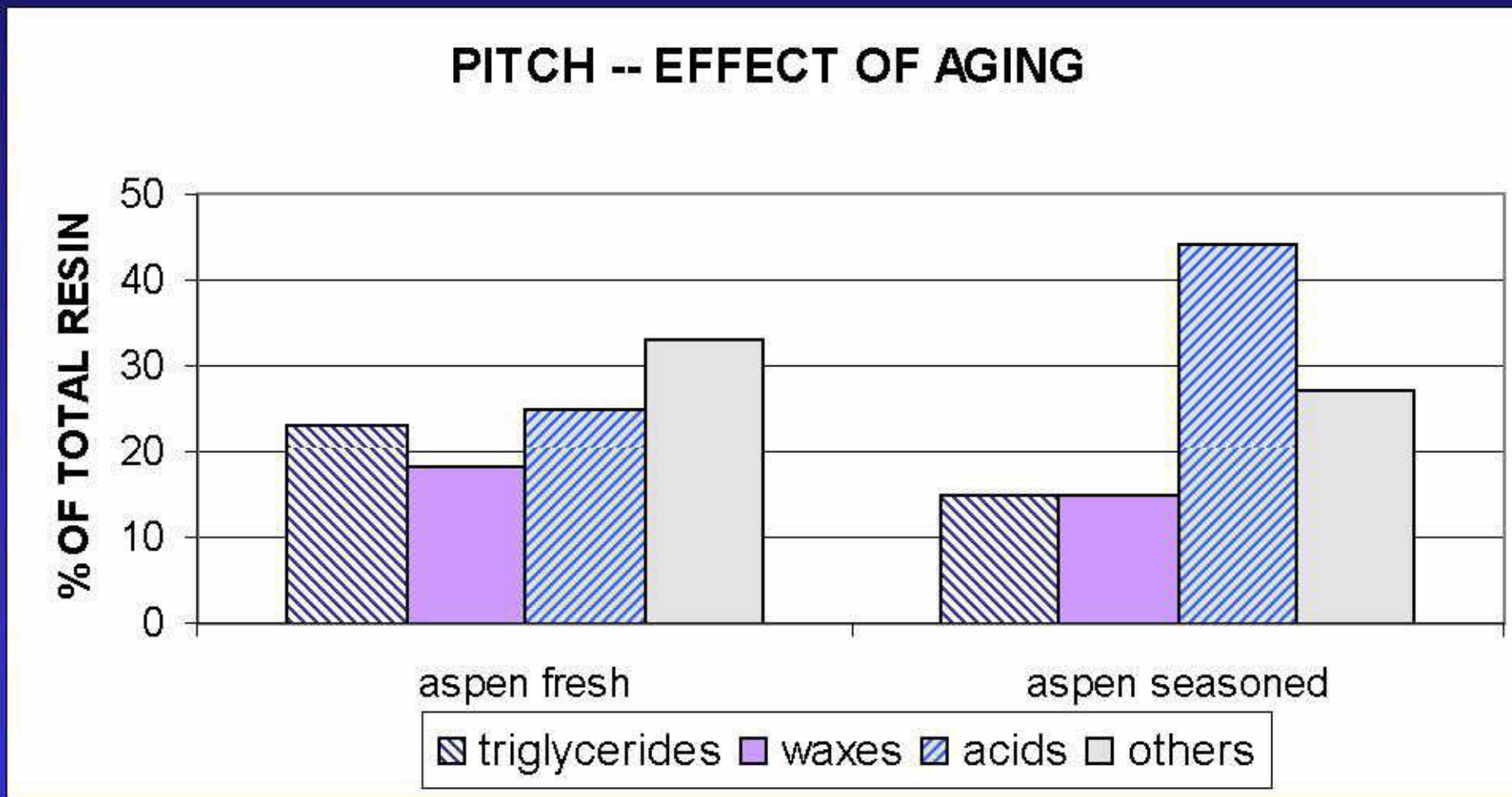
- "Others" include



RESINS CHEMISTRY - EUCALYPTUS

- Major component:
  - stearyl esters of fatty acids
- Minor components:
  - fatty acids, triglycerides, gallic acid, ellagic acid
- Seasoning chips reduces the amount of resin, primarily reducing the stearyl esters


PITCH -- EFFECT OF AGING
RESIN - % ON PULP
25
20
15
10
5
0
aspen fresh
aspen seasoned
total resin
triglycerides
w axes
acids
others


PITCH -- EFFECT OF AGING
% OF TOTAL RESIN
50
40
30
20
10
0
aspen fresh
aspen seasoned
triglycerides
waxes
acids
others

PITCH - EFFECT OF KRAFT PROCESS ON RESIN CHEMISTRY

COMPONENTS	DESCRIPTION	IN KRAFT PROCESS
Triglycerides	Nonionic, not water-soluble	Primarily converted to soaps
Fatty Acids	Anionic, soluble at high pH	Converted to soaps
Resin Acids	Anionic, soluble at high pH	Converted to soaps
Waxes	Nonionic, not water-soluble	Not changed

RELEASE OF PITCH FROM WOOD

- Released by Shear in Refiners
- High Temperature Extraction
- Pressure from Screw Presses
- Shear from Pumps & other Equipment

NATURE OF PITCH

- Released as Free-Floating Droplets
  (1 - 10 um)
- More Tacky with Increased Ca^{++} hardness
- Affinity w/ Stickies can cause Deposits
- Tendency to Deposit in Presence of Aluminum (Al^{+++})

AGGLOMERATION

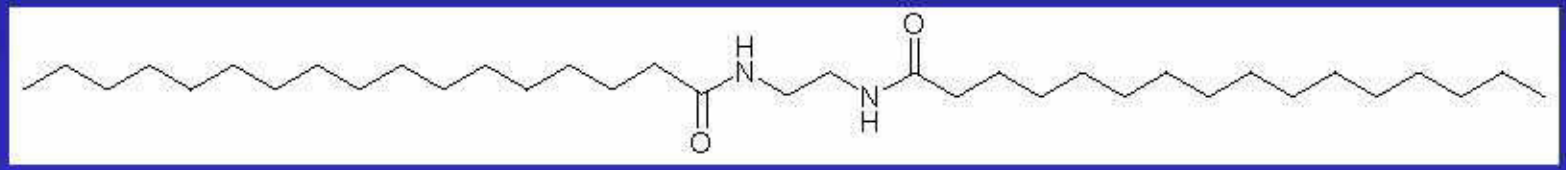
- Pitch Particles can be seen under the microscope
- Pitch has a tendency to Re-agglomerate -
- It's very INsoluble in water
- Like chemistry attracts like …

DEFOAMERS AND PITCH

- Like attracts like: some components of Defoamers are very similar to pitch
- EBS (used in some oil-based defoamers) is VERY insoluble in water
- Oil used on some defoamers is VERY insoluble in water
- Oil & EBS can deposit with pitch

DEFOAMERS AND PITCH

- EBS = ethylenebis(stearamide)
- EBS structure:



DEFOAMERS AND PITCH

- Better technology is available
- Eliminates oil and EBS
- Can have a major positive effect to reduce pitch problems
- New technology: Water-based, oil-free, with 21st century silicone chemistries

FACTORS THAT FACILITATE AGGLOMERATION OF PITCH

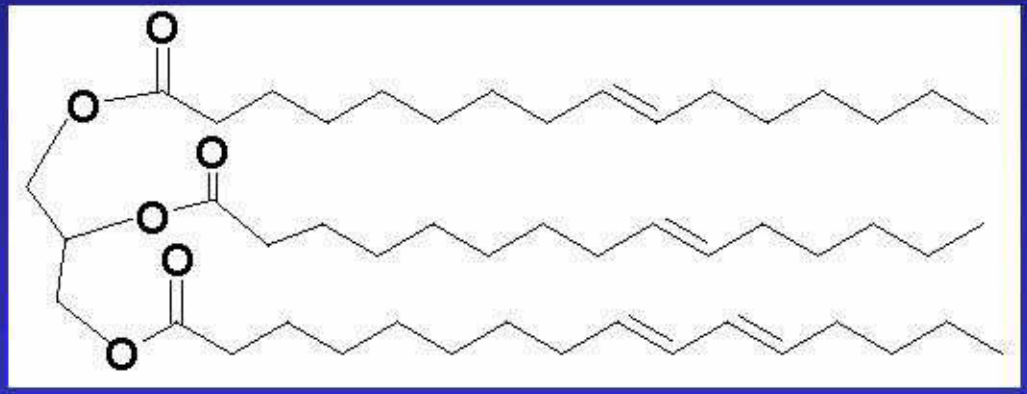
- Shear
- Temperature Shock
- pH Shock
- Increased Concentration - Mill Closure
- Different Wood Species
- Fresh wood (not aged)

TRADITIONAL PITCH CONTROL

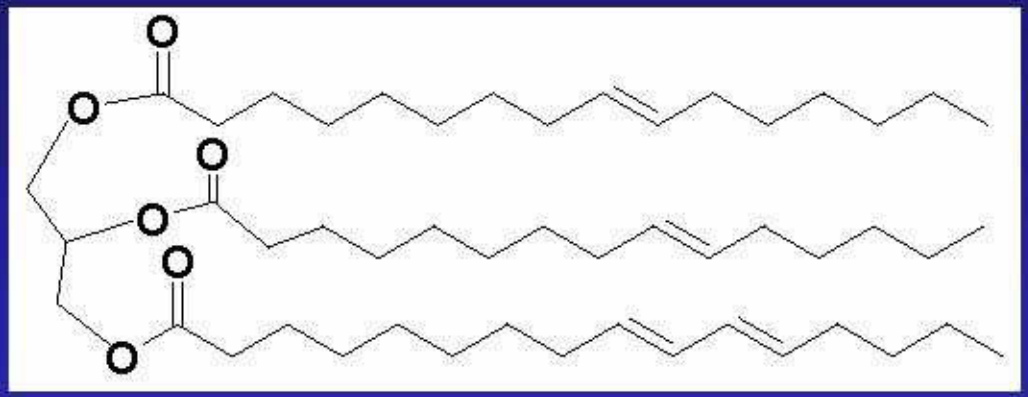
- Less - closed System -- use more water, send more water to the sewer
- Dispersants
- Talc - sometimes works to adsorb pitch
- Alum & Aluminate
  - Cationic material precipitates pitch particles
- Cationic Polymers
- NEW!! Enzymes for pitch control

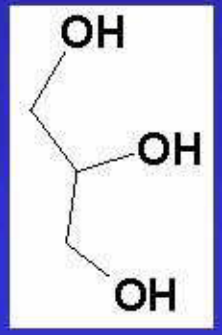
ENZYMES FOR PITCH CONTROL

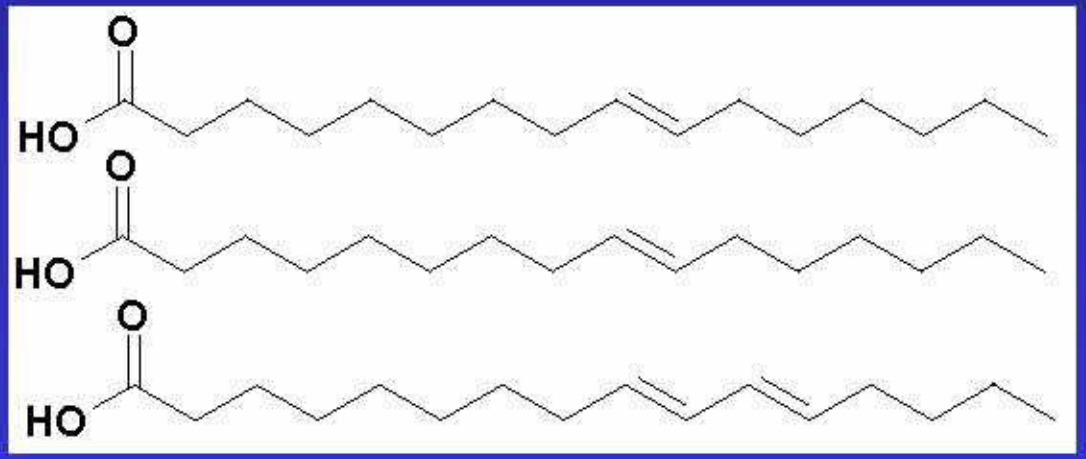
- Lipase breaks down Triglycerides



ENZYMATIC HYDROLYSIS OF TRIGLYCERIDES







ENZYMES & PITCH - SUMMARY

- Some Lipases can Hydrolyze Triglycerides
  - Triglycerides are the troublesome component of pitch -- sticky, non-water soluble, neutral
  - Triglycerides changed to glycerol and fatty acids
- NOTE: cationic polymers may be needed to control the Fatty Acids

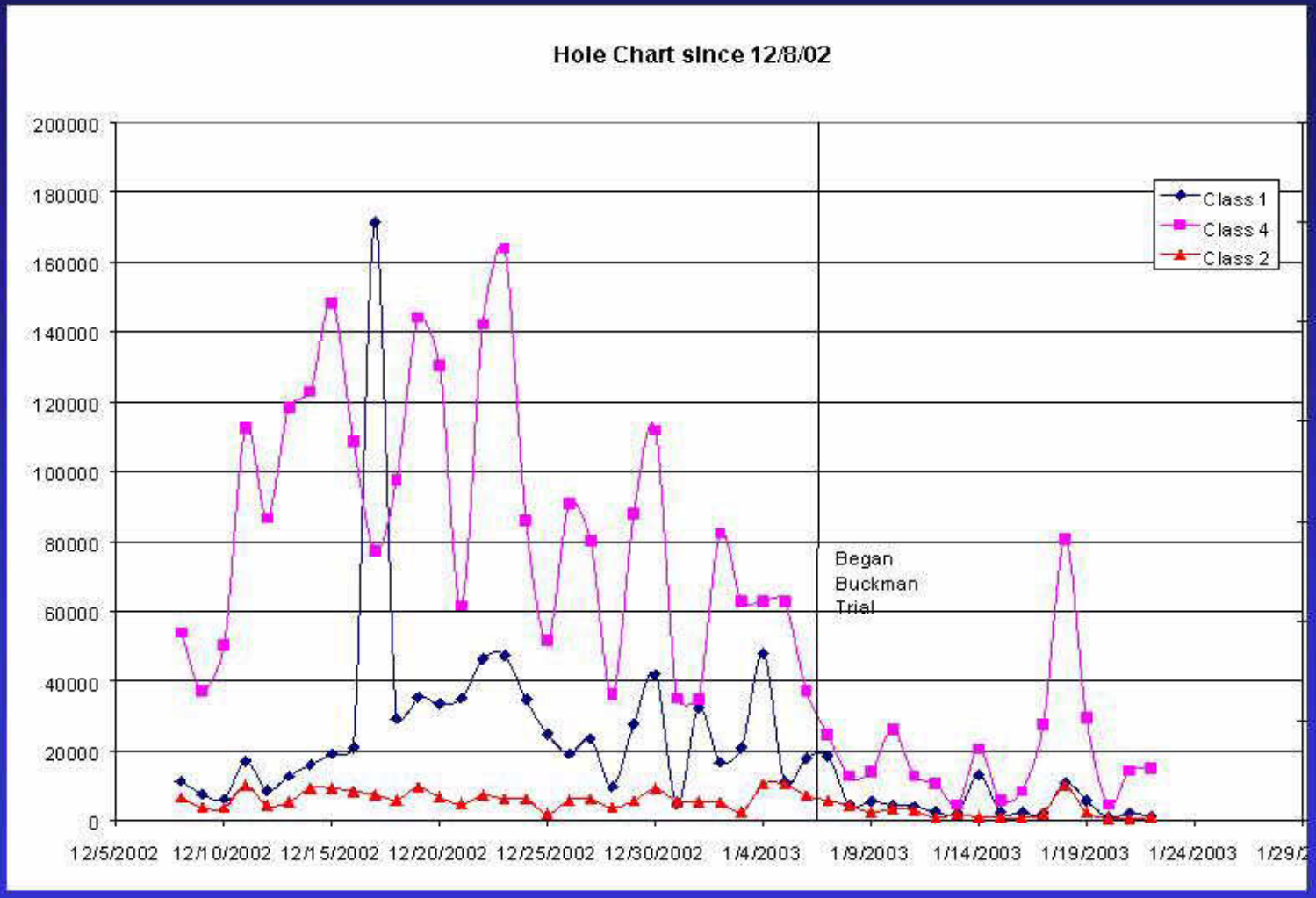
Pitch Sample - Traditional Treatment

Sans enzymes

Pitch Sample - Treated w/ enzyme

BENEFITS OF ENZYMATIC PITCH CONTROL

- U.S. newsprint mill [TMP/DIP 70/30]
- Alum used (11-13 kg/tonne)
- In winter, chip temperature affects pitch control
  - Cold weather slows "aging" of chips
- At this mill, the level of triglycerides in system correlates with pitch problems


Hole Chart since 12/8/02
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Class 1
Class 4
Class 2
Began
Buckman
Trial
12/5/2002
12/10/2002
12/15/2002
12/20/2002
12/25/2002
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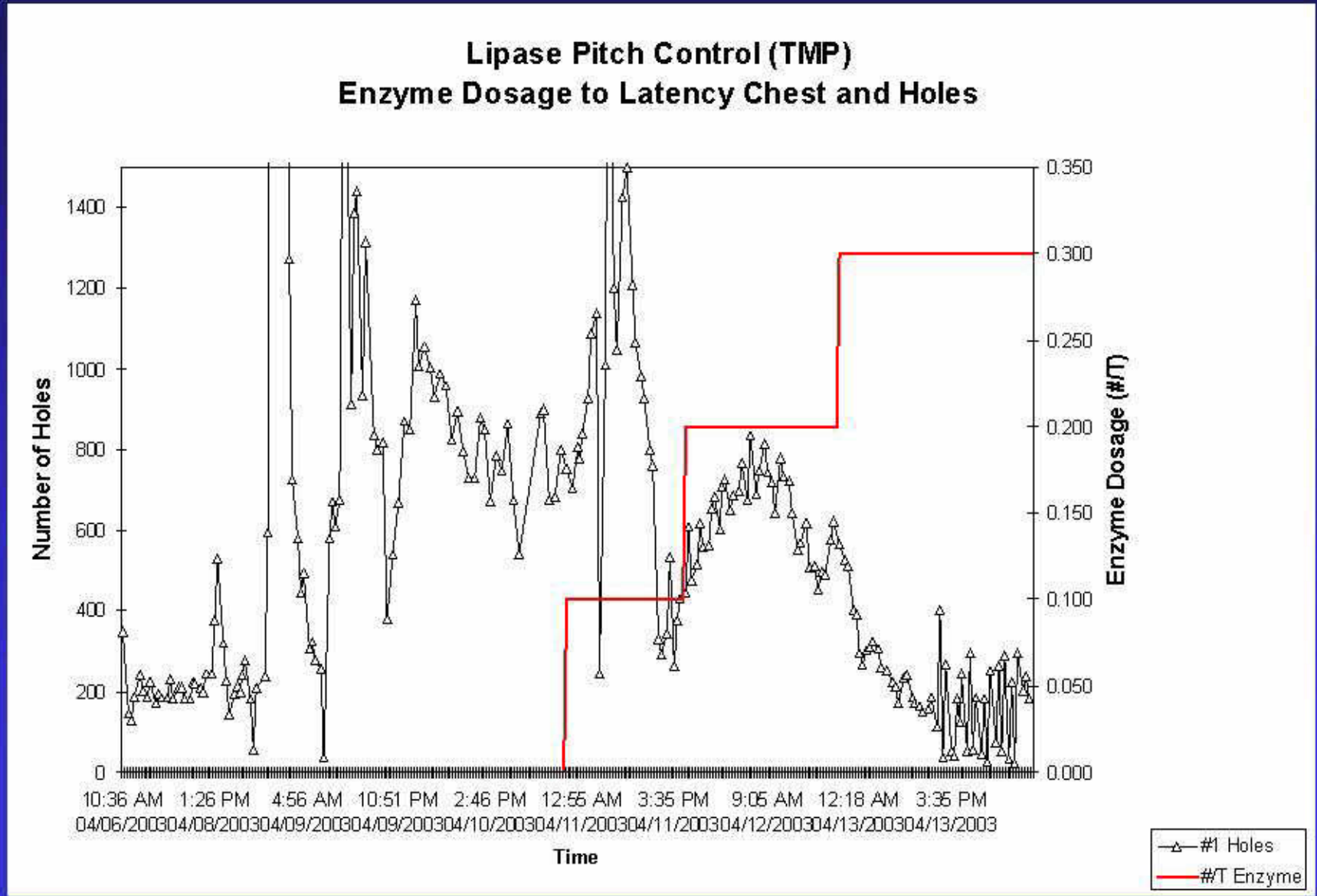
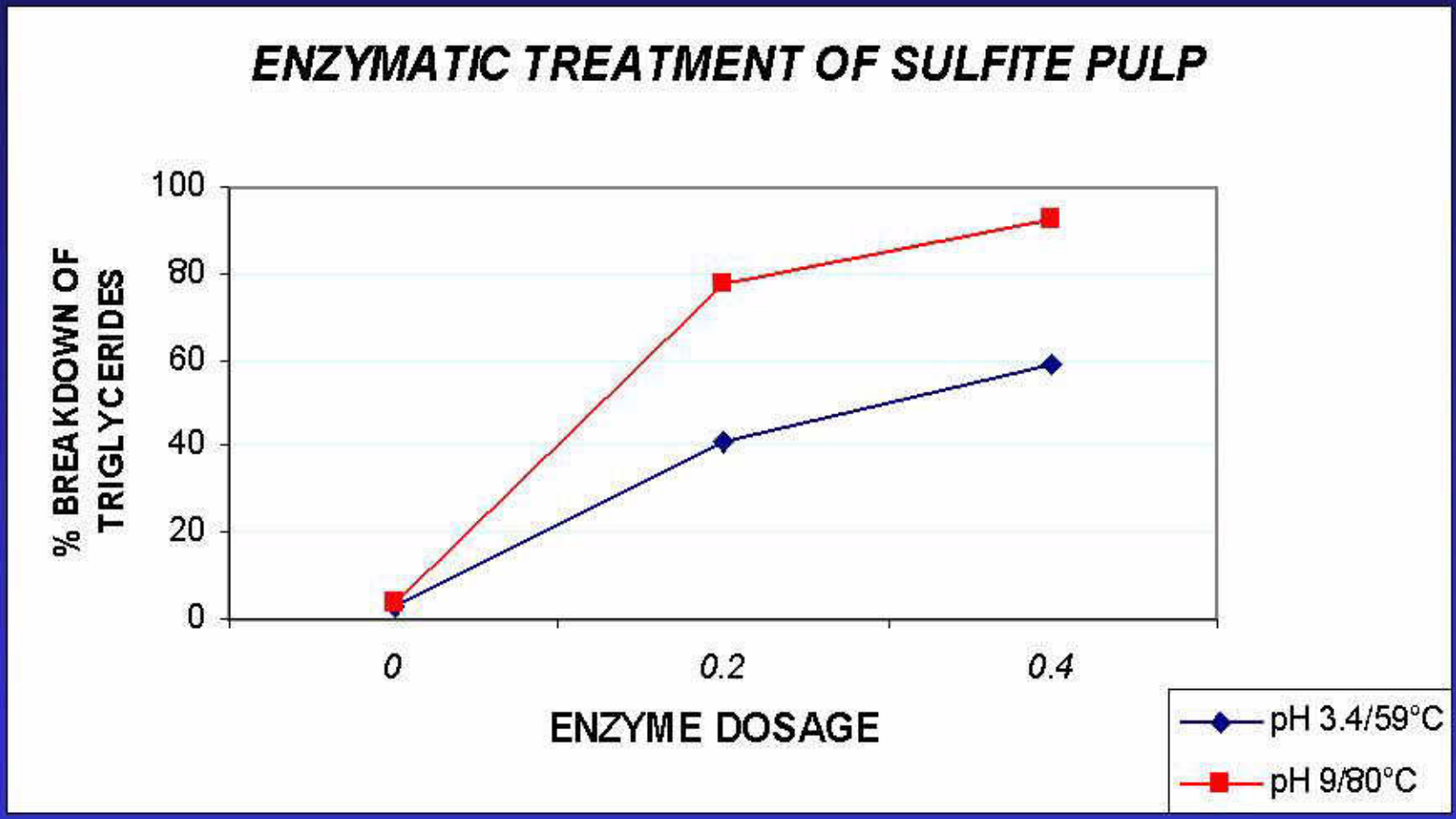
1/4/2003
1/9/2003
1/14/2003
1/19/2003
1/24/2003


Lipase Pitch Control (TMP)
Enzyme Dosage to Latency Chest and Holes
Number of Holes
0
200
400
600
800
1000
1200
1400
Enzyme Dosage (#/T)
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
10:36 AM 1:26 PM 4:56 AM 10:51 PM 2:46 PM 12:55 AM 3:35 PM 9:05 AM 12:18 AM 3:35 PM
04/06/200304/08/200304/09/200304/09/200304/10/200304/11/200304/11/200304/12/200304/13/200304/13/2003
Time
#1 Holes
#/T Enzyme

ENZYMATIC PITCH CONTROL IN NEWSPRINT MILL - BENEFITS SEEN

- Reduced Pitch Problems
- Improved Coefficient of Friction
- Improved Strength Properties

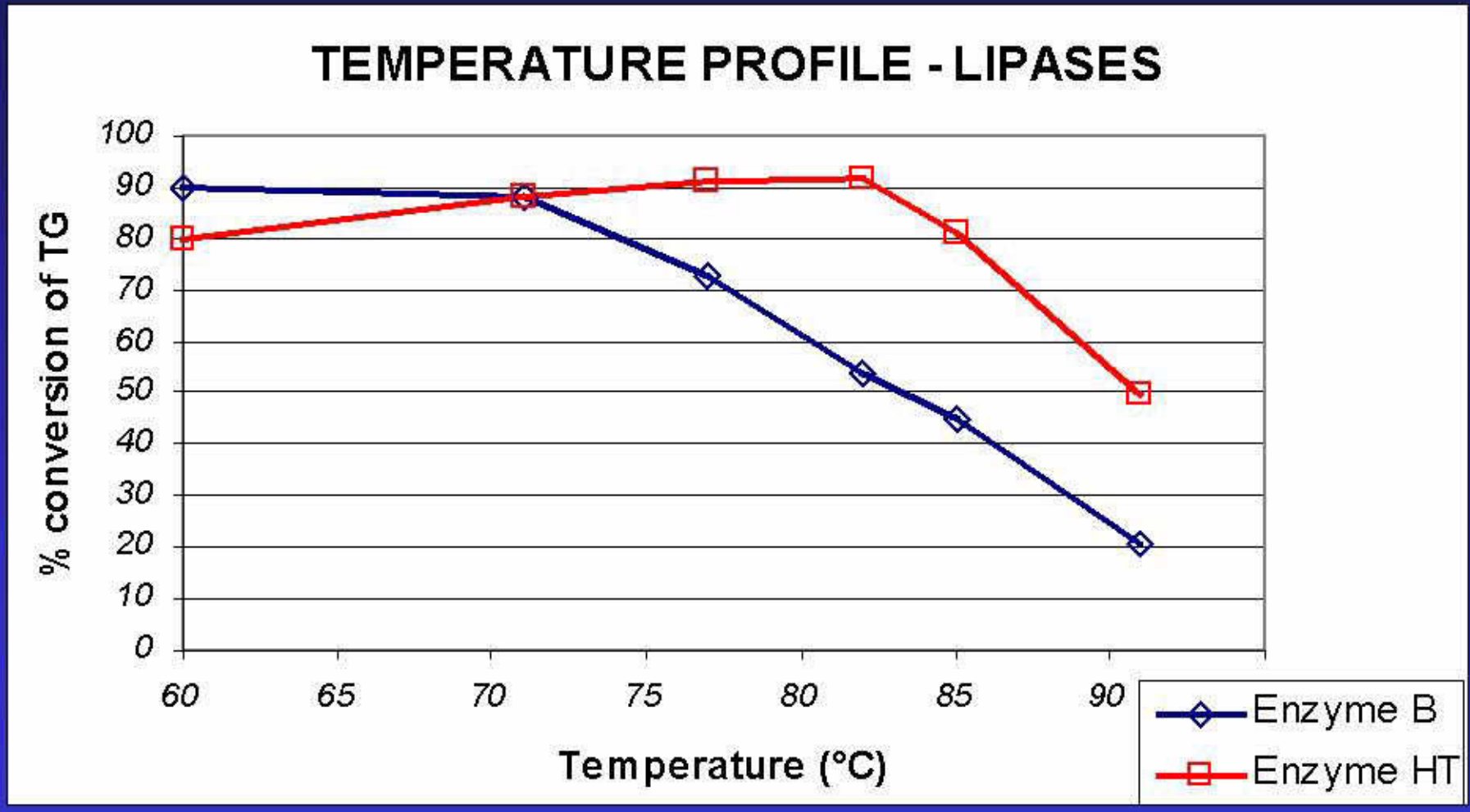
LIPASE & SULFITE PULP



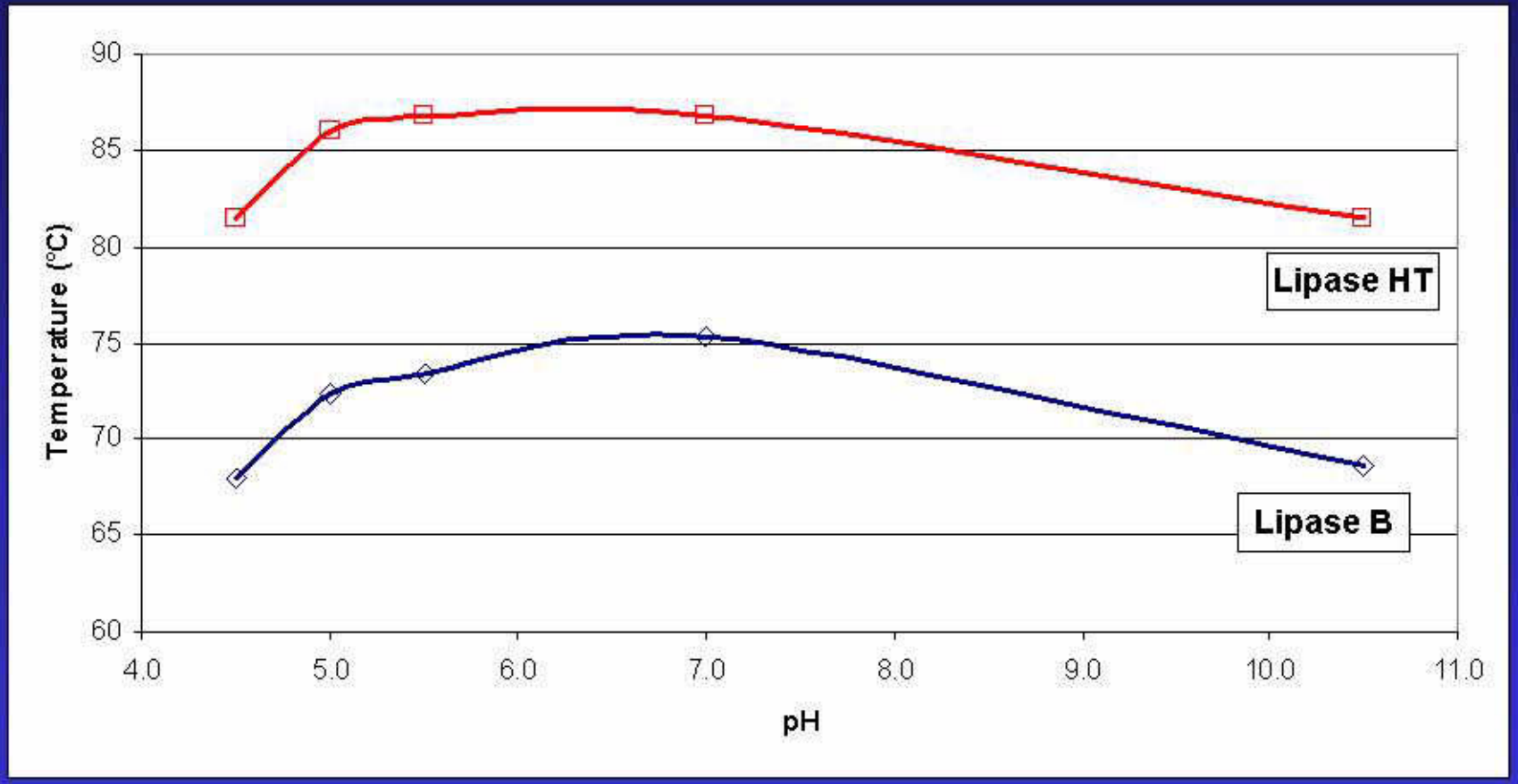
CONDITIONS FOR ENZYMES

- Contact time
- Temperature conditions
- pH conditions
- Possible interference from other chemicals

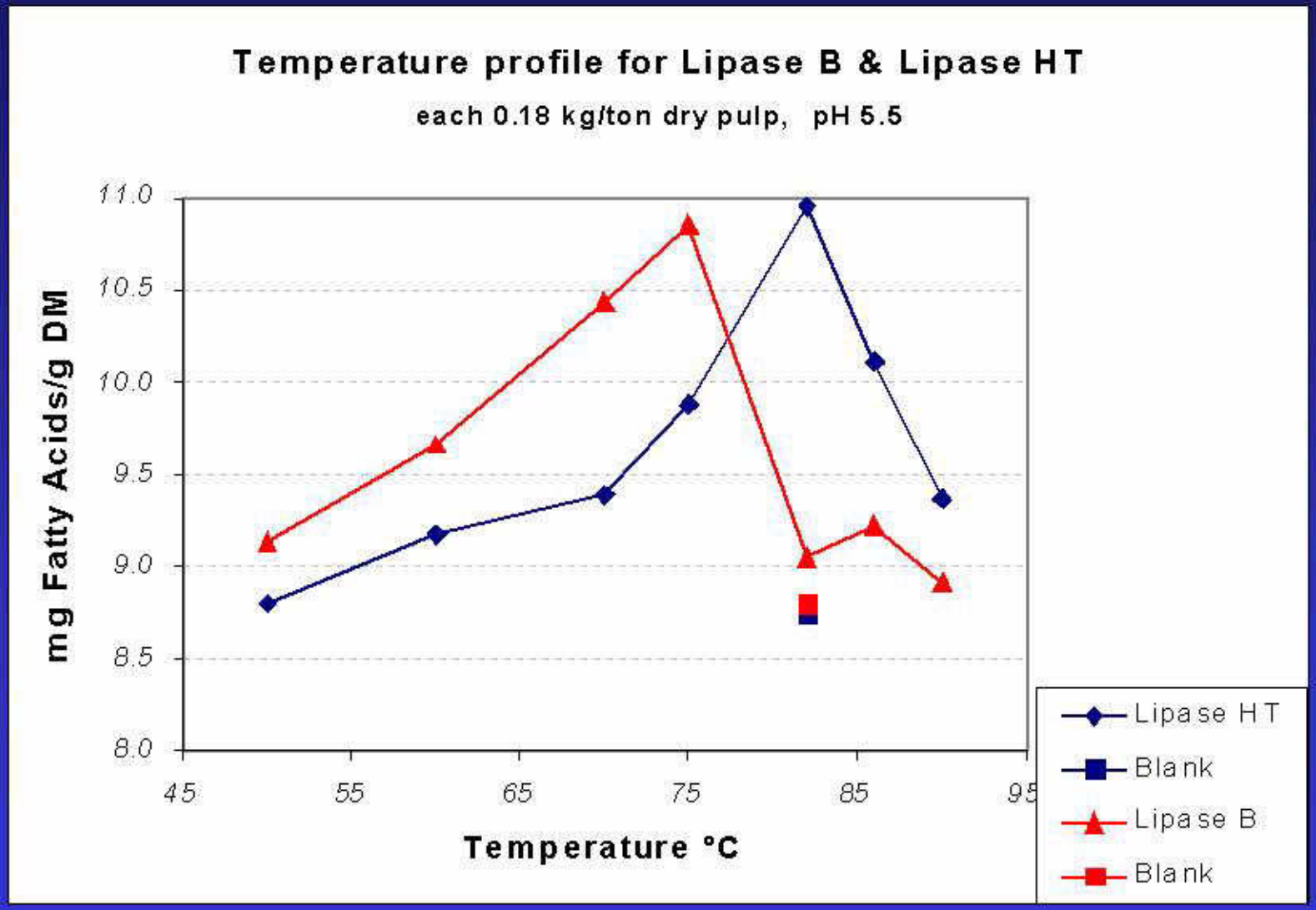
EFFECT OF TEMPERATURE



EFFECT OF pH / TEMPERATURE



EFFECT OF TEMPERATURE



ADDITIONAL PITCH CONTROL CHEMISTRY

- Enzymatic treatment produces more fatty acids
- In some cases additional chemistry is needed to prevent pitch problems
- Cationic Polymers may be used

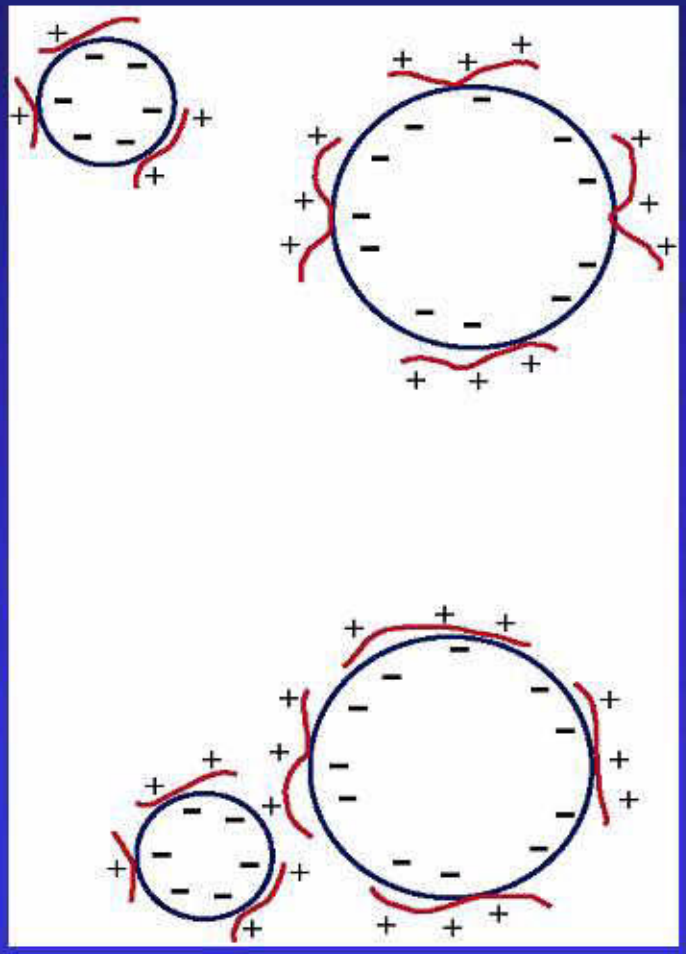
STRATEGY OF POLYMERIC PITCH CONTROL

- Polymer keeps Pitch from agglomerating and depositing
- Pitch Particles are attached to Fibers and removed from the paper machine system

TYPICAL PITCH CONTROL POLYMERS

- Low Molecular Weight
  (300,000 - 1,000,000)
- Cationic charge
- High Charge Density

POLYMER ADSORBS ONTO PITCH SURFACE



POLYMER / PITCH COMPLEX

- Changes Pitch Charge to Positive
- Gives Pitch a means of Attraction to Fibers

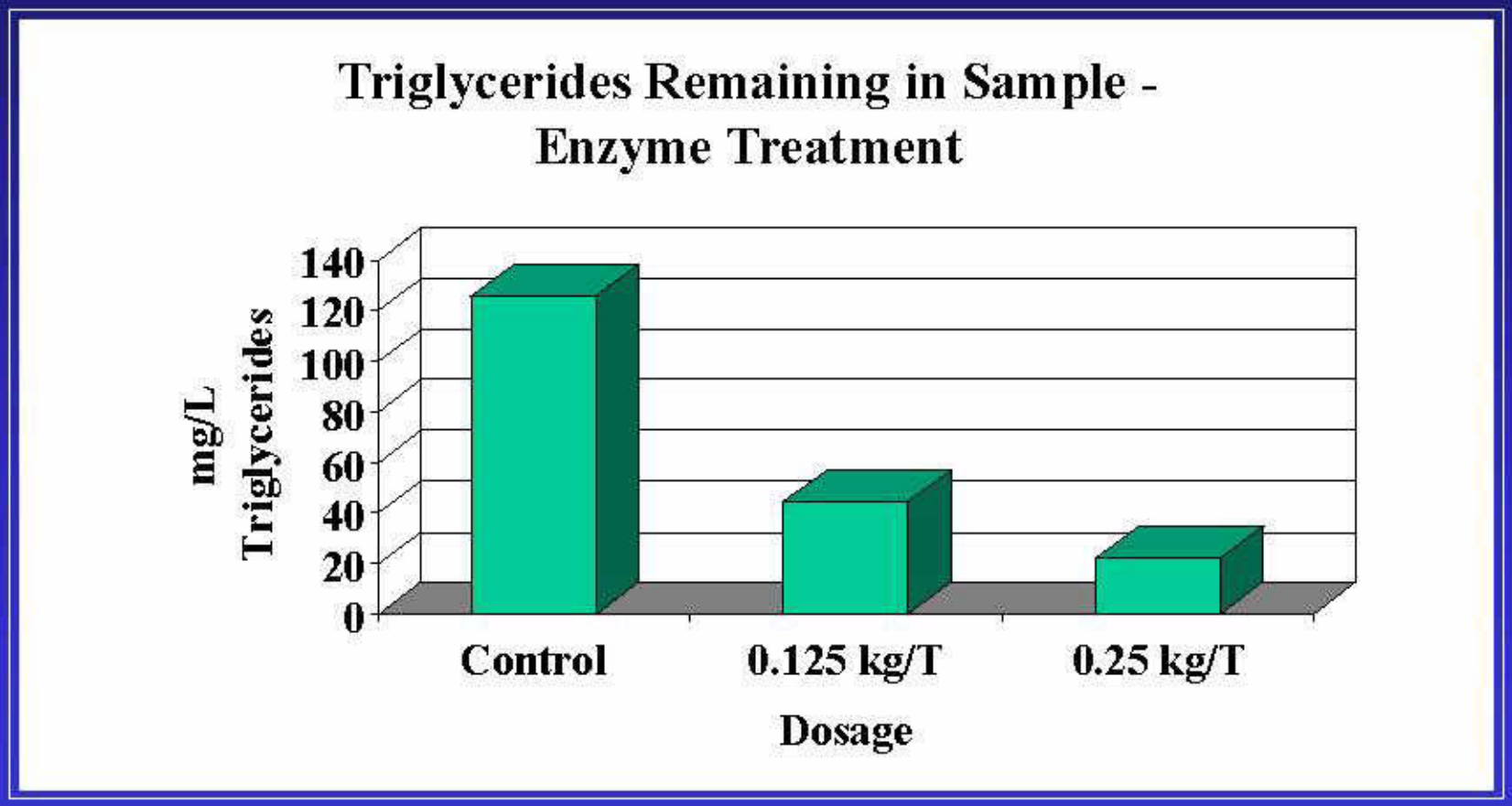
SETTING UP A POLYMER PITCH CONTROL PROGRAM

- Identify where Pitch is throughout the System
- Identify where Pitch is in SMALLEST Form
  - **we want to prevent Agglomeration**
- Identify where Destabilization might occur
  - **e.g. in Bleaching System, or where Deinked Pulp is added, or contact with paper machine white water (pH shock, Ca^{++} added)**
  - **Establish additional treatment to RESTABILIZE Pitch**

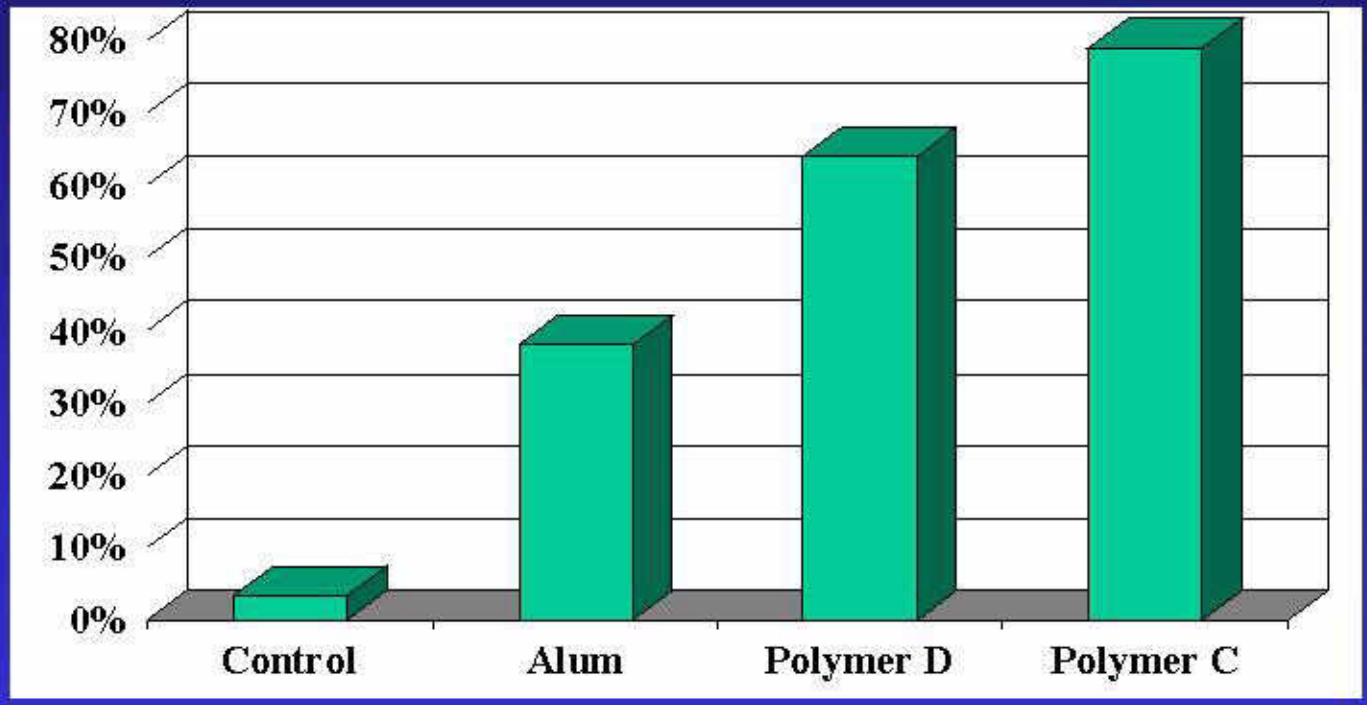
SETTING UP AN ENZYME + POLYMER PITCH CONTROL PROGRAM

- Feed polymer where pitch particles are smallest
- Screen polymers in laboratory testing to find the best performer
- If Alum or Aluminate is used, increase feed 33%
  - **pitch particles are smaller, so there is a higher surface area**

ENZYME TREATMENT – LAB STUDY



POLYMERS FOR FATTY ACID REDUCTION



WHY USE ENZYMES?

- Worker Health & Safety
- Environment
- Can be More Effective than Traditional Methods
- Can Give Unique Effects

THE FUTURE OF PITCH CONTROL

- More effective Enzymes
- Better Understanding of Mechanisms
- Greater Demands for Better Quality
- Greater Demands for Environmental Issues

ENZYMES and PITCH CONTROL

Thank you very much!

QUESTIONS / COMMENTS ?