

Production of Bio-based Phenol Formaldehyde Foams for Floral/Hydroponic Applications

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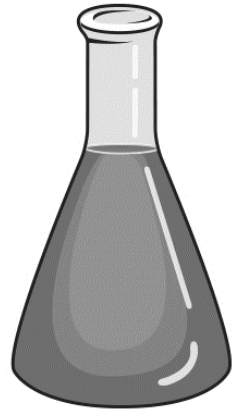
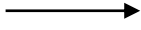
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- Conclusion and Future Work



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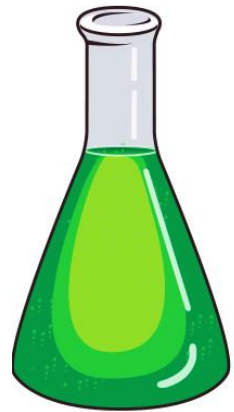
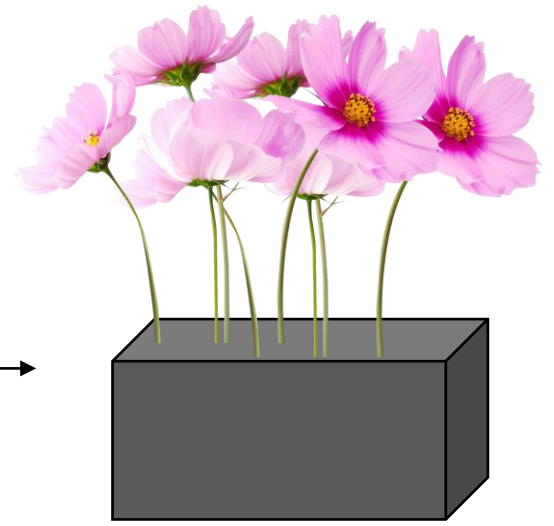
Introduction and Motivation



Phenol



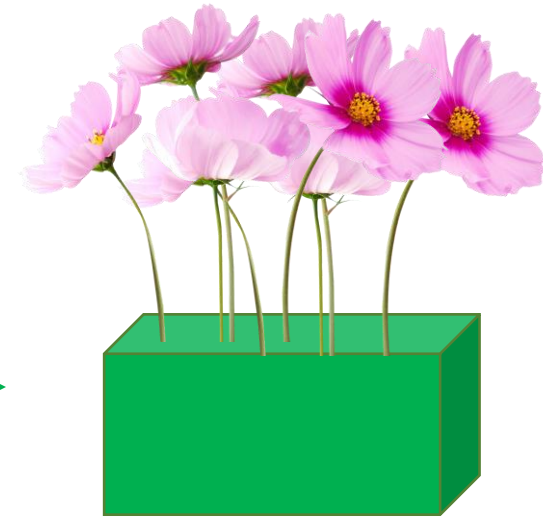
Fossil fuel
Based PF foam



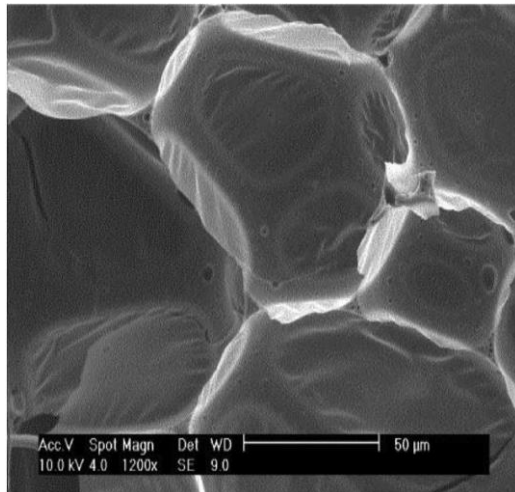
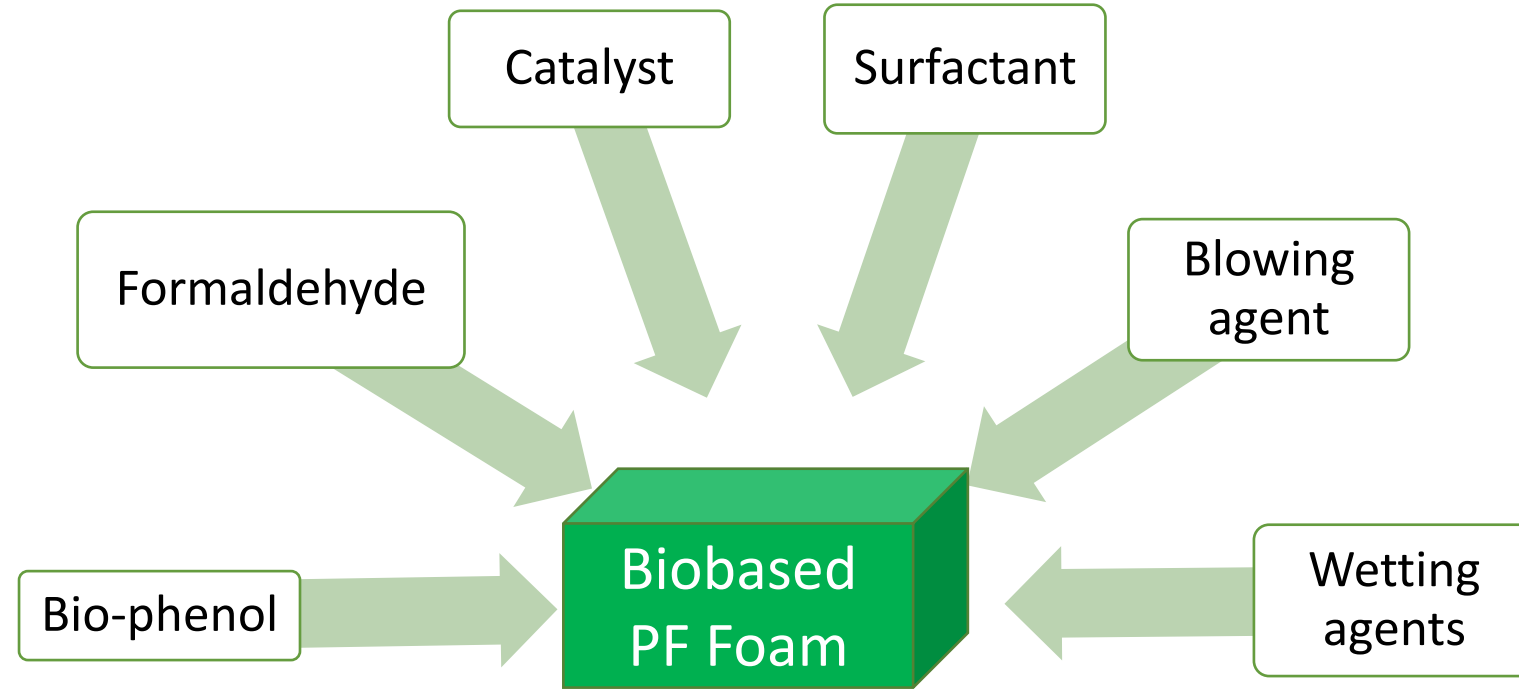
Biophenol



Biobased PF foam



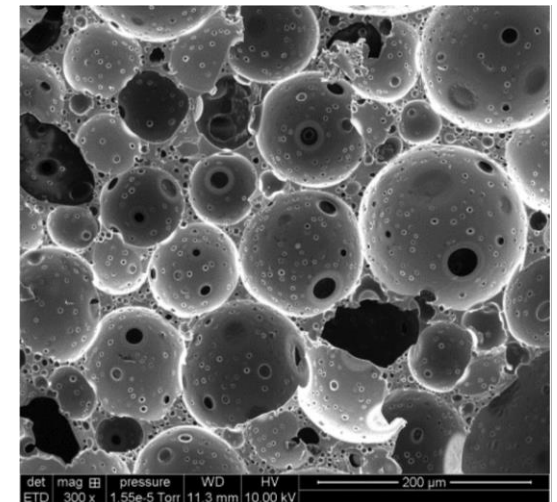
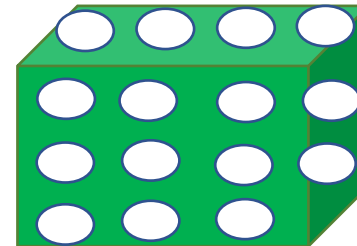
Constituents of Biobased PF foams



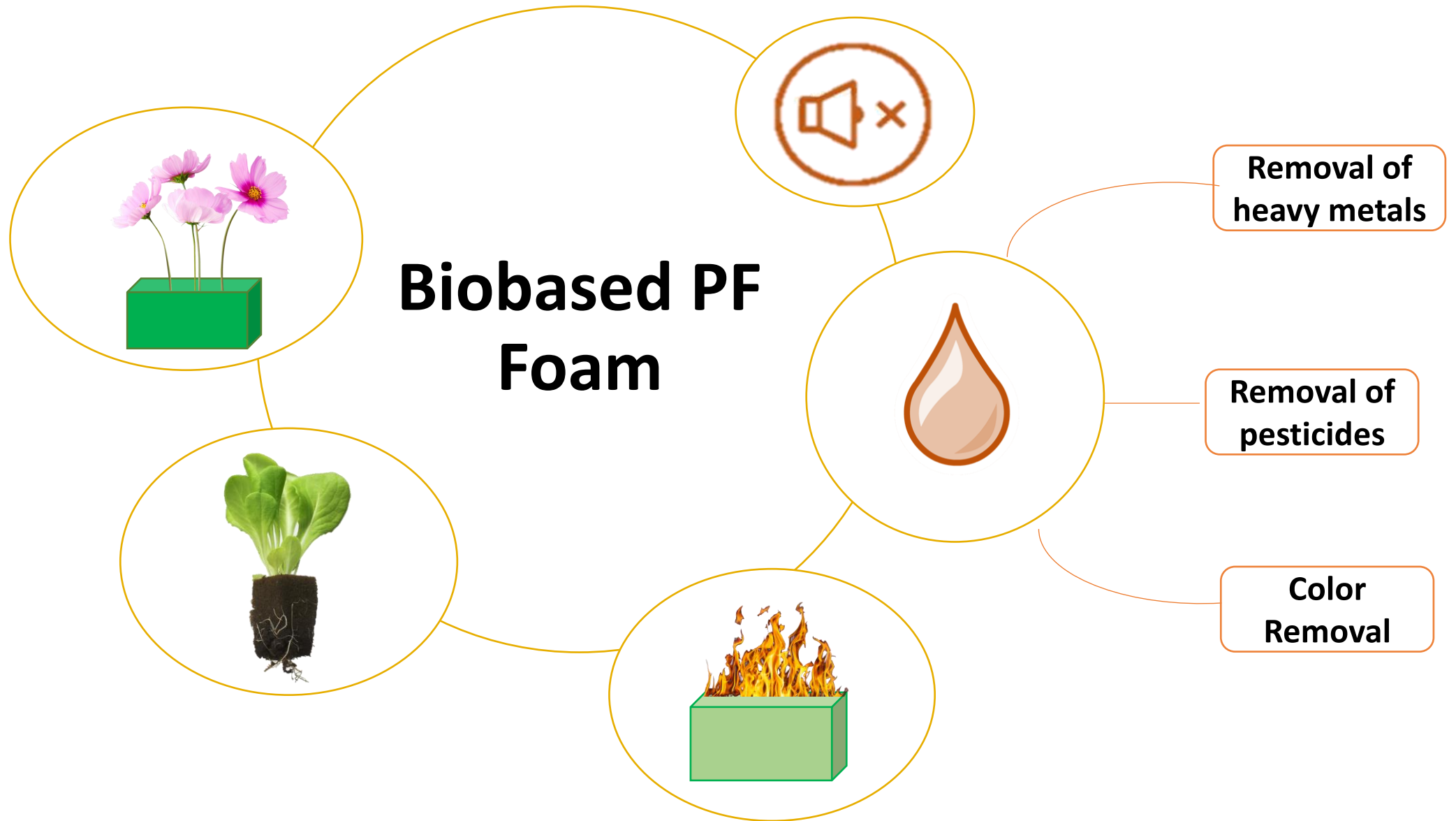
Close-Celled



Open-Celled



Applications of biobased PF foams





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Problem Statement

Existing problems with PF foams



Hazardous Substances

- Chemical vapors
- Aerosols
- Formaldehydes
- Phenols and Cresols



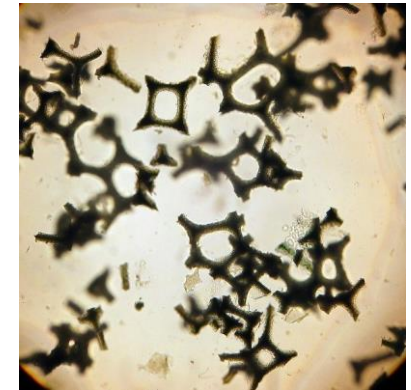
Health Hazards

- Asthma
- Sensitization
- Respiratory Illness
- Lung damage
- Skin irritations
- Eye irritations



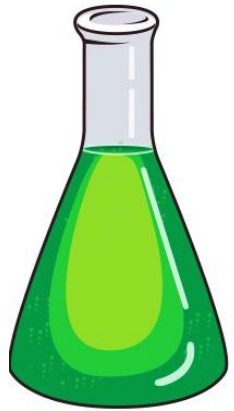
Environmental Impacts

- Non-Biodegradable
- Disintegrate to microplastics
- Bioaccumulation

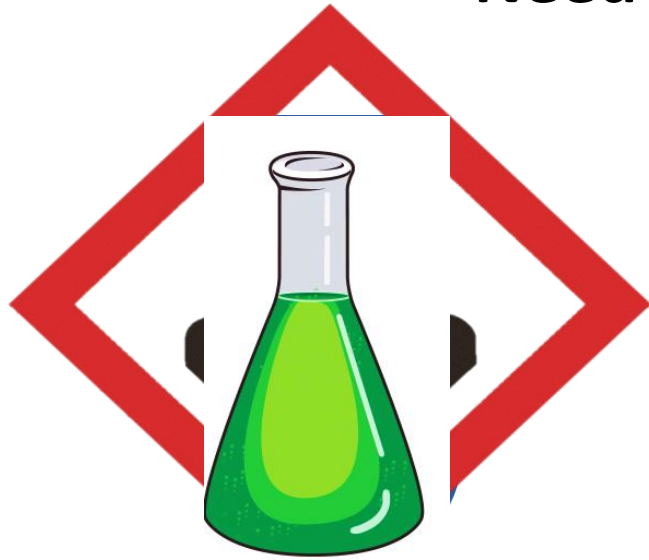


- Biofoam – Breaks down in a landfill – not in composting and aquatic environments
- Can undergo anaerobic degradation @ 50 °C; 51.5% in 365 days under biologically active landfill conditions

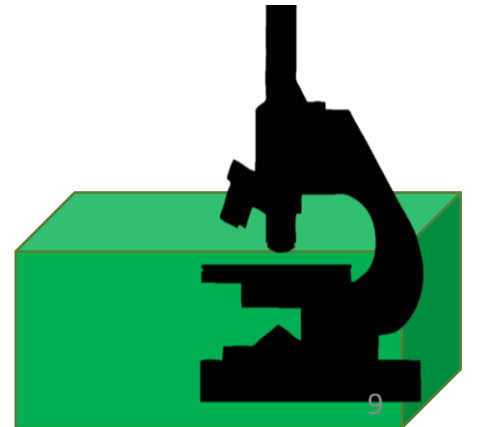
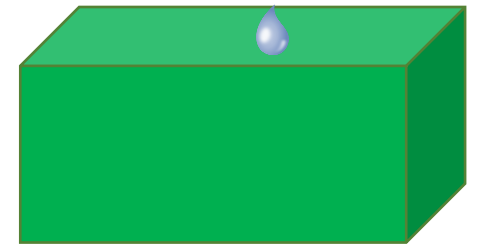
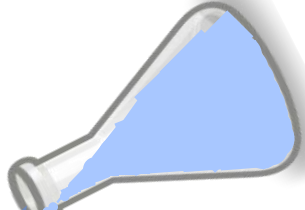
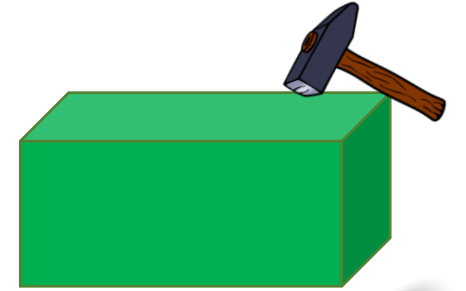
Need for innovation...



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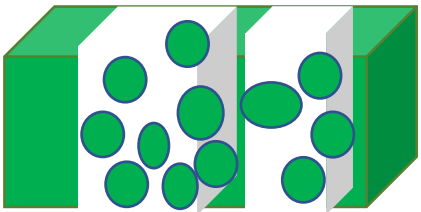
Testing



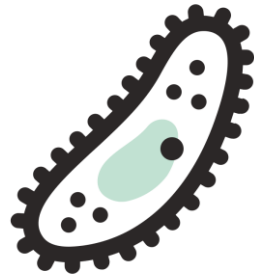
Bio-based Phenol

Green Formaldehyde
Formaldehyde

Bio-based foam



Biodegradation

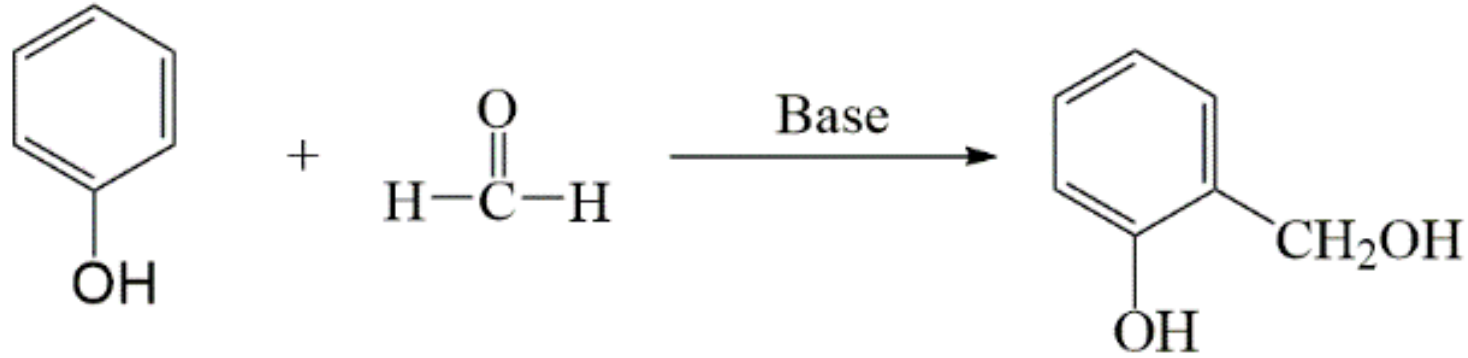




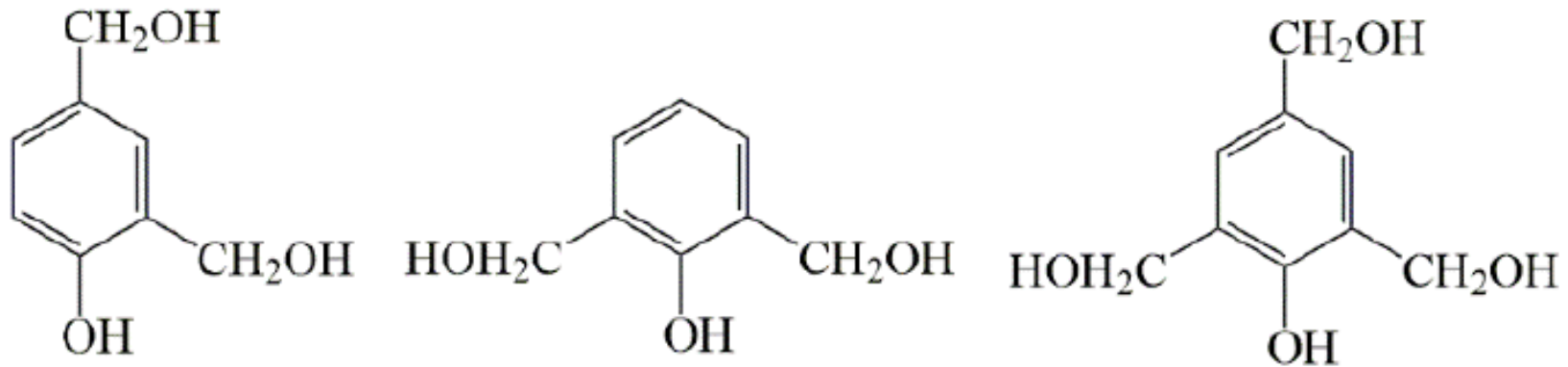
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Basic Chemistry

Chemistry of Synthetic PF Resole

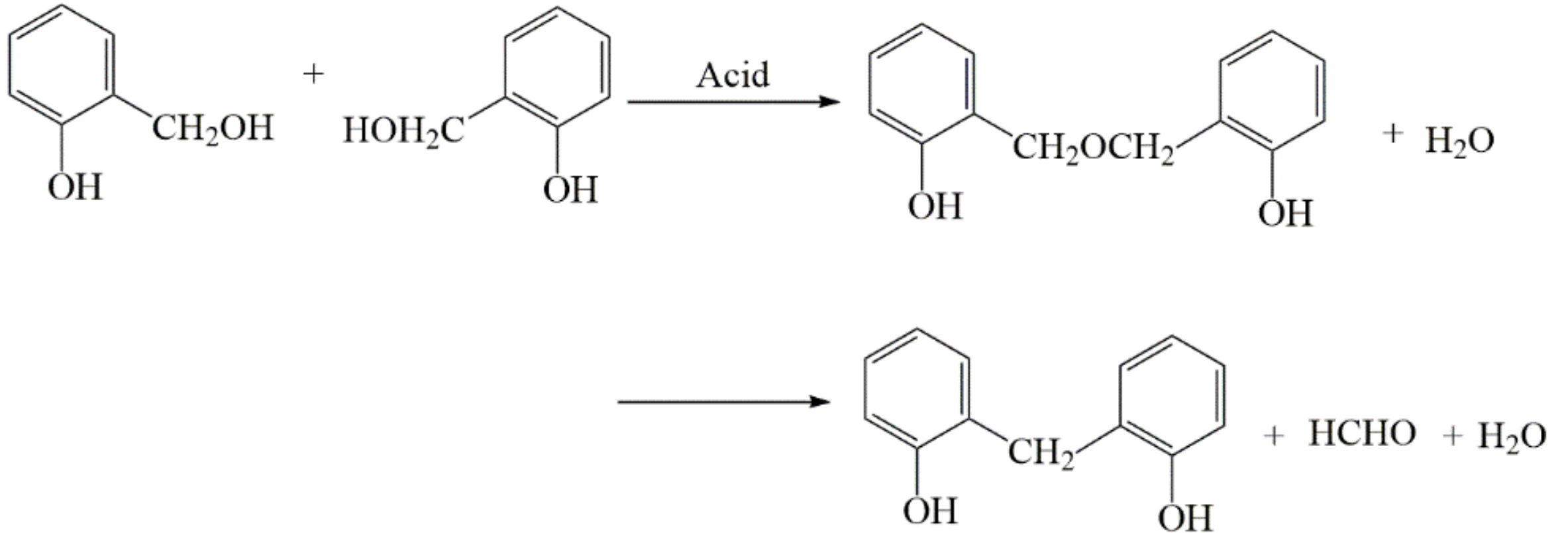


Reaction between Phenol and Formaldehyde



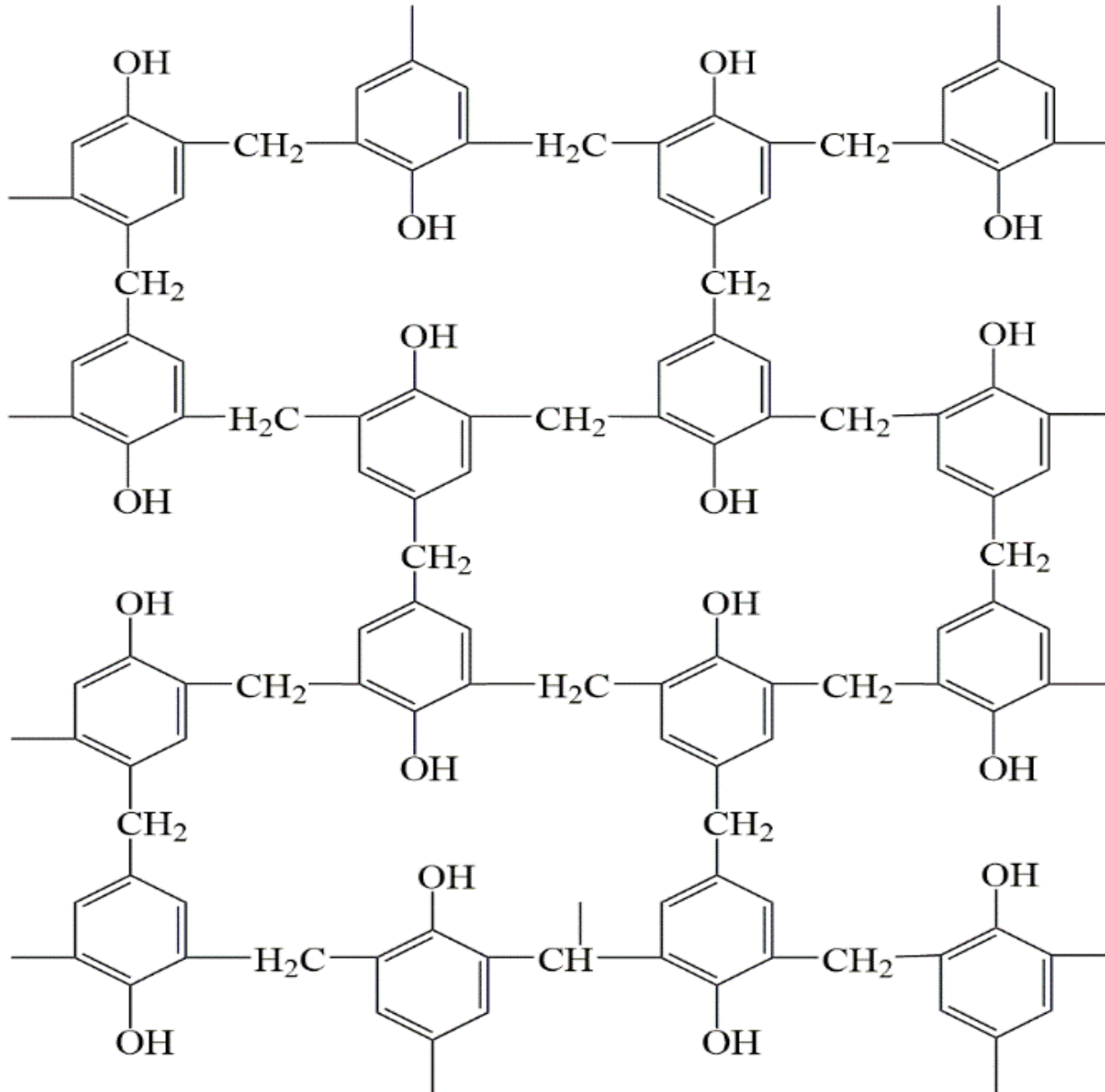
Di-Methylolphenol and Tri-Methylolphenol produced when Methylolphenol reacts with Formaldehyde

PF Foam Curing Chemistry



Curing reaction of foamable PF resin

PF Foam Curing Chemistry

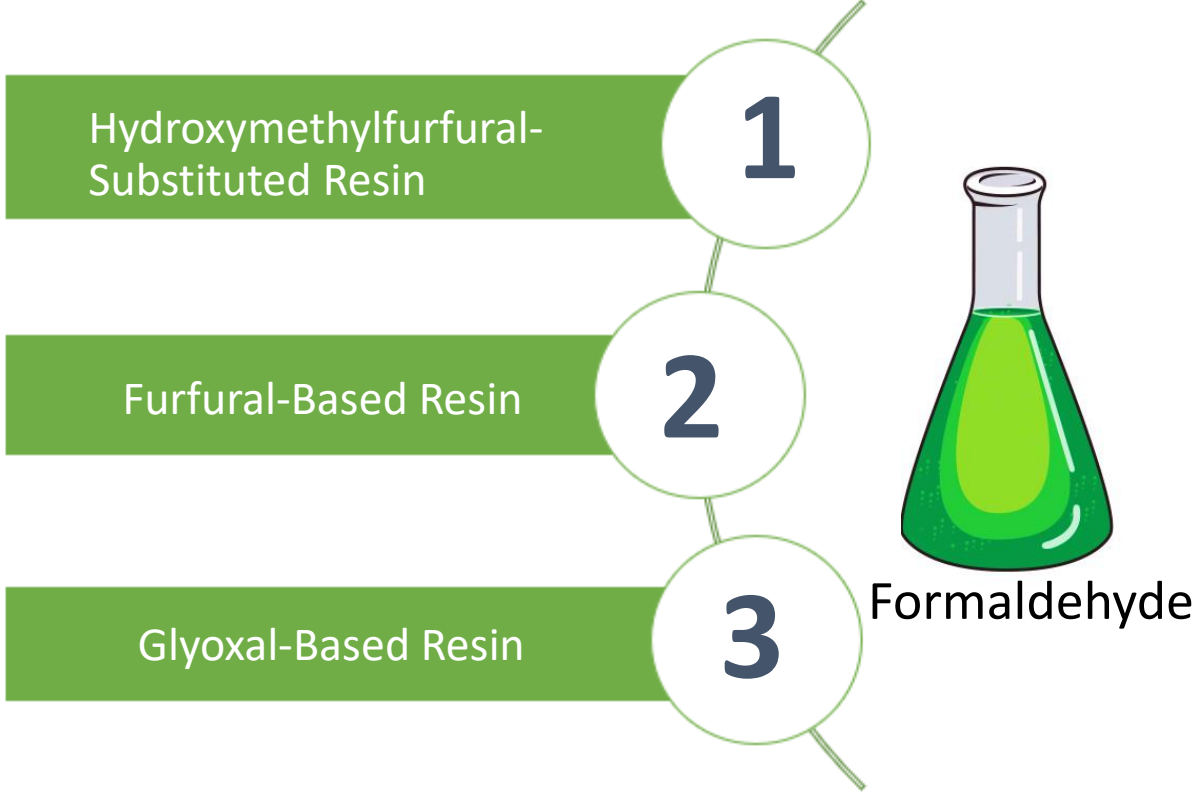
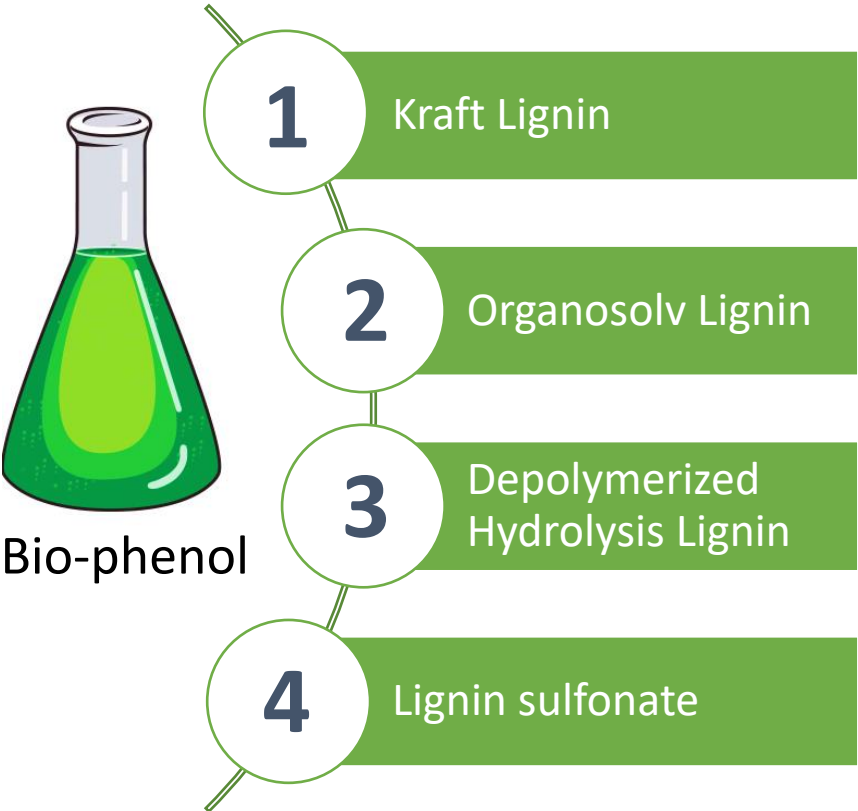




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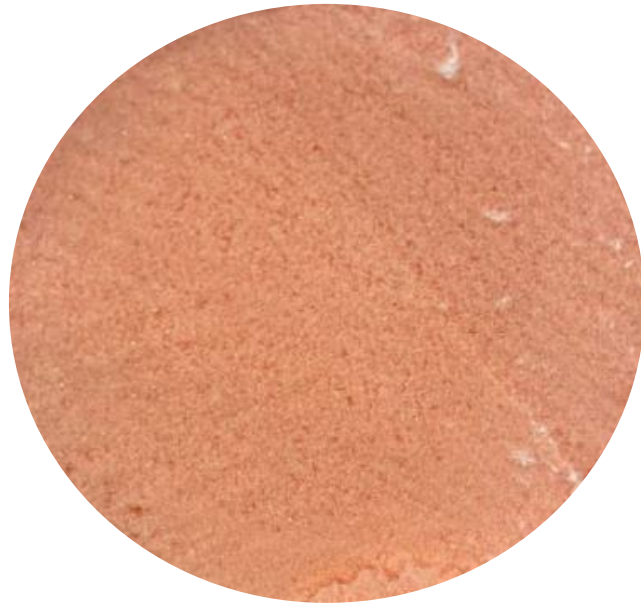
Research Directions

Green/Renewable Alternatives for PF Foam Production



Showcase of Foam Samples

Synthetic PF Foam (0% Lignin Substitution)



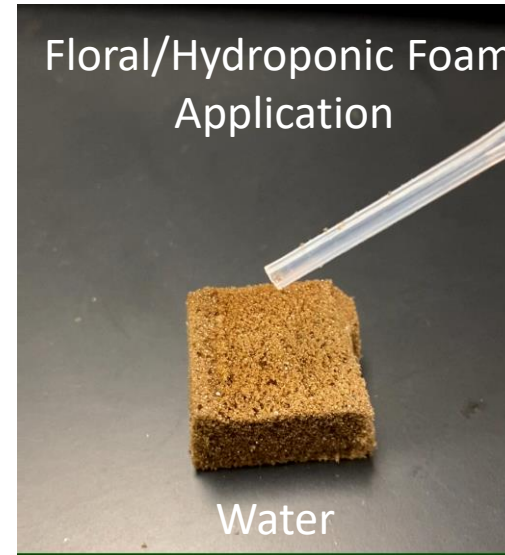
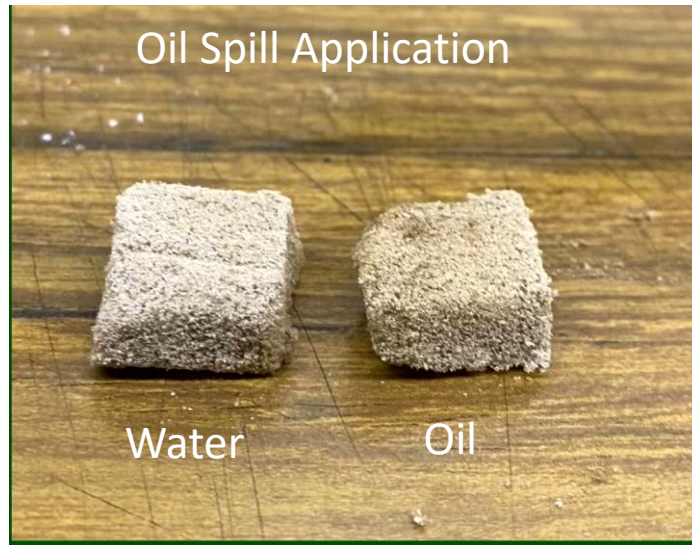
Property	Value
Foam density	48-110 kg/m ³
Open Cell Content	48-75 %
Water Retention Capacity	600-2200 %

Showcase of Foam Samples

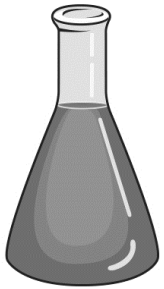
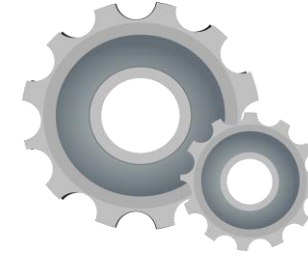
Biobased PF Foam (30% Acid-Washed Kraft Lignin Substitution)



Property	Value
Foam density	52-150 kg/m ³
Open Cell Content	>66 %
Water Retention Capacity	600-2000 %

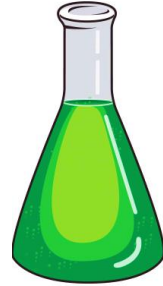


Experimental Overview and Future Scope



Synthetic PF foams

- Effect of F/P ratio
- Effect of surfactants
- Effect of wetting agents
- Effect of blowing agents



Biobased foams

- Lignosulfonate Phenol Formaldehyde foams
- Kraft Lignin v/s Organosolv Lignin v/s Acid Hydrolysis Lignin Phenol Formaldehyde foams
- Lignin-Glyoxal foams

Applications

- Hydroponics/Floral foams
- Thermal insulation
- Environmental pollution control
- Other applications

THANK YOU