INTRODUCTION

Objective:
Scale up an existing reaction used to chemically modify lignin, making it more suitable for material applications

Motivation:
- The current cost of carbon fiber limits its application to specialty products
- Precursor materials account for 51% of traditional carbon fiber cost[1]

Why Lignin?
Lignin, a major component of wood and annual plants, is an inexpensive and renewable resource

Why use a Plasticizer?
Lignin, a thermoset material, crosslinks upon heating

Other Characteristics
- In toluene
- Solvent-free
- Higher extent of reaction
- Material degradation

Lignin Modification:
1. Modification Advantages
   - Increase reactivity
   - Reduce brittleness of lignin polymers
   - Increase solubility in organic solvents

What is the Benefit?
Chemically modify lignin to compensate for its shortcomings and to ease in processing

Potential Process Characteristics:
- Shorter reaction time
- Solvent-free
- Higher extent of reaction
- Material degradation

Safe Operating Condition Determination:
- Temperature range = 140-160°C
  1. Lower bound – Tg from DSC
     - Unmodified Lignin = 140°C
     - Modified Lignin = 121°C
  2. Upper bound – DVDZ boiling temperature, lignin degradation
- Plasticizer selection = glycerol
  1. Non-reactive with inputs
  2. Inexpensive

CRITERIA
1. Process is safe for both equipment and operator
2. The lignin is modified
3. Able to produce high yield of modified product
4. Process is economically and environmentally friendly

REACTIVE EXTRUSION

INITIAL ITERATION

Purpose:
- Determine effect of reactant concentration and residence time on reaction

Conditions:
- At 140°C and 35 wt. % plasticizer
- DVDZ-lignin ratio = 0.5:1, 1:1, 1.5:1
- Residence time = 1, 5, 9 minutes

Results:
- Reaction did not occur
- Verified using solubility test and FTIR

CONCLUSIONS
1. Process is safe for both equipment and operator
   - Yes
2. The lignin is modified
   - No
3. Able to produce high yield of modified product
   - No
4. Process is economically and environmentally friendly
   - Inconclusive

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- References: