CLAIMS

What is claimed is:

~~1. A method of preparing lignin from lignocellulolosic biomass, comprising:~~

~~providing lignocellulosic biomass under a first pressure of at least about 220 bar and at a first temperature of at least about 360ºC, comprising:~~

~~a first solid fraction comprising:~~

~~insoluble lignin; and~~

~~a first liquid fraction comprising:~~

~~soluble C_6 saccharides; and~~

~~soluble lignin;~~

~~gradually reducing said first pressure of said lignocellulosic biomass to a second pressure while substantially simultaneously and gradually reducing said first temperature of said lignocellulosic biomass to a second temperature at least about 1ºC above the glass transition temperature of lignin at said second pressure;~~

~~wherein said first liquid fraction is not substantially gasified; and~~

~~optionally, substantially simultaneously reducing said second pressure and said second temperature to a third pressure and a third temperature in a time less than about 1 second to precipitate said soluble lignin in said first liquid fraction and form a mixture comprising:~~

~~a second solid fraction comprising:~~

~~insoluble lignin; and~~

~~precipitated lignin; and~~

~~a second liquid fraction comprising:~~

~~soluble C_6 saccharides.~~

~~2. A method of claim 1,~~

~~wherein said first temperature is about 360ºC to about 380ºC.~~

~~3. A method of claim 1,~~

~~wherein said second temperature is at least about 5ºC above the glass transition temperature of lignin at said second pressure.~~

4. A method of claim 1,

wherein said second temperature is about 110ºC to about 120ºC.

5. A method of claim 1,

wherein said third temperature is about 20ºC to about 100ºC.

6. A method of claim 1,

wherein said first pressure is about 220 bar to about 250 bar.

7. A method of claim 1,

wherein said second pressure is greater than atmospheric pressure.

8. A method of claim 1,

wherein said second pressure is about 50 bar to about 150 bar.

9. A method of claim 1,

wherein said second pressure is atmospheric pressure.

10. A method of claim 1, further comprising:

recovering at least a portion of heat.

11. A method of claim 1, further comprising:

permitting said insoluble lignin and said precipitated lignin to separate out by gravity.

12. A method of claim 1, further comprising:

separating said second solid fraction and said second liquid fraction.

13. A method of claim 1,

wherein said method is continuous.

~~14. A method of claim 1,~~

~~wherein said method employs multiple pressure down valves and multiple heat exchangers.~~

~~15. A method of claim 1,~~

~~wherein said lignocellulosic biomass is fractionated to remove at least a portion of C_5 saccharides prior to said providing step.~~

~~16. A method of claim 1,~~

~~wherein the average particle size of said insoluble lignin and precipitated lignin is less than about 500 microns.~~

~~17. A lignin product produced by the method of claim 1.~~

~~18. A lignin product of claim 17,~~

~~wherein said lignin product is used as a fuel, tackifier, phenol formaldehyde resin extender in the manufacture of particle board and plywood, in the manufacture of molding compounds, urethane and epoxy resins, antioxidants, controlled-release agents, flow control agents, cement/concrete mixing, plasterboard production, oil drilling, general dispersion, tanning leather, road covering, vanillin production, dimethyl sulfide and dimethyl sulfoxide production, phenol substitute in phenolic resins incorporation into polyolefin blends, aromatic (phenol) monomers, additional miscellaneous monomers, carbon fibers, metal sequestration in solutions, basis of gel formation, polyurethane copolymer, and combinations thereof.~~

~~19~~1. A method of reducing lignin fouling during processing of ~~lignocellulolosic~~ lignocellulosic biomass, comprising:

providing lignocellulosic biomass under a first pressure of at least about 220 bar and at a first temperature of at least about 360ºC, comprising:

a first solid fraction comprising:

insoluble lignin; and

a first liquid fraction comprising:

soluble C_6 saccharides; and

soluble lignin;

gradually reducing said first pressure of said lignocellulosic biomass to a second pressure while substantially simultaneously and gradually reducing said first temperature of said lignocellulosic biomass to a second temperature at least about 1ºC above the glass transition temperature of lignin at said second pressure;

wherein said first liquid fraction is not substantially gasified; and

optionally, substantially simultaneously reducing said second pressure and said second temperature to a third pressure and a third temperature in a time less than about 1 second to precipitate said soluble lignin in said first liquid fraction and form a mixture comprising:

a second solid fraction comprising:

insoluble lignin; and

precipitated lignin; and

a second liquid fraction comprising:

soluble C_6 saccharides.

~~20~~2. A method of claim ~~19~~1,

wherein said first temperature is about 360ºC to about 380ºC.

~~21~~3. A method of claim ~~19~~1,

wherein said second temperature is at least about 5ºC above the glass transition temperature of lignin at said second pressure.

~~22~~4. A method of claim ~~19~~1,

wherein said second temperature is about 110ºC to about 120ºC.

~~23~~5. A method of claim ~~19~~1,

wherein said third temperature is about 20ºC to about 100ºC.

~~24~~6. A method of claim ~~19~~1,

wherein said first pressure is about 220 bar to about 250 bar.

~~25~~7. A method of claim ~~19~~1,

wherein said second pressure is greater than atmospheric pressure.

~~26~~8. A method of claim ~~19~~1,

wherein said second pressure is about 50 bar to about 150 bar.

~~27~~9. A method of claim ~~19~~1,

wherein said second pressure is atmospheric pressure.

~~28~~10. A method of claim ~~19~~1, further comprising:

recovering at least a portion of heat.

~~29~~11. A method of claim ~~19~~1, further comprising:

permitting said insoluble lignin and said precipitated lignin to separate out by gravity.

~~30~~12. A method of claim ~~19~~1,

wherein said method is continuous.

~~31~~13. A method of claim ~~19~~1,

wherein said method employs multiple pressure down valves and multiple heat exchangers.

~~32~~14. A method of claim ~~19~~1,

wherein said lignocellulosic biomass is fractionated to remove at least a portion of C_5 saccharides prior to said providing step.

~~33~~15. A method of claim ~~19~~1,

wherein the average particle size of said insoluble lignin and precipitated lignin is less than about 500 microns.

~~34. A lignin product produced by the method of claim 19.~~

~~35. A lignin product of claim 34,~~

~~wherein said lignin product is used as a fuel, tackifier, phenol formaldehyde resin extender in the manufacture of particle board and plywood, in the manufacture of molding compounds, urethane and epoxy resins, antioxidants, controlled release agents, flow control agents, cement/concrete mixing, plasterboard production, oil drilling, general dispersion, tanning leather, road covering, vanillin production, dimethyl sulfide and dimethyl sulfoxide production, phenol substitute in phenolic resins incorporation into polyolefin blends, aromatic (phenol) monomers, additional miscellaneous monomers, carbon fibers, metal sequestration in solutions, basis of gel formation, polyurethane copolymer, and combinations thereof.~~

~~36. A composition, comprising:~~

~~lignin;~~

~~wherein said lignin is processed from lignocellulosic biomass using supercritical or near critical fluid extraction.~~

~~37. A composition of claim 36,~~

~~wherein said lignin has an average particle size is less than about 500 microns.~~

~~38. A composition of claim 36,~~

~~wherein said lignin has a heating value as measured by ASTM D240 of at least about 5,000 BTU/lb at 30% moisture content.~~

~~39. A composition of claim 36,~~

~~wherein said lignin has a heating value as measured by ASTM D240 of at least about 7,500 BTU/lb at 15% moisture content.~~

~~40. A composition of claim 36,~~

~~wherein said lignin has a heating value as measured by ASTM D240 of at least about 8,000 BTU/lb at 5% moisture content.~~

~~41. A composition of claim 36,~~

~~wherein said composition is substantially free of organic solvent.~~