CLAIMS

What is claimed is:

1. A process for manufacturing polymers of sulfur-containing heterocyclic compounds, the process comprising the steps of:

isolating a sulfur-containing heterocyclic compound from cracked naphtha, and

protonating the sulfur-containing heterocyclic compound with a super acid to produce a polymer of the sulfur-containing heterocyclic compound.

2. The process as claimed in Claim 1, wherein the sulfur-containing heterocyclic compound is thiophene, an alkylated derivative of thiophene, benzothiophene, or an alkylated derivative of benzothiophene.

3. The process as claimed in either Claim 1 or Claim 2, further comprising:

isolating the cracked naphtha from a reaction product gas stream of a fluid catalytic cracking unit, wherein the sulfur-containing heterocyclic compound is isolated from the cracked naphtha according to a boiling point of the sulfur-containing heterocyclic compound.

4. The process as claimed in Claim 3, further comprising:

performing a solvent extraction using an aprotic solvent to further isolate the sulfur-containing heterocyclic hydrocarbon from other compounds of the cracked naphtha.

5. The process as claimed in any of Claims 1 or 3-4, wherein the sulfur-containing heterocyclic compound is thiophene, and wherein the boiling point is from 82°C to 86°C.

6. The process as claimed in any of Claims 1 or 3-4, wherein the sulfur-containing heterocyclic compound is benzothiophene, and wherein the boiling point is 218°C to 224°C.

7. The process as claimed in any of Claims 1-6, further comprising:

using an aprotic solvent to concentrate the sulfur-containing heterocyclic compound so that a rate of reaction with the super acid increases.

8. The process as claimed in Claim 7, wherein the aprotic solvent is acetonitrile or methylene chloride.

9. An apparatus for manufacturing polymers of sulfur-containing heterocyclic compounds, the apparatus comprising:

a primary distillation column adapted to isolate cracked naphtha from a reaction product gas stream of a fluid catalytic cracking unit,

a secondary distillation column adapted to isolate one or more sulfur-containing heterocyclic compounds from the cracked naphtha, and

a reactor adapted to react the one or more sulfur-containing heterocyclic compounds with a super acid to produce a polymer of the one or more sulfur-containing heterocyclic compounds.

10. An apparatus as claimed in Claim 9, further comprising:

a solvent extraction tank adapted to perform a solvent extraction using an aprotic solvent to further purify the one or more sulfur-containing heterocyclic compounds, wherein the aprotic solvent is acetonitrile or methylene chloride.

11. An apparatus as claimed in either Claim 9 or Claim 10, further comprising:

a tertiary distillation column adapted to further isolate the one or more sulfur-containing heterocyclic compounds from other compounds of the cracked naphtha.

12. An apparatus as claimed in any of Claims 9-11, further comprising:

a membrane separator adapted to further isolate the one or more sulfur-containing heterocyclic compounds as permeate from other compounds of the cracked naphtha, wherein the membrane separator permeates the one or more sulfur-containing heterocyclic compounds using a cross-linked fluorinated polyolefin membrane, a polyester-imide membrane, a polyuria membrane, or a urethane membrane.

13. The apparatus as claimed in any of Claims 9-12, wherein the one or more sulfur-containing heterocyclic compounds includes thiophene, and wherein the secondary distillation column has a side-cut with a boiling point range from 82°C to 86°C for isolating the one or more sulfur-containing heterocyclic compounds.

14. The apparatus as claimed in any of Claims 9-12, wherein the one or more sulfur-containing heterocyclic compounds includes benzothiophene, and wherein the secondary distillation column has a side-cut with a boiling point range from 218°C to 224°C for isolating the one or more sulfur-containing heterocyclic compounds.

CLAIMS

1. A process for manufacturing polymers of sulfur-containing heterocyclic compounds, the process comprising the steps of:

isolating a sulfur-containing heterocyclic compound from cracked naphtha,

wherein the sulfur-containing heterocyclic compound is selected from the group consisting of a thiophene, an alkylated derivative of thiophene, benzothiophene, an alkylated derivative of benzothiophene, and combinations thereof, and

protonating the sulfur-containing heterocyclic compound with a super acid to produce a polymer of the sulfur-containing heterocyclic compound.

2. The process as claimed in either Claim 1, further comprising:

isolating the cracked naphtha from a reaction product gas stream of a fluid catalytic cracking unit, wherein the sulfur-containing heterocyclic compound is isolated from the cracked naphtha according to a boiling point of the sulfur-containing heterocyclic compound.

3. The process as claimed in Claim 2, further comprising:

performing a solvent extraction using an aprotic solvent to further isolate the sulfur-containing heterocyclic hydrocarbon from other compounds of the cracked naphtha.

4. The process as claimed in any of Claims 1 or 2-3, wherein the sulfur-containing heterocyclic compound is thiophene, and wherein the boiling point is from 82°C to 86°C.

5. The process as claimed in any of Claims 1 or 2-3, wherein the sulfur-containing heterocyclic compound is benzothiophene, and wherein the boiling point is 218°C to 224°C.

6. The process as claimed in any of Claims 1-5, further comprising:

using an aprotic solvent to concentrate the sulfur-containing heterocyclic compound so that a rate of reaction with the super acid increases.

7. The process as claimed in Claim 6, wherein the aprotic solvent is acetonitrile or methylene chloride.

8. An apparatus for manufacturing polymers of sulfur-containing heterocyclic compounds, the apparatus comprising:

a primary distillation column adapted to isolate cracked naphtha from a reaction product gas stream of a fluid catalytic cracking unit,

a secondary distillation column adapted to isolate one or more sulfur-containing heterocyclic compounds from the cracked naphtha, and

a reactor adapted to react the one or more sulfur-containing heterocyclic compounds with a super acid to produce a polymer of the one or more sulfur-containing heterocyclic compounds.

9. An apparatus as claimed in Claim 8, further comprising:

a solvent extraction tank adapted to perform a solvent extraction using an aprotic solvent to further purify the one or more sulfur-containing heterocyclic compounds, wherein the aprotic solvent is acetonitrile or methylene chloride.

10. An apparatus as claimed in either Claim 8 or Claim 9, further comprising:

a tertiary distillation column adapted to further isolate the one or more sulfur-containing heterocyclic compounds from other compounds of the cracked naphtha.

11. An apparatus as claimed in any of Claims 8-10, further comprising:

a membrane separator adapted to further isolate the one or more sulfur-containing heterocyclic compounds as permeate from other compounds of the cracked naphtha, wherein the membrane separator permeates the one or more sulfur-containing heterocyclic compounds using a cross-linked fluorinated polyolefin membrane, a polyester-imide membrane, a polyuria membrane, or a urethane membrane.

12. The apparatus as claimed in any of Claims 8-11, wherein the one or more sulfur-containing heterocyclic compounds includes thiophene, and wherein the secondary distillation column has a side-cut with a boiling point range from 82°C to 86°C for isolating the one or more sulfur-containing heterocyclic compounds.

13. The apparatus as claimed in any of Claims 8-11, wherein the one or more sulfur-containing heterocyclic compounds includes benzothiophene, and wherein the secondary distillation column has a side-cut with a boiling point range from 218°C to 224°C for isolating the one or more sulfur-containing heterocyclic compounds.