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(71) Applicant: **RJ LEE GROUP, INC.** [US/US]; 350 Hochberg Road, Monroeville, Pennsylvania 15146 (US).

(72) Inventors: **LEVINE, Alan M.**; 339 Coleman Drive, Monroeville, Pennsylvania 15146 (US). **MONACO, Steven J.**; 114 Grouse Ct., Venetia, Pennsylvania 15367 (US). **LEE, Richard J.**; 3498 Meadowgate Drive, Murrysville, Pennsylvania 15668 (US).

(74) Agent: **SILVERMAN, Arnold B.**; Eckert Seamans Cherin & Mellott, LLC, 600 Grant Street, 44th Floor, Pittsburgh, Pennsylvania 15219 (US).

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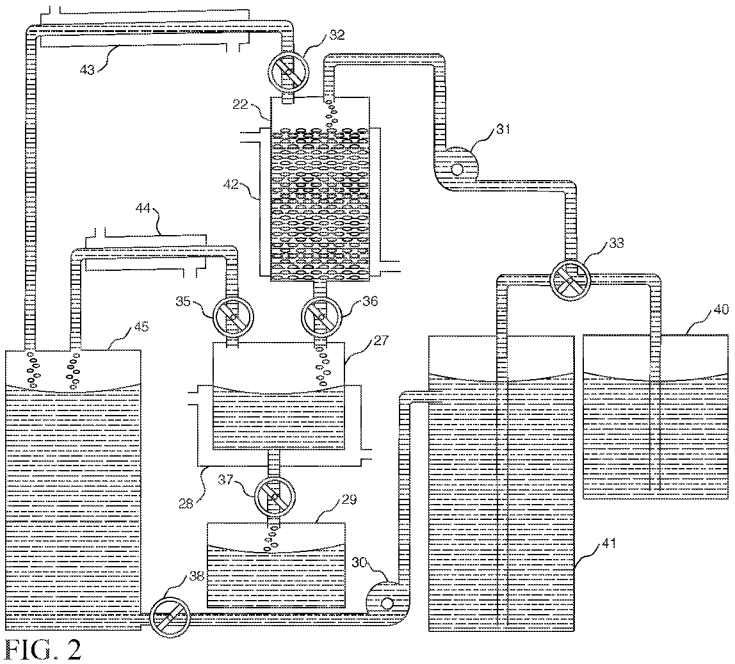

FIG. 2

(57) Abstract: The present invention provides a method and apparatus for processing to improve the properties of pyrolysis oil and, as a result, the commercial value of the same. The net result is creation of an oil with a much lighter color in lieu of the black color, reducing or elimination the undesired sulfury/amine aroma and reducing the amount of PAH which is believed to be a carcinogen.

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1. A method of processing pyrolysis oil comprising

adjusting the polarity of said oil with a non-polar solvent,

binding unwanted components to clay,

eluting the clean oil in the non-polar solvent, and

separating the non-polar solvent from the oil.

2. The method of claim 1 including

employing an alkane as said non-polar solvent.

3. The method of claim 2 including

employing an alkane selected from the group consisting of alkanes having 4 to 10 carbons.

4. The method of claim 2 including

employing a mixture of two or more alkanes selected from the group consisting of alkanes having 4 to 10 carbons.

5. The method of claim 2 including

Employing an alkane selected from the group consisting of alkanes having 5 to 7 carbons.

6. The method of claim 2 including

employing hexane as said alkane.

7. The method of claim 2 including

mixing said oil and alkane to adjust polarity.

8. The method of claim 7 including

mixing said oil and alkane preferably in a ratio of oil to alkane to about 1:2 to 1:30.

9. The method of claim 7 including

mixing said oil and alkane preferably in a ratio of oil to alkane to about 1:4 to 1:15.

10. The method of claim 7 including

mixing said oil and alkane most preferably in a ratio of oil to alkane to about 1:6 to 1:10.

11. The method of claim 7 including

after mixing said oil and alkane allow it to sit for at least 30 minutes to allow precipitation.

12. The method of claim 1 including

effecting said separation of said solvent from said oil by evaporation.

13. The method of claim 1 including

employing attapulgite as said clay.

14. The method of claim 1 including

prior to a cycle of said process activating said clay.

15. The method of claim 1 including

said ratio of clay to oil being about 4:1 to 20:1 by weight.

16. The method of claim 1 including

said ratio of clay to oil being about 6:1 to 15:1 by weight.

17. The method of claim 1 including

cleaning said clay before performing a next cycle of said processing of said pyrolysis oil.

18. The method of claim 17 including

employing a polar solvent to clean said clay.

19. The method of claim 18 including

employing acetone as said clay cleaning polar solvent.

20. The method of claim 17 including

employing as said clay cleaning polar solvent a material selected from the group consisting of methanol, tetrahydrofuran and dimethylformamide.

21. The method of claim 1 including

employing a column in performing the processing of said binding unwanted components to clay.

22. The method of claim 21 including

employing hexane as said alkane in said oil and alkane mixture.

23. The method of claim 22 including

creating flow of said oil-alkane mixture through said column at the rate of about 0.1 to 0.6 liters per hour of column flow per liter of column void volume.

24. The method of claim 21 including

employing hexane as said alkane in said oil and alkane mixture, and

creating flow of said mixture through said column at the rate of about 0.2 to 0.4 liters per hour of column flow per liter of column void volume.

25. The method of claim 1 including,

employing hexane as said alkane in said oil and alkane mixture, and

creating flow of said mixture through said column at the rate of about 0.3 to 3.5 liters per hour of column flow per liter of column void volume.

26. The method of claim 1 including

effecting said separation of said non-polar solvent from said oil by heating said mixture to a temperature high enough to evaporate said non-polar solvent but not high enough to evaporate said oil.

27. The method of claim 1 including

effecting said separation of said non-polar solvent from said oil by heating said mixture to between the boiling point of the non-polar solvent and 32°C above the boiling point of the most volatile compound in the particular pyrolysis oil fraction.

28. The method of claim 1 including

effecting said separation of said non-polar solvent from said oil by heating said mixture preferably to between the boiling point of the particular solvent and 10°C above the boiling point of the most volatile compound in the particular pyrolysis oil fraction.

29. The method of claim 1 including

effecting said separation of said non-polar solvent from said oil by heating said mixture to between the boiling point of the particular solvent and 2°C above the boiling point of the most volatile compound in the oil fraction.

30. The method of claim 20 including

employing hexane as said non-polar solvent and heating said mixture to between 68°C to 100°C to evaporate said hexane.

31. The method of claim 20 including

employing hexane as said non-polar solvent and heating said mixture to preferably between 68°C and 78°C to evaporate said hexane.

32. The method of claim 1 including

effecting said processing by employing a distillation-elution method.

33. The method of claim 1 including

effecting said processing by forced flow elution methods.

34. The method of claim 12 including

condensing said evaporated alkane,

introducing said condensed alkane into a first vessel,

said oil being in a second vessel, and

said second vessel being substantially alkane free.

35. The method of claim 14 including

regenerating said clay with a polar solvent, and

reactivating said regenerated clay.

36. Apparatus for processing pyrolysis oil comprising

a first vessel for receiving a mixure of said pyrolysis oil and a non-polar solvent,

a heater for evaporating said non-polar solvent,

a first condenser for receiving said evaporated non-polar solvent and condensing the same, and

a clay column for receiving condensed vapors from said condenser and eluting said non-polar solvent therefrom into a second vessel.

37. The apparatus of claim 36 including

said apparatus structured to deliver said evaporated non-polar solvent to a second vessel leaving said oil in said first vessel.

38. The apparatus of claim 37 including

said first vessel structured to receive substantially all of said pyrolysis oil and to be substantially devoid of said non-polar solvent.

39. The apparatus of claim 36 including

said apparatus structured to clean said clay column after a cycle of operation.

40. The apparatus of claim 39 including

said apparatus structured to employ acetone as said clay cleaning polar solvent.

41. The apparatus of claim 36 including

said apparatus structured to process non-polar solvents which are alkanes having 4 to 10 carbons.

42. The apparatus of claim 40 including

said apparatus structured to process hexane.

43. The apparatus of claim 36 including

said apparatus structured to function as distillation apparatus in processing said pyrolysis oils.

44. The apparatus of claim 36 including

said apparatus being employable in both the processing of said pyrolysis oils and the cleaning of said apparatus after a cycle of operation.

45. An apparatus for processing pyrolysis oils comprising

a first vessel for holding a mixture of said oil and a non-polar solvent,

a clay column for receipt of said mixture,

a second vessel for receiving said mixture passing through said clay column,

said second vessel structured to heat said mixture to a temperature at which said non-polar-solvent will vaporize, but said oil will not vaporize,

a condenser for condensing said vapors,

a third vessel for receipt of said condensed vapors until only oil remains in said second vessel, and

delivery means for delivering a clay cleaning material to said clay column after a cycle of operation.

46. The apparatus of claim 45 including

said apparatus structured to process non-polar solvents which are alkanes having 4 to 10 carbons.

47. The apparatus of claim 45 including

said apparatus structured to process a non-polar solvent which is hexane.

48. The apparatus of claim 45 including

said apparatus structured to simultaneously process a plurality of non-polar solvents which are alkanes having 4 to 10 carbons.

49. The apparatus of claim 45 including

said clay cleaning material being acetone.

50. The apparatus of claim 45 including

said clay being attapulgite.

51. The apparatus of claim 50 including

said apparatus structured to activate said clay before performing a next cycle of said processing of pyrolysis oil.

52. The apparatus of claim 51 including

said apparatus structured to effect said activation by drying said clay up to about 150°C until there is no more weight loss.