

CLAIMS

What is claimed is:

1. A waste plastic separation method comprising separating a mixed plastic waste (MPW) into a polyethylene terephthalate (PET)-enriched stream and a PET-depleted stream, wherein said PET-enriched stream comprises at least 70 weight percent PET on a dry basis and at least 0.1 weight percent and not more than 10 weight percent halogens on a dry basis.

2. ~~The method of claim 1, wherein said PET-enriched stream is also enriched in PVC and said PET-depleted stream is also depleted in PVC.~~

3. ~~The method of claim 1 or 2, wherein said PET-enriched stream is depleted in polyolefins and said PET-depleted stream is enriched in polyolefins.~~

4. ~~The method of claim 1 or 2, wherein said PET-enriched stream comprises not more than 2 weight percent of adhesives on a dry basis, and/or wherein said PET-enriched stream comprises not more than 4 weight percent plastic fillers and additives on a dry basis.~~

5. ~~The method of claim 1 or 2, wherein said PET-depleted stream comprises not more than 10 weight percent PVC on a dry basis.~~

6. ~~The method of claim 1 or 2, wherein said PET-enriched stream comprises not more than 50 weight percent polyolefins on a dry basis.~~

7. ~~The method of claim 1 or 2, wherein said PET-depleted stream comprises at least 50 weight percent polyolefins on a dry basis.~~

8. ~~The method of claim 1 or 2, wherein said separating comprises at least one density separation stage.~~

9. ~~—The method of claim 8, wherein said separating comprises at least a first density separation stage and a second density separation stage.~~

10. ~~—The method of claim 8, wherein said at least one density separation stage includes a sink-float separation stage and/or a centrifugal force separation stage.~~

11. 2. The method of claim ~~10~~1, wherein said separating comprises a first density separation stage and a second density separation stage, wherein said first density separation stage is a high-density sink-float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.

12. ~~—The method of claim 1 or 2, wherein each of said PET-enriched stream and said PET-depleted stream comprises at least 90 weight percent plastic.~~

13. ~~—The method of claim 1 or 2, wherein the concentration of PET in said PET-enriched stream is higher than the concentration of PET in said PET-depleted stream.~~

14. ~~—The method of claim 1 or 2, wherein said method comprises separating said MPW into at least two PET-depleted streams.~~

15. ~~—The method of claim 1 or 2, wherein PVC is not separated from said MPW or said PET-enriched stream as a PVC-enriched stream relative to said MPW or said PET-enriched stream.~~

16. 3. The method of claim ~~1 or 2~~, wherein at least 50 weight percent of the PVC content in said MPW is separated from said MPW together with the PET into said PET-enriched stream.

~~17. The method of claim 1 or 2, wherein the PVC content in said PET-enriched stream is not separated from said PET-enriched stream prior to processing the PET in said PET-enriched stream in a chemical recycling process.~~

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~~18.~~ 4. A waste plastic separation method comprising:

(a) introducing mixed waste plastic (MPW) particulates into a first density separation stage; and

10 (b) feeding an output stream from said first density separation stage into a second density separation stage,

wherein one of said first and second density separation stages is a low-density separation stage and the other of said first and second density separation stages is a high-density separation stage,

15 wherein said low-density separation stage has a target separation density that is less than 1.35 g/cc and/or at least 1.25 g/cc,

wherein said high-density separation stage has a target separation density that is at least 0.01 g/cc greater than the target separation density of said low-density separation stage.

20 ~~19. The method of claim 18, wherein the target separation density of said high-density separation stage is at least 1.31 g/cc and/or not more than 1.45 g/cc.~~

25 ~~20. The method of claim 18 or 19, wherein said MPW particulates comprise PET and polyolefins in combination in an amount of at least 50 weight percent.~~

~~21. The method of claims 18 or 19, wherein said MPW particulates comprise at least 5 weight percent PET.~~

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~~22.~~ 5. The method of claims ~~18 or 19~~4, wherein said first density separation stage has a separation efficiency with respect to PET of at least 90

percent, and/or wherein said second density separation stage has a separation efficiency with respect to PET of at least 90 percent.

23. 6. The method of claims ~~18 or 19~~4, wherein said first density separation stage is a high-density sink-float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.

24. ~~The method of claims 18 or 19, wherein said first density separation stage is said high density separation stage and said second density separation stage is said low density separation stage.~~

25. 7. A waste plastic separation method comprising:
a) introducing MPW particulates into a first density separation stage to form a particulate plastic solids output stream and a high-density particulate plastic solids stream having a higher average particulate plastic solids density than said particulate plastic solids output stream, and
b) feeding at least a portion of said particulate plastic solids output stream into a second density separation stage to form a medium density particulate plastic solids stream and a low-density particulate plastic solids stream,

wherein the average particulate plastic solids density of the high-density particulate plastic solids stream is higher than the average particulate plastic solids density of the medium density particulate plastic solids stream, and wherein the medium density particulate plastic solids stream has an average particulate plastic solids density that is higher than the average particulate plastic solids density of low density particulate plastic solids stream.

26. ~~The method of claim 25, wherein said first density separation stage produces a first PET-enriched stream as said output stream and a heavies-~~

~~enriched stream as said high density particulate plastic solids stream that is depleted of PET.~~

27. 8. The method of claim ~~26~~7, wherein said second density separation stage separates said first PET-enriched stream into a second PET-enriched stream as said medium density particulate plastic solids stream and a polyolefins-enriched stream as said low-density particulate plastic solids stream.

~~28. The method of any of claims 25 to 27, wherein said output stream is PVC-enriched.~~

~~29.~~ 9. The method of ~~any of claims 25 to 27~~7, wherein said low density plastic stream comprises less than 10 weight percent PET, wherein said high density plastic stream comprises non-plastic solids and/or heavy plastics having densities greater than 1.41 g/cc, wherein said non-plastic solids comprise sand, metal, and/or glass.

~~30. The method of any of claims 25 to 27, wherein said medium density plastic stream is PVC-enriched.~~

~~31. The method of any of claims 25 to 27, wherein said second PET-enriched stream and/or said medium density plastic stream is polyolefin-depleted.~~

~~32. The method of any of claims 25 to 27, wherein said high density plastic stream comprises less than 10 weight percent PET on a dry plastic basis.~~

~~33. The method of any of claims 25 to 27, wherein said high density plastic stream comprises non-plastic solids and/or heavy plastics having densities greater than 1.41 g/cc.~~

34. ~~The method of claim 33, wherein said non-plastic solids comprise sand, metal, and/or glass.~~

35. ~~The method of claims 25 or 26, wherein the mass of said high density particulate plastic solids stream is less than the mass of said output stream on a dry plastic basis.~~

36. ~~The method of claims 25 or 26, wherein the mass of said high density particulate plastic solids stream is not more than 20 percent by weight of said MPW particulates introduced into said first density separation stage on dry plastic weight basis.~~

37. ~~The method of claims 25 or 26, wherein the ratio of the plastic mass of said high density particulate plastic solids stream to the plastic mass of said medium density particulate plastic solids stream is from 10:1 — 1:10.~~

38. 10. The method of claims 25 or 26~~7~~, wherein said medium density particulate plastic solids stream is enriched in PET relative to said low density particulate plastic solids stream and/or said high density particulate plastic solids stream.

39. ~~The method of claims 25 or 26, wherein said medium density particulate plastic solids stream is enriched in PET relative to the combination of said low density particulate plastic solids stream and said high density particulate plastic solids stream.~~

40. 11. The method of claims 25 or 26~~7~~, wherein said low density particulate plastic solids stream and said high density particulate plastic solids stream are combined into a single stream.

41. ~~The method of claims 25 or 26, wherein said low density particulate plastic solids stream is enriched in polyolefin relative to said medium density particulate plastic solids stream.~~

5 42. ~~The method of claims 25 or 26, wherein said medium density particulate plastic solids stream further comprises PVC in an amount of at least 0.1 weight percent and not more than 10 weight percent on a dry plastic basis.~~

10 43. ~~The method of claims 18 or 25, wherein each of said first density separation stage and second density separation stage comprise a centrifugal force separation stage and/or a sink-float separation stage.~~

15 44. ~~The method of claim 43, wherein said first density separation stage is a high-density sink-float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.~~

20 45. ~~The method of claims 18 or 25, further comprising recovering a first PET-enriched stream from said first separation stage and recovering a second PET-enriched stream from said second separation stage, wherein said second PET-enriched has a higher concentration of PET than said first PET-enriched stream on a dry plastic basis.~~

25 46. ~~The method of claim 45, wherein said first PET-enriched stream comprises at least 55 weight percent PET on a dry plastic basis, and/or wherein said second PET-enriched stream comprises at least 90 weight percent PET on a dry plastic basis.~~

30 47. ~~The method of claim 45, further comprising subjecting said second PET-enriched stream to solid-liquid separation and/or drying to provide a PET-enriched plastic material product.~~

48. 12. The method of claims ~~18 or 25~~7, further comprising mixing a salt and/or saccharide with water to form a concentrated salt and/or saccharide solution and feeding said concentrated salt and/or saccharide solution to at least one of said first or second density separation stages.

~~49. The method of claim 48, wherein said concentrated salt and/or saccharide solution comprises a saccharide or non-halogenated salt, such as acetates, carbonates, citrates, nitrates, nitrites, phosphates, sulfates, and/or hydroxides.~~

~~50. The method of claim 49, wherein said concentrated salt and/or saccharide solution comprises potassium carbonate.~~

~~51. The method of claim 50, wherein said concentrated salt solution comprising potassium carbonate is fed into said first density separation stage.~~

~~52. The method of claim 51, wherein said concentrated salt solution is fed to both of said first and second density separation stages.~~

~~53. The method of claim 52, further comprising controlling the flow rates of said concentrated salt solution such that the salt concentration in one of said first or second density separation stage is greater than the other of said first or second density separation stage.~~

~~54. The method of claims 18 or 25, further comprising mixing a caustic component and water to form a caustic solution and feeding said caustic solution to said MPW particulates, said first density separation stage, said outlet stream, said second separation stage, and/or one or more PET-enriched or polyolefin-enriched streams from said first or said second density separation stages.~~

~~55. The method of claim 48, wherein no separate caustic component is introduced into said first density separation stage and/or said second density separation stage, and/or wherein said MPW particulates are not subjected to a separate antimicrobial processing stage before being introduced into said first density separation stage.~~

56. 13. A waste plastic separation method comprising:

(a) mixing a salt and/or saccharide with water to form a concentrated salt and/or saccharide solution and feeding said concentrated salt and/or saccharide solution to at least one of a first or second density separation stages;

(b) introducing mixed waste plastic (MPW) particulates into said first density separation stage; and

(c) feeding an output stream from said first density separation stage into the second density separation stage,

wherein one of said first and second density separation stages is a low-density separation stage and the other of said first and second density separation stages is a high-density separation stage,

wherein no separate caustic component is introduced into said first density separation stage and/or said second density separation stage, and/or wherein said MPW particulates are not subjected to a separate antimicrobial processing stage before being introduced into said first density separation stage.

~~57. The method of claim 56, wherein said concentrated salt and/or saccharide solution comprises a saccharide or non-halogenated salt, such as acetates, carbonates, citrates, nitrates, nitrites, phosphates, sulfates, and/or hydroxides.~~

58. 14. The method of claim ~~57~~13, wherein said first density separation stage is a high-density sink-float separation stage, and wherein said second density separation stage is a low-density centrifugal density separation stage.

59. ~~15.~~ 15. The method of ~~any of claims 57 to 58~~13, wherein said concentrated salt and/or saccharide solution is fed into said first density separation stage.

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60. 16. A waste plastic separation method comprising:
(a) introducing mixed plastic waste (MPW) particulates into a high-density sink-float density separation stage; and
(b) feeding an output stream from said high-density sink-float density separation stage into a low-density centrifugal density separation stage.

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61. 17. A waste plastic separation method comprising separating a mixed plastic waste (MPW) into a polyethylene terephthalate (PET)-enriched stream and a PET-depleted stream, wherein said PET-enriched stream is depleted in nylons.

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62. ~~The method of claim 61, wherein said PET-enriched stream comprises not more than 1 weight percent nylons on a dry plastic basis.~~

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63. ~~The method of claims 61 or 62, wherein said PET-depleted stream is enriched in nylons, and/or wherein the weight ratio of the nylons in the PET-depleted stream to the nylons in the PET-enriched stream is at least 1:1.~~

64. 18. The method of claims ~~61 or 62~~17, wherein said separating comprises a first density separation stage and a second density separation stage, wherein said first density separation stage is a high-density sink-float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.

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65. 19. A waste plastic separation method comprising separating a mixed plastic waste (MPW) into a polyethylene terephthalate (PET)-enriched

stream and a PET-depleted stream, wherein said PET-enriched stream is depleted in multi-layer polymers.

5 ~~66.—The method of claim 65, wherein said PET-enriched stream comprises not more than 10 weight percent multi-layer polymers on a dry basis.~~

10 ~~67.—The method of claims 65 or 66, wherein said PET-depleted stream is enriched in multi-layer polymers, and/or wherein the weight ratio of multi-layer polymers in the PET-depleted stream to the multi-layer polymers in the PET-enriched stream is at least 1:1.~~

15 ~~68.—The method of claims 65 or 66, wherein said separating comprises a first density separation stage and a second density separation stage, wherein said first density separation stage is a high-density sink float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.~~

20 ~~69.—The method of claims 65 or 66, wherein said PET-depleted stream comprises at least 0.1 weight percent nylons on a dry basis.~~

25 ~~70.—The method of claims 65 or 66, wherein said MPW comprises multi-layer polymers comprising PET and at least one other synthetic natural polymer or non-polymer solid, the method further comprising pre-processing said MPW to dissociate at least a portion of said PET in said multi-layer polymers before said separating.~~

30 ~~71.~~ 20. A waste plastic separation method comprising separating a mixed plastic waste (MPW) into a polyethylene terephthalate (PET)-enriched stream and a PET-depleted stream, wherein said PET-enriched stream is depleted in multi-component polymers.

72.—~~The method of claim 71, wherein said PET-enriched stream comprises not more than 10 weight percent multi-component polymers on a dry basis.~~

5 73.—~~The method of claims 71 or 72, wherein said PET-depleted stream is enriched in multi-component polymers, and/or wherein the weight ratio of multi-component polymers in the PET-depleted stream to the multi-component polymers in the PET-enriched stream is at least 1:1.~~

10 74.—~~The method of claims 71 or 72, wherein said separating comprises a first density separation stage and a second density separation stage, wherein said first density separation stage is a high-density sink-float density separation stage, and wherein said second density separation stages is a low-density centrifugal density separation stage.~~

15 75.—~~The method of claims 71 or 72, wherein said PET-depleted stream comprises at least 0.1 weight percent nylons on a dry plastic basis.~~

20 76.—~~The method of claims 71 or 72, wherein said multi-component polymers comprises a heterogenous mixture of PET, a compatibilizer, and at least one non-PET synthetic or natural polymer or non-polymer component.~~

25 77.—~~The method of claims 71 or 72, wherein said MPW comprises multi-component polymers comprising PET and at least one other synthetic or natural polymer or non-polymer solid component, the method further comprising pre-processing said MPW to dissociate at least a portion of said PET in said multi-component polymers before said separating.~~

30 78.—~~A PET-enriched plastic material formed by the method of any one of claims 1, 18, 25, 57, 60, 61, 65, or 71.~~

79.—~~The PET-enriched plastic material of claim 78, comprising at least 90 weight percent PET on a dry plastic basis.~~

~~80. The PET-enriched plastic material of claim 78, comprising less than 10 weight percent polyolefins on a dry plastic basis.~~

5 ~~81. A polyolefin-enriched plastic material formed by the method of any one of claims 1, 18, 25, 57, 60, 61, 65, or 71.~~

~~82. The polyolefin-enriched plastic material of claim 81, comprising less than 10 weight percent PET on a dry plastic basis.~~

10 ~~83. The polyolefin-enriched plastic material of claim 81, comprising less than 10 weight percent PVC on a dry plastic basis.~~