CLAIMS

1. An oxidative desulfurization process comprising:

a. mixing a hydrocarbon feedstock containing hetero-aromatic sulfides benzothiopenes, and dibenzothiopenes, and an excess of gaseous oxidant in a mixing zone under predetermined conditions of temperature and pressure to dissolve a portion of the gaseous oxidant in the hydrocarbon feedstock to produce a mixture of an undissolved gaseous oxidant portion and a liquid phase portion of gaseous oxidant-enriched hydrocarbon feedstock;

b. passing the mixture from step (a) to a flashing zone;

c. in the flashing zone, flashing light hydrocarbon compounds and undissolved gaseous oxidant from the liquid phase gaseous oxidant-enriched hydrocarbon feedstock; and

d. from the flashing zone, passing the liquid phase gaseous oxidant-enriched hydrocarbon feedstock to an oxidation reaction zone, and maintaining the gaseous oxidant-enriched hydrocarbon feedstock in the oxidation reaction zone under conditions effective to oxidize hetero-aromatic sulfides into corresponding hetero-aromatic sulfoxides and/or sulfones.

2. The process of claim 1, wherein a mixture of hydrocarbons and hetero-aromatic sulfoxides and/or sulfones is produced, further comprising

e. separating hetero-aromatic sulfoxides and/or sulfones from the mixture of hydrocarbons and hetero-aromatic sulfoxides and/or sulfones; and

f. recovering a hydrocarbon product having reduced concentration of hetero-aromatic sulfides.

3. The process of claim 2, further comprising

g. recycling a portion of hydrocarbon product from step (f) to step (a) as diluent.

4. The process of claim 1, wherein undissolved gaseous oxidant is recycled to the mixing zone.

5. The process of claim 1, wherein steps (a) - (d) occur at a pressure of between 1 bar and 100 bar.

6. The process of claim 1, wherein steps (a) - (d) occur at a pressure of between 1 bar and 50 bar.

7. The process of claim 1, wherein steps (a) - (d) occur at a pressure of between 1 bar and 30 bar.

8. An oxidative desulfurization process comprising:

a. mixing a hydrocarbon feedstock containing hetero-aromatic sulfides benzothiopenes, and dibenzothiopenes, peroxide precursor, and an excess of gaseous oxidant in a mixing zone under predetermined conditions of temperature and pressure to dissolve a portion of the gaseous oxidant in the hydrocarbon feedstock to produce a mixture of an undissolved gaseous oxidant portion and a liquid phase portion of gaseous oxidant-enriched hydrocarbon feedstock;

b. passing the mixture from step (a) to a flashing zone;

c. in the flashing zone, flashing light hydrocarbon compounds and undissolved gaseous oxidant from the liquid phase gaseous oxidant-enriched hydrocarbon feedstock containing peroxide precursor;

d. from the flashing zone, passing the liquid phase gaseous oxidant-enriched hydrocarbon feedstock containing peroxide precursor to an oxidation reaction zone, and maintaining the gaseous oxidant-enriched hydrocarbon feedstock containing peroxide precursor under conditions effective to form peroxide oxidant; and

e. maintaining the peroxide oxidant formed in step (d) with remaining original feed and optionally additional feed under conditions to oxidize hetero-aromatic sulfides into corresponding hetero-aromatic sulfoxides and/or sulfones.

9. The process of claim 8, wherein a mixture of hydrocarbons and hetero-aromatic sulfoxides and/or sulfones is produced, further comprising

f. separating hetero-aromatic sulfoxides and/or sulfones from the mixture of hydrocarbons and hetero-aromatic sulfoxides and/or sulfones; and

g. recovering a hydrocarbon product having reduced concentration of hetero-aromatic sulfides.

10. The process of claim 9, further comprising

h. recycling a portion of hydrocarbon product from step (g) to step (a) as diluent.

11. The process of claim 8, wherein undissolved gaseous oxidant is recycled to the mixing zone.

12. The process of claim 8, wherein steps (a) - (e) occur at a pressure of between 1 bar and 100 bar.

13. The process of claim 8, wherein steps (a) - (e) occur at a pressure of between 1 bar and 50 bar.

14. The process of claim 8, wherein steps (a) - (e) occur at a pressure of between 1 bar and 30 bar.

15. The process of claim 1, wherein step (d) occurs in the presence of heterogeneous catalyst and the oxidation reaction zone operates in substantially solid-liquid phase.

16. The process of claim 1, wherein step (d) occurs in the presence of homogeneous catalyst and the oxidation reaction zone operates in substantially liquid phase.

17. The process of claim 8, wherein step (d) occurs in the presence of heterogeneous catalyst and the oxidation reaction zone operates in substantially solid-liquid phase.

18. The process of claim 8, wherein step (d) occurs in the presence of homogeneous catalyst and the oxidation reaction zone operates in substantially liquid phase.

19. The process of claim 1, wherein the mixing zone is one or more gas-liquid distributor vessels with integrated spargers, injection nozzles, or other devices that impart sufficient velocity to inject the gaseous oxidant into the hydrocarbon feedstock with turbulent mixing and thereby promote saturation of the gaseous oxidant into the hydrocarbon feedstock.

20. The process of claim 8, wherein the mixing zone is one or more gas-liquid distributor vessels with integrated spargers, injection nozzles, or other devices that impart sufficient velocity to inject the gaseous oxidant into the hydrocarbon feedstock with turbulent mixing and thereby promote saturation of the gaseous oxidant into the hydrocarbon feedstock.