

13

comprising the remaining first hydrogen-containing gas and the majority of the H₂S gas; and recycling a selected fraction of the first H₂S-containing gas back to the organic sulfur conversion reaction without removing the H₂S gas from the first hydrogen-containing gas.

12. The method of claim 11, wherein:

reacting the elemental sulfur compounds in the hydrocarbon occurs at a pressure and temperature sufficient to form H₂S gas and wherein the second catalyst used in reacting the elemental sulfur compounds in the hydrocarbon is a ZnO catalyst; and

wherein separating the second H₂S-containing gas formed from conversion of the elemental sulfur compounds comprises reacting the formed H₂S gas with the ZnO catalyst to form ZnS, yielding the desulfurized hydrocarbon with a concentration of sulfur below a preselected maximum and the second H₂S-containing gas with a reduced concentration of H₂S.

13. The method of claim 12, wherein the second H₂S-containing gas formed in the reaction with elemental sulfur compounds over the ZnO catalyst and separated from the desulfurized hydrocarbon is used as the first hydrogen-containing gas in the organic sulfur conversion reaction.

14. The method of claim 1, wherein the first hydrogen-containing gas used in the organic sulfur conversion reaction includes a quantity of the second H₂S-containing gas obtained from conversion of the elemental sulfur compounds, wherein the first hydrogen-containing gas flows by pressure differential from the elemental sulfur reaction vessel through a heat exchanger and into the organic sulfur conversion reaction vessel, and wherein the hydrocarbon containing sulfur primarily in the form of elemental sulfur compounds from the organic sulfur conversion reaction is pumped up in pressure to react and remove the elemental sulfur compounds.

15. The method of claim 1, wherein the reaction with the hydrocarbon containing sulfur primarily in the form of

14

elemental sulfur compounds includes sparging the second hydrogen-containing gas through the hydrocarbon while the hydrocarbon is in contact with the catalyst.

16. The method of claim 1, wherein the reaction with the hydrocarbon containing sulfur primarily in the form of elemental sulfur compounds is performed in a countercurrent stripping column that is packed with the second catalyst in a pelletized form so as to be in contact with the liquid hydrocarbon introduced to the column, wherein the hydrocarbon flows in a first direction and the second hydrogen-containing gas flows in a second direction.

17. The method of claim 16, wherein the countercurrent stripping column is loaded with a packing coated with the catalyst such that the hydrocarbon is in contact with the catalyst when introduced to the column.

18. The method of claim 17, wherein the packing is a structured packing or a random packing.

19. The method of claim 1, wherein the second hydrogen-containing gas is a reformat gas obtained from: a steam reformer, an autothermal reformer, or a partial oxidation reactor.

20. The method of claim 1, wherein the second hydrogen-containing gas is a hydrogen-depleted reformat obtained from a hydrogen-separation process selected from the group consisting of: pressure-swing adsorption processes, temperature-swing adsorption processes, hydrogen-permeating membrane processes, and combinations thereof.

21. The method of claim 1, wherein the second hydrogen-containing gas is a retentate gas obtained from a hydrogen permeable membrane separation.

22. The method of claim 1, wherein the reaction of elemental sulfur compounds in the hydrocarbon occurs at a temperature between 50° C. and 150° C., a pressure between about 1 atmospheres (atm) absolute and 4 atmospheres (atm) absolute, and for a time sufficient to convert the elemental sulfur to H₂S.

* * * * *