CLAIMS

1. A method for producing mixed xylenes from a heavy reformate feed, the method comprising the steps of:

introducing the heavy reformate feed and a hydrogen feed to a dealkylation reactor, wherein the dealkylation reactor comprises a dealkylation catalyst, wherein the heavy reformate comprises aromatic hydrocarbons with nine or more carbon atoms (C9+ aromatics), wherein the hydrogen feed comprises hydrogen gas;

reacting the heavy reformate feed with the hydrogen gas in the presence of the dealkylation catalyst in the dealkylation reactor to produce a dealkylation effluent, wherein the dealkylation reactor is at a dealkylation temperature, wherein the dealkylation reactor is at a dealkylation pressure, wherein the dealkylation reactor has a liquid hourly space velocity;

introducing the dealkylation effluent to a splitter unit, where the dealkylation effluent comprises light gases, toluene, benzene, mixed xylenes, and C9+ aromatics;

separating the dealkylation effluent into a light gas stream, a toluene stream, a benzene stream, a C9 aromatics stream, a C10+ aromatics stream, and a mixed xylene stream in the splitter unit, wherein the light gas stream comprises light hydrocarbons and hydrogen, wherein the toluene stream comprises toluene, wherein the benzene stream comprises benzene, wherein the mixed xylene stream comprises mixed xylenes, wherein the C9 stream comprises C9 aromatics, wherein the C10+ aromatics stream comprises C10+ aromatics;

introducing the toluene stream, the C9 aromatics stream, and a hydrogen stream into a transalkylation reactor, wherein the transalkylation reactor comprises a transalkylation catalyst, wherein the hydrogen stream comprises hydrogen gas;

reacting the toluene stream and the C9 aromatics stream in the presence of the transalkylation catalyst to produce a transalkylation effluent, wherein the transalkylation reactor is at a transalkylation temperature, wherein the transalkylation reactor is at a transalkylation pressure, wherein the transalkylation reactor has a liquid hourly space velocity;

introducing the transalkylation effluent to the splitter unit, wherein the transalkylation effluent comprises light gases, toluene, benzene, mixed xylenes, and C9+ aromatics; and

separating the transalkylation effluent in the splitter unit such that mixed xylenes in the transalkylation effluent exit the splitter unit as part of the mixed xylene stream.

2. The method of claim 1 further comprising the steps of:

introducing the light gas stream to a gas separator; and

separating the light gas stream into a produced hydrogen and a light gas product.

3. The method of claim 1 further comprising the step of introducing the benzene stream to the transalkylation reactor.

4. The method of claim 1 further comprising the step of supplying an added aromatic stream to the transalkylation reactor, such that there is an excess of toluene for transalkylation reactions in the transalkylation reactor.

5. The method of claim 1, wherein the dealkylation temperature is between 200 deg C and 500 deg C.

6. The method of claim 1, wherein the dealkylation pressure is between 5 bar and 40 bar.

7. The method of claim 1, wherein the liquid hourly space velocity in the dealkylation reactor is between 1 hr^{-1} and 10 hr^{-1}.

8. The method of claim 1, wherein the transalkylation temperature is between 300 deg C and 500 deg C.

9. The method of claim 1, wherein the transalkylation pressure is between 10 bar and 40 bar.

10. The method of claim 1, wherein the liquid hourly space velocity in the transalkylation reactor is between 0.5 hr^{-1} and 6 hr^{-1}.

11. An apparatus for producing xylenes from a heavy reformate feed, the apparatus comprising:

a dealkylation reactor, the dealkylation reactor configured to convert a heavy reformate feed and a hydrogen feed in the presence of a dealkylation catalyst to produce a dealkylation effluent, wherein the heavy reformate comprises aromatic hydrocarbons with nine or more carbon atoms (C9+ aromatics), wherein the hydrogen feed comprises hydrogen gas, wherein the dealkylation reactor is at a dealkylation temperature, wherein the dealkylation reactor is at a

dealkylation pressure, wherein the dealkylation reactor has a liquid hourly space velocity, wherein the dealkylation effluent comprises light gases, toluene, benzene, mixed xylenes, and C9+ aromatics;

a splitter unit fluidly connected to the dealkylation reactor, the splitter unit configured to separate the dealkylation effluent and a transalkylation effluent into a light gas stream, a toluene stream, a benzene stream, a C9 aromatics stream, a C10+ aromatics stream, and a mixed xylene stream, wherein the light gas stream comprises light hydrocarbons and hydrogen, wherein the toluene stream comprises toluene, wherein the benzene stream comprises benzene, wherein the mixed xylene stream comprises mixed xylenes, wherein the C9 aromatics stream comprises C9 aromatics, wherein the C10+ aromatics stream comprises C10+ aromatics; and

a transalkylation reactor fluidly connected to the splitter unit, the transalkylation reactor configured to convert the C9 aromatics stream, the toluene stream, and a hydrogen stream in the presence of a transalkylation catalyst to a transalkylation effluent, wherein the hydrogen stream comprises hydrogen gas, wherein the transalkylation reactor is at a transalkylation temperature, wherein the transalkylation reactor is at a transalkylation pressure, wherein the transalkylation reactor has a liquid hourly space velocity.

12. The apparatus of claim 11 further comprising a gas separator fluidly connected to the splitter unit, the gas separator configured to separate the light gas stream into a produced hydrogen and a light gas product.

13. The apparatus of claim 11, wherein the dealkylation temperature is between 200 deg C and 500 deg C.

14. The apparatus of claim 11, wherein the dealkylation pressure is between 5 bar and 40 bar.

15. The apparatus of claim 11, wherein the liquid hourly space velocity in the dealkylation reactor is between 1 hr^{-1} and 10 hr^{-1}.

16. The apparatus of claim 11, wherein the transalkylation temperature is between 300 deg C and 500 deg C.

17. The apparatus of claim 11, wherein the transalkylation pressure is between 10 bar and 40 bar.

18. The apparatus of claim 11, wherein the liquid hourly space velocity in the transalkylation reactor is between 0.5 hr^{-1} and 6 hr^{-1}.