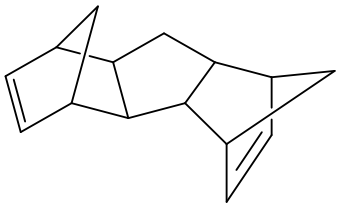
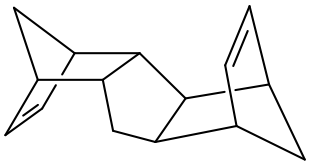
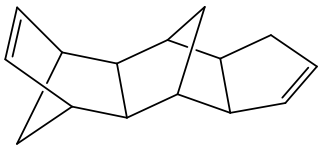
CLAIMS:

What is claimed is:

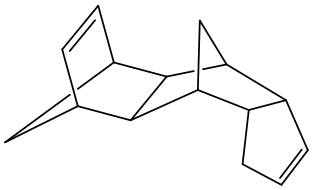
1. A composition, comprising:

0.1 wt% to 6 wt% of TCPD-7 having a structure of  ;

5 wt% to 25 wt% of TCPD-3 having a structure of  ;

15 wt% to 30 wt% of TCPD-5 having a structure of  ;

and

55 wt% to 75 wt% of TCPD-1 having a structure of  ,

wherein all wt% values are based on the combined weight of TCPD-7, TCPD-3, TCPD-5, and TCPD-1 in the composition.

2. The composition of claim 1, further comprising di-cyclopentadiene.

3. The composition of claim 2, wherein the composition comprises ≥ 97 wt% of a combined amount of di-cyclopentadiene and tri-cyclopentadiene, based on the total weight of the composition.

4. The composition of claim 2 or claim 3, wherein a weight ratio of tri-cyclopentadiene to di-cyclopentadiene is ≥ 1.

5. The composition of claim 1, further comprising di-cyclopentadiene and tetra-cyclopentadiene.

6. The composition of claim 5, wherein the composition comprises 50 wt% to 80 wt% of tri-cyclopentadiene, 20 wt% to 50 wt% of di-cyclopentadiene, and 0.1 wt% to 7 wt% of tetra-cyclopentadiene, based on the total weight of the composition.

7. The composition of claim 5 or claim 6, wherein a weight ratio of tri-cyclopentadiene to tetra-cyclopentadiene is > 10.

8. The composition of any one of claims 5 to 7, wherein the composition comprises ≥ 97 wt% of a combined amount of tri-cyclopentadiene, di-cyclopentadiene, and tetra-cyclopentadiene, based on the total weight of the composition.

9. The composition of any one of claims 5 to 8, wherein the composition comprises ≤ 7 wt% of tetra-cyclopentadiene, based on the total weight of the composition.

10. The composition of any one of claims 5 to 9, wherein a weight ratio of tri-cyclopentadiene to di-cyclopentadiene in the composition is ≥ 1.

11. A process for making tri-cyclopentadiene, comprising:

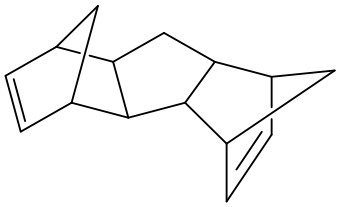
(I) feeding a hydrocarbon feed comprising cyclopentadiene and di-cyclopentadiene into a reaction zone;

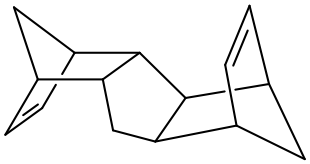
(II) subjecting the hydrocarbon feed to reaction conditions sufficient to effect reaction between the cyclopentadiene and the di-cyclopentadiene within the reaction zone to produce an effluent comprising residual cyclopentadiene, residual di-cyclopentadiene, tri-cyclopentadiene, and tetra-cyclopentadiene;

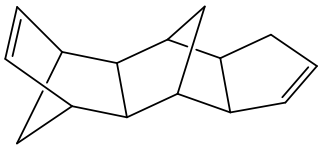
(III) separating from the effluent a recycle stream comprising residual cyclopentadiene and residual di-cyclopentadiene and a first product stream comprising residual di-cyclopentadiene, tri-cyclopentadiene, and tetra-cyclopentadiene; and

(IV) feeding at least a portion of the recycle stream into the reaction zone.

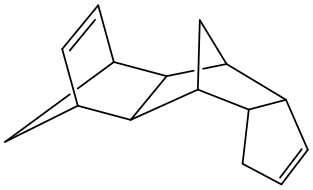
12. The process of claim 11, wherein the tri-cyclopentadiene in the effluent comprises:

0.1 wt% to 6 wt% of TCPD-7 having a structure of  ;

5 wt% to 25 wt% of TCPD-3 having a structure of  ;

15 wt% to 30 wt% of TCPD-5 having a structure of  ;

and

55 wt% to 75 wt% of TCPD-1 having a structure of  ,

wherein all wt% values are based on the combined weight of TCPD-7, TCPD-3, TCPD-5, and TCPD-1 in the effluent.

13. The process of claim 12, wherein TCPD-7, TCPD-3, TCPD-5, and TCPD-1, in total, constitute at least 95 wt% of all tri-cyclopentadiene in the effluent.

14. The process of any one of claims 11 to 13, wherein the first product stream comprises 50 wt% to 80 wt% of tri-cyclopentadiene, 20 wt% to 50 wt% of di-cyclopentadiene, and 0.1 wt% to 7 wt% of tetra-cyclopentadiene, based on the total weight of the first product stream.

15. The process of any one of claims 11 to 14, wherein the hydrocarbon feed and the recycle stream fed into the reaction zone comprise 0.1 wt% to 50 wt% of cyclopentadiene and 50 wt% to 99.9 wt% of di-cyclopentadiene, based on the total combined amount of the cyclopentadiene and the di-cyclopentadiene in the hydrocarbon feed and the recycle stream.

16. The process of claim 15, wherein a molar ratio of di-cyclopentadiene to cyclopentadiene, based on the total combined amount of the cyclopentadiene and the di-

cyclopentadiene in the hydrocarbon feed and the recycle stream, is in a range of from 4.5 to 49.5.

17. The process of any of claims 11 to 16, wherein a residence time within the reaction zone is in a range of from 10 minutes to 70 minutes, and wherein the reaction zone is adiabatic, isothermal, or a combination of adiabatic and isothermal.

18. The process of any one of claims 11 to 17, wherein di-cyclopentadiene in the hydrocarbon feed and the recycle stream fed into the reaction zone, combined, comprise a mixture of endo-di-cyclopentadiene and exo-di-cyclopentadiene, and wherein a weight ratio of endo-di-cyclopentadiene to exo-di-cyclopentadiene fed into the reaction zone is in a range of from 4.5 to 20.

19. The process of any one of claims 11 to 18, further comprising:

(V) pre-heating the hydrocarbon feed and the recycle stream either separately or as a mixture thereof to a temperature in a range from 155°C to 180°C before the hydrocarbon feed, the recycle stream, or the mixture thereof is fed into the reaction zone in step (I), wherein:

the reaction conditions comprise a temperature in a range from 160°C to 190°C and a pressure sufficient to maintain the compounds within the reaction zone in a liquid phase, and

< 15 wt% of the di-cyclopentadiene in the hydrocarbon feed is converted to tri-cyclopentadiene and/or tetra-cyclopentadiene.

20. The process of any one of claims 11 to 19, further comprising:

(VI) feeding at least a portion of the recycle stream into a dimerization zone to effect conversion of at least a portion of the residual cyclopentadiene to di-cyclopentadiene to produce a dimerized recycle stream that is fed to the reaction zone in step (IV).

21. The process of claim 20, wherein the dimerized recycle stream comprises 1 wt% to 6 wt% of residual cyclopentadiene, based on the weight of the dimerized recycle stream.

22. The process of any one of claims 11 to 21, wherein the hydrocarbon feed, the recycle stream, or both the hydrocarbon feed and the recycle stream comprise molecular oxygen, the process further comprising:

(VII) stripping at least a portion of any oxygen present in the hydrocarbon feed to produce an oxygen-lean hydrocarbon feed that is fed into the reaction zone;

(VIII) stripping at least a portion of any oxygen present in the recycle stream to produce an oxygen-lean recycle stream that is fed into the reaction zone; or

(IX) carrying out both steps (VII) and (VIII), wherein the at least a portion of any oxygen present in the hydrocarbon feed, the recycle stream, or both the hydrocarbon feed and the recycle stream is stripped with a stripping gas comprising nitrogen, one or more C_1-C_5 hydrocarbons, or a mixture thereof.

23. The process of any one of claims 11 to 22, further comprising:

(X) separating from the first product stream a second product that is rich in tri-cyclopentadiene and lean in tetra-cyclopentadiene and a third product that is rich in tetra-cyclopentadiene and lean in tri-cyclopentadiene.

24. The process of claim 23, wherein the second product further comprises residual di-cyclopentadiene, and wherein the second product comprises ≥ 95 wt% of a combined amount of residual di-cyclopentadiene and tri-cyclopentadiene.

25. The process of claim 24, wherein a weight ratio of tri-cyclopentadiene to residual di-cyclopentadiene in the second product is ≥ 1.