Claims

The invention claimed is:

1. A process for producing para-xylene, the process comprising: separating, in a xylene column, a C_8 aromatic hydrocarbon stream and a C_9^+ hydrocarbon stream, from at least a portion of an impure ethylbenzene-containing feed; separating, in a xylene separation zone, a para-xylene rich product from at least a portion of the C_8 aromatic hydrocarbon stream, to provide a para-xylene-depleted effluent; isomerizing, in an isomerization zone, at least a portion of the para-xylene-depleted effluent, to provide a xylene-equilibrated isomerate; recycling at least a portion of the xylene-equilibrated isomerate to the xylene column, and separating, in an ethylbenzene (EB) separation unit, an ethylbenzene-rich product from (i) a portion of the ethylbenzene-containing feed to provide an ethylbenzene-depleted feed, and combining at least a portion of the ethylbenzene-depleted feed with all or a portion of the C_8 aromatic hydrocarbon stream, (ii) a portion of the C_8 aromatic hydrocarbon stream to provide an ethylbenzene-depleted C_8 aromatic hydrocarbon stream, and combining at least a portion of the ethylbenzene-depleted C_8 aromatic hydrocarbon stream with a portion of the C_8 aromatic hydrocarbon stream bypassing the EB separation unit, (iii) a portion of the para-xylene-depleted effluent to provide an ethylbenzene-, para-xylene-depleted effluent, and combining at least a portion of the ethylbenzene-, para-xylene-depleted effluent with a portion of the para-xylene-depleted effluent bypassing the EB separation unit, (iv) a portion of the xylene-equilibrated isomerate to provide an ethylbenzene-depleted, xylene-equilibrated isomerate, and combining at least a portion of the ethylbenzene-depleted, xylene-equilibrated isomerate with a portion of the xylene-equilibrated isomerate bypassing the EB separation unit, or a combination thereof.

2. The process of claim 1, wherein the ethylbenzene-rich product is separated from a portion of the para-xylene-depleted effluent to provide the ethylbenzene, para-xylene-depleted effluent.

3. The process of claim 1, wherein the ethylbenzene-containing feed comprises a product of naphtha reforming, naphtha cracking, or transalkylation.

4. The process of claim 3, wherein the product of naphtha cracking is pyrolysis gasoline.

5. The process of claim 1, wherein the xylene separation zone comprises adsorptive separation or crystallization for the separating of the para-xylene rich product.

6. The process of claim 1, wherein the isomerization zone comprises an isomerization reactor, through which the at least a portion of the para-xylene-depleted effluent is passed in the liquid phase.

7. The process of claim 6, wherein the isomerization reactor is operated under isomerization conditions including a temperature from about 200^{ov}C. (392^o F.) to about 300^o

C. (572° F.) and an absolute pressure from about 2.5 MPa (363 psi) to about 4.5 MPa (653 psi).

8. The process of claim 1, wherein a para-xylene process flow loop is completed by said recycling of said at least a portion of the xylene-equilibrated isomerate to the xylene column.

9. The process of claim 1, wherein the EB separation unit comprises extractive distillation.

10. A process for producing para-xylene, the process comprising forming a para-xylene process flow loop comprising: (i) a C_8 aromatic hydrocarbon stream, separated as a low-boiling fraction in a xylene column, (ii) a para-xylene-depleted effluent, separated in a xylene separation zone from at least a portion of the C_8 aromatic hydrocarbon stream, and (iii) a xylene-equilibrated isomerate, provided from isomerization of at least a portion of the para-xylene-depleted effluent, wherein the process flow loop is completed by recycling at least a portion of the xylene-equilibrated isomerate to the xylene column, and wherein an overall conversion of ethylbenzene introduced into the para-xylene process flow loop is less than about 20 wt-%, or wherein an overall loss of aromatic rings introduced into the para-xylene process flow loop is less than about 5 mol-%, the process further comprising removing an ethylbenzene-rich product, comprising ethylbenzene in an amount of greater than about 90 wt-%, from the para-xylene-depleted effluent of the para-xylene process flow loop or from the xylene-equilibrated isomerate of the para-xylene process flow loop, wherein the removing of the ethylbenzene-rich product is performed by extractive distillation.

11. The process of claim 10, wherein greater than about 80 wt-% of the ethylbenzene introduced into the para-xylene process flow loop is present in an ethylbenzene-containing feed to the xylene column and/or to an ethylbenzene (EB) separation unit.

12. The process of claim 10, wherein the isomerization of the at least a portion of the para-xylene-depleted effluent is carried out with a per-pass aromatic ring loss of less than about 2 mol-%.

13. The process of claim 10, wherein each of (i), (ii), and (iii) of the process flow loop comprises less than about 25 wt-% ethylbenzene.

14. The process of claim 10, wherein the ethylbenzene-rich product comprises greater than about 95 wt-% ethylbenzene.

15. The process of claim 14, wherein the ethylbenzene-rich product comprises greater than about 99.5 wt-% ethylbenzene.

16. A process for producing para-xylene, the process comprising: separating an ethylbenzene-rich product from a portion of an ethylbenzene-containing feed to provide an ethylbenzene-depleted feed; separating, in a xylene column, a C_8 aromatic hydrocarbon

stream as low-boiling fraction and a C_9^+ hydrocarbon stream as a high-boiling fraction, from a portion of the ethylbenzene -containing feed; combining at least a portion of the ethylbenzene-depleted feed with a C_8 aromatic hydrocarbon stream, to provide a combined, ethylbenzene-depleted feed/C_8 aromatic hydrocarbon stream; in a xylene separation zone, separating a para-xylene rich product from at least a portion of the combined, ethylbenzene-depleted feed/C_8 aromatic hydrocarbon stream, to provide a para-xylene-depleted effluent; in an isomerization zone, isomerizing at least a portion of the para-xylene-depleted effluent, to provide a xylene-equilibrated isomerate; and recycling at least a portion of the xylene-equilibrated isomerate to the xylene column, wherein a per-pass ethylbenzene conversion in the isomerization zone is less than about 5 wt-%.

17. The process of claim 16, wherein the separating of the ethylbenzene-rich product is performed by extractive distillation.

18. The process of claim 17, wherein the extractive distillation further provides a C_9^+ hydrocarbon-enriched heavy fraction, the process further comprising combining the C_9^+ hydrocarbon-enriched heavy fraction with the C_9^+ hydrocarbon stream, separated from the xylene column.

19. The process of claim 1, wherein (i) the ethylbenzene-containing feed or portion thereof, (ii) the portion of the C_8 aromatic hydrocarbon stream, (iii) the portion of the para-xylene-depleted effluent, or (iv) the portion of the xylene-equilibrated isomerate, from which the ethylbenzene-rich product is separated, represents from about 1 wt-% to about 95 wt-% of the para-xylene-depleted effluent, or the xylene-equilibrated isomerate.

20. The process of claim 1, wherein (i) the ethylbenzene-containing feed or portion thereof, (ii) the portion of the C_8 aromatic hydrocarbon stream, (iii) the portion of the para-xylene-depleted effluent, or (iv) the portion of the xylene-equilibrated isomerate, from which the ethylbenzene-rich product is separated, comprises from about 3 wt-% to about 50 wt-% of ethylbenzene.