TTMB = tetramethylbenzenes (3 isomers)

[0005] Note that MEB hydrocracking (Reaction 2) produces TOL, which can react with TMB to form xylenes (Reaction 3) or disproportionate to form xylenes and benzene (Reaction 1). Thus, A9+ can be a feed to a TOL/A9+ reactor alone, i.e., TOL in the feed can be zero.

[0006] MEB and propylbenzene hydrocracking (Reactions 2 and 4) can be driven to very high conversion. However, transalkylation reactions that produce xylene isomers (such as Reactions 1 and 3) are equilibrium limited. Thus, the reactor effluent from TOL/A9+ TA will contain light ends, including C2 and C3, Bz, XYL, and unreacted TOL and A9+. The reactor effluent is separated into streams rich in light ends, Bz, XYL, and unreacted TOL and A9+. The TOL and components of the A9+ are recycled to the reactor. Separation of the reactor effluent into these streams is energy intensive and represents a substantial portion of the variable cost for these processes.

[0007] Accordingly, there remains the need for other energy and capital efficient schemes for separating the reactor effluent from TOL/A9+ transalkylation reactors.

SUMMARY

[0008] The present disclosure addresses the energy efficient separation of the effluent from a TOL/A9+ TA reactor into streams concentrated in light ends, benzene, TOL, A8, and A9+. In an embodiment, the disclosure is directed to a process that includes (a) providing a prefractionation column feed stream including toluene, C8 aromatics, and C9+ aromatics to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream; and (b) providing the prefractionation column top stream and the prefractionation column bottom stream to a sidedraw column to produce a sidedraw column top stream including toluene, and a sidedraw column first side stream

including C8 aromatics. The process also includes producing a sidedraw column bottoms stream including C9+ aromatics. Alternatively, the process may include producing a sidedraw column second side stream including A9 for recycle to a TOL/A9+ transalkylation reactor without further fractionation, and a C10+ sidedraw column bottoms stream that is substantially free of A9.

In one aspect, the present disclosure relates to a A process comprising the steps of: (a) providing a prefractionation column feed stream comprising toluene, C8 aromatics, and C9+ aromatics to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream; and (b) providing the prefractionation column top stream and the prefractionation column bottom stream to a reboiled sidedraw column to produce a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics, and a sidedraw column bottoms stream comprising C9+ aromatics, wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.

[0009] In various embodiments of the disclosure, the process includes recovering paraxylene from the sidedraw column first side stream including C8 aromatics to produce a paraxylene product stream and a paraxylene lean stream.

[0010] In one particular embodiment of the disclosure a benzene column feed stream including benzene, toluene, C8 aromatics, and C9+ aromatics is provided to a benzene column to produce a benzene column top stream including benzene and a benzene column bottom stream including toluene, C8 aromatics, and C9+ aromatics, wherein the benzene column bottom stream is the prefractionation column feed stream.

[0011] In another embodiment, the benzene column feed stream is obtained by the process including providing a stabilizer column feed stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics to a stabilizer column to produce a stabilizer column top stream or streams including light ends and a stabilizer column bottom stream including

benzene, toluene, C8 aromatics, and C9+ aromatics, wherein the stabilizer column bottom stream is the benzene column feed stream.

[0012] In these and other embodiments of the disclosure, the process may include mixing a transalkylation reactor effluent stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics with a paraxylene unit stream including benzene and toluene to produce the stabilizer column feed stream.

[0013] In one embodiment, the process includes operating the sidedraw column at a pressure above atmospheric pressure and using the condensing vapors in the sidedraw column

top stream to generate steam, to reboil the benzene column, and/or reboil the stabilizer column.

[0014] The disclosure is also directed to an apparatus that includes a reboiled prefractionation column for receiving a prefractionation feed stream including toluene, C8 aromatics, and C9+ aromatics and producing a prefractionation column top stream and a prefractionation column bottom stream; and a sidedraw column for receiving the prefractionation column top stream and the prefractionation column bottom stream and producing a sidedraw column top stream including toluene, and a sidedraw column first side stream including C8 aromatics.

In another aspect, the present disclosure relates to an apparatus comprising: (a) a reboiled prefractionation column for receiving a prefractionation feed stream comprising toluene, C8 aromatics, and C9+ aromatics and producing a prefractionation column top stream and a prefractionation column bottom stream; and (b) a reboiled sidedraw column for receiving the prefractionation column top stream and the prefractionation column bottom stream and producing a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics, wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.

In various embodiments of this embodiment, the sidedraw column further produces a sidedraw column bottoms stream including C9+ aromatics. Alternatively, the sidedraw column further produces a sidedraw column second sidedraw stream including A9 for recycle to a TOL/A9+ transalkylation reactor without further fractionation, and a C10+ sidedraw column bottoms stream that is substantially free of A9.

[0015] In another embodiment, the apparatus includes a benzene column for receiving a benzene column feed stream including benzene, toluene, C8 aromatics, and C9+ aromatics,

and separating the benzene column feed stream into a benzene column top stream including benzene and a benzene column bottom stream including toluene, C8 aromatics, and C9+ aromatics, wherein the benzene column bottom stream is the prefractionation column feed stream.

[0016] The apparatus may also include a stabilizer column for receiving a stabilizer column feed stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics, and producing a stabilizer column top stream including light ends and a stabilizer column bottom stream including benzene, toluene, C8 aromatics, and C9+ aromatics; wherein the stabilizer column bottom stream is the benzene column feed stream.

[0017] The apparatus may also include a mixer for mixing a transalkylation reactor effluent stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics with a paraxylene unit stream including benzene and toluene to produce the stabilizer column feed stream.

[0018] The disclosure is also directed to a process including the steps of: reacting in a transalkylation reactor a reactor feed stream including toluene and, optionally, C9+ aromatics to produce a transalkylation reactor effluent stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics; optionally mixing the transalkylation reactor effluent stream with a paraxylene unit stream including benzene and toluene to produce a stabilizer column feed stream including light ends, benzene, toluene, C8 aromatics, and C9+ aromatics; separating the stabilizer column feed stream in a stabilizer column to produce a stabilizer column top stream including light ends and a stabilizer column bottom stream including benzene, toluene, C8 aromatics, and C9+ aromatics; separating the stabilizer column bottom stream in a benzene column to produce a benzene column top stream including benzene and a benzene column bottom stream including toluene, C8 aromatics, and C9+ aromatics; providing the benzene column bottom stream to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream; providing the prefractionation column top stream and the prefractionation column bottom stream to a sidedraw column to produce a sidedraw column top stream including toluene, and a sidedraw column first side stream including C8 aromatics; recovering paraxylene from the sidedraw column side stream including C8 aromatics; and recovering benzene from the benzene column top stream, wherein at least a portion of the sidedraw column top stream containing toluene and optionally a sidedraw column stream containing C9+ aromatics is recycled to the transalkylation reactor.

In another aspect, the present disclosure relates to a process comprising the steps of:

(a) reacting in a transalkylation reactor a reactor feed stream comprising toluene and, optionally, C9+ aromatics to produce a transalkylation reactor effluent stream comprising light ends, benzene, toluene, C8 aromatics, and C9+ aromatics; (b) optionally mixing the transalkylation reactor effluent stream with a paraxylene unit stream comprising benzene and toluene to produce a stabilizer column feed stream comprising light ends, benzene, toluene, C8 aromatics, and C9+ aromatics; (c) separating the stabilizer column feed stream in a stabilizer column to produce a stabilizer column top stream comprising light ends and a stabilizer column bottom stream comprising benzene, toluene, C8 aromatics, and C9+ aromatics; (d) separating the stabilizer column bottom stream in a benzene column to produce a benzene column top stream comprising benzene and a benzene column bottom stream comprising toluene, C8 aromatics, and C9+ aromatics; (e) providing the benzene column bottom stream to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream; (f) providing the prefractionation column top stream and the prefractionation column bottom stream to a reboiled sidedraw column to produce a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics; (g) recovering paraxylene from the sidedraw column side stream comprising C8 aromatics; and (h) recovering benzene from the benzene column top stream, wherein at least a portion of the sidedraw column top stream is recycled to the transalkylation reactor, and wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.

WHAT IS CLAIMED IS:

1. A process comprising the steps of:

(a) providing a prefractionation column feed stream comprising toluene, C8 aromatics, and C9+ aromatics to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream; and

(b) providing the prefractionation column top stream and the prefractionation column bottom stream to a reboiled sidedraw column to produce a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics, and a sidedraw column bottoms stream comprising C9+ aromatics,

wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.

2. The process of claim 1, further comprising producing a sidedraw column second side stream comprising A9 for recycle to a TOL/A9+ transalkylation reactor without further fractionation, and a C10+ sidedraw column bottoms stream that is substantially free of A9.

3. The process of claim 1, further comprising recovering paraxylene from the sidedraw column first side stream comprising C8 aromatics to produce a paraxylene product stream and a paraxylene lean stream.

4. The process of claim 1, further comprising recycling at least a portion of the sidedraw column top stream to a transalkylation reactor.

5. The process of claim 1, further comprising recycling at least a portion of the sidedraw column bottoms stream comprising C9+ aromatics to a transalkylation reactor.

6. The process of claim 2, further comprising recycling at least a portion of the sidedraw column second side stream comprising A9 to a transalkylation reactor.

7. The process of claim 1, wherein the sidedraw column top stream is substantially free of C8 aromatics.

8. The process of claim 1, wherein the sidedraw column side stream comprising C8 aromatics is substantially free of toluene and C9+ aromatics.

9. The process of claim 1, wherein the sidedraw column receives the prefractionation column top stream as a vapor stream without condensation.

10. An apparatus comprising:

(a) a reboiled prefractionation column for receiving a prefractionation feed stream comprising toluene, C8 aromatics, and C9+ aromatics and producing a prefractionation column top stream and a prefractionation column bottom stream; and

(b) a reboiled sidedraw column for receiving the prefractionation column top stream and the prefractionation column bottom stream and producing a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics,

wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.

(d) separating the stabilizer column bottom stream in a benzene column to produce a benzene column top stream comprising benzene and a benzene column bottom stream comprising toluene, C8 aromatics, and C9+ aromatics;

(e) providing the benzene column bottom stream to a reboiled prefractionation column to produce a prefractionation column top stream and a prefractionation column bottom stream;

(f) providing the prefractionation column top stream and the prefractionation column bottom stream to a reboiled sidedraw column to produce a sidedraw column top stream comprising toluene, and a sidedraw column first side stream comprising C8 aromatics;

(g) recovering paraxylene from the sidedraw column side stream comprising C8 aromatics; and

(h) recovering benzene from the benzene column top stream,

wherein at least a portion of the sidedraw column top stream is recycled to the transalkylation reactor, and

wherein the side draw column is separately reboiled from the prefractionation column, and a liquid stream is recovered from the side draw column and used as reflux to the prefractionation column.