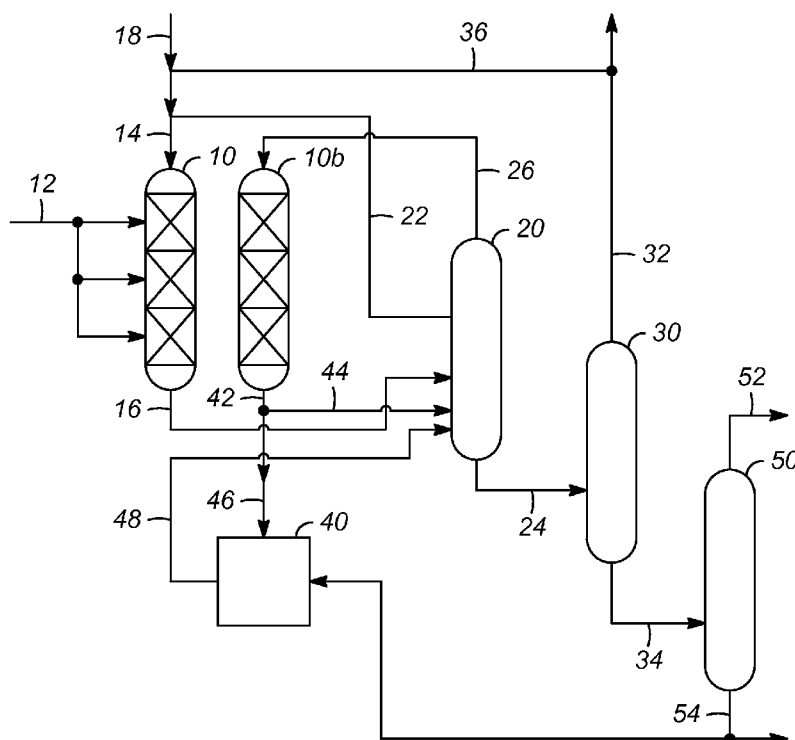




- | | |
|--|--|
| <p>(51) International Patent Classification:
 C07C 2/66 (2006.01) C07C 15/107 (2006.01)</p> | <p>(74) Agent: GOODING, Arthur E.; UOP LLC, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).</p> |
| <p>(21) International Application Number:
 PCT/US2014/032970</p> | <p>(81) Designated States <i>(unless otherwise indicated, for every kind of national protection available):</i> AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.</p> |
| <p>(22) International Filing Date:
 4 April 2014 (04.04.2014)</p> | |
| <p>(25) Filing Language:
 English</p> | |
| <p>(26) Publication Language:
 English</p> | |
| <p>(30) Priority Data:
 13/922,533 20 June 2013 (20.06.2013) US</p> | |
| <p>(71) Applicant: UOP LLC [US/US]; 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).</p> | |
| <p>(72) Inventors: MAJUMDER, Debarshi; Uop Llc, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US). SOHN, Stephen W.; Uop Llc, 25 East Algonquin Road, P. O. Box 5017, Des Plaines, Illinois 60017-5017 (US).</p> | <p>(84) Designated States <i>(unless otherwise indicated, for every kind of regional protection available):</i> ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,</p> |

[Continued on next page]

- (54) Title:** DETERGENT ALKYLATION PROCESS FOR CONTROLLING ALKYLATION EXOTHERM WITH PARAFFINS



- (57) Abstract:** The process of producing an alkylbenzene compound from the alkylation of an aromatic compound with an acyclic monoolefin is an exothermic process. A process for maintaining a relatively constant temperature improves the process and allows for controlling the yields. The process includes recycling a compound through the reactor that is relatively inert, but will moderate the exotherm, while maintaining the 2-phenyl content of the final alkylbenzene product.



MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, **Published:**
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, — *with international search report (Art. 21(3))*
GW, KM, ML, MR, NE, SN, TD, TG).

DETERGENT ALKYLATION PROCESS FOR CONTROLLING ALKYLATION EXOTHERM WITH PARAFFINS

STATEMENT OF PRIORITY

[0001] This application claims priority to U.S. Application No. 13/922,533 which was filed on June 20, 2013, the contents of which are hereby incorporated by reference in its entirety.

FIELD OF THE INVENTION

[0002] A process is presented for the production of linear alkylbenzenes. The process includes contacting an aromatic compound with an olefin in the presence of a selective zeolite catalyst. The process further includes the use of an inert compound for moderating the heat release resulting from the reaction.

BACKGROUND OF THE INVENTION

[0003] Alkylation of benzene produces alkylbenzenes that may find various commercial uses, e. g. , alkylbenzenes can be sulfonated to produce surfactants, for use in detergents. In the alkylation process, benzene is reacted with an olefin of the desired length to produce the sought alkylbenzene. The alkylation conditions comprise the presence of homogeneous or heterogeneous alkylation catalyst such as aluminum chloride, hydrogen fluoride, or zeolitic catalysts and elevated temperature.

[0004] Various processes have been proposed to alkylate benzene. One commercial process involves the use of hydrogen fluoride as the alkylation catalyst. The use and handling of hydrogen fluoride does provide operational concerns due to its toxicity, corrosiveness and waste disposal needs. Solid catalytic processes have been developed that obviate the need to use hydrogen fluoride. Improvements in these solid catalytic processes are sought to further enhance their attractiveness through reducing energy costs and improving selectivity of conversion while still providing an alkylbenzene of a quality acceptable for downstream use such as sulfonation to make surfactants.

[0005] Alkylbenzenes, to be desirable for making sulfonated surfactants must be capable of providing a sulfonated product of suitable clarity, biodegradability and efficacy. With

respect to efficacy, alkylbenzenes having higher 2-phenyl contents are desired as they tend, when sulfonated, to provide surfactants having better solubility and detergency. Thus, alkylbenzenes having a 2-phenyl isomer content in the range from 30 to 40 percent are particularly desired. Improvements in the catalysts have facilitated the production of linear alkylbenzenes, as shown in U.S. Pat. No. 6,133,492; U.S. Pat. No. 6,521,804; U.S. Pat. No. 6,977,319; and U.S. Pat. No. 6,756,030. However, the processes can also be further modified to improve the performance of the reaction to obtain better control over the product yields.

SUMMARY OF THE INVENTION

[0006] The present invention is a process for the formation of alkylaryl compounds. The process utilizes the inert properties of paraffins for controlling the exotherm during the alkylation process. The process includes passing an aromatic compound to an alkylation zone, and passing a feed stream comprising olefins and paraffins to the alkylation zone. The olefins and aromatic compounds react to form a process stream having alkylaryl compounds. The process stream is then passed to a first fractionation unit to separate the feeds to the fractionation unit into a first bottoms stream having the alkylaryl compounds, and a first fractionation stream having unrected aromatics compounds. The first fractionation stream is passed back to the alkylation zone while the bottoms stream is passed to a second fractionation unit to provide for recycling of the unreacted olefins and some of the paraffins. The bottoms stream from the first fractionation column is passed to a second fractionation unit to generate a second overhead stream having paraffins, and a second bottoms stream having alkylaryl compounds. A portion of the second overhead stream is passed to the alkylation zone.

[0007] In a preferred embodiment, the aromatic compound is benzene, and the desired product is a linear alkylbenzene. In the preferred embodiment, the process includes passing the second bottoms stream to a third fractionation zone to generate an overhead stream having a linear alkylbenzene, and a bottoms stream having heavies. The heavies include polyalkylated benzene having dialkylated benzene as the largest fraction. The dialkylated benzene is passed to a transalkylation reaction unit along with benzene to increase the yields of linear alkylbenzenes.

[0008] Other objects, advantages and applications of the present invention will become apparent to those skilled in the art from the following detailed description and drawings.

BRIEF DESCRIPTION OF THE DRAWING

[0009] Figure is a schematic of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0010] With the use of gas-to-liquid (GTL) technologies for the generation of C9-C16 range material, there is interest from various parties to produce linear alkylbenzenes (LAB) using GTL-based feed source. Current linear alkylbenzene manufacturing process uses kerosene based Pacol-derived C9-C16 material, which is typically a 9-15% mixture of olefins in paraffin. The alkylation of this paraffin/olefin mixture with benzene can be accomplished by solid-bed Detal catalyst. Current state-of-the-art Detal Plus technology using ZDA-2 alkylation catalyst optimizes the solid-bed alkylation technology by maximizing feedstock utilization and minimizing energy consumption. The use of GTL-based paraffin / olefin feedstock to produce commercial grade alkylbenzenes in the C9-C16 range allows to avoid dependence on crude-based feedstock and uses a feedstock that is natural-gas dependent.

[0011] In the process scheme, the GTL-based feedstock for alkylation is a mixture of olefins/paraffins. Alkylation of benzene by olefins is an exothermic process, and a higher concentration of olefins in the feed results in a higher exotherm. One method of controlling the exotherm is to recycle additional benzene, as an excess of benzene is used in the alkylation process. However, if only benzene is used, the resulting 2-phenyl content of the final LAB product will be found to be significantly lower than that required for a commercial LAB product.

[0012] Both linearity and 2-phenyl are significant properties in the linear alkylbenzene product. Linearity is responsible for the biodegradability of the surfactant, and should be maintained as high as possible, preferably above 90%. The linearity of the LAB is highly dependent on the effluent temperature of the alkylation reactor bed. A higher temperature is detrimental to the linearity and renders the LAB unacceptable for commercial application. 2-phenyl on the other hand determines the solubility and sulfonability of the alkylbenzene, and a precise control of 2-phenyl is required to maintain optimum product quality. 2-phenyl is

dependent on the molar ratio of benzene:olefin in the reactor, and a ratio that is higher or lower than the optimum can make the LAB quality unacceptable.

[0013] The present process provides for the formation of an alkylaryl compound, while controlling the exotherm. The process, as exemplified by the Figure, includes passing a stream 14 comprising an aromatic compound to an alkylation zone 10. A feedstream 12 comprising olefins and paraffins is passed to the alkylation zone 10, wherein the aromatic compound is alkylated over an alkylation catalyst, and a first process stream 16 is generated having alkylaryl compounds. The first process stream 16 is passed to a first fractionation unit 20 to generate a first fractionation stream 22 having unalkylated aromatic compounds. The fractionation unit 20 also generates a first bottoms stream 24 having alkylaryl compounds. The bottoms stream 24 is passed to a second fractionation unit 30 to generate a second overhead stream 32 having paraffins, and a second bottoms stream having alkylaryl compounds 34. The first fractionation stream 22 is returned to the alkylation zone 10. A fresh benzene stream 18 is supplied to make up for benzene consumed in the alkylation process. In one aspect of the process, a portion 36 of the second overhead stream 32 is passed to the alkylation zone 10.

[0014] The paraffins present in the process stream provide for moderating the heat rise in the reaction while remaining unreactive in the process. The aromatic compound to be alkylated can include benzene, toluene, ethylbenzene, and xylenes. A preferred aromatic compound is benzene. The alkylation zone 10 comprises one or more alkylation catalyst beds, and can be a fixed catalyst bed, or a moving bed system. For the alkylation process with fixed beds, a plurality of beds is desired, such that when one or more beds are on stream, at least one bed can be taken off-line to be regenerated.

[0015] In one embodiment, the first fractionation stream 22 is a side draw stream from the rectification section of the first fractionation unit 20. The first fractionation stream 22 can be a low purity aromatics stream generated by the first fractionation unit 20, and can include olefins and paraffins.

[0016] The feedstream 12 having olefins and paraffins can be a process stream generated by gas to liquids technology to utilize effluent streams generated from natural gas conversion processes, or from a syngas system, or a Fischer-Tropsch process.

[0017] In one embodiment, the process includes generating a high purity aromatics stream 26 from the first fractionation unit 20. The high purity aromatics stream 26 can be passed to an alkylation reactor 10b that is off-line for regeneration of the alkylation catalyst. The aromatics stream passing through the regenerated alkylation unit 10b produces a regeneration effluent stream. The regeneration effluent stream 42 is split into two portions: a first portion 44 and passed to the first fractionation column 20, and a second portion 46 and passed to a transalkylation reactor 40. The second bottoms stream 34 is passed to an LAB column 50 to generate an LAB overhead stream 52 and an LAB bottoms stream 54. A portion of the LAB bottoms stream 54 is passed to the transalkylation reactor 40. The LAB bottoms stream comprises heavies, wherein the heavies are dialkylated aromatic compounds and trialkylated aromatic compounds. The largest fraction of heavies will comprise dialkylbenzenes. The transalkylation reactor 40 will react the benzene, or aromatic compound, from the regenerated alkylation unit 10b with the dialkylbenzene from the heavies stream 54. The transalkylation reactor 40 generates an effluent stream 48 comprising mono-alkylaryl compounds. In particular, the mono-alkylaryl compounds are linear alkylbenzenes. The effluent stream 48 is passed to the first fractionation unit 20 for the recovery of LABs.

[0018] In the present process, the feedstream mixture 12 comprises a mixture of olefins and paraffins. The olefin content is in a range from 10 mass % to 30 mass %, and the paraffin content is in the range from 70 mass % to 90 mass %. A preferred mixture of olefins and paraffins in the feedstream includes an olefins content in the range from 20 mass % to 30 mass %, and paraffins in the range from 70 mass % to 80 mass %.

[0019] In one embodiment, the process includes splitting the feedstream into at least two portions. The alkylation zone 10 includes two or more alkylation beds. The feedstream is split into a first portion and a second portion. An aromatics stream and the first portion of the feedstream is passed to the first alkylation bed to generate a first alkylation bed effluent stream. The first alkylation bed effluent stream and the second portion of the feedstream is passed to the second alkylation bed to generate a second alkylation bed effluent stream, where the second alkylation bed effluent stream is the first process stream.

[0020] This process can include more beds, and a particular example includes a third alkylation bed. The second alkylation effluent stream is passed to the third alkylation bed to generate a third alkylation bed effluent stream, and where the third alkylation bed effluent

stream is the first process stream. With the third alkylation bed, an alternative arrangement includes splitting the feedstream into three portions, with the third portion fed to the third alkylation bed.

[0021] In another embodiment, the high purity benzene stream can be passed to the transalkylation reactor. The LAB bottoms stream comprising heavies is passed to the transalkylation reactor to generate the transalkylation reactor effluent stream. The transalkylation effluent stream is passed to the benzene column to start the process of separating and recovering the linear alkylbenzenes.

[0022] The current process uses a novel process flowscheme to control the product quality of the final LAB product in a detergent alkylation process. The proposed scheme uses a split-bed reactor design that is optimized for feedstock utilization and energy consumption, and adds a feature to this flowscheme to manage the exotherm by increasing the heat-capacity, while still maintaining the desired benzene:olefin ratio in the reactor. If only recycle benzene is used, the resulting 2-phenyl content of the final LAB product will be found to be significantly lower than solid-bed alkylation based commercial grade LAB. Instead of adding more recycle benzene to provide additional heat absorbing capacity, the proposed scheme recycles additional paraffin to lower the exotherm. As the paraffins are unreactive species in the alkylation reactor, the paraffins do not participate in the reaction mechanism. Also, the addition of paraffin allows the maintenance of benzene:olefin ratio in the reactor to obtain optimum product 2-phenyl.

[0023] While the invention has been described with what are presently considered the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but it is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

SPECIFIC EMBODIMENTS

[0024] While the following is described in conjunction with specific embodiments, it will be understood that this description is intended to illustrate and not limit the scope of the preceding description and the appended claims.

[0025] A first embodiment of the invention is a process for the formation of an alkylaryl compound, comprising passing an aromatic compound to an alkylation zone; passing a

feedstream comprising olefins and paraffins to the alkylation zone, to generate a first process stream comprising alkylaryl compounds; passing the first process stream to first fractionation unit to generate a first fractionation stream comprising the aromatic compound, and a first bottoms stream comprising alkylaryl compounds; passing the bottoms stream to a second fractionation unit to generate a second overhead comprising paraffins, and a second bottoms stream comprising alkylaryl compounds; passing the first fractionation stream to the alkylation zone; and passing a portion of the second overhead stream to the alkylation zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the aromatic compound is benzene. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the alkylation zone comprises a fixed catalyst bed comprising an alkylation catalyst. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the feedstream comprises an effluent from a gas to liquids technology. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the feedstream comprises an effluent from a syngas system or a Fischer-Tropsch system. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the first fractionation stream is a side stream from the rectification section of the first fractionation unit and comprises a low purity aromatics stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising generating an overhead stream from the first fractionation unit comprising a high purity aromatics stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising passing the high purity aromatics stream to an alkylation reactor in regeneration mode, thereby creating a regeneration effluent stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising splitting the regeneration effluent stream into a first portion and a second portion; passing the first portion to the first fractionation column; passing the second portion to a transalkylation reactor; passing the second bottoms stream from the second fractionation column to an LAB column to generate

an LAB overhead stream comprising LABs, and an LAB bottoms stream comprising heavies; and passing a portion of the LAB bottoms stream to the transalkylation reactor to create a transalkylation effluent stream comprising mono-alkylaromatic compounds. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising passing the transalkylation effluent stream to the first fractionation column. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the feedstream mixture comprises olefins in the range from 10 mass % to 30 mass % and paraffins in the range from 70 mass % to 90 mass %. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the feedstream mixture comprises olefins in the range from 20 mass % to 30 mass % and paraffins in the range from 70 mass % to 80 mass %. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the first fractionation stream is an overhead stream comprising low purity aromatics, and further comprising passing the overhead stream to the alkylation zone. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph wherein the alkylation zone comprises at least two alkylation beds, a first alkylation bed and a second alkylation bed, and the process further comprises splitting the feedstream into a first portion and a second portion; passing the aromatics stream to the first alkylation zone; passing the first portion of the feedstream to the first alkylation bed to generate a first alkylation bed effluent stream; passing the second portion of the feedstream to the second alkylation bed; passing the first alkylation bed effluent stream to the second alkylation bed, creating the first process stream. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the first embodiment in this paragraph further comprising a third alkylation bed, wherein the effluent stream from the second alkylation bed is passed to the third alkylation bed, and wherein the effluent from the third alkylation bed is the first process stream.

[0026] A second embodiment of the invention is a process for the formation of an alkylbenzene, comprising splitting a feedstream comprising olefins and paraffins into at least two portions, comprising a first portion and a second portion; passing the first portion to a first alkylation reactor bed; passing a benzene feedstream to the first alkylation bed, to

generate a first alkylation reactor effluent stream; passing the second portion of the feedstream to a second alkylation reactor bed; passing the first alkylation reactor effluent stream to the second alkylation reactor bed to generate a second alkylation reactor effluent stream; passing the second reactor effluent stream to a benzene column to generate a high purity benzene stream, a low purity benzene stream and a benzene column bottoms stream comprising alkylbenzenes; passing the benzene column bottoms stream to a paraffin column to generate a bottoms stream comprising alkylbenzenes, and a paraffin overhead stream comprising paraffins; and passing a portion of the paraffin overhead stream to the first alkylation reactor bed. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the feedstream comprises between 20% and 30% by weight olefins and between 70% and 80% by weight paraffins. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising passing the bottoms stream comprising alkylbenzenes to an LAB column to generate an LAB overhead stream comprising LABs, and an LAB bottoms stream comprising heavies; and passing the LAB bottoms stream to a transalkylation reactor; passing the high purity benzene stream to the transalkylation reactor to generate a transalkylation reactor effluent stream; and passing the transalkylation reactor effluent stream to the benzene column. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph further comprising passing the high purity benzene stream to an alkylation reactor in regeneration mode, thereby creating a regeneration effluent stream; passing the regeneration effluent stream to a transalkylation reactor; passing the bottoms stream comprising alkylbenzenes to an LAB column to generate an LAB overhead stream comprising LABs, and an LAB bottoms stream comprising heavies; passing the LAB bottoms stream to the transalkylation reactor, to create a transalkylation effluent stream; and passing the transalkylation reactor effluent stream to the benzene column. An embodiment of the invention is one, any or all of prior embodiments in this paragraph up through the second embodiment in this paragraph wherein the feedstream comprises an effluent stream from a gas to liquids technology.

[0027] Without further elaboration, it is believed that using the preceding description that one skilled in the art can utilize the present invention to its fullest extent and easily ascertain

the essential characteristics of this invention, without departing from the spirit and scope thereof, to make various changes and modifications of the invention and to adapt it to various usages and conditions. The preceding preferred specific embodiments are, therefore, to be construed as merely illustrative, and not limiting the remainder of the disclosure in any way whatsoever, and that it is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims.

[0028] In the foregoing, all temperatures are set forth in degrees Celsius and, all parts and percentages are by weight, unless otherwise indicated.

CLAIMS:

1. A process for the formation of an alkylaryl compound, comprising:
 - passing an aromatic compound to an alkylation zone;
 - passing a feedstream comprising olefins and paraffins to the alkylation zone, to generate a first process stream comprising alkylaryl compounds;
 - passing the first process stream to first fractionation unit to generate a first fractionation stream comprising the aromatic compound, and a first bottoms stream comprising alkylaryl compounds;
 - passing the bottoms stream to a second fractionation unit to generate a second overhead comprising paraffins, and a second bottoms stream comprising alkylaryl compounds;
 - passing the first fractionation stream to the alkylation zone; and
 - passing a portion of the second overhead stream to the alkylation zone.
2. The process of claim 1 wherein the aromatic compound is benzene.
3. The process of claim 1 wherein the alkylation zone comprises a fixed catalyst bed comprising an alkylation catalyst.
4. The process of claim 1 wherein the first fractionation stream is a side stream from the rectification section of the first fractionation unit and comprises a low purity aromatics stream.
5. The process of claim 1 further comprising generating an overhead stream from the first fractionation unit comprising a high purity aromatics stream.
6. The process of claim 5 further comprising passing the high purity aromatics stream to an alkylation reactor in regeneration mode, thereby creating a regeneration effluent stream.

7. The process of claim 6 further comprising:

- splitting the regeneration effluent stream into a first portion and a second portion;
- passing the first portion to the first fractionation column;
- passing the second portion to a transalkylation reactor;
- passing the second bottoms stream from the second fractionation column to an LAB column to generate an LAB overhead stream comprising LABs, and an LAB bottoms stream comprising heavies; and
- passing a portion of the LAB bottoms stream to the transalkylation reactor to create a transalkylation effluent stream comprising mono-alkylaromatic compounds.

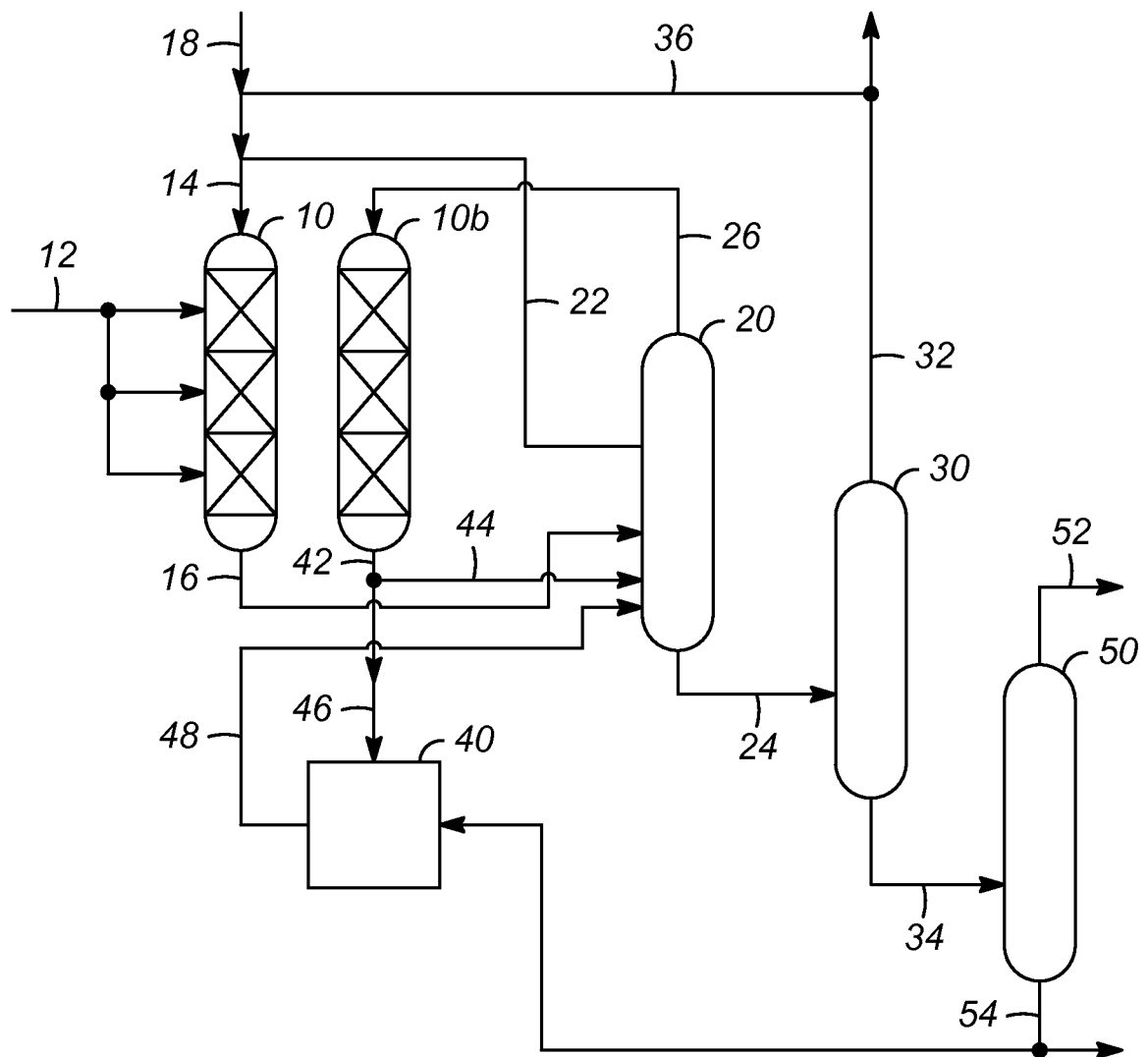
8. The process of claim 1 wherein the feedstream mixture comprises olefins in the range from 10 mass % to 30 mass % and paraffins in the range from 70 mass % to 90 mass %.

9. The process of claim 1 wherein the first fractionation stream is an overhead stream comprising low purity aromatics, and further comprising passing the overhead stream to the alkylation zone.

10. The process of claim 1 wherein the alkylation zone comprises at least two alkylation beds, a first alkylation bed and a second alkylation bed, and the process further comprises:

- splitting the feedstream into a first portion and a second portion;
- passing the aromatics stream to the first alkylation zone;
- passing the first portion of the feedstream to the first alkylation bed to generate a first alkylation bed effluent stream;
- passing the second portion of the feedstream to the second alkylation bed;
- passing the first alkylation bed effluent stream to the second alkylation bed, creating the first process stream.

1/1



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/032970**A. CLASSIFICATION OF SUBJECT MATTER****C07C 2/66(2006.01)i, C07C 15/107(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C07C 2/66; C07C 309/24; C07C 15/107; C07C 2/64; C11D 17/08; C09D 9/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords:alkylaryl, alkylation, olefin, paraffin, alkylation catalyst, aromatics stream, alkylbenzene

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 03-082782 A1 (EXXONMOBIL CHEMICAL PATENTS, INC. et al.) 09 October 2003 See abstract and claims 1-31.	1-10
A	US 2006-0241328 A1 (STEINBRENNER, ULRICH et al.) 26 October 2006 See abstract and claims 12-22.	1-10
A	US 2007-0078075 A1 (BOTKE, NILS et al.) 05 April 2007 See abstract and claims 12-20.	1-10
A	US 2007-0142258 A1 (STEINBRENNER, ULRICH et al.) 21 June 2007 See abstract and claims 1-10.	1-10



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 July 2014 (29.07.2014)

Date of mailing of the international search report

29 July 2014 (29.07.2014)

Name and mailing address of the ISA/KR

International Application Division
Korean Intellectual Property Office
189 Cheongsu-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

Jung, Da Won

Telephone No. +82-42-481-8491



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/032970

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 03-082782 A1	09/10/2003	AU 2003-218440 A1	13/10/2003
		CA 2478161 A1	09/10/2003
		CN 100457696 C0	04/02/2009
		CN 101468961 A	01/07/2009
		EP 1490314 A1	29/12/2004
		KR 10-0965981 B1	24/06/2010
		US 2005-0165264 A1	28/07/2005
		US 2010-0022802 A1	28/01/2010
		US 7622621 B2	24/11/2009
		US 8183420 B2	22/05/2012
		WO 0308-2782A1	09/10/2003
US 2006-0241328 A1	26/10/2006	AT 399747 T	15/07/2008
		AU 2004-230225 A1	28/10/2004
		BR PI0409375 A	25/04/2006
		BR PI0409375 B1	20/05/2014
		CA 2522330 A1	28/10/2004
		CN 1325445 C	11/07/2007
		CN 1774408 A	17/05/2006
		DE 10317294 A1	28/10/2004
		DE 502004007490 D1	14/08/2008
		EP 1615864 A2	18/01/2006
		EP 1615864 B1	02/07/2008
		ES 2307008 T3	16/11/2008
		JP 2006-523643 A	19/10/2006
		KR 20060010749 A	02/02/2006
		RU 2005134985 A	27/06/2006
		RU 2308444 C2	20/10/2007
		US 7652183 B2	26/01/2010
		WO 2004-092096 A2	28/10/2004
		WO 2004-092096 A3	25/11/2004
		ZA 200508329 A	31/01/2007
US 2007-0078075 A1	05/04/2007	BR PI0415901A	16/01/2007
		CA 2543744 A1	12/05/2005
		CN 1874978 A	06/12/2006
		CN 1874978 C0	17/12/2008
		DE 10350333 A1	25/05/2005
		EP 1682467 A1	26/07/2006
		JP 2007-533649 A	22/11/2007
		KR 20060133982 A	27/12/2006
		MY 140598 A	31/12/2009
		RU 2006118263 A	10/12/2007
		RU 2344114 C2	20/01/2009
		SG 147467 A1	28/11/2008
		US 7601861 B2	13/10/2009
		WO 2005-042448 A1	12/05/2005
		ZA 200603279 A	26/09/2007

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/032970

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007-0142258 A1	21/06/2007	BR PI0417365 A	10/04/2007
		CA 2544867 A1	07/07/2005
		CN 1997611 A	11/07/2007
		DE 10360026 A1	21/07/2005
		EP 1697314 A2	06/09/2006
		KR 20060134966 A	28/12/2006
		MY 136695 A	28/11/2008
		WO 2005-061447 A2	07/07/2005
		WO 2005-061447 A3	04/01/2007
		ZA 200604943 A	27/12/2007