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(54) Title: IONIC LIQUID COMPOUND BASED TRANSALKYLATION PROCESS

(57) **Abstract:** The present disclosure relates to a transalkylation process for conversion of heavy aromatic compounds to light alkyl aromatic compound using liquid salt, such as but not limiting to ionic liquid compound. In another embodiment, the ionic liquid compound is an amine and metal salt based ionic liquid compound. The instant disclosure also relates a system for the transalkylation process in the presence of the ionic liquid compound.



“IONIC LIQUID COMPOUND BASED TRANSALKYLATION PROCESS”**TECHNICAL FIELD**

[001] The present disclosure relates to organic chemistry in general. Particularly, the present disclosure relates to a transalkylation process for converting heavy aromatic compounds to light alkyl aromatic compounds in the presence of salt such as liquid salt including but not limited to ionic liquid compound. In an embodiment, the ionic liquid compound for transalkylation process is amine and metal salt based ionic liquid compound. The present disclosure further relates to a system for carrying out the transalkylation process in the presence of the ionic liquid compound.

BACKGROUND AND PRIOR ARTS OF THE DISCLOSURE

[002] Alkylation of aromatics with olefins produces alkyl aromatics that have various commercial applications e.g., benzene with olefins of 8 to 15 carbon atoms produce linear alkyl benzenes which can be sulphonated to produce detergents. During alkylation process, various side reactions will take place leading to the formation of dialkylaromatics, oligomers of olefins (referred to as heavier's) which have very low commercial value as compared to the lighter alkyl aromatics. Use of excess reactant helps in minimizing the heavier's but they cannot be eliminated. Further, the catalysts currently used are not selective and other reactions of olefins will occur to produce heavier's, i.e., dimers and dialkylaryl compounds. Also skeletal isomerization of the olefin will occur, resulting in a loss of selectivity to the alkylbenzene. A process called Transalkylation is adapted to convert the heavier's back to alkyl aromatics. However, the transalkylation process in the prior arts for the conversion of heavier's to lighter aromatic compound uses solid aromatic compound, which has its own limitation towards the transalkylation process.

[003] United States Patent No. 2222632 discloses a clay comprising of alumina and silica for transalkylation of poly aromatics. United States Patent No. 3385906 describes a process for transalkylating benzene and diisopropylbenzene to make Cumene in the presence of a zeolite molecular sieve catalyst wherein not more than 90% of aluminium atoms in the zeolite are associated with monovalent cations.

[004] United States Patent No. 3410921 describes transalkylating a polyalkylated aromatic compound by reacting the compound in admixture with hydrogen, with an alkylatable aromatic compound in contact with a catalyst comprising an active catalytic component, preferably a group VIII metal, on an aluminium support having
5 suspended therein less than about 20wt% of a finely divided crystalline aluminosilicate under transalkylation conditions. The transalkylation reaction is carried out at 250°C - 700°C and 1atm -200 atm pressure and the hydrogen to hydrocarbon mole ratio is 2:1 to 20:1.

[005] United States Patent Nos. 3751504 and 3571506 show transalkylation and
10 alkylation in the vapour phase over ZSM-5 type zeolite catalysts. ZSM-5 is a medium pore size zeolite having an effective pore size between 5Å° and 6Å°. United States Patent Nos. 3769360, 3776971, 3778415, 3843739 and 4459426 relate to methods for combining alkylation and transalkylation to obtain improved yields of monoalkylated aromatics. Rare earth exchanged Y and steam stabilized Y zeolites are cited in these
15 patents as being particularly effective catalysts.

[006] United States Patent No. 4891458 describes a process for the alkylation or transalkylation of an aromatic hydrocarbon which comprises contacting the aromatic hydrocarbon with C2 to C4 olefin alkylating agent or a polyalkylaromatic hydrocarbon transalkylating agent under at least partial liquid phase conditions and in the presence
20 of a catalyst comprising zeolite beta.

[007] United States Patent No. 5157180 discloses a process for producing alkylated organic compound via alkylation and /or transalkylation in the presence of a molecular sieve catalyst. The catalyst comprises of a molecular sieve having alkylation and/or transalkylation activity and contains 250 -20000 ppm of ammonium ions calculated as
25 (NH₄)₂O on a volatiles free basis.

[008] Similarly several United States patent Nos. 4599470, 4885426, 7414163, 7456124, 7626064, 7642389, 8148592 and European patent Nos. EP0358792, EP1358141, EP1572838 have reported various zeolite catalysts for transalkylation reactions.

[009] However, these catalysts described in the prior art for the transalkylation process
30 reported so far suffers certain disadvantages such as higher operating conditions,

catalyst instability with feed stock and higher regeneration cost, thereby increasing the operating cost and making the transalkylation process of the prior arts uneconomical

[010] Thus the present disclosure aims to overcome the limitations in the transalkylation reaction by the means as described herein in the description below.

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SUMMARY OF THE DISCLOSURE

[011] Accordingly, the present disclosure relates to a process for converting heavy aromatic compound to light alkyl aromatic compound, said process comprising a step

10 of contacting a mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound with ionic liquid compound of formula $I-[(NR_1R_2R_3)_iM_1]^{n+}[(M_2Y_k)_LX_j]^{n-}$

wherein

$NR_1R_2R_3$ is amine;

15 R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein $R_1=R_2=R_3$ or $R_1=R_2\neq R_3$ or $R_1=R_3\neq R_2$ or $R_3=R_2\neq R_1$;

M_1 and M_2 are independently metals selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any

20 combinations thereof;

X and Y are independently selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combination thereof;

'n' is an integer ranging from about 1 to 4;

25 'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

$M_1 = M_2$ or $M_1 \neq M_2$, and

30 $X = Y$ or $X \neq Y$.

to obtain the light alkyl aromatic compound.

[012] In another embodiment, the present disclosure relates to a system for transalkylation process for converting a heavy aromatic compound to light alkyl aromatic compound, said system comprises:

- a) at least one mixer adapted to independently receive mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I--

$$[(NR_1R_2R_3)_iM_1]^{n+}[(M_2Y_k)_LX_j]^{n-};$$

wherein

$NR_1R_2R_3$ is amine:

R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein $R_1=R_2=R_3$ or $R_1=R_2 \neq R_3$ or $R_1=R_3 \neq R_2$ or $R_3=R_2 \neq R_1$;

M_1 and M_2 are independently metal selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any combinations thereof;

X or Y is selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combinations thereof;

'n' is an integer ranging from about 1 to 4;

'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

$M_1 = M_2$ or $M_1 \neq M_2$, and

$X = Y$ or $X \neq Y$.

and wherein the mixer is adapted to convert the heavy aromatic compound to the light alkyl aromatic compound in presence of ionic liquid compound of formula I

- b) at least one settler unit fluidly connected to at least one mixer, wherein the settler unit is adapted to receive at least one of the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the ionic liquid compound of formula I and the light alkyl aromatic

compound from the mixer, and wherein the settler unit is adapted to separate at least one of light alkyl aromatic compound, ionic liquid compound of formula I, heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound;

c) at least one purifier fluidly connected to at least one of the settler unit, the purifier is adapted to receive at least one of the light alkyl aromatic compound, the ionic liquid compound of formula I, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and alkali solution and wherein the purifier is adapted to purify the light alkyl aromatic compound;

d) at least one fractionating column adapted to receive at least one of the light alkyl aromatic compound, the heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I from at least one settler unit and wherein the fractionating column is adapted to separate at least one of the light alkyl aromatic compound, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I and paraffin; and

e) at least one catalyst recovery unit adapted to receive at least one of the ionic liquid compound of formula I, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the light alkyl aromatic compound, independently from at least one of the settler unit and at least one of the fractionating column and wherein the catalyst recovery unit is adapted to regenerate the ionic liquid compound of formula I.

BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURE

[013] In order that the disclosure may be readily understood and put into practical effect, reference will now be made to exemplary embodiments as illustrated with reference to the accompanying figure. The figure(s) incorporated herein form part of the specification, and serve to further illustrate the embodiments and explain various principles and advantages, in accordance with the present disclosure:

[014] **Figure 1** illustrates system of the present disclosure employed for carrying out transalkylation process of the present disclosure.

DETAILED DESCRIPTION

[015] The present disclosure relates to transalkylation process for conversion of heavy aromatic compounds to light alkyl aromatic compounds, using salt such as liquid salt including but not limited to ionic liquid compound.

[016] In another embodiment, the heavy aromatic compound is a heavy alkyl aromatic compound, wherein the alkyl group comprises carbon atom ranging from about 3 to 50.

[017] In another embodiment, the ionic liquid compound employed in the transalkylation process of the present disclosure comprises at least one electron-pair acceptor and at least one electron-pair donor.

[018] In a non-limiting embodiment, the electron-pair acceptor of the ionic liquid compound includes but is not limited to a Lewis acid and the electron-pair donor of the ionic liquid compound includes but is not limited to a Lewis base.

[019] In a non-limiting embodiment, the Lewis acid of the ionic liquid compound for the transalkylation process of the present disclosure, is a salt of cation selected from a group comprising Aluminium (Al^{3+}), Magnesium (Mg^{2+}), Calcium (Ca^{2+}), Chromium ($\text{Cr}^{2+}/\text{Cr}^{3+}$), Manganese ($\text{Mn}^{2+}/\text{Mn}^{3+}$), Iron ($\text{Fe}^{2+}/\text{Fe}^{3+}$), Cobalt ($\text{Co}^{2+}/\text{Co}^{3+}$), Nickel (Ni^{2+}), Copper ($\text{Cu}^+/\text{Cu}^{2+}$), Zinc (Zn^{2+}), Gallium (Ga^{3+}), Germanium (Ge^{4+}), Indium (In^{3+}), Tin ($\text{Sn}^{2+}/\text{Sn}^{4+}$), Titanium ($\text{Ti}^{2+}/\text{Ti}^{3+}$), Lead (Pb^{2+}), Cadmium (Cd^{2+}) and Mercury (Hg^{2+}), or any combination thereof.

[020] In an embodiment, the Lewis acid of the ionic liquid compound for the transalkylation process of the present disclosure is complexed with an alkyl amine.

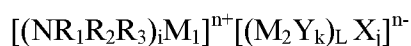
[021] In another non-limiting embodiment, the Lewis base or anion of the ionic liquid compound for transalkylation process of the present disclosure is selected from a group comprising halide ion, Sulphate (SO_4^-), Sulphonate (HSO_3^-), Nitrate (NO_3^-), Carbonate (CO_3^{2-}), Phosphonate ($\text{C-PO}(\text{OH})_2$), Citrate ($\text{C}_6\text{H}_5\text{O}_7^{3-}$), Cyanide ion (CN^-), Nitrite (NO_2^-), Phosphate (PO_4^{3-}), and Acetate ($\text{C}_2\text{H}_3\text{O}_2^-$), or any combinations thereof.

[022] In an exemplary embodiment, the halide ion of the ionic liquid compound for transalkylation process of the present disclosure is selected from a group comprising fluoride (F^-), chloride (Cl^-), bromide (Br^-), iodide (I^-) and astatide (At^-), or any combination thereof.

[023] In an exemplary embodiment, the ionic liquid compound for the transalkylation process comprises metal selected from a group comprising Aluminium (Al), Iron (Fe), Zinc (Zn), Manganese (Mn), Magnesium (Mg), Titanium (Ti), Tin (Sn), Palladium (Pd), Platinum (Pt), Rhodium (Rh), Copper (Cu), Chromium (Cr), Cobalt (Co), Cerium (Ce), Nickel (Ni), Gallium (Ga), Indium (In), Antimony (Sb) and Zirconium (Zr) or any combinations thereof, wherein the metal of the ionic liquid compound is complexed with alkyl amine.

[024] In a preferred embodiment, the ionic liquid compound is an amine and metal salt based ionic liquid compound.

[025] In an embodiment of the present disclosure, the ionic liquid compound for the transalkylation process of the present disclosure is represented by Formula I



wherein;

$NR_1R_2R_3$ is amine;

R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein

$R_1=R_2=R_3$ or $R_1=R_2 \neq R_3$ or $R_1=R_3 \neq R_2$ or $R_3=R_2 \neq R_1$;

M_1 and M_2 are independently metals selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any combinations thereof;

X and Y are independently selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combination thereof;

'n' is an integer ranging from about 1 to 4;

'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

$M_1 = M_2$ or $M_1 \neq M_2$, and

$X = Y$ or $X \neq Y$.

[026] In a preferred embodiment, the ionic liquid compound for the transalkylation process of the present disclosure is $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^-]_3$.

[027] In an exemplary embodiment, the ionic liquid compound for the transalkylation process of the present disclosure is a pure substance (form).

[028] In an alternate embodiment, the ionic liquid compound for the transalkylation of the present disclosure is mixed with an organic compound or inorganic compound to lower its viscosity by the formation of an Ionic liquid compound complex with organic compound or inorganic compound, wherein the organic compound is an aromatic compound or aliphatic compound. In an exemplary embodiment, the aromatic compound is selected from a group comprising benzene and toluene, or a combination thereof.

[029] In an exemplary embodiment, the process of transalkylation of the present disclosure for converting heavy aromatic compound to light alkyl aromatic compound or hydrocarbon layer comprises step of:

(a) contacting mixture comprising heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound with ionic liquid compound of formula I to obtain hydrocarbon layer or light alkyl aromatic compound;

[030] In a non-limiting embodiment, the light alkyl aromatic compound or hydrocarbon layer is deacidified followed by distilling to remove components comprising unreacted alkylated products.

[031] In a non-limiting embodiment, the transalkylation process comprises the step of recycling the ionic liquid of formula I after obtaining the light alkyl aromatic compound.

[032] In a non-limiting embodiment, the heavy alkyl aromatic compound of the mixture is alkyl benzene wherein the alkyl group comprises carbon atom ranging from about 3 to 50; and wherein the unsubstituted aromatic compound of the mixture is selected

from a group comprising benzene and methyl substituted aromatic compound is selected from a group comprising toluene.

[033] In a non-limiting embodiment, the heavy alkyl aromatic compound comprises benzene attached to alkyl group having carbon atom ranging from about 3 to 50, wherein the heavy alkyl aromatic compound is selected from a group comprising 1,4-didecylbenzene, 1,4-dodidecyl benzene and trimethyl benzene, or any combination thereof. In another non-limiting embodiment, the light alkyl aromatic compound is selected from a group comprising benzene attached to alkyl group containing carbon atoms ranging from about 1 to 14.

[034] In an exemplary embodiment, the heavy alkyl aromatic compound 1,4-dodidecyl benzene undergoes trans-alkylation process as per the present disclosure with benzene to produce light alkyl alkyl aromatic compound 1,4-decyl benzene. Similarly tri methyl benzene undergoes trans-alkylation process as per the present disclosure with benzene to produce toluene or diethyl benzene.

[035] In an exemplary embodiment, if the heavy alkyl aromatic compound is 1,4-dodidecyl benzene (benzene with C-24) upon undergoing the transalkylation as described in the instant invention, it forms 1-dodecyl benzene (benzene with C-12), which is considered as light aromatic compound. On the other hand, if tri-methyl benzene undergoes transalkylation as described in the instant invention, it forms dimethyl benzene or methyl benzene (benzene with C-2 or C-1). In this case tri-methyl benzene is the heavier aromatic compound and dimethyl benzene is the light aromatic compound. Therefore, the heavy aromatic alkyl aromatic compound comprises alkyl group having carbon atoms ranging from about 3 to 50 and lighter aromatic compound comprises alkyl group having carbon atoms ranging from about 1 to 14.

[036] In a non-limiting embodiment, the mixture of heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I during the transalkylation process is contacted in a reactor such as but not limited to transalkylation reactor for the conversion of the heavy alkyl aromatic compound to light alkyl aromatic compound, followed by allowing the components of the conversion to settle to obtain light alkyl aromatic

compound or hydrocarbon layer. The heavier alkyl aromatic compound consists of mostly benzene attached to alkyl having carbon C-20 or more.

[037] In a non-limiting embodiment, molar ratio of the unsubstituted aromatic compound or methyl substituted aromatic compound to the heavy alkyl aromatic compound in the mixture is ranging from about 1:1 to 20:1, preferably the molar ratio of the unsubstituted aromatic compound or methyl substituted aromatic compound to the heavy alkyl aromatic compound is ranging from about 2:1 to 8:1.

[038] In a non-limiting embodiment, the mixture comprising heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound is contacted with pure form (pure substance) of ionic liquid compound of formula I.

[039] In an alternate embodiment, the mixture comprising heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound is contacted with mixed form of ionic liquid compound of formula I, wherein the mixed form of ionic liquid compound of formula I refers to ionic liquid compound of formula I mixed with benzene or toluene to lower the viscosity of the ionic liquid compound of formula I.

[040] In another alternate embodiment, the mixture comprising heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound is contacted with recycled form of ionic liquid compound of formula I, wherein the recycled form of ionic liquid compound of formula I refers to ionic liquid compound of formula I obtained after regeneration, post conversion of heavy alkyl aromatic compound to light alkyl aromatic compound.

[041] In a non-limiting embodiment, the mixture comprising heavy alkyl aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound is contacted with ionic liquid compound of formula I at a temperature ranging from about 5°C to 170°C, preferably at a temperature ranging from about 50°C to 150°C and at a pressure ranging from about 1 atmosphere to 50 atmosphere, preferably at a pressure ranging from about 1 atmosphere to 10 atmosphere.

[042] In another non-limiting embodiment, the volume ratio of the ionic liquid compound of formula I to the mixture comprising heavy alkyl aromatic compound and

unsubstituted aromatic compound or methyl substituted aromatic compound, is 0.01 to 1.5.

[043] In a non-limiting embodiment, the deacidification during the process of transalkylation is carried out using techniques including but not limited to washing with aqueous solution such as alkali solution including but not limited to sodium hydroxide (NaOH), calcium hydroxide (Ca(OH)₂) and potassium hydroxide (KOH), centrifugation, alumina treatment, and acid stripping.

[044] In a non-limiting embodiment, the volume ratio of alkali solution to the light alkyl aromatic compound is 0.2 to 1 and concentration of alkali in the solution is ranging from about 2% to 50%.

[045] In an exemplary embodiment, the ionic liquid compound of formula I after the conversion of heavy aromatic compound to light alkyl aromatic compound is either recycled as such or recycled after regeneration.

[046] In a non-limiting embodiment, the transalkylation process of the present disclosure in the presence of ionic liquid compound of formula I lead to about 50% to 60% conversion of heavy aromatic compound including but not limiting to heavy alkyl benzene, wherein the alkyl group comprises about 3 to 50 carbon atoms.

[047] In an embodiment, the present disclosure further relates to a system for transalkylation process in the presence of the ionic liquid compound of formula I.

[048] In a non-limiting embodiment, the system for transalkylation process in the presence of the ionic liquid compound of formula I comprises:

- a) at least one mixer adapted to independently receive mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid of compound of formula I; wherein the mixer is adapted to convert heavy aromatic compound to light alkyl aromatic compound;
- b) at least one settler unit fluidly connected to at least one mixer, the settler unit is adapted to receive at least one of the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I and the light alkyl aromatic compound, and wherein the settler unit is adapted to separate at least one of

light alkyl aromatic compound, ionic liquid compound of formula I, heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound;

5 c) at least one purifier fluidly connected to at least one of the settler unit, the purifier is adapted to receive at least one of the light alkyl aromatic compound, ionic liquid compound of formula I, heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound and alkali solution and wherein the purifier is adapted to purify the light alkyl aromatic compound;

10 d) at least one fractionating column adapted to receive at least one of the light alkyl aromatic compound, the heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I from at least one settler unit and wherein the fractionating column is adapted to separate at least one of the light alkyl aromatic compound, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I ; and

15 e) at least one catalyst recovery unit adapted to receive at least one of the ionic liquid compound of formula I, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the light alkyl aromatic compound, independently from at least one of the settler unit and at least one of the fractionating column; wherein the catalyst recovery unit is adapted to regenerate the ionic liquid compound of formula I.

20 [049] In an exemplary embodiment, figure 1 illustrates the system (100) for transalkylation process for converting heavy aromatic compounds to light alkyl aromatic compounds in the presence of ionic liquid compound of formula I.

25 [050] In a non-limiting embodiment, the system (100) for the transalkylation process in the presence of ionic liquid compound of formula I is operated in a mode selected from a group comprising batch mode semi-continuous mode and continuous mode, or any combination thereof.

[051] In an embodiment, the system (100) comprises one or more mixers M1, M2, M3...Mn (collectively referred as M) configured to carry out transalkylation process between the heavy alkyl aromatic compound and the unsubstituted aromatic compound or the methyl substituted aromatic compound, in the presence of the ionic liquid compound of formula I; one or more settler units S1, S2, S3...Sn (collectively referred as S) which are fluidly connected to one or more mixers (M). The settler units (S) are configured to receive at least one of the heavy alkyl aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I and the light alkyl aromatic compound from the one or more mixers (M), and are adapted to carry out layer separation of at least one of the heavy alkyl aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I and the light alkyl aromatic compound. The system (100) also includes a purifier (PU) fluidly connected to the one or more settlers (S), and is configured to receive separated layer comprising the light alkyl aromatic compound from the one or more settlers (S). The purifier (PR) is adapted to purify the light alkyl aromatic compound. Further, the purified light alkyl aromatic compound from the purifier (PR) is fed back to the one or more settler unit (S) for further layer separation. The system (100) also comprises one or more fractionating columns D1, D2, D3...Dn (collectively referred as D) fluidly connected to the one or more settlers units (S) for receiving further the separated layer comprising light alkyl aromatic compound from the one or more settler (S). The one or more fractionating columns (D) are configured to further separate the light alkyl aromatic compounds and recycle at least one of the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the ionic liquid compound of formula I, use to the one or more mixers (M). Further, a catalytic recovery unit (CRU) is provided in the system (100), and is fluidly connected to one or more settler units (S) for recovering or regenerating ionic liquid compound of formula I after layer separation, and recycle the ionic liquid compound of formula I to the one or more mixers (M).

[052] In a non-limiting embodiment of the present disclosure, the system (100) comprises first mixer (M1), second mixer (M2) and third mixer (M3). In an

embodiment, the mixers M1, M2 and M3 are selected from a group comprising stirred vessel, plug flow reactor, static mixer, jet mixer and pump mixer, or any combination thereof. The system also comprises a first settler unit (S1), a second settler unit (S2) and a third settler unit (S3). In an embodiment, the settler units S1, S2 and S3 is a settling vessel such as but not limited to gravity settling vessel, arranged either horizontally or vertically, comprising single step settling or multi-step settling with a series of settlers arranged inside the settler units, either horizontally or vertically.

[053] In a non-limiting embodiment, the purifier (PR) of the system is selected from a group comprising vessel such as stirred vessel, a separator such as centrifuge separator a column packed with alumina, an evaporator, and an acid stripper. In an exemplary embodiment, the purifier of the system removes acid traces from the light alkyl aromatic compound.

[054] In an exemplary embodiment the working of the system (100) for transalkylation process employing the ionic liquid compound of formula I comprises following steps: Initially, the reaction raw material is prepared by mixing an unsubstituted aromatic compound such as but not limited to benzene; and heavy aromatic compound such as but not limited to heavy alkyl benzene (HAB) coming from lines 1 and 2, respectively to obtain pre-mixed feed. The pre-mixed feed is then fed to first mixer (M1) where pure form/ mixed form /recycled/regenerated ionic liquid compound of formula I is added via line 3. The first mixer (M1) is maintained at a temperature ranging from about 30°C to 150°C and maintained at a pressure ranging from about 1 atmosphere to 20 atmosphere . The molar ratio of unsubstituted aromatic compound to heavy alkyl aromatic compound is ranging from about 2:1 to 8:1. The volume ratio of the ionic liquid compound of formula I to the mixture comprising heavy aromatic compound and unsubstituted aromatic compound is 0.01 to 1.5, preferably the volume ratio is 0.03 to 0.5. The conversion of heavy aromatic compound to light alkyl aromatic compound in the presence of ionic liquid compound of formula I takes place in the first mixer (M1). The outlet of the first mixer (M1) is directly fed into second mixer (M2) where further conversion of heavy aromatic compound to light alkyl aromatic compound in the presence of ionic liquid compound of formula I takes place. In one embodiment, the temperature and pressure conditions in the second mixer (M2) are

same as the first mixer (M1). In alternate embodiment the temperature of the second mixer is ranging from about 5°C to 170°C, preferably ranging from about 50°C to 150°C. The outlet from the second mixer (M2) is fed into first settler unit (S1) where the light alkyl aromatic compound and the ionic liquid compound of formula I layer are separated. The heavier catalyst layer which is denser than the light alkyl aromatic compound, from first settler unit (S1) via line 4 is recycled to at least one of first mixer (M1), and the third mixer (M3) through catalyst recovery unit (CRU). The upper layer from the settler unit (S1) comprises the light alkyl aromatic compound which is fed to third mixer (M3) via line 5 where pure form/ mixed form/recycled/regenerated ionic liquid compound of formula I is added via line 3. The outlet from the third mixer (M3) is fed into second settler unit (S2) where the light alkyl aromatic compound layer and the ionic liquid compound of formula I are separated. The heavier catalyst layer which is denser than the light alkyl aromatic compound, from the second settler unit (S2) via line 6 is recycled to at least one of the first mixer (M1) and the third mixer (M3) through catalytic regeneration unit (CRU). The upper light alkyl aromatic compound layer from settler unit (S2) is fed to purifier (PR) via line 7, where the light alkyl aromatic compound is washed with alkali solution such as but not limiting to sodium hydroxide (NaOH) via line 8; or directly centrifuged without addition of alkali solution to remove trace acid content in the light alkyl aromatic compound. The volume ratio of alkali solution to the light alkyl aromatic compound is 0.2 to 1 and the concentration of alkali in the solution is ranging from about 2% to 50%, preferably about 5% to 20%. In an alternate embodiment, the purifier (PR) is a packed column filled with alumina to remove acidic traces in the light alkyl aromatic compound. The outlet from (PR) is directly fed to third settler unit (S3) where further separation of light alkyl aromatic compound occurs. In case of alkali solution wash, the bottom layer in the settler unit (S) is the layer of alkali solution, which is sent for effluent treatment plant (ETP) via line 9 while in case of centrifugation or crystallization is performed in the purifier (PR), the bottom layer is ionic liquid compound of formula I which is fed to catalyst recovery unit (CRU) via line 9. The upper layer comprising the light alkyl aromatic compound from third settler unit (S3) is fed to first fractionating column (D1) via line 10 where the unsubstituted aromatic compound such as benzene is distilled off

and recycled to line 1 via line 11. The residue of first fractionating column (D1) is fed to second fractionating column (D2) via line 12 to remove and recover light alkyl aromatic compound via line 13. The residue of second fractionating column (D2) is fed to third fractionating column (D3) via line 14 to separate light alkyl aromatic compound such as linear alkyl benzene product by line 15 and unreacted heavy alkyl aromatic compound by line 16 is recycled to line 2. The fractionating columns (D1, D2 and D3) of the system are operated under pressure ranging from about 1.05Kg/cm² to 1.5kg/cm². Alternatively, the fractionating columns (D1, D2 and D3) of the system are operated under vacuum ranging from about 0.05 kg/cm² to 0.5 kg/cm²

[055] Additional embodiments and features of the present disclosure will be apparent to one of ordinary skill in art based upon description provided herein. The embodiments herein provide various features and advantageous details thereof in the description. Descriptions of well-known/conventional methods and techniques are omitted so as to not unnecessarily obscure the embodiments herein. Further, the disclosure herein provides for examples illustrating the above described embodiments, and in order to illustrate the embodiments of the present disclosure certain aspects have been employed. The examples used herein for such illustration are intended merely to facilitate an understanding of ways in which the embodiments herein may be practiced and to further enable those of skill in the art to practice the embodiments herein. Accordingly, the following examples should not be construed as limiting the scope of the embodiments herein.

EXAMPLES

EXAMPLE 1: Preparation of triethylamine - Aluminium chloride salt precursor.

[056] About 8.08 g (0.061 mol) of AlCl₃ and about 50 ml of ethyl acetate are charged into a 250 ml round bottom flask under N₂ atmosphere. Slowly under stirring, about 18.4 g (0.0182 mol) of triethylamine is added for about 30 minutes at a temperature of about 20°C to obtain a mass. The whole mass is then stirred for about 4 hours. The resultant mixture is then separated by filtration. The solids are washed with about 100 ml fresh ethyl acetate followed by drying to get about 22 g of triethylamine - Aluminum chloride salt precursor.

EXAMPLE 2: Preparation of Ionic liquid compound in presence of solvent.

[057] About 15 g (0.034 mol) of total solid powder obtained in EXAMPLE-1 and about 20 ml benzene are charged into a 100 ml single neck round bottom flask and kept on a magnetic stirrer. N₂ flow is ensured inside the flask. The flask is kept in a water bath at a temperature of about 15°C. A magnetic needle is kept inside the flask for stirring. Slowly, about 27.5 g (0.206 mol) of AlCl₃ is added to the flask under stirring for about 30 minutes. The obtained mass is stirred for about 4 hours. The resultant ionic liquid compound is kept under closed conditions.

EXAMPLE-3: Preparation of Ionic liquid compound.

[058] About 15 g (0.034 mol) of total solid powder obtained in EXAMPLE-1 is charged into a 100 ml single neck round bottom flask kept under overhead stirrer. N₂ flow is ensured inside the flask. The flask is kept in a water bath at a temperature of about 15°C. Slowly, under stirring about 29.3 g (0.21 mol) of AlCl₃ is added to the flask for about 30 minutes. The obtained mass is stirred for about 4 hours. The resultant ionic liquid compound is kept under closed conditions.

EXAMPLE-4: Transalkylation reaction

[059] About 117 ml (100 g) of heavy alkyl benzene comprising about 7% linear alkyl benzene and about 93% heavy alkyl benzene containing dialkyl benzene and oligomers of dialkyl benzene is added to a 500 ml round bottom flask and kept under an overhead stirrer. N₂ flow is ensured inside the flask. The flask is kept in a water bath at a temperature of about 85°C. To the flask, about 320 ml (280 g) of benzene is added. The mixture is heated to a temperature of about 80°C and maintained for about 20 minutes under stirring. Once the temperature of about 80°C is achieved, about 22 g of freshly prepared ionic liquid compound of formula I, $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^-]_3$ is added at once and stirred for about 3 hours. After about 3 hours, the reaction mass is cooled and allowed to settle for about 20 minutes, followed by separating the layers. The upper layer is the benzene rich light alkyl compound while the lower layer is ionic liquid compound of formula I. The upper layer comprising benzene rich light alkyl compound is subjected to gas chromatography.

[060] The conversion of heavy alkyl benzene obtained is to be about 60%.

EXAMPLE-5: Comparative experimentation depicting the improved conversion of heavy aromatic compound by the transalkylation process of present disclosure.

5 Comparative experimentation 1: Molar ratio of about 1:3 of heavy alkyl benzene to benzene is subjected to transalkylation process employing about 5% ionic liquid of formula 1, $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^-]_3$ at a temperature of about 80°C. The transalkylation process is carried for about 1.5hours under stirring condition.

Observation: The conversion of heavy alkyl benzene obtained is about 57.68%.

10 Comparative experimentation 2: Molar ratio of about 1:3 of heavy alkyl benzene to benzene is subjected to transalkylation process employing about 5% $[BMIM]^+[Al_2Cl_6Br]^-$ at a temperature of about 80°C. The transalkylation process is carried for about 1.5hours under stirring condition.

15 Observation: The conversion of heavy alkyl benzene obtained is about 41.4%

From the comparative experimentation it is observed that the transalkylation process of the present disclosure in the presence of ionic liquid compound of formula I lead to improved conversion of heavy aromatic compound when compared to conventional
20 transalkylation process not employing the ionic liquid compound of formula I.

[061] Additional embodiments and features of the present disclosure will be apparent to one of ordinary skill in art based on the description provided herein. The embodiments herein provide various features and advantageous details thereof in the description.
25 Descriptions of well-known/conventional methods and techniques are omitted so as to not unnecessarily obscure the embodiments herein.

[062] The foregoing description of the specific embodiments fully reveals the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments
30 without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the

phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments in this disclosure have been described in terms of preferred embodiments, those skilled in the art will recognize that the embodiments herein can be practiced with modification within the spirit and scope of the embodiments as described herein.

[063] Throughout this specification, the word “comprise”, or variations such as “comprises” or “comprising” wherever used, will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

[064] With respect to the use of substantially any plural and/or singular terms herein, those having skill in the art can translate from the plural to the singular and/or from the singular to the plural as is appropriate to the context and/or application. The various singular/plural permutations may be expressly set forth herein for sake of clarity.

[065] The use of the expression “at least” or “at least one” suggests the use of one or more elements or ingredients or quantities, as the use may be in the embodiment of the disclosure to achieve one or more of the desired objects or results.

[066] Any discussion of documents, acts, materials, devices, articles and the like that has been included in this specification is solely for the purpose of providing a context for the disclosure. It is not to be taken as an admission that any or all of these matters form a part of the prior art base or were common general knowledge in the field relevant to the disclosure as it existed anywhere before the priority date of this application.

[067] While considerable emphasis has been placed herein on the particular features of this disclosure, it will be appreciated that various modifications can be made, and that many changes can be made in the preferred embodiments without departing from the principles of the disclosure. These and other modifications in the nature of the disclosure or the preferred embodiments will be apparent to those skilled in the art from the disclosure herein, whereby it is to be distinctly understood that the foregoing descriptive matter is to be interpreted merely as illustrative of the disclosure and not as a limitation.

REFERENCE NUMERAL TABLE:

Reference No.	Description
100	System.
M1	First Mixer.
M2	Second Mixer.
M3	Third Mixer unit.
S1	First Settler unit.
S2	Second Settler unit.
S3	Third Settler unit.
PR	Purifier.
CRU	Catalyst Recovery Unit.
ETP	Effluent Treatment Plant
D1	First Fractionating Column.
D2	Second Fractionating Colum.
D3	Third Fractionating Column Connects the First Reactor with the Solid Separation Unit.
Line 1	Carries aromatic compound for mixing with contents from Line 2.
Line 2	Carries heavy alkyl aromatic compound for mixing with contents of Line 1.
Line 3	Connected to first mixer for adding catalyst.
Line 4	Connects first settler to first/third mixer for recycling heavier catalyst layer from first settler to first/third mixer.
Line 5	Connects first settler to third mixer for feeding upper light alkyl aromatic compound layer.
Line 6	Connects second settler to first/third mixer for recycling heavier catalyst layer.
Line 7	Connects second settler to purifier for feeding

	upper light alkyl aromatic compound layer.
Line 8	Connected to purifier for feeding aqueous/alkali solution for washing the light alkyl aromatic compound layer.
Line 9	Connects third settler to catalyst recovery unit for sending bottom aqueous layer for effluent treatment/feeding bottom catalyst layer into CRU.
Line 10	Connects third settler to first fractionating column for feeding upper light alkyl aromatic compound layer.
Line 11	Connects first fractionating column to line 1 for recycling distilled aromatic compound.
Line 12	Connects first fractionating column to second fractionating column for feeding residue.
Line 13	Connected to second fractionating column for removing and recovering light alkyl aromatic compound.
Line 14	Connects second fractionating column to third fractionating column for feeding residue.
Line 15	Connected to third fractionating column for separating alkyl aromatic compound.
Line 16	Connects third fractionating column to line 2 for recycling unreacted heavy alkyl aromatic compound.

We Claim:

1. A transalkylation process for converting heavy aromatic compound to light alkyl aromatic compound, said process comprising a step of contacting a mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound with ionic liquid compound of formula $I-[(NR_1R_2R_3)_iM_1]^{n+}[(M_2Y_k)_LX_j]^{n-}$ wherein

$NR_1R_2R_3$ is amine;

R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein $R_1=R_2=R_3$ or $R_1=R_2 \neq R_3$ or $R_1=R_3 \neq R_2$ or $R_3=R_2 \neq R_1$;

M_1 and M_2 are independently metals selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any combinations thereof;

X and Y are independently selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combination thereof;

'n' is an integer ranging from about 1 to 4;

'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

$M_1 = M_2$ or $M_1 \neq M_2$, and

$X = Y$ or $X \neq Y$.

to obtain the light alkyl aromatic compound.

2. The transalkylation process as claimed in claim 1, wherein the heavy aromatic compound is heavy alkyl aromatic compound, wherein the alkyl group comprises carbon atom of about 3 to 50, wherein the heavy alkyl aromatic compound is selected from a group comprising 1,4-didecylbenzene, 1,4-dododecyl benzene and trimethyl benzene, or any combination thereof; and wherein the light alkyl aromatic compound is selected from a group comprising benzene attached to alkyl group containing carbon atoms about 1 to 14.

3. The transalkylation process as claimed in claim 1, wherein the unsubstituted aromatic compound is benzene; and wherein the methyl substituted aromatic compound is selected from a group comprising toluene, ethyl benzene, or a combination thereof.
- 5 4. The transalkylation process as claimed in claim 1, wherein molar ratio of the unsubstituted aromatic compound or methyl substituted aromatic compound to heavy aromatic compound is ranging from about 1:1 to 20:1.
- 10 5. The transalkylation process as claimed in claim 1, wherein volume ratio of the ionic liquid compound of formula I to the mixture comprising the heavy aromatic compound and the unsubstituted aromatic compound or the methyl substituted aromatic compound is 0.01 to 1.5.
- 15 6. The transalkylation process as claimed in claim 1, wherein the ionic liquid compound of formula I is $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^-]_3$
7. The transalkylation process as claimed in claim 1, wherein the contacting is at a temperature ranging from about 5°C to 170°C and at a pressure ranging from about 1
20 atmosphere to 50 atmosphere.
8. The transalkylation process as claimed in claim 1, wherein the transalkylation process comprises deacidification of the light alkyl aromatic compound by method selected from a group comprising washing with alkali solution, centrifugation, alumina treatment and
25 acid stripping, or any combination thereof.
9. The transalkylation process as claimed in claim 8, wherein the deacidification of the light alkyl aromatic compound is carried out by washing the light alkyl aromatic compound with the alkali solution having about 2% to 50% concentration of alkali in the solution, and wherein the alkali is selected from a group comprising sodium hydroxide, potassium
30 hydroxide and calcium hydroxide.
10. The transalkylation process as claimed in claim 1, wherein the conversion of heavy aromatic compound is ranging from about 50% to 60%.

11. A system for transalkylation process for converting a heavy aromatic compound to light alkyl aromatic compound, said system comprises:

- a) at least one mixer adapted to independently receive mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I--

$$[(NR_1R_2R_3)_iM_1]^{n+}[(M_2Y_k)_LX_j]^{n-};$$

wherein

$NR_1R_2R_3$ is amine:

R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein $R_1=R_2=R_3$ or $R_1=R_2\neq R_3$ or $R_1=R_3\neq R_2$ or $R_3=R_2\neq R_1$;

M_1 and M_2 are independently metal selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any combinations thereof;

X or Y is selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combinations thereof;

'n' is an integer ranging from about 1 to 4;

'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

$M_1 = M_2$ or $M_1 \neq M_2$, and

$X = Y$ or $X \neq Y$.

and wherein the mixer is adapted to convert the heavy aromatic compound to the light alkyl aromatic compound in presence of ionic liquid compound of formula I

- b) at least one settler unit fluidly connected to at least one mixer, wherein the settler unit is adapted to receive at least one of the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the ionic liquid compound of formula I and the light alkyl aromatic

compound from the mixer, and wherein the settler unit is adapted to separate at least one of light alkyl aromatic compound, ionic liquid compound of formula I, heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound;

- 5 c) at least one purifier fluidly connected to at least one of the settler unit, the purifier is adapted to receive at least one of the light alkyl aromatic compound, the ionic liquid compound of formula I, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and alkali solution and wherein the purifier is adapted to purify the light alkyl aromatic compound;
- 10 d) at least one fractionating column adapted to receive at least one of the light alkyl aromatic compound, the heavy aromatic compound, unsubstituted aromatic compound or methyl substituted aromatic compound and ionic liquid compound of formula I from at least one settler unit and wherein the fractionating column is adapted to separate at least one of the light alkyl aromatic compound, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound, the ionic liquid compound of formula I and paraffin; and
- 15 e) at least one catalyst recovery unit adapted to receive at least one of the ionic liquid compound of formula I, the heavy aromatic compound, the unsubstituted aromatic compound or the methyl substituted aromatic compound and the light alkyl aromatic compound, independently from at least one of the settler unit and at least one of the fractionating column and wherein the catalyst recovery unit is adapted to regenerate the ionic liquid compound of formula I.
- 20

12. The system as claimed in claim 11, wherein the heavy aromatic compound is heavy alkyl aromatic compound, wherein the alkyl group comprises carbon atom of about 3 to 50, wherein the heavy alkyl aromatic compound is selected from a group comprising 1,4-didecylbenzene, 1,4-dodidecyl benzene and trimethyl benzene, or any combination thereof; and wherein the light alkyl aromatic compound is selected from a group comprising benzene attached to alkyl group containing carbon atoms of about 1 to 14.
- 25

13. The system as claimed in claim 11, wherein the mixer is selected from a group comprising stirred vessel, plug flow reactor, static mixer, jet mixer and pump mixer, or any combination thereof.

14. The system as claimed in claim 11, wherein the settler unit is selected from a group comprising gravity settling vessel and decanter, and wherein the settler unit is arranged horizontally or vertically comprising series of settlers arranged inside the settler unit either horizontally or vertically, or a combination thereof.

15. The system as claimed in claim 11, wherein the purifier is selected from a group comprising stirred vessel, centrifuge separator, column packed with alumina, evaporation and stripper, or any combination thereof.

16. The system as claimed in claim 11, wherein the mixer is at a temperature ranging from about 5°C to 170°C and at a pressure ranging from about 1 atmosphere to 50 atmosphere.

17. The system as claimed in claim 11, wherein molar ratio of the unsubstituted aromatic compound or the methyl substituted aromatic compound to the heavy aromatic compound is ranging from about 1:1 to 20:1; and wherein volume ratio of the ionic liquid compound of formula I to the mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound is 0.01 to 1.5.

18. The system as claimed in claim 11, wherein the ionic liquid compound of formula I is $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^{-3}]$.

19. The system as claimed in claim 11, wherein the conversion of heavy aromatic compound is ranging from about 50% to 60%.

We Claim:

1. A transalkylation process for converting heavy aromatic compound to light alkyl aromatic compound, said process comprising a step of contacting a mixture comprising heavy aromatic compound and unsubstituted aromatic compound or methyl substituted aromatic compound with ionic liquid compound of formula I-

$$[(NR_1R_2R_3)_iM_1]^{n+}[(M_2Y_k)_LX_j]^{n-}$$

wherein

$NR_1R_2R_3$ is amine;

R_1 , R_2 and R_3 are independently selected from a group comprising alkyl, aryl and H or any combinations thereof, wherein $R_1=R_2=R_3$ or $R_1=R_2\neq R_3$ or $R_1=R_3\neq R_2$ or $R_3=R_2\neq R_1$;

M_1 and M_2 are independently metals selected from a group comprising Al, Fe, Zn, Mn, Mg, Ti, Sn, Pd, Pt, Rh, Cu, Cr, Co, Ce, Ni, Ga, In, Sb and Zr or any combinations thereof;

X and Y are independently selected from a group comprising halide ion, nitrate, sulphate, sulfonate, carbonate, phosphonate, citrate, cyanide ion, nitrite, phosphate and acetate, or any combination thereof;

'n' is an integer ranging from about 1 to 4;

'i' is an integer ranging from about 1 to 6;

'j' is an integer ranging from about 1 to 4;

'k' is an integer ranging from about 1 to 4;

'L' is an integer ranging from about 1 to 7;

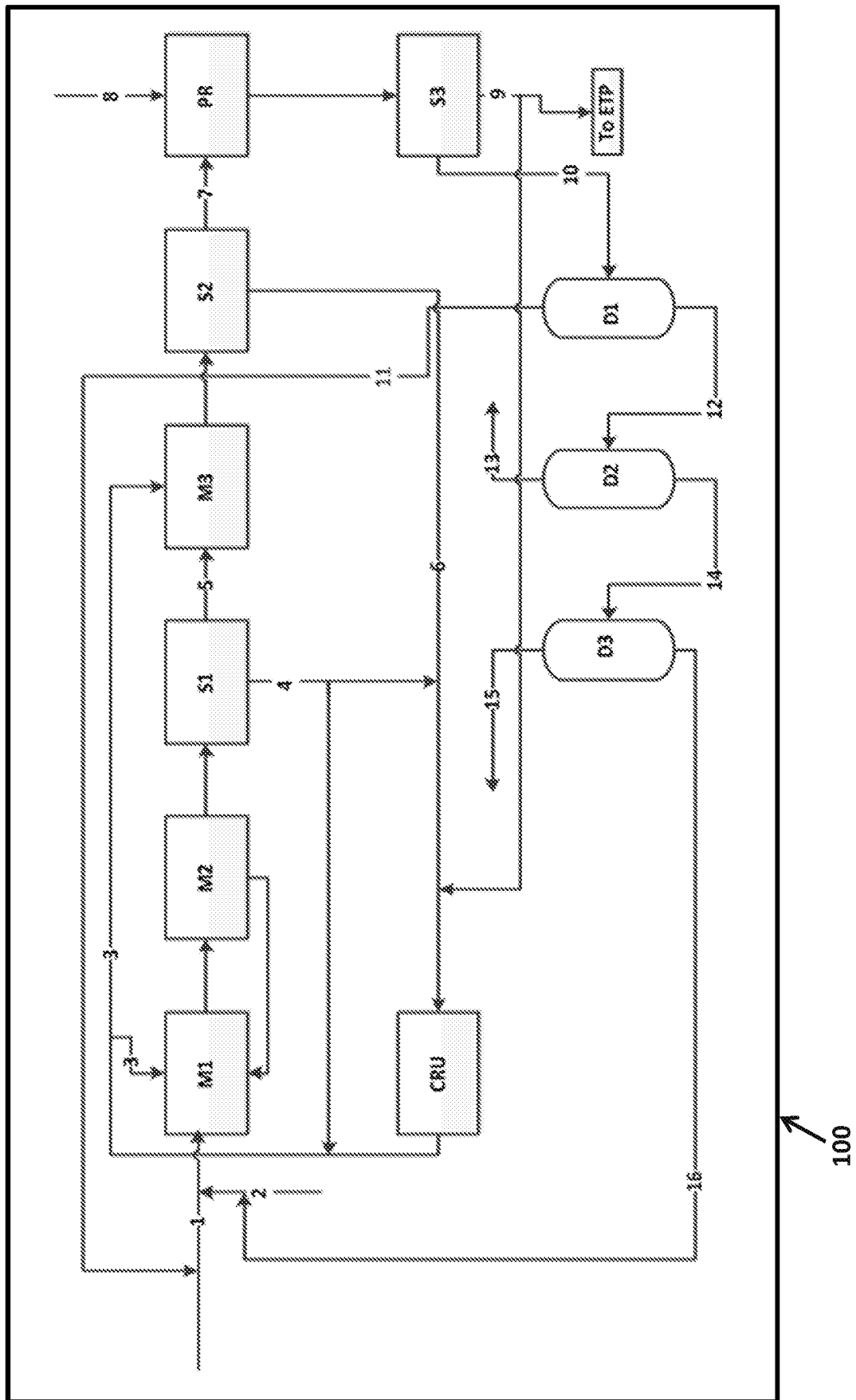
$M_1 = M_2$ or $M_1 \neq M_2$, and

$X = Y$ or $X \neq Y$.

to obtain the light alkyl aromatic compound.

2. The transalkylation process as claimed in claim 1, wherein the heavy aromatic compound is heavy alkyl aromatic compound, wherein the alkyl group comprises carbon atom of about 3 to 50, wherein the heavy alkyl aromatic compound is selected from a group comprising 1,4-didecylbenzene, 1,4-dodidecyl benzene and trimethyl benzene, or any combination thereof; and wherein the light alkyl aromatic compound is selected from a group comprising benzene attached to alkyl group containing carbon atoms about 1 to 14.

3. The transalkylation process as claimed in claim 1, wherein the unsubstituted aromatic compound is benzene; and wherein the methyl substituted aromatic compound is selected from a group comprising toluene, ethyl benzene, or a combination thereof.
4. The transalkylation process as claimed in claim 1, wherein molar ratio of the unsubstituted aromatic compound or methyl substituted aromatic compound to heavy aromatic compound is ranging from about 1:1 to 20:1.
5. The transalkylation process as claimed in claim 1, wherein volume ratio of the ionic liquid compound of formula I to the mixture comprising the heavy aromatic compound and the unsubstituted aromatic compound or the methyl substituted aromatic compound is 0.01 to 1.5.
6. The transalkylation process as claimed in claim 1, wherein the ionic liquid compound of formula I is $[(N(C_2H_5)_3-Al)^+ [Al_2Cl_7]^-]_3$
7. The transalkylation process as claimed in claim 1, wherein the contacting is at a temperature ranging from about 5°C to 170°C and at a pressure ranging from about 1 atmosphere to 50 atmosphere.
8. The transalkylation process as claimed in claim 1, wherein the transalkylation process comprises deacidification of the light alkyl aromatic compound by method selected from a group comprising washing with alkali solution, centrifugation, alumina treatment and acid stripping, or any combination thereof.
9. The transalkylation process as claimed in claim 8, wherein the deacidification of the light alkyl aromatic compound is carried out by washing the light alkyl aromatic compound with the alkali solution having about 2% to 50% concentration of alkali in the solution, and wherein the alkali is selected from a group comprising sodium hydroxide, potassium hydroxide and calcium hydroxide.
10. The transalkylation process as claimed in claim 1, wherein the conversion of heavy aromatic compound is ranging from about 50% to 60%.



INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2015/058576

A. CLASSIFICATION OF SUBJECT MATTER

INV. C07C6/12 C10G29/20 C10G57/00 C10G11/02
ADD.

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 C10G

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

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

EPO-Internal, CHEM ABS Data, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2014/178075 A2 (RELIANCE IND LTD [IN]) 6 November 2014 (2014-11-06) claim 1; examples 4,6 -----	11-19
A	CN 101 020 619 A (UNIV HEILONGJIANG [CN]) 22 August 2007 (2007-08-22) examples 1-9 -----	1-10
A	WO 00/41809 A1 (BP CHEM INT LTD [GB]; ELLIS BRIAN [GB]; HUBERT FABIENNE [GB]; WASSERSC) 20 July 2000 (2000-07-20) claims 1,2 -----	1-10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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

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"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

8 February 2016

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2015/058576

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2014178075 A2	06-11-2014	CA 2909562 A1 CN 105142773 A EP 2986371 A2 WO 2014178075 A2	06-11-2014 09-12-2015 24-02-2016 06-11-2014
-----	-----	-----	-----
CN 101020619 A	22-08-2007	NONE	
-----	-----	-----	-----
WO 0041809 A1	20-07-2000	AU 1672100 A WO 0041809 A1	01-08-2000 20-07-2000
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