Abstract: The present disclosure relates to a compound of Formula I: [Formula should be inserted here] wherein, R1, R2, R3, R4 and R5 have the meaning as defined in the description. The present disclosure also relates to a process for preparing the compound of Formula I and its application for dissolution of pulp and polymer.
FIELD OF THE DISCLOSURE:

The present disclosure relates to a novel solvent system for dissolution of pulp and polymer. The present disclosure particularly relates to a solvent system containing zwitterionic compound.

BACKGROUND:

The conventional method for the commercial preparation of cellulosic fibers is the viscose process. The viscose process involves the hazardous chemicals such as carbon disulphide and sulphuric acid, which is a major concern for the environment.

Further, the lyocell process which involves the dissolution of cellulose/pulp in non-derivatizing solvents such as N-methylmorpholine-N-oxide (NMMO), is environmentally more accepted, the resulting fiber are easily fibrillated. Another disadvantage of the NMMO is the fact that it is thermally unstable, leading to its degradation and is explosive at higher temperature.

Therefore, it is necessary to investigate the non-derivatizing solvent system for the preparation of non-fibrillating fibers and develop a process, which is simple, cost effective and environment friendly.

The imidazolium based ionic liquids are well known for the dissolution of cellulose. Non-fibrillating cellulosic fibers were prepared by using imidazolium based ionic liquid as a solvent system. Ionic liquids are a group of salts that exist as liquids at relatively low temperatures (<100 °C). They have many attractive properties, including chemical and thermal stability, non-flammability, and immeasurably low vapor pressure. Due to the extremely low vapor pressure of ionic liquids, they could be recycled, which make it cost effective and environment friendly.
However, it has been reported that the ionic liquids react very slowly with cellulose under specific conditions to form low molecular weight impurities. To remove these impurities an additional process of purification is required. Further, the purification process of ionic liquids results in the alteration of anion/cation ratio as the ionic liquid is a two component system, i.e., cation and anion.

Therefore, the inventors of the present disclosure envisaged a compound wherein both the cation and the anion are covalently bonded and the anion/cation balance could not be disturbed during the purification/recycling process.

**OBJECTS:**

Some of the objects of the present disclosure which at least one embodiment herein satisfies are as follows:

It is an object of the present disclosure to provide a zwitterionic compound.

It is another object of the present disclosure to provide a zwitterionic compound which is thermally and chemically stable.

It is another object of the present disclosure to provide a zwitterionic compound which can efficiently dissolve pulps and polymers.

It is another object of the present disclosure to provide a simple and economic process for preparing a zwitterionic compound.

It is still another object of the present disclosure to provide a solvent system comprising zwitterionic compound for dissolution of pulps and polymers.

Other objects and advantages of the present disclosure will be more apparent from the following description when read in conjunction with the accompanying figures, which are not intended to limit the scope of the present disclosure.

**SUMMARY:**

In one aspect of the present disclosure there is provided a compound of Formula I:
wherein, R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R1 and R3 are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

at least one of R1, R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO\(^-\)), sulfate (-SO\(_4\)\(^-\)), sulfonate (-SO\(_3\)R\(_6\)), phosphate (-PO\(_4\)) and phosphonate (-P\(_3\)R\(_7\)).

wherein R6 and R7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.

Typically, R2, R4 and R5 are hydrogen,

R1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO\(^-\)) at the terminal end, and

R3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neo-hexyl, heptyl, iso-heptyl, neo-heptyl, octyl and tetradecyl.

Typically, R2, R4 and R5 are hydrogen,

R1 is ethanoate (CH\(_3\)-COCT), and

R3 is methyl.

Typically, R2, R4 and R5 are hydrogen,

R1 is butanoate (CH\(_3\)-CH\(_2\)-CH\(_2\)-COO\(^-\)), and
R3 is propyl.

Typically, R2, R4 and R5 are hydrogen,

- R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
- R3 is butyl.

Typically, R2, R4 and R5 are hydrogen,

- R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
- R3 is hexyl.

Typically, R2, R4 and R5 are hydrogen,

- R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
- R3 is octyl.

Typically, R2, R4 and R5 are hydrogen,

- R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
- R3 is tetradecyl.

In another aspect of the present disclosure there is provided a process for preparing a compound of Formula I, said process comprising the following steps:

a. reacting a compound of Formula IV and a compound of Formula V to obtain a compound of Formula II;

\[
\text{Formula V} \quad \text{Formula IV} \quad \text{Formula H}
\]

wherein, m is an integer ranging between 1 and 20;
R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R3 is an organic group with 1 to 20 carbon atoms;

at least one of R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO⁻), sulfate (-SO₄²⁻), sulfonate (-SO₃R₆⁻), phosphate (-PO₄³⁻) and phosphonate (-PO₃R₆R₁₀⁻), wherein R6 and R7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms; and

R' is selected from the group consisting of carboxylate (-COOR₈), sulfate (-SO₄R₉⁻), sulfonate (-SO₃R₆R₁₀), phosphate (-PO₄R₁₁⁻) and phosphonate (-PO₃R₆R₁₀R₁₂⁻), wherein R6, R7, R8, R9, R₁₀, R₁₁ and R₁₂ are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.

b. converting a compound of Formula II into a compound of Formula III;

and

![Reaction diagram](image)

wherein, m, R2, R3, R4, R5, X, and R' have the same meaning as defined above,

c. hydrolyzing a compound of Formula III to obtain a compound of Formula I.
wherein, \( m \), \( R_1 \), \( R_2 \), \( R_3 \), \( R_4 \), \( R_5 \) and \( R' \) have the same meaning as defined above.

Typically, \( m \) is an integer ranging between 1 and 20;

- \( R_2 \), \( R_4 \) and \( R_5 \) are hydrogen;
- \( R' \) is carboxylate \((-\text{COOR}_8\)) wherein \( \text{R}_8 \) is selected from the group consisting of an organic group with 1 to 5 carbon atoms;
- \( R_1 \) is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion \((-\text{COO}^-)\) at the terminal end; and
- \( R_3 \) is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neoheptyl, heptyl, isohexyl, neoheptyl, octyl and tetradecyl.

Preferably, \( R_2 \), \( R_4 \) and \( R_5 \) are hydrogen,

- \( R_1 \) is selected from the group consisting of ethanoate \((-\text{CH}_3\text{-COO}^-)\),
  - butanoate \((-\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COO}^-)\) and
  - hexanoate \((-\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COO}^-)\), and

- \( R_3 \) is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.

Typically, the method step (a) is carried out at a temperature ranging between 20 °C and 50 °C for a time period ranging between 24 hours and 72 hours.
Typically, the method step (b) is carried out at a temperature ranging between 20 °C and 50 °C for a time period ranging between 1 hour and 6 hours, using at least one reagent selected from the group consisting of Amberlyst A-26 (-OH form), INDION-GS300 (-OH form), Dowex Marathon 550A (OH form), Dowex Monosphere 550A (OH form), Amberjet 4400 (OH form) and Amberjet 9000 (OH form) in the presence of a solvent selected from the group consisting of methanol, ethanol, propanol, isopropanol and butanol.

Typically, the method step (c) is carried out at a temperature ranging between 55 °C and 130 °C for a time period ranging between 2 hours and 10 hours in the presence of a solvent selected from the group consisting of methanol, ethanol, propanol, isopropanol and butanol.

In yet another aspect of the present disclosure there is provided a solvent system comprising:

i. a compound of Formula I,

```
    R5
   / \   /
  R4 /   \
     /     \
    R1     R3
       /     /     \
      /   R2   R6   \
     /     /     /   \
    @     @     @     @
```

Formula I

wherein, R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R1 and R3 are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

at least one of R1, R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO⁻), sulfate (-SO₄²⁻), sulfonate (-SO₃R⁶⁻), phosphate (-P⁴⁻).
P0\textsubscript{4}\textsuperscript{−} and phosphonate (-P0\textsubscript{3}R\textsubscript{7}−), wherein R\textsubscript{6} and R\textsubscript{7} are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms, and

ii. optionally, at least one solvent selected from the group consisting of dimethyl formamide, dimethyl sulfoxide, dimethyl acetamide, dimethyl imidazole, N-methyl pyrrolidinone, valerolactam, caprolactam, pyrrolidinone, dimethyl propylene urea, sulfolane, acetyl acetone, butanol, pentanol, isopropanol, propylene glycol, butane-diol, glycerol, m-cresol, methyl ethyl ketone, mixture of calcium chloride and methanol, trifluoroethanol and water.

wherein, said solvent system being capable of dissolving at least one polymer selected from the group consisting of cellulose, acrylic, nylon and polyester.

Typically, R\textsubscript{2}, R\textsubscript{4} and R\textsubscript{5} are hydrogen,

R\textsubscript{1} is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO\textsuperscript{−}) at the terminal end, and

R\textsubscript{3} is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, iso hexyl, neohexyl, heptyl, isoheptyl, neoheptyl, octyl and tetradecyl.

Preferably, R\textsubscript{2}, R\textsubscript{4} and R\textsubscript{5} are hydrogen,

R\textsubscript{1} is selected from the group consisting of ethanoate (CH\textsubscript{3}-COO\textsuperscript{−}), butanoate (CH\textsubscript{3}-CH\textsubscript{2}-CH\textsubscript{2}-COO\textsuperscript{−}) and hexanoate (CH\textsubscript{3}-CH\textsubscript{2}-CH\textsubscript{2}-CH\textsubscript{2}-CH\textsubscript{2}-COO\textsuperscript{−}), and

R\textsubscript{3} is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.
BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS:

Figure 1: illustrates HPLC Curve of the Zwitterionic liquid i.e., ZJL (hexyl hexanoate imidazolium) solvent recycled thrice, and

Figure 2: illustrates HPLC Graph of Zwitterionic liquid i.e., ZJL (Ethyl Methyl Imidazolium Acetate) solvent recycled thrice

DETAILED DESCRIPTION:

In accordance with one aspect of the present disclosure there is provided a compound of formula I:

![Formula I](image)

wherein, R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R1 and R3 are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

at least one of R1, R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO⁻), sulfate (-SO₄²⁻), sulfonate (-SO₃R⁻), phosphate (-P0₄³⁻) and phosphonate (-P0₃R⁻), wherein R6 and R7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.

In accordance with the present disclosure the compound of Formula I is
wherein, R2, R4 and R5 are hydrogen, 

R1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (\(-\text{COO}^-\)) at the terminal end, and 

R3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neohexyl, heptyl, isoheptyl, neoheptyl, octyl and tetradecyl. 

In first embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is ethanoate (\(\text{CH}_3\text{-COCT}\)), and R3 is methyl. 

In second embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is butanoate (\(\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-COO}^-\)), and R3 is propyl. 

In third embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is hexanoate (\(\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COO}^-\)), and R3 is butyl. 

In fourth embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is hexanoate (\(\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COO}^-\)), and R3 is hexyl. 

In fifth embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is hexanoate (\(\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COO}^-\)), and R3 is octyl. 

In sixth embodiment of the present disclosure, R2, R4 and R5 are hydrogen, R1 is hexanoate (\(\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-CH}_2\text{-COO}^-\)), and R3 is tetradecyl.
In accordance with another aspect of the present disclosure there is provided a process for preparing a compound of Formula I.

In the first step, a compound of Formula IV and a compound of Formula V are reacted at a temperature ranging between 20 °C and 50 °C for a time period ranging between 24 hours and 72 hours to obtain a mixture containing a compound of Formula II. The reaction is represented as below;

\[
\text{Formula V} \quad \text{Formula IV} \quad \text{Formula II}
\]

wherein, \( m \) is an integer ranging between 1 and 20;

\( R2, R4 \) and \( R5 \) are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

\( R3 \) is an organic group with 1 to 20 carbon atoms;

at least one of \( R2, R3, R4 \) and \( R5 \), at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO\(^-\)), sulfate (-SO\(_4\)^-), sulfonate (-SO\(_3\)R\(_6\)^-), phosphate (-PO\(_4\)^-) and phosphonate (-P0\(_3\)R\(_7\)^-), wherein \( R6 \) and \( R7 \) are independently selected form the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms; and

\( R' \) is selected from the group consisting of carboxylate (-COOR\(_8\)), sulfate (-SO\(_4\)R\(_9\)), sulfonate (-SO\(_3\)R\(_6\)R\(_{10}\)), phosphate (-P0\(_4\)R\(_{11}\)) and phosphonate (-P0\(_3\)R\(_7\)R\(_{12}\)), wherein \( R6, R7, R8, R9, R10, R11 \) and \( R12 \) are independently selected form the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.

After completion of the first step, the reaction mixture of the first step containing a compound of Formula II is diluted with at least one solvent selected from the group
consisting of methanol, ethanol, propanol, isopropanol and butanol. To this at least one resin selected from the group consisting of Amberlyst A-26 (-OH form), INDION-GS300 (-OH form), Dowex Marathon 550A (OH form), Dowex Monosphere 550A (OH form), Amberjet 4400 (OH form) and Amberjet 9000 (OH form) is added. This reaction mixture is then stirred at a temperature ranging between 20 °C and 50 °C for a time period ranging between 1 hour and 6 hours to obtain a compound of Formula III. The reaction is represented as below:

\[
\text{Formula II} \quad \rightarrow \quad \text{Formula III}
\]

wherein, \(m\), \(R_1\), \(R_2\), \(R_3\), \(R_4\), \(R_5\), \(X\), and \(R'\) have the same meaning as defined above.

Finally, the compound of Formula III is hydrolyzed to obtain a compound of Formula I. The hydrolysis reaction is carried out at a temperature ranging between 55 °C and 130 °C for a time period ranging between 2 hours and 10 hours in the presence of a solvent selected from the group consisting of methanol, ethanol, propanol, isopropanol and butanol. The hydrolysis of a compound of Formula III is represented as below:

\[
\text{Formula III} \quad \rightarrow \quad \text{Formula I}
\]

wherein, \(m\), \(R_1\), \(R_2\), \(R_3\), \(R_4\), \(R_5\) and \(R'\) have the same meaning as defined above.
In one of the embodiments m is an integer ranging between 1 and 20; R2, R4 and R5 are hydrogen; R’ is carboxylase (-COOR8), wherein R8 is selected from the group consisting of an organic group with 1 to 5 carbon atoms; R1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO-) at the terminal end; and R3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neohexyl, heptyl, isohexyl, neoheptyl, octyl and tetradecyl.

In another embodiment R2, R4 and R5 are hydrogen, R1 is selected from the group consisting of ethanoate (CH\textsubscript{3}-COO\textsuperscript{-}), butanoate (CH\textsubscript{3}-CH\textsubscript{2}-CH\textsubscript{2}-COO\textsuperscript{-}) and hexanoate (CH\textsubscript{3}-CH\textsubscript{2}-CH\textsubscript{2}-CH\textsubscript{2}-CH\textsubscript{2}-COO\textsuperscript{-}), and R3 is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.

In accordance with yet another aspect of the present disclosure there is provided a solvent system. The solvent system comprises:

i. a compound of Formula I,

\[ \text{Formula I} \]

wherein, R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R1 and R3 are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

at least one of R1, R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO\textsuperscript{-}), sulfate (-SO\textsubscript{4}\textsuperscript{-}), sulfonate (-SO\textsubscript{3}R6\textsuperscript{-}), phosphate (-PO\textsubscript{4}\textsuperscript{-}) and
phosphorate (-P_3^\text{R}_7^-), wherein R_6 and R_7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms, and

ii. optionally, at least one solvent selected from the group consisting of dimethyl formamide, dimethyl sulfoxide, dimethyl acetamide, dimethyl imidazole, N-methyl pyrrolidinone, valerolactam, caprolactam, pyrrolidinone, dimethyl propylene urea, sulfolane, acetyl acetone, butanol, pentanol, isopropanol, propylene glycol, butane-diol, glycerol, m-cresol, methyl ethyl ketone, mixture of calcium chloride and methanol, trifluoroethanol and water.

In one of the embodiments the solvent system comprises a compound of Formula I in which, R_2, R_4 and R_5 are hydrogen, R_1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO^-) at the terminal end, and R_3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isoheptyl, heptyl, isohexyl, neoheptyl, heptyl, isoheptyl, neoheptyl, octyl and tetradecyl.

In yet another embodiments the solvent system comprising a compound of Formula I in which, R_2, R_4 and R_5 are hydrogen, R_1 is selected from the group consisting of ethanoate (CH_3-COO^-), butanoate (CH_3-CH_2-CH_2-COO^-) and hexanoate (CH_3-CH_2-CH_2-CH_2-CH_2-COO^-), and R_3 is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.

The solvent system of the present disclosure is capable of dissolving at least one compound selected from the group consisting of cellulose, acrylic polymer, nylon polymer and polyester polymers.

In an exemplary embodiment cellulose pulp with varying percentage of alpha cellulose (80% to 97%), hemi-cellulose (3 to 20%) and cellulose DP (100 to 4000) can be dissolved in 1 to 30% concentration in the solvent system of the present disclosure at a temperature ranging from 50 °C to 150 °C.
In an another exemplary embodiment acrylic polymer containing at least 50 percent acrylonitrile monomer units can be dissolved in 1 to 30% concentration in the solvent system of the present disclosure at a temperature ranging from 50 °C to 150 °C. The other co-monomers present in the acrylic polymer is at least one selected from the group consisting of methacrylate, vinyl acetate, methacrylic acid, acrylic acid, ethyl vinyl ether, vinyl bromide, vinyl chloride, vinylidene chloride, vinyl sulfonic acid, itaconic acid, methylmethacrylate, and sulfonated monomers such as sodium styrene sulfonate, sodium methallyl sulfonate, and sodium sulfophenyl methallyl ether.

In yet another exemplary embodiment nylon polymer can be dissolved in 1 to 15% concentration in the solvent system of the present disclosure at a temperature ranging from 50 °C to 150 °C.

In yet another exemplary embodiment polyester polymer can be dissolved in 1 to 10% concentration in the solvent system of the present disclosure at a temperature ranging from 50 °C to 150 °C.

The cellulose solution in the said solvent system may be converted into cellulosic fibers, films or particles by precipitating in a dilute solution of the said solvent system in a protic non-solvent, by wet spinning or air-jet-wet spinning techniques. The cellulose solution is passed through a die of desired geometry, into a coagulating bath containing non-solvent such as water and washed subsequently to remove all residual solvents from the cellulose product.

The polymer solution in the said solvent system may be converted into polymeric fibers, films, sheet, or particles by precipitating in a dilute solution of the said solvent system in a protic non-solvent, for example, the polymeric solution can be passed through a spinneret into a water coagulating bath using wet spinning or dry-jet-wet spinning and washed subsequently to remove all residual solvents from the cellulose fiber.

The present disclosure is further described in light of the following non-limiting examples which are set forth for illustration purpose only and not to be construed for limiting the scope of the disclosure.
Example 1:

20 g (89.6 mmol) of ethyl 6-bromohexanoate was added to 11.13 g (89.6 mmol) of N-butylimidazole at once in a 100 ml four necked RB flask and allowed to stir for 48 h at room temperature. After the completion of reaction, as monitored by TLC, the reaction mixture was diluted with 100 mL of methanol and 60 g of Amberlyst A-26 (-OH form) was added and allowed to stir for 2 h. The resin was filtered off and the solution was stirred for 4 h at 60 °C. The reaction mixture was concentrated at reduced pressure, diluted with water (100 mL) and washed with dichloromethane (3 x 30 mL). The aqueous solution was concentrated under reduced pressure up to complete dryness to obtain 20.9 g of 1-carboxyhexyl-3-butylimidazolium i.e zwitterionic liquid (ZIL), as colorless viscous oil.

Example 2:

89.6 mmol of ethyl 2-bromoethanoate was added to 89.6 mmol of N-methylimidazole at once in a 100 ml four necked RB flask and allowed to stir for 48 h at room temperature. After the completion of reaction, as monitored by TLC, the reaction mixture was diluted with 100 mL of methanol and 60 g of Amberlyst A-26 (-OH form) or INDION-GS300 (-OH form) was added and allowed to stir for 2 h. The resin was filtered off and the solution was refluxed for 4 h. The reaction mixture was concentrated at reduced pressure, diluted with water (200 ml) and washed three times with 30 ml dichloromethane. The aqueous solution was concentrated under reduced pressure up to complete dryness to obtain 1-carboxyethyl 3-methyl imidazolium i.e zwitterionic liquid (ZIL).

Five grams of Cellulose pulp of DP 760 was weighed and dissolved in 95 grams of 1-carboxyethyl 3-methyl imidazolium at 110 °C with overhead stirrer at 500 rpm for 18 hrs. However the final solution containing undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.
Example 3:

The compound of Formula I i.e. zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is propyl and R1 is butanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

4.0 grams of Cellulose pulp of DP 760 was weighed and dissolved in 96 grams of ZIL at 110 °C with overhead stirrer at 500 rpm for 18 hrs. The final solution showed complete dissolution with no undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 4:

The compound of Formula I i.e. zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is octyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

10.0 grams of Cellulose pulp of DP 760 was weighed and dissolved in 90 grams of said ZIL at 110 °C with overhead stirrer at 500 rpm for 6 hrs. The final solution showed complete dissolution with no undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 5:

The compound of Formula I i.e. zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is tetradecyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

10 grams of Cellulose pulp of DP 760 was weighed and dissolved in 90 grams of said ZIL at 110 °C with overhead stirrer at 500 rpm for 4 hrs. The final solution showed complete dissolution with no undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.
Example 6:
The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is butyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

10 grams of Cellulose pulp of DP 760 was weighed and dissolved in 90 grams of said ZIL and dimethyl sulfoxide mixture in the 55:35 ratio at 110 oC with overhead stirrer at 500 rpm for 6 hrs. The final solution showed complete dissolution with no undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 7:
The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is tetradecyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

10 grams of Cellulose pulp of DP 760 was weighed and dissolved in 90 grams of said ZIL at 110 oC with overhead stirrer at 500 rpm for 4 hrs. The final solution showed complete dissolution with no undissolved cellulose pulp fibers detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 8:
The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is octyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

10 grams of acrylic polymer with 45,000 Mw and 30,000 Mn was weighed and dissolved in 90 grams of said ZIL at 110 oC with overhead stirrer at 500 rpm for 6 hrs. The final solution showed complete dissolution with no undissolved acrylic polymer detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.
Example 9:

The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is octyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

1.5 grams of acrylic polymer with 45,000 Mw and 30,000 Mn and 8.5 grams of cellulose pulp of DP 760 were weighed and dissolved in 90 grams of said ZIL at 110 oC with overhead stirrer at 500 rpm for 6 hrs. The final solution showed complete dissolution with no undissolved acrylic polymer detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 10:

The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is octyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

5 grams of nylon-6 textile grade chips was weighed and dissolved in 95 grams of said ZIL at 110 oC with overhead stirrer at 500 rpm for 8 hrs. The final solution showed complete dissolution with no undissolved nylon^6 detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 11:

The compound of Formula I i.e zwitterionic liquid (ZIL), wherein R2=R4=R5=H atom and R3 is octyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

3 grams of textile grade polyester chips was weighed and dissolved in 97 grams of said ZIL at HOoC with overhead stirrer at 500 rpm for 6 hrs. The final solution showed complete dissolution with no undissolved textile grade polyester detectable in an optical microscope at 400X. The polymer solution was precipitated in water to obtain a polymer product.

Example 12: Recycling of compound of Formula I i.e zwitterionic liquid (ZIL)
Recycling:

As cellulose is a natural polymer and have more impurities as compared to other polymers such as acrylic, nylon and polyester, was used for recycling stability assessment of the solvent. After 3 cycles of processing sequence of cellulose dissolution at 110 °C for up to 8 hours followed by cellulose regeneration in water and solvent distillation. From the HPLC results it was observed that even after three recycles the cellulose solubility in the recycled solvent and the HPLC purity (greater than 99.5%) remains constant. Further, to the surprise it was observed that even after 3 recycles inventors were able to dissolve 1-30% cellulose at 60-130 degree Celsius. Still further, the DP (degree of polymerization) was changed from 720 to 576, which is similar to lyocell fiber DP. It shows that the cellulose did not degrade significantly.

Step 1: ZJL with chemical structure R2=R4=R5=H atom and R3 is hexyl and R1 is hexanoate was prepared as per the method given above in Example 1 and replacing appropriate reactants.

Step 2: 10 grams of Cellulose pulp of DP 760 was weighed and dissolved in 90 grams of said ZJL at 110 °C with overhead stirrer at 500 rpm for 6 hrs.

Step 3: The final clear polymer solution was completely precipitated by contacting with 10 times water.

Step 4: The precipitating water was distilled to remove the excess water.

The residue of the distillation obtained is step 4 was recycled by adding in Step 2 for further two times. The final residue of ZIL collected after 3rd recycle was evaluated using HPLC for percentage purity (Fig. 1). The HPLC curve showed high purity (98.17%) of the solvent after 3 cycles.

A standard ionic liquid such as ethyl methyl imidazole acetate (Fig. 2) shows peaks of imidazole, ethyl imidazole and methyl imidazole in the example showed a HPLC purity of 97.21% after 3 cycles.
From the above study it is observed that the compound of Formula I of the present disclosure has higher thermal stability than standard ionic liquids.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", 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.

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 invention to achieve one or more of the desired objects or results.

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

The numerical values mentioned for the various physical parameters, dimensions or quantities are only approximations and it is envisaged that the values higher/lower than the numerical values assigned to the parameters, dimensions or quantities fall within the scope of the disclosure, unless there is a statement in the specification specific to the contrary.

While considerable emphasis has been placed herein on the product and the process, it will be appreciated that alterations can be made and that many modifications can be made in the preferred embodiment departing from the principles of the disclosure. These and other changes in the preferred product and the process of the disclosure 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.
Claims:

1. A compound of Formula I:

   \[
   \text{Formula I}
   \]

   wherein, \( R_2, R_4 \) and \( R_5 \) are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

   \( R_1 \) and \( R_3 \) are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

   at least one of \( R_1 \), \( R_2 \), \( R_3 \), \( R_4 \) and \( R_5 \), at a terminal end, bears an anion selected from the group consisting of carboxylate \((-\text{COO}^-)\), sulfate \((-\text{SO}_4^-)\), sulfonate \((-\text{SO}_3^-R_6^-)\), phosphate \((-\text{P}_0^-)\) and phosphonate \((-\text{P}_3^-R_7^-)\), wherein \( R_6 \) and \( R_7 \) are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.

2. The compound as claimed in claim 1, wherein

   \( R_2, R_4 \) and \( R_5 \) are hydrogen,

   \( R_1 \) is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion \((-\text{COO}^-)\) at the terminal end, and

   \( R_3 \) is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neo_hexyl, heptyl, isoheptyl, neoheptyl, octyl and tetradecyl.

3. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is ethanoate (CH$_3$-COO$^-$), and
R3 is methyl.

4. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is butanoate (CH$_3$-CH$_2$-CH$_2$-COO$^-$), and
R3 is propyl.

5. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
R3 is butyl.

6. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
R3 is hexyl.

7. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
R3 is octyl.

8. The compound as claimed in claim 1, wherein
R2, R4 and R5 are hydrogen,
R1 is hexanoate (CH$_3$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-CH$_2$-COO$^-$), and
R3 is tetradecyl.

9. A process for preparing a compound of Formula I, said process comprising the following steps:

   a. reacting a compound of Formula IV and a compound of Formula V to obtain a compound of Formula II;

wherein, m is an integer ranging between 1 and 20;

R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R3 is an organic group with 1 to 20 carbon atoms;

at least one of R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO⁻), sulfate (-SO₄²⁻), sulfonate (-SO₃R₆⁻), phosphate (-P0₄⁻) and phosphonate (-P0₃R⁷⁻), wherein R6 and R7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms; and

R' is selected from the group consisting of carboxylate (-COOR8), sulfate (-SO₄R9), sulfonate (-SO₃R6RIO), phosphate (-P0₄R11) and phosphonate (-P0₃R7R12), wherein R6, R7, R8, R9, RIO, R11 and R12 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms.
b. converting a compound of Formula II into a compound of Formula III; and

\[ \text{Formula II} \quad \rightarrow \quad \text{Formula III} \]

wherein, \( m, R_2, R_3, R_4, R_5, X, \) and \( R' \) have the same meaning as defined above,

c. hydrolyzing a compound of Formula III to obtain a compound of Formula I.

\[ \text{Formula III} \quad \rightarrow \quad \text{Formula I} \]

wherein, \( m, R_1, R_2, R_3, R_4, R_5 \) and \( R' \) have the same meaning as defined above.

10. The process as claimed in claim 9, wherein

- \( m \) is an integer ranging between 1 and 20;
- \( R_2, R_4 \) and \( R_5 \) are hydrogen;
- \( R' \) is carboxylate (-COOR\(_8\)), wherein \( R_8 \) is selected from the group consisting of an organic group with 1 to 5 carbon atoms;
R1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO⁻) at the terminal end; and

R3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neohexyl, heptyl, isoheptyl, neoheptyl, octyl and tetradecyl.

11. The process as claimed in claim 9, wherein

R2, R4 and R5 are hydrogen,

R1 is selected from the group consisting of ethanoate (CH₃-COO⁻), butanoate (CH₃-CH₂-CH₂-COO⁻) and hexanoate (CH₃-CH₂-CH₂-CH₂-CH₂-COO⁻), and

R3 is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.

12. The process as claimed in claim 9, wherein the method step (a) is carried out at a temperature ranging between 20 °C and 50 °C for a time period ranging between 24 hours and 72 hours.

13. The process as claimed in claim 9, wherein the method step (b) is carried but at a temperature ranging between 20 °C and 50 °C for a time period ranging between 1 hour and 6 hours, using at least one reagent selected from the group consisting of Amberlyst A-26 (-OH form), INDION-GS300 (-OH form), Dowex Marathon 550A -(OH form), Dowex Monosphere 550A (OH form), Amberjet 4400 (OH form) and Amberjet 9000 (OH form) in the presence of a solvent selected from the group consisting of methanol, ethanol, propanol, isopropanol and butanol.

14. The process as claimed in claim 9, wherein the method step (c) is carried out at a temperature ranging between 55 °C and 130 °C for a time period ranging
between 2 hours and 10 hours in the presence of a solvent selected from the group consisting of methanol, ethanol, propanol, isopropanol and butanol.

15. A solvent system comprising:

i. a compound of Formula I,

![Formula Image]

**Formula I**

wherein, R2, R4 and R5 are independently selected from the group consisting of hydrogen and an organic group with 1 to 20 carbon atoms;

R1 and R3 are independently selected from the group consisting of an organic group with 1 to 20 carbon atoms; and

at least one of R1, R2, R3, R4 and R5, at a terminal end, bears an anion selected from the group consisting of carboxylate (-COO\(^-\)), sulfate (-SO\(_4\)^-), sulfonate (-SO\(_3\)R\(^-\)), phosphate (-PO\(_4\)^-) and phpsphoiiate (-PO\(_3\)R\(^-\)), wherein R6 and R7 are independently selected from the group consisting of hydrogen and an organic group with 1 to 5 carbon atoms, and

ii. optionally, at least one solvent selected from the group consisting of dimethyl formamide, dimethyl sulfoxide, dimethyl acetamide, dimethyl imidazole, N-methyl pyrrolidinone, valerolactam, eaprolactam, pyrrolidinone, dimethyl propylene urea, sulfolane, acetyl acetone, butanol, pentanol, isopropanol, propylene glycol, butane-diol, glycerol, m-cresol, methyl ethyl ketone, mixture of calcium chloride and methanol, trifluoroethanol and water.
wherein, said solvent system being capable of dissolving at least one polymer selected from the group consisting of cellulose, acrylic, nylon and polyester.

16. The solvent system as claimed in claim 15, wherein

R2, R4 and R5 are hydrogen,

R1 is selected from the group consisting of an organic group with 1 to 20 carbon atoms bearing carboxylate anion (-COO⁻) at the terminal end, and

R3 is selected from the group consisting of methyl, ethyl, propyl, butyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, isohexyl, neohexyl, heptyl, isohexyl, neoheptyl, octyl and tetradecyl.

17. The solvent system as claimed in claim 15, wherein

R2, R4 and R5 are hydrogen,

R1 is selected from the group consisting of ethanoate (CH₃-COO⁻), butanoate (CH₃-CH₂-CH₂-COO⁻) and hexanoate (CH₃-CH₂-CH₂-CH₂-CH₂-COO⁻), and

R3 is selected from the group consisting of methyl, propyl, butyl, hexyl, octyl and tetradecyl.
### INTERNATIONAL SEARCH REPORT

**International application No**
PCT/IN2013/001176

**A. CLASSIFICATION OF SUBJECT MATTER**

**INV. C07D233/64**

**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:)

C07D

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**

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Further documents are listed in the continuation of Box C.

See patent family annex.

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**Date of the actual completion of the international search**

4 September 2013

**Date of mailing of the international search report**

20/09/2013

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