



(51) International Patent Classification:

C02F 1/26 (2006.01) C02F 103/36 (2006.01)
 C02F 1/68 (2006.01) C02F 1/00 (2006.01)
 C02F 101/32 (2006.01) C02F 1/02 (2006.01)
 C02F 101/34 (2006.01)

(21) International Application Number:

PCT/IB2016/051220

(22) International Filing Date:

4 March 2016 (04.03.2016)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

705/MUM/2015 4 March 2015 (04.03.2015) IN
 706/MUM/2015 4 March 2015 (04.03.2015) IN

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(81) Designated States (unless otherwise indicated, for every
 kind of national protection available): AE, AG, AL, AM,
 AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY,
 BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM,
 DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
 HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR,
 KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG,
 MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM,
 PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC,
 SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,
 TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
 kind of regional protection available): ARIPO (BW, GH,
 GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ,
 TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU,
 TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,
 DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
 LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
 SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
 GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— of inventorship (Rule 4.17(iv))

Published:

— with international search report (Art. 21(3))

(54) Title: METHOD FOR SEPARATING POLLUTANT FROM WASTEWATER AND SYSTEM THEREOF

(57) Abstract: The present disclosure relates to separation or recovery of pollutant from wastewater. The instant process involves the use of ionic liquid, such as but not limiting to ionic liquid with a hydrophobic nature. The pollutant being recovered from the wastewater may be a Chemical Oxygen Demand (COD) contributing compound. The present disclosure also includes a system for carrying out the separation or recovery of pollutant from wastewater using ionic liquid.



WO 2016/139626 A1

**“METHOD FOR SEPARATING POLLUTANT FROM WASTEWATER AND
SYSTEM THEREOF”**

TECHNICAL FIELD

5 **[001].** The present disclosure relates to the field of wastewater management and ionic liquids in general. Specifically, the present disclosure relates to separation or recovery of pollutant from wastewater. The instant process involves the use of ionic liquid, such as but not limiting to ionic liquid with a hydrophobic nature. The pollutant being recovered from the wastewater may be a Chemical Oxygen Demand (COD) contributing compound. The instant disclosure
10 also includes a system for carrying out the separation or recovery of pollutant from wastewater using ionic liquid.

BACKGROUND

15 **[002].** One of the most common problems faced in today's era is water pollution. Water is contaminated due to various effluents from industrialization, mining, sewage discharge, oil leakages, marine dumping, urbanization, refineries etc. Industries pump various harmful chemicals like organic and inorganic pollutants into water, thereby increasing the hazardous chemical concentration in water. The content of such hazardous chemicals in the water can be measured by checking Chemical Oxygen Demand (COD) level of the water.

20 **[003].** Generally, petroleum crude contains various salts such as NaCl, MgCl₂ and CaCl₂. Along with these salts, the aqueous phase of the petroleum crude is associated with the oil from the crude oil well. The amount of water received at the refinery with the crude varies widely in the range of 0.1–2.0% volume. The salts present in the crude oil accounts to a range from 10 to 250 pounds per thousand barrels (p.t.b.) of crude oil. Typically, the first operation
25 in a refinery crude unit is desalting of the crude petroleum, which is used to wash out all the salts present in the crude. Some of the reasons for removing the salts from the crude are to prevent plugging and fouling of process equipment by salt deposition and to reduce the corrosion caused by the formation of HCl from the chloride salts present in the crude during the subsequent processing of the crude. In order to achieve this, wash water is generally
30 injected into the desalter for removing the above mentioned salts of the crude, at high temperature of around 140-160°C.

[004]. The effluent/ wastewater obtained after such processes contains oil components, phenols and gaseous components like H₂S and NH₃, along with the dissolved salts as major contaminants. Some of the mud particles that come along with the crude during drilling tend

to accumulate in the desalter which needs to be removed to avoid any processing problems. This can be achieved by increasing the wash water flow to the mud washing nozzles located at the bottom of the desalter. However, when this operation is carried out, it can result in increased discharges of hydrocarbons to the wastewater treatment system. As a result of this, desalter wastewater often contains significant concentration of aromatic and aliphatic hydrocarbons, and other volatile gases like NH₃ and H₂S, that tend to vaporize in the sewers, leading to excessive emissions as well as odor problems in the surroundings.

[005]. Particularly, the desalter wastewater contains fine colloidal particles or fine aggregates of asphaltene mud particles along with high concentration of NH₃ and H₂S gases. Generally these gases are removed (stripped) through low pressure steam available in the refinery. The fine particles of mud and asphaltene aggregates cause choking (failure) of the stripper valves, and often require maintenance issues forcing the shutdown of the NH₃/H₂S gas stripping process.

[006]. Usually employed refinery wastewater treatment method consists of two types of oil removal systems prior to feeding it to a biological treatment process. They include API (American Petroleum Institute) separator followed by DAF (Dissolved Air Flotation) or IAF (Induced Air Flotation). In the initial API separator, the floating and settleable materials such as oil, water and solids in the wastewater are removed. This step is usually followed by DAF and IAF methods; these units are used for the removal of fine micron size suspension of oil in water emulsions and fine colloidal solids.

[007]. The API separator is normally the first wastewater treatment step in most refineries. The primary function of a properly designed API separator is to remove the gross quantities of hydrocarbons and suspended solids in the wastewater. Typically, the difference between the specific gravity of oil to be separated and water is much closer than the specific gravity of the suspended solids and water. Therefore, the design of the API separator is based on the difference in the specific gravity of the oil that is to be separated from the wastewater. However, the efficiency of separator goes down when the oil is in the emulsified form, and fine particles are in colloidal form. Thus, to remove the emulsified form of oils and fine colloidal particles, DAF and IAF methods were used. After these treatments, the water is sent to biological treatment process. Further depending on the local regulatory discharge standards, tertiary treatment may also employed (if necessary). However, DAF and IAF methods have limitations in separation of dissolved hydrocarbons and hydrocarbons having less than 35-50 μ m droplet size.

[008]. Polymer grade Terephthalic acid (1, 4-benzenedicarboxylic acid) ranks 25th in total tonnage of manufactured chemicals in the world. The American Amoco process is the established technology for manufacturing polymer-grade Terephthalic acid. It consists of a liquid-phase air oxidation of p-Xylene using Acetic acid as solvent, Co acetate, Mn acetate as catalysts and Bromine as a renewable source of free radicals. In the oxidation process, Terephthalic acid is obtained along with some impurities such as Benzoic acid, 4-formyl Benzoic acid, Trimellitic acid, ortho-Phthalic acid and p-Toluic acid. The presence of small fraction of 4-formyl Benzoic acid in product profile inhibits the properties of the end product (i.e., polyethylene terephthalate). This 4-formyl Benzoic acid impurity is hydrogenated back to p-Toluic acid in presence of water at 250 °C under hydrogen pressure, with noble metal catalyst (Pd) on a carbon support. After crystallisation of pure Terephthalic acid from the mother liquor, the waste stream typically contains 4-formyl Benzoic acid and p-Toluic acid (4-methylbenzoic acid). These impurities together with Terephthalic, benzoic and acetic acids are found to be the main organic pollutants in the wastewaters generated by the oxidation and the purification steps. Approximately 3-4 m³ of wastewater with around 10 kg COD/m³ is produced for 1 tonne of PTA (Purified Terephthalic Acid) manufactured.

[009]. At present, the most commonly used methods for PTA wastewater treatment operate in two stages, anaerobic digestion followed by aerobic treatment. The term 'anaerobic treatment' implies a treatment process that is carried out without oxygen in the temperature range of 35-40°C. Anaerobic digestion of organic matter is carried out by a special mixed group of anaerobic micro-organisms, which utilize the organic matter contained in the effluent/ wastewater as a source of food and energy. As a result of their normal growth cycle, the micro-organisms convert organic matter to a gaseous by-product called biogas/ methane and small amount of new cell mass. However, implementation of the anaerobic digestion process has substantial drawbacks, largely responsible for its limited uptake. The anaerobic bacteria tend to be slow growing and more sensitive to changes in conditions. Several operating parameters such as pH, temperature and presence of toxic metals need to be tightly controlled in order to achieve optimum performance. Despite the methane produced by anaerobic digestion, the high initial costs required to develop an anaerobic digester and the inherent complexities associated with it continue to hamper its economic development for PTA plant wastewater treatment.

[010]. Prior art also provides other methods that are adopted. Methods such as advanced oxidation process (AOP), supercritical water oxidation, UV-assisted ozonation (UV/O₃), ozone assisted photochemical oxidation (UV/O₃/H₂O₂), Photo-fenton oxidation

(UV/H₂O₂/FeSO₄), ozone assisted Photo-Fenton oxidation (UV/O₃/H₂O₂/FeSO₄) and Gamma ray assisted radiation treatment, have been used for PTA wastewater treatment. However, high costs for treatment and generation of toxic intermediates and sludge, which in turn cause secondary pollution, have been identified as major limitations of these methods. In all the above mentioned methods, organic matter is simply converted/ oxidised to the simple molecules such as CO₂.

[011]. The instant disclosure overcomes all the drawbacks observed in the prior art by providing a simple and cost-effective process to separate pollutants from wastewater by using ionic liquid.

SUMMARY OF THE DISCLOSURE

[012]. In some embodiments, the present disclosure relates to a method for separating pollutant from wastewater, said method comprising acts of:

- a) contacting wastewater with at least one phosphonium based ionic liquid and mixing to obtain mixture;
- b) incubating mixture of step a) to obtain upper layer comprising phosphonium based ionic liquid along with pollutant and lower layer comprising treated wastewater; and
- c) separating the upper layer comprising phosphonium based ionic liquid along with pollutant from the lower layer comprising treated wastewater.

[013]. In an embodiment, the upper layer of step c) is treated to recover the ionic liquid and the pollutant separately; wherein the treating is carried out by technique selected from group comprising solvent extraction, filtration and distillation or any combinations thereof.

[014]. In some embodiments, the present disclosure also relates to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is

configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater.

[015]. In an embodiment of the present disclosure, at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[016]. In some embodiments, the present disclosure also relates to a system for recovery of pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid;
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater; and
- d) at least one regeneration unit (IRU) fluidly connected to the at least one settling unit, the at least one regeneration unit receives the upper layer comprising ionic liquid and pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[017]. In an embodiment of the present disclosure, at least one solid separation unit (F1) configured in between the at least one heat exchanging unit (X) and the at least one mixing unit, wherein the at least one solid separation unit is configured to separate solid waste from the wastewater.

[018]. In an embodiment of the present disclosure, at least one separation unit (F2) configured in between the at least one settling unit and the at least one regeneration unit (IRU), wherein the at least one separation unit is configured to separate solid waste from the upper layer comprising phosphonium based ionic liquid and pollutant.

BRIEF DESCRIPTION OF THE ACCOMPANYING FIGURES

[019]. In order that the disclosure may be readily understood and put into practice, reference will now be made to exemplary embodiments as illustrated with reference to the accompanying figure. The figure together with detailed description below, are incorporated in
 5 and form part of the specification, and serve to further illustrate the embodiments and explain various principles and advantages, in accordance with the present disclosure where:

[020]. **Figure 1** depicts an exemplary embodiment of the present disclosure towards process flow diagram for separating pollutant from refinery wastewater.

10 [021]. **Figure 2** depicts an exemplary embodiment of the present disclosure towards process flow diagram for separating pollutant from PTA wastewater.

[022]. **Figure 3(A)** depicts sample of wastewater from the desalter/refinery (left vial) and sample of the wastewater treated using ionic liquid (right vial), at ionic liquid to wastewater ratio is 1:39.

15 [023]. **Figure 3(B)** depicts sample of the wastewater treated using ionic liquid, at ionic liquid to wastewater ratio of 1:78.

[024]. **Figure 4** depicts PTA wastewater treated with various IL/wastewater ratio.

A. PTA

B. IL/Wastewater ratio= 1:39

20 C. IL/Wastewater ratio= 1:78

D. IL/Wastewater ratio= 1:117

E. IL/Wastewater ratio= 1:156

DETAILED DESCRIPTION

25 [025]. To overcome the non-limiting drawbacks as stated in the background and to provide for simple, cost-effective and efficient method for separation or recovery of pollutant, the present disclosure provides a method which facilitates removal of pollutant from wastewater.

[026]. In some embodiments, the present disclosure relates to a method for separating pollutant from wastewater, said method comprising acts of:

- 30 a) contacting wastewater with at least one phosphonium based ionic liquid and mixing to obtain mixture;
- b) incubating mixture of step a) to obtain upper layer comprising phosphonium based ionic liquid along with pollutant and lower layer comprising treated wastewater; and

- c) separating the upper layer comprising phosphonium based ionic liquid along with pollutant from the lower layer comprising treated wastewater.

[027]. In some embodiments, the present disclosure relates to a system for separating pollutant from wastewater, the system comprising:

- 5 a) at least one heat exchanging unit (X) adapted to receive wastewater, the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to
- 10 mix the wastewater and the phosphonium based ionic liquid; and
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising
- 15 phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater.

[028]. In some embodiments, the present disclosure relates to a system for recovery of pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, the at least one
- 20 heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid;
- 25 c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising
- 30 treated wastewater; and
- d) at least one regeneration unit (IRU) fluidly connected to the at least one settling unit, the at least one regeneration unit receives the upper layer comprising ionic liquid and pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[029]. In an embodiment of the present disclosure, the upper layer of step c) is separated from the lower layer by decantation; the upper layer of step c) is treated to recover the ionic liquid and the pollutant separately; the treating is carried out by technique selected from group comprising solvent extraction, filtration and distillation or any combinations thereof; and the treating is carried out in unit selected from group comprising separation unit [F2] and regeneration unit [IRU] or combination thereof.

[030]. In an embodiment of the present disclosure, the contacting and the mixing is carried out in mixing unit [M]; the incubating of step b) is carried out in settling unit [S]; and the contacting, mixing, incubating or separating is carried out at temperature ranging from about 10°C to about 100°C for a time period ranging from about 1 minute to about 120 minutes.

[031]. In an embodiment of the present disclosure, at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[032]. In an embodiment of the present disclosure, the system comprises at least one solid separation unit (F1) configured in between the at least one heat exchanging unit (X) and the at least one mixing unit, the at least one solid separation unit is configured to separate solid waste from the wastewater.

[033]. In an embodiment of the present disclosure, the system comprises at least one separation unit (F2) configured in between the at least one settling unit and the at least one regeneration unit (IRU), the at least one separation unit is configured to separate solid waste from the upper layer comprising phosphonium based ionic liquid and pollutant.

[034]. In an embodiment of the present disclosure, the at least one settling unit is fluidly connected to at least one biological treatment assembly (ASP) to obtain the wastewater from the settling unit.

[035]. In an embodiment of the present disclosure, the at least one mixing unit comprises an inlet port fluidly connected to a phosphonium based ionic liquid source through a first passage.

[036]. In an embodiment of the present disclosure, the system comprises a bypass passage fluidly connected between at least one of:
the at least one regeneration unit (IRU) and the at least one settling unit (S); and
the first passage.

[037]. In an embodiment of the present disclosure, the system is operational in mode selected from group comprising batch mode, semi-continuous mode and continuous mode, or

any combinations thereof; the heat exchanging unit [X] is a heat exchanger selected from group comprising shell heat exchanger, tube heat exchanger and flash evaporator or any combinations thereof; the mixing unit [M] is selected from group comprising stirred vessel reactor, plug flow reactor, static mixer, jet mixer and pump mixer or any combinations thereof; the settling unit [S] is selected from group comprising gravity settling vessel and centrifuge settler or combinations thereof; the biological treatment assembly (ASP) is activated sludge assembly; the regeneration unit [IRU] is selected from group comprising distillation column, filtration unit and extraction column or any combinations thereof; and the solid separation unit [F1] and the separation unit [F2] is selected from group comprising nutsch filter, bag filter and press filter or any combinations thereof.

[038]. In an embodiment of the present disclosure, the wastewater is selected from group comprising industrial wastewater, PTA wastewater, refinery wastewater and desalter wastewater.

[039]. In an embodiment of the present disclosure, the pollutant is selected from group comprising organic compound, inorganic compound and solid waste or any combinations thereof; the organic compound is hydrocarbon compound; and the solid waste is selected from group comprising mud particle, asphaltene, resin, silt and solid particulate matter or any combinations thereof.

[040]. In an embodiment of the present disclosure, the hydrocarbon is selected from group comprising aliphatic hydrocarbon or aromatic hydrocarbon or combination thereof; and the hydrocarbon is selected from group comprising oil, benzoic acid, p-toluic acid, terephthalic acid, 4-carboxy benzoic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid or any combinations thereof.

[041]. In an embodiment of the present disclosure, the phosphonium based ionic liquid is selected from group comprising trihexyl (tetradecyl) phosphonium chloride and trihexyl (tetradecyl) phosphonium bromide, or combination thereof; volume ratio of the ionic liquid to the wastewater is ranging from about 1:30 to about 1:200, preferably about 1:39 to about 1:150.

[042]. As used herein, the term 'method' and 'process' have the same scope and meaning and are used interchangeably.

[043]. As used herein, the term 'wastewater' refers to water produced as a by-product of industrial or commercial activities. In an embodiment, the wastewater employed in the present disclosure is in treated or untreated form.

[044]. As used herein, the term 'PTA wastewater' or 'Purified Terephthalic Acid wastewater' refers to wastewater generated from PTA manufacturing industry.

[045]. As used herein, the term 'refinery wastewater' refers to wastewater generated from refinery industry. In an exemplary embodiment of the present disclosure, the refinery industry is selected from but not limiting to oil refinery, petroleum refinery, etc.

[046]. As used herein, the term 'desalter wastewater' or 'refinery desalter wastewater' refers to wastewater generated from desalting operation.

[047]. As used herein, the term 'pollutant' refers to undesired substance(s) or contaminant(s) present in the wastewater. In an embodiment, the undesired substance(s) or contaminant(s) may cause harm to living beings or environment or equipment or any industrial/commercial setup. In an embodiment of the present disclosure, the pollutant is in a form selected from a group comprising solid, liquid and gas or any combinations thereof.

[048]. As used herein, the term 'modulate temperature' refers to increasing, decreasing or maintaining temperature.

[049]. Ionic liquids which are hydrophobic in nature, and are stable in the presence of air and water, are a possible candidate solvent for liquid-liquid extraction. These hydrophobic ionic liquids are used to extract pollutants such as hydrocarbon compounds and organic compounds from aqueous solutions. The task specific solvent includes a metal ion-ligating functional group which is incorporated into one of the ions of an ionic liquid, such that it functions as both a hydrophobic solvent and an extracting agent.

[050]. The present disclosure relates to a method of treating wastewater using ionic liquid (IL) or separation/ recovery of pollutant from wastewater using ionic liquid.

[051]. In the present disclosure, an extraction or separation method is introduced for the recovery of pollutant such as but not limiting to organic compound, using ionic liquid such as the hydrophobic nature Phosphonium based cationic type ionic liquid, which recovers the COD contributing organic compound from the wastewater with high efficiency.

[052]. In a non-limiting embodiment, the wastewater includes but is not limiting to wastewater evolved during various process steps conducted to prepare final product in various industries and refineries or any combinations thereof. In a preferred non limiting embodiment, the wastewater is selected from group comprising industrial wastewater, PTA wastewater, isophthalic acid wastewater, refinery wastewater and desalter wastewater or any combinations thereof.

[053]. In an embodiment, the wastewater is selected from group comprising refinery wastewater and PTA wastewater.

[054]. In an embodiment, the wastewater comprises pollutant such as but not limiting to organic compound(s), inorganic compound(s), non-metals, salt(s) solid waste and dissolved gas or any combinations thereof. In an embodiment of the present disclosure, the organic compound is hydrocarbon compound.

5 [055]. In a non-limiting embodiment, the hydrocarbon compound includes but is not limited to aliphatic or aromatic hydrocarbon or combination thereof. In a preferred non limiting embodiment, the hydrocarbon compound is emulsified hydrocarbon. In another non-limiting embodiment, the hydrocarbon compound is high molecular weight hydrocarbon. In another non-limiting embodiment, the hydrocarbon compound is in dissolved or dispersed form.

10 [056]. In an exemplary embodiment of the present disclosure, the hydrocarbon is selected from group comprising oil, phenol, benzoic acid, p-toluic acid, terephthalic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid or any combinations thereof.

[057]. In an exemplary embodiment of the present disclosure, the inorganic compound is
15 selected from a non-limiting group comprising CaCl_2 , MgCl_2 , NaCl , silt (SiO_2) or any combinations thereof.

[058]. In an exemplary embodiment of the present disclosure, the solid waste is selected from group comprising mud particle, asphaltene, resin, silt and solid particulate matter, or any combinations thereof.

20 [059]. In a non-limiting embodiment of the present disclosure, solid particulate matter is precipitated organic compounds such as precipitated organic acid.

[060]. In an exemplary embodiment of the present disclosure, the dissolved gas is selected from a non-limiting group comprising H_2S and NH_3 or combination thereof.

[061]. In an embodiment, the present disclosure employs ionic liquid as an extractant for
25 separation/recovery of pollutant from wastewater.

[062]. In an embodiment, the ionic liquid used for treating wastewater is a hydrophobic ionic liquid.

[063]. In another embodiment, the ionic liquid is cationic type ionic liquid.

[064]. In an exemplary embodiment, the cation of the ionic liquid is phosphonium. In an
30 embodiment, the phosphonium cation of the ionic liquid is capable of extracting pollutants.

[065]. In a preferred embodiment, the ionic liquid is phosphonium based ionic liquid.

[066]. In an embodiment, structure of cation influences extractive properties of ionic liquid. Coordination mechanism (where in hydrogen bonding) is the main principle which governs the extraction of organic compound and hydrocarbons, which is facilitated by the

phosphonium cation of the ionic liquid. Phosphonium cation can either donate or accept electrons.

[067]. In an exemplary embodiment, the anion of the ionic liquid is selected from group comprising chloride and bromide.

5 [068]. In an exemplary embodiment, the ionic liquid is trihexyl (tetradecyl) phosphonium chloride [C₃₂H₆₈P⁺Cl⁻]. In an embodiment, the density of ionic liquid is 0.882 gm/cc.

[069]. In an embodiment of the present disclosure, the ionic liquid and pollutant form a separate layer from the wastewater layer after the ionic liquid is mixed with the wastewater and the ionic liquid extracts the pollutant.

10 [070]. In an embodiment, the layer comprising ionic liquid, being hydrophobic in nature, gets separated from the layer comprising aqueous wastewater, because of density difference. The separation of layers occurs by normal sedimentation.

[071]. In an embodiment, after sedimentation, the upper layer and the lower layer are separated by technique including but not limiting to decantation.

15 [072]. In an embodiment, contacting wastewater with phosphonium based ionic liquid and mixing provides a mixture; and sedimentation of this mixture provides upper layer comprising phosphonium based ionic liquid along with pollutant and lower layer comprising treated wastewater.

[073]. In an embodiment of the present disclosure, the ionic liquid is recovered/ regenerated.

20 [074]. In an embodiment of the present disclosure, the ionic liquid is recovered or regenerated by separation of the pollutant associated with the ionic liquid, after the extraction of pollutant from wastewater. The ionic liquid and pollutant are separated by technique selected from group comprising filtration, distillation and extraction or any combinations thereof.

25 [075]. In an exemplary embodiment, the ionic liquid interacts with wastewater and facilitates the separation/extraction of Chemical Oxygen Demand (COD) contributing pollutant. Chemical Oxygen Demand indicates the amount of oxidisable organic compounds present in the water (expressed as parts per million or milligrams per liter of water). Higher the chemical oxygen demand, higher the amount of pollutant in the test sample. In an
30 embodiment, the COD is measure of water quality and indicates amount of oxidisable chemical pollutant present in the wastewater. Thus, in an embodiment, the reduction in COD of a wastewater sample after treatment with ionic liquid is used to calculate the percentage (%) of extraction of pollutant such as organic compound from the sample.

[076]. In an embodiment of the present disclosure, the COD level of water is detected using normal laboratory method of analysis, such as but not limiting to potassium dichromate method.

[077]. In an embodiment of the present disclosure, the COD level of wastewater is reduced by the method of the present disclosure from a range of about 2000-10000 ppm to about 300 to 1500 ppm.

[078]. In a preferred embodiment, during the process of extraction of pollutant such as organic compound from the wastewater, the process decreases/reduces the COD level of wastewater.

[079]. In an embodiment of the present disclosure, extraction of the pollutant from the wastewater ranges from about 70% to about 95%, preferably from about 80% to about 90% by weight of the initial pollutant present in the wastewater.

[080]. In an embodiment, hydrocarbon compound contributes to the COD in the wastewater.

[081]. In an embodiment, mode of extraction of the pollutant from wastewater is due to affinity of the pollutant towards hydrophobic ionic liquid.

[082]. In an embodiment of the present disclosure, pollutant interacts with ionic liquid by mechanisms such as coordination mechanism (i.e., hydrogen bonding) and ion exchanging mechanism with dissociated organic acids.

[083]. In an embodiment of the present disclosure, pollutants such as mud particles attach to the hydrocarbon pollutant such as high molecular weight hydrocarbon and thus are indirectly associated to the ionic liquid, facilitating their extraction.

[084]. In an embodiment of the present disclosure, pollutant of the wastewater, such as organic acid not limiting to benzoic acid, p-toluic acid, terephthalic acid, 4-carboxy benzoic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid is precipitated as solid waste, upon reduction of temperature in Heat exchanging Unit, and the concentration level of the acid is decreased in the wastewater, till it dissolves in the wastewater. The dissolved organic acid in the wastewater is further extracted from the wastewater on contacting with the ionic liquid.

[085]. In an embodiment of the present disclosure, pollutant of the wastewater, such as organic acid not limiting to benzoic acid, p-toluic acid, terephthalic acid, 4-carboxy benzoic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid interacts with the Ionic Liquid in the Mixing Unit and is separated from the wastewater by extracting with the Ionic Liquid.

[086]. In an embodiment of the present disclosure, the existence of polarizable π electrons present in aromatic pollutants has a positive effect on solubility in ionic liquids. This aspect is used in selective extraction of valuable organic compounds.

[087]. In an embodiment, the hydrocarbon compound(s) which contribute to the COD in the refinery wastewater, the gasses causing pungent smell/odor and the fine mud particles adsorbed with asphaltenes are the major components in the desalter wastewater. In another embodiment, ionic liquid such as but not limited to the phosphonium based hydrophobic ionic liquid has the ability to extract these pollutant(s) from desalter wastewater stream.

[088]. In a non-limiting embodiment, the instant extraction method using ionic liquid can replace or eliminate the troublesome ammonia/H₂S stripping sections used for the removal of various odor causing pollutants and cost intensive primary treatment processes involved in treating the wastewater. The equipment generally used for primary treatment processes are API separator followed by air flotation systems. In an alternative embodiment, subsequently, the load on the biological treatment process, i.e., load on the activated sludge process which is for e.g.: the aeration tank/clarifier; can be reduced drastically, and the tertiary treatment methods can be eliminated completely.

[089]. In another embodiment, following the instant method, the ionic liquid is recovered back by settling/filtering the fine mud particles followed by distilling the pollutant. In an embodiment, the regenerated ionic liquid is used for further treatment without any loss of its extraction efficiency.

[090]. In an embodiment, the instant disclosure relates to a method of recovering the pollutant from the desalter wastewater by simple extraction process using the phosphonium based hydrophobic ionic liquid.

[091]. In an embodiment, the instant method is a method for replacing the cost intensive and time consuming primary treatment process such as API separator and air flotation methods that are involved in the treatment of desalter wastewater.

[092]. In another embodiment, the treated wastewater can be reused for various applications such as but not limiting to refinery operations, cooling tower make up, irrigation purpose, internal equipment washing, etc.

[093]. In yet another embodiment, the extracted/recovered/separated pollutant such as hydrocarbon is recycled back to the main process lines/crude distillation unit after the desalting operation in the refinery, without much loss of process yields.

[094]. In an embodiment, the present disclosure relates to method of separating or extracting or recovering pollutant from wastewater such as but not limited to desalter wastewater, wherein said method comprises act selected from group comprising:

- a) subjecting the wastewater comprising pollutant, such as but not limiting to refinery desalter wastewater, present at high temperature to heat exchanging unit to reduce the temperature;
- b) mixing the desalter wastewater obtained from the above step with ionic liquid in mixing unit and thereafter separating the lower aqueous layer and upper layer comprising ionic liquid and recovered pollutant in settling unit;
- c) optionally subjecting the separated ionic liquid layer to recycling;
- d) optionally subjecting the ionic liquid layer from the step b) to separation in separation unit for removal of pollutants such as fine solid contaminants;
- e) optionally recycling and/or regeneration of the ionic liquid along with recovery of the pollutant such as hydrocarbon, asphaltene and resin in regeneration unit; and
- f) optionally subjecting the separated wastewater to biological treatment process in biological treatment assembly for further decrease of COD levels; or
- g) any combinations thereof.

[095]. In an embodiment of the present disclosure, solid pollutant such as silt, mud particles, etc. extracted with the ionic liquid are separated from the upper layer comprising ionic liquid and pollutant in the filtration unit; and pollutant such as liquid and high volatile pollutant such as hydrocarbons, resins, asphaltene, organic acid etc. extracted with the ionic liquid are separated from the upper layer comprising ionic liquid and pollutant in the regeneration unit.

In an embodiment of the present disclosure, the method of extraction of pollutant from wastewater such as but not limiting to PTA wastewater, using the ionic liquid such as but not limiting to phosphonium based hydrophobic ionic liquid has the ability to extract the pollutant such as but not limiting to organic compound, which contributes to the COD in the PTA wastewater. In a further embodiment, the instant method replaces or eliminates the cost intensive anaerobic digestion process typically practiced in the PTA wastewater treatment process. In an alternative embodiment, the COD level of wastewater after extraction/separation of pollutant with ionic liquid is suitable for feeding to process such as but not limiting to activated sludge aerobic treatment. In a non-limiting embodiment, the instant process is followed by aerobic treatment. In another embodiment, the treated wastewater produces less sludge during the aerobic treatment.

[096]. In an embodiment, the instant method provides for replacing the cost intensive and time consuming anaerobic digestion by simple extraction process using the phosphonium based cationic type ionic liquid as an extractant.

[097]. In an embodiment, the present disclosure relates to method of separating or extracting or recovering pollutant from wastewater such as but not limiting to PTA wastewater, wherein said process comprises act selected from group comprising:

- a) subjecting the wastewater solution present at high temperature to heat exchanging unit to reduce the temperature of the wastewater, facilitating precipitation of solid waste and separating the same from the wastewater in the solid separation unit;
- b) mixing ionic liquid and the wastewater obtained from the above step in mixing unit and thereafter separating layer comprising ionic liquid and recovered pollutant from layer comprising the aqueous wastewater in settling unit;
- c) optionally subjecting the separated ionic liquid layer containing pollutant to recycling and/or regeneration of the ionic liquid along with recovery of the pollutant in regeneration unit; and
- d) optionally subjecting the separated wastewater to biological treatment process in biological treatment assembly for further decrease of COD levels; or
- e) any combinations thereof.

[098]. In an embodiment, the ionic liquid and the wastewater are mixed at temperature ranging from about 10oC to about 100oC, preferably about 30oC to about 70oC, more preferably about 50°C; pressure ranging from about 0.1 atmosphere to about 10 atmospheres, preferably about 0.5 atmosphere to about 5 atmospheres; and time duration ranging from about 10 min to about 120 min, preferably about 20 min to about 70 min.

[099]. In another embodiment, the ratio of ionic liquid to wastewater is ranging from about 1:30 to about 1:200, preferably from about 1:39 to about 1:150, more preferably from about 1:39 to about 1:100.

[0100]. In another embodiment, the ratio of ionic liquid to wastewater ranges from about 1:30 to about 1:200, about 1:30 to about 1:190, about 1:40 to about 1:180, about 1:50 to about 1:170, about 1:60 to about 1:160, about 1:70 to about 1:150, about 1:80 to about 1:140, about 1:90 to about 1:130, about 1:100 to about 1:120.

[0101]. In another embodiment, the ratio of ionic liquid to wastewater is about 1:30, about 1:39, about 1:40, about 1:50, about 1:60, about 1:70, about 1:80, about 1:90, about 1:100, about 1:110, about 1:120, about 1:130, about 1:140, about 1:150, about 1:160, about 1:170, about 1:180, about 1:190, about 1:200.

[0102]. In another embodiment, the method of the present disclosure requires lower amount of ionic liquid to treat wastewater and is cost effective.

[0103]. In another embodiment, the process volume occupied in the present disclosure is less.

[0104]. In an embodiment, the present disclosure provides for a solvent based extraction process and can hence also be employed for separation of dissolved hydrocarbons and hydrocarbons having lesser than 35 μm to 50 μm droplet size. Further, the method of the present disclosure requires use of lower quantity of ionic liquid. Furthermore, the ionic liquid employed in the process can be recovered/regenerated for further treatment without any loss of its extraction efficiency.

[0105]. In an embodiment, the process of the present disclosure is not sensitive to changes in operating parameter, wherein operating parameter includes but is not limited to pH, temperature, presence of toxic metal and high organic shock loadings; or any combinations thereof.

[0106]. In an embodiment, the present disclosure relates to a method for separating pollutant from wastewater, said method comprising acts of:

- a) modulating temperature of wastewater obtained from source;
- b) contacting the wastewater with at least one phosphonium based ionic liquid and mixing to obtain mixture;
- c) incubating mixture of step a) to obtain upper layer comprising phosphonium based ionic liquid along with pollutants and lower layer comprising treated wastewater; and
- d) separating the upper layer comprising phosphonium based ionic liquid along with pollutant from the lower layer comprising treated wastewater.

[0107]. In an embodiment, the temperature of wastewater in above step a) is modulated to range from about 30°C to about 70°C.

[0108]. In an embodiment, the contacting, mixing, incubating or separating is carried out at temperature ranging from about 10°C to about 100°C for a time period ranging from about 1 minutes to about 120 minutes.

[0109]. In an embodiment, the contacting is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 10 minutes to about 100 minutes.

[0110]. In an embodiment, the mixing is carried out at temperature ranging from about 10°C to about 100°C for a time period ranging from about 1 minute to about 120 minutes.

[0111]. In an embodiment, the incubating is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 5 minutes to about 100 minutes.

[0112]. In an embodiment, the separating is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 5 minutes to about 100 minutes.

[0113]. In an embodiment, the solid particulate matter is precipitated organic compound such as but not limiting to precipitated organic acid.

5 [0114]. In an embodiment, recovery of pollutant such as hydrocarbons from the upper layer comprising ionic liquid and pollutant is by method selected from group comprising filtration, extraction such as solvent extraction and distillation or any combinations thereof.

[0115]. The present disclosure also relates to a system for the separation or recovery of pollutant from wastewater.

10 [0116]. In a non-limiting embodiment, the system is operational in either batch mode or semi-continuous mode or in continuous mode.

[0117]. In an embodiment, the recovery of the pollutant such as but not limited to hydrocarbon, mud particle, aggregates of asphaltene or combination thereof, from wastewater is done by subjecting the wastewater such as but not limited to desalter wastewater,
15 preferably refinery desalter wastewater to instant system [100].

[0118]. In an embodiment crude oil is subjected to desalting unit [D] to desalt the crude oil with water and the desalter wastewater from desalting unit is then subjected to unit selected from group comprising heat exchanging unit [X], solid separation unit [F1], mixing unit [M], settling unit [S], separation unit [F2], ionic liquid regeneration unit [IRU] and biological
20 treatment assembly [ASP] or any combinations thereof.

[0119]. In an embodiment, the recovery of the pollutant such as but not limited to hydrocarbon, solid waste or combination thereof, from wastewater is done by subjecting the wastewater such as but not limited to PTA wastewater, to instant system [200].

[0120]. In an embodiment, wastewater is subjected to unit selected from group comprising
25 heat exchanging unit [X], solid separation unit [F1], mixing unit [M], settling unit [S], separation unit [F2], ionic liquid regeneration unit [IRU] and biological treatment assembly [ASP] or any combinations thereof.

[0121]. In an embodiment, process such as but not limiting to activated sludge process and clarification is carried out in biological treatment assembly [ASP] for further reduction of
30 COD of the wastewater to below 150 ppm.

[0122]. In an embodiment, wastewater is subjected to unit selected from group comprising heat exchanging unit [X], optionally solid separation unit [F1], mixing unit [M], settling unit [S], optionally ionic liquid regeneration unit [IRU] and optionally biological treatment assembly [ASP] or any combinations thereof.

[0123]. In an embodiment, wastewater is subjected to unit selected from group comprising heat exchanging unit [X], mixing unit [M], settling unit [S], optionally separation unit [F2], optionally ionic liquid regeneration unit [IRU] and optionally biological treatment assembly [ASP] or any combinations thereof.

5 [0124]. In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- 10 b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater.

20 [0125]. In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- 25 b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater; and

- d) optionally at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

5 **[0126].** In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;

- 10 b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and

- 15 c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater; and

- 20 d) at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

25 **[0127].** In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;

- 30 b) at least one solid separation unit (F1) configured to the at least one heat exchanging unit (X), wherein the at least one solid separation unit is configured to separate solid waste from the wastewater;

- c) at least one mixing unit (M) fluidly connected to the at least one solid separation unit, the at least one mixing unit is configured to receive the wastewater from the at least

one solid separation unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and

- d) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater; and
- e) optionally, at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[0128]. In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit, the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid;
- c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater;
- d) at least one separation unit (F2) fluidly connected to the at least one settling unit, wherein the at least one separation unit is configured to separate solid waste from the upper layer comprising phosphonium based ionic liquid and pollutant; and
- e) at least one regeneration unit (IRU) is fluidly connected to the at least one separation unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[0129]. In an embodiment, the present disclosure pertains to a system for separating pollutant from wastewater, the system comprising:

- a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
- b) at least one solid separation unit (F1) configured to the at least one heat exchanging unit (X), wherein the at least one solid separation unit is configured to separate solid waste from the wastewater;
- c) at least one mixing unit (M) fluidly connected to the at least one solid separation unit, the at least one mixing unit is configured to receive the wastewater from the at least one solid separation unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and
- d) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater;
- e) at least one separation unit (F2) fluidly connected to the at least one settling unit, wherein the at least one separation unit is configured to separate solid waste from the upper layer comprising phosphonium based ionic liquid and pollutant; and
- f) at least one regeneration unit (IRU) is fluidly connected to the at least one separation unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.

[0130]. In an embodiment, the steps in the at least one heat exchanging unit, the at least one mixing unit or the at least one settling unit, is carried out at temperature ranging from about 10°C to about 100°C for a time period ranging from about 1 minutes to about 120 minutes.

[0131]. In an embodiment, the temperature of wastewater obtained from the source is modulated in at least one heat exchanging unit to range from about 30°C to about 70°C.

[0132]. In an embodiment, the step in the mixing unit is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 10 minutes to about 100 minutes.

[0133]. In an embodiment, the step in the settling unit is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 5 minutes to about 100 minutes.

[0134]. In an embodiment, the separating of the upper layer comprising the ionic liquid and pollutant from the lower layer comprising the separated wastewater is carried out at temperature ranging from about 30°C to about 80°C for a time period ranging from about 5 minutes to about 100 minutes.

[0135]. In an embodiment, recovery of pollutant such as hydrocarbons from the upper layer comprising ionic liquid and pollutant is by method selected from group comprising filtration, extraction such as solvent extraction and distillation or any combinations thereof.

[0136]. Figure 1 is an exemplary embodiment of the present disclosure which illustrates block diagram of the system [100] for recovering pollutant from wastewater such as but not limiting to refinery desalter wastewater. The system is operated in either batch or semi-continuous or continuous mode. The desalting unit [D] such as but not limited to refinery desalter, removes the salt present in the crude oil; and generates the desalter wastewater. The desalter wastewater obtained comprises pollutants such as but not limiting to salt, hydrocarbon, asphaltene, silt, etc. The desalting unit is fluidly connected via stream [A0] to the heat exchanging unit [X], wherein the desalter wastewater stream coming from desalting unit at temperature of about 140°C to about 160°C, is cooled down to temperature of about 30°C to about 80°C. In an embodiment, the heat exchanging unit is a heat exchanger including but not limiting to shell exchanger, tube heat exchanger and flash evaporator or any combinations thereof. The heat exchanging unit is fluidly connected via stream A1 to the mixing unit [M], through which the cooled wastewater stream enters the mixing unit. The ionic liquid such as but not limited to hydrophobic ionic liquid is fed into the mixing unit via stream A2. Hence, the hydrophobic ionic liquid and wastewater stream coming from the streams [A2] and [A1] respectively are mixed in the mixing unit [M]. In an alternate embodiment, the streams A2 and A1 are pre-mixed and then fed into the mixing unit. In an embodiment, the mixing unit [M] is including but not limited to reactor such stirred vessel reactor, plug flow reactor, and not limited to mixer such as static mixer, jet mixer and pump mixer or any combinations thereof. The streams are fed to mixing unit [M], wherein the temperature in M is ranging from about 10°C to about 100°C, with pressure ranging from about 0.1 atmosphere to about 10 atmospheres. In yet another embodiment, the volume ratio of ionic liquid to wastewater is in the range of about 1:30 to about 1:200. The time required for sufficient mixing/ extraction of pollutant by ionic liquid varies from about 10 min to

about 120 min. In an embodiment, the pollutant(s) present in the desalter wastewater stream are extracted/recovered into the ionic liquid phase.

[0137]. The outlet of mixing unit [M] is directly fed to the settling unit [S], where separation of layer comprising the hydrophobic ionic liquid and COD contributing dissolved pollutant such as but not limiting to hydrocarbon compound takes place from layer comprising the aqueous wastewater. In an embodiment, the settling unit [S] is including but not limited to gravity settling vessel and centrifuge settler or combination thereof. The mixing unit and the settling unit may be either jointly or separately present in the system. The separated aqueous wastewater is collected separately via stream A4 which is fluidly connected to the biological treatment assembly [ASP] such as but not limited to clarifier and activated sludge apparatus. In an embodiment, the biological treatment assembly [ASP] provides for further reduction of COD of the wastewater to below 150 ppm. In an embodiment, the separated stream A7 from the biological treatment assembly is sent for tertiary treatment or for refinery internal reuse.

[0138]. In an embodiment, the separated upper ionic liquid layer via stream A3 is termed as recycle ionic liquid which is sent via stream A5 for further mixing with the fresh desalter wastewater stream in the mixing unit. In a further embodiment, the ionic liquid collected via stream A3 can be recycled for about 3 - 10 times, before it is sent for filtration in separation unit [F2] such as filter system including but not limiting to nustch filter, bag filter and press filter or any combinations thereof; for removal of pollutants such as accumulated aggregates of asphaltene solid particles, silt, particulate solids and mud particles present in the ionic liquid layer via stream A10.

[0139]. In an embodiment, a part of the ionic liquid emerging via stream A3 from the Settling Unit [S] is fluidly connected via stream A5 to stream A2 and thereby to the Mixing Unit [M] for ionic liquid recycle. In an embodiment, the separation unit [F2] is fluidly connected via stream A6 to regeneration unit [IRU] such as but not limiting to distillation column/apparatus, wherein the ionic liquid is regenerated by known methods such as but not limiting to distillation, fractional distillation etc. The regenerated ionic liquid can be used for further extraction or recovery of pollutant such as hydrocarbons from the desalter wastewater. In an embodiment, the regenerated ionic liquid emerging from the regeneration unit [IRU] is fluidly connected via stream A8 to the stream A2 and thereby to the Mixing Unit [M] for ionic liquid recycle. In another embodiment, the distilled (low boilers) pollutants such as hydrocarbons are sent via stream A9 to crude distillation unit for further refining process.

[0140]. Figure 2 is an exemplary embodiment of the present disclosure which illustrates block diagram of the system [200] for recovering pollutant such as but not limiting to organic

compound, preferably aromatic organic compound, more preferably aromatic organic acid, from wastewater, for example PTA wastewater. The system is operated in either batch or semi-continuous or continuous mode. The storage tank [St] stores the wastewater such as but not limited to the PTA wastewater or Isophthalic acid wastewater, from which the pollutant has to be separated or recovered. The storage tank is fluidly connected via stream B1 to the heat exchanger [X]. The stream B1 carrying the wastewater, for ex.: wastewater stored in the storage tank [St] to the heat exchanging unit [X]; is at a temperature of ranging from about 25 °C to about 100 °C. In the heat exchanging Unit, the wastewater is cooled down to ambient temperature ranging from about 30°C to about 70°C. In an embodiment, the heat exchanging unit is a heat exchanger including but not limiting to shell heat exchanger, tube heat exchanger and flash evaporator or combination thereof. In a non-limiting embodiment, at this prevailing temperature ranging from about 30°C to about 70°C, solid waste such as Terephthalic acid and other impurities such as but not limiting to p-toluic acid, trimellitic acid, 4-carboxy benzoic acid, Phthallic acid, Benzoic acid, acetic acid etc. gets precipitated out. The heat exchanging unit is fluidly connected to the solid separation unit [F1] via stream B9, which helps in the removal of these precipitated solid waste pollutants from the process stream. In an exemplary embodiment, the Solid Separation Unit is filter system including but not limiting to nustch filter, bag filter and press filter or any combinations thereof.

[0141]. In another embodiment, the solid separation unit [F1] is fluidly connected via stream B2 to the mixing unit [M]. The ionic liquid is fed into the mixing unit via stream B3. Hence, the hydrophobic ionic liquid and wastewater stream coming from the streams B3 and B2 respectively; is mixed in the mixing unit [M]. In an embodiment, the mixing unit is including but not limited to reactor such as stirred vessel reactor, plug flow reactor, and mixer such as static mixer, jet mixer, pump mixer or any combinations thereof. The streams are fed to mixing unit [M], wherein the temperature in M is ranging from about 10°C to about 100°C, with pressure ranging from about 0.1 to about 10 atmospheres. In yet another embodiment, the volume ratio of ionic liquid to wastewater is in the range of about 1:30 to about 1:200. The time required for sufficient mixing/ extraction varies from about 10 min to about 120 min. In an embodiment, organic compound such as but not limited to Benzoic acid, p-toluic acid, Terephthalic acid, Isophthalic acid, trimellitic acid, Acetic acid, 4 formyl benzoic acid, orthophthalic acid and various other organic compounds present in the wastewater stream are extracted/ recovered into the ionic liquid phase. In an embodiment, the outlet of mixing unit [M] is directly fed to the settling unit [S], where separation of layer comprising the hydrophobic ionic liquid and the recovered pollutant takes place from layer comprising the

aqueous wastewater which may comprise about 5% of un-extracted pollutant such as organic compound. In an embodiment, the settling unit [S] is including but not limited to gravity settling vessel and centrifuge settler or combination thereof. The mixing unit and the settling unit may be either jointly or separately present in the system. The separated aqueous wastewater is collected separately via stream B5; which is fluidly connected to the aerobic treatment assembly [ASP].

[0142]. In an embodiment, the separated upper ionic liquid layer via stream B4 is termed as recycle ionic liquid, which is sent for further mixing with the fresh PTA wastewater stream in the mixing unit. In a further embodiment, the ionic liquid collected via stream B4 can be recycled for about 3 - 10 times, before it is sent for regeneration.

[0143]. In an embodiment, the separated aqueous wastewater from settling unit is sent via stream B5 to aerobic treatment assembly, for further removal of COD contributing pollutant such as organic compound by known aerobic method. The aqueous stream generated from aerobic treatment assembly is used for internal reuse or is discharged to water bodies via stream B7. The sludge separated from the wastewater in the ASP unit in this process is discharged through stream B8. Stream B6 connects Settling Unit to Regenerating Unit for ionic liquid regeneration.

[0144]. 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

[0145]. COD level of wastewater obtained from desalter/desalting unit of refinery process outlet is detected by potassium dichromate method, and is found to be about 2343 ppm. The desalter wastewater having temperature of around 150°C is cooled down to temperature of

about 50°C in the heat exchanging unit [X]. The cooled wastewater from the heat exchanging unit is mixed with the ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C, at 1 atmospheric pressure; and time duration of about 30 minutes. The volume ratio of ionic liquid to wastewater is about 1:39. The combined
5 volume of the ionic liquid and wastewater employed in the mixing unit is about 100 ml. The pollutants in the desalter wastewater stream are separated/ extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit is fed to settling unit [S], where separation of layer comprising the hydrophobic ionic liquid and the recovered pollutant such as but not limiting to hydrocarbon compound takes place from the layer comprising the separated
10 aqueous wastewater. The COD level of the separated wastewater obtained is about 474 ppm. The percentage of extraction is about 79.7%. Comparative view of samples of untreated wastewater and wastewater treated with the ionic liquid is depicted in Figure 3(a). As can be observed from the Figure 3(a), the color of the untreated (left) and treated (right) wastewater significantly changes. The change in color of the treated wastewater is due to removal of
15 pollutants such as hydrocarbons, asphaltene and colored compounds like silt, by the ionic liquid treatment.

[0146]. The separated aqueous wastewater is further fed into the biological treatment assembly [ASP], for further reduction of COD levels.

[0147]. The separated upper layer of ionic liquid is recycled about 3 – 4 times by entering the
20 mixing unit and settling unit, after which the ionic liquid is fed to solid separation unit [F2] for removing of pollutants such as solid particles/waste. Thereafter, the ionic liquid is filtered and subjected to regeneration in the regeneration unit [IRU] to separate the remaining pollutants and the ionic liquid. The regenerated ionic liquid is used for further extraction.

25 **EXAMPLE 2**

[0148]. COD level of wastewater obtained from desalter/desalting unit of refinery process outlet is detected by potassium dichromate method, and is found to be about 2343 ppm. The desalter wastewater having temperature of around 150°C is cooled down to temperature of about 50°C in the heat exchanging unit [X]. The cooled wastewater from the heat exchanging
30 unit is mixed with the ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C, at 1 atmospheric pressure; and time duration of about 30 minutes. The volume ratio of ionic liquid to wastewater is about 1:78. The combined volume of the ionic liquid and wastewater employed in the mixing unit is about 197.5 ml. The pollutants in the desalter wastewater stream are separated/ extracted/ recovered into the

ionic liquid phase. The mixture from the mixing unit is fed to the settling unit [S], where separation of layer comprising hydrophobic ionic liquid containing and recovered pollutant takes place from the layer comprising separated aqueous wastewater.

[0149]. The COD level of the separated wastewater obtained is about 343 ppm. The percentage of extraction is about 85.3%. Figure 3(b) depicts sample of the wastewater post treatment with the ionic liquid. As can be observed from the Figure 3(b), the color of the treated wastewater significantly changes due to removal of pollutants such as hydrocarbons, asphaltene and colored compounds like silt, by the ionic liquid treatment.

10 **EXAMPLE 3**

[0150]. COD level of wastewater obtained from desalter/desalting unit of refinery process outlet is detected by potassium dichromate method, and is found to be about 2343 ppm. The desalter wastewater having temperature of around 150°C is cooled down to temperature of about 50°C in the heat exchanging unit [X]. The cooled wastewater from the heat exchanging unit is mixed with the ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C, at 1 atmospheric pressure; and time duration of about 30 minutes. The volume ratio of ionic liquid to wastewater is about 1:117. The combined volume of the ionic liquid and wastewater employed in the mixing unit is about 295 ml. The pollutants in the desalter wastewater stream are separated/ extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit is fed to settling unit [S], where separation of layer comprising hydrophobic ionic liquid and recovered pollutant takes place from layer comprising the aqueous wastewater. The COD level of the wastewater obtained is about 445 ppm. The percentage of extraction is about 81%.

25 **EXAMPLE 4**

[0151]. COD level of wastewater obtained from desalter/desalting unit of refinery process outlet is detected by potassium dichromate method, and is found to be about 2343 ppm. The desalter wastewater having temperature of around 150°C is cooled down to temperature of about 50°C in the heat exchanging unit [X]. The cooled wastewater from the heat exchanging unit is mixed with the ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C, at 1 atmospheric pressure; and time duration of about 30 minutes. The volume ratio of ionic liquid to wastewater is about 1:156. The volume of the ionic liquid and wastewater employed in the mixing unit is about 392.5 ml. The pollutants in the desalter wastewater stream are separated/ extracted/ recovered into the ionic liquid phase.

The mixture from the mixing unit is fed to settling unit [S], where separation of layer comprising the ionic liquid containing the recovered pollutant takes place from the layer comprising aqueous wastewater. The COD level of the separated wastewater obtained is about 497 ppm. The percentage of extraction is about 78.8%. The separated aqueous wastewater is further fed into the biological treatment assembly [ASP], for further reduction of COD levels.

[0152]. The separated upper layer of ionic liquid is recycled about 3 – 4 times by entering the mixing unit and settling unit, after which the ionic liquid layer is fed to solid separation unit [F2] for removing of pollutants such as solid waste/particles. Thereafter, the ionic liquid is filtered and subjected to regeneration in the regeneration unit [IRU]. The regenerated ionic liquid is used for further extraction.

EXAMPLE 5

[0153]. COD level of wastewater obtained from desalter/desalting unit of refinery process outlet is detected by potassium dichromate method, and is found to be about 2343 ppm. The desalter wastewater having a temperature of around 150°C is cooled down to temperature of about 50°C in the heat exchanging unit [X]. The cooled wastewater from the heat exchanging unit is mixed with the ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C, at 1 atmospheric pressure; and time duration of about 30 minutes. The volume ratio of ionic liquid to wastewater is about 1:39. The volume of the ionic liquid and wastewater employed in the mixing unit is about 2000 ml. The pollutants in the desalter wastewater stream are separated/ extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit is fed to the settling unit [S], where separation of layer comprising hydrophobic ionic liquid containing recovered pollutant takes place from the layer comprising separated aqueous wastewater. The COD level of the separated wastewater obtained is about 700 ppm. The percentage of extraction is about 70.1%. The separated aqueous wastewater is further fed into the biological treatment assembly [ASP], for further reduction of COD levels.

[0154]. The separated upper layer of ionic liquid is recycled about 3 – 4 times by entering the mixing unit and settling unit, after which the ionic liquid layer is fed to solid separation unit [F2] for removing of pollutants such as solid waste/particles. Thereafter, the ionic liquid is filtered and subjected to regeneration in the regeneration unit [IRU]. The regenerated ionic liquid is used for further extraction.

EXAMPLE 6

[0155].The PTA wastewater for this example is obtained from RIL PTA Plant Patalaganga, and subjected to the instant process for separation or recovery of pollutants such as organic compound from the wastewater. The initial COD of the wastewater is 6252 ppm.

5 [0156].100 g of the PTA wastewater at a high temperature of around 150°C is cooled down to temperature of about 60°C to 65°C in the heat exchanging unit; precipitating pollutants such as solid waste. These precipitated solids are collected in the solid separation unit.

[0157].The solution from the solid separation unit is mixed with the 2.5 g of ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about
10 50°C to 55°C, pressure of about 1 atmosphere; for a time duration of about 30 minutes-35 minutes. The volume ratio of ionic liquid to wastewater is about 1:39. The pollutant such as organic acids like benzoic acid, p-toluic acid, terephthalic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid are extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit (M) is fed to the settling unit (S), where
15 separation of layer comprising the hydrophobic ionic liquid and the recovered organic compounds takes place from layer comprising the aqueous wastewater. The layer comprising ionic liquid being hydrophobic in nature, gets separated from the layer comprising aqueous wastewater, because of density difference. In the present example, the density of ionic liquid is 0.882 gm/cc. The separation then occurs by normal sedimentation.

20 [0158].The separated aqueous wastewater may be fed to the aerobic treatment assembly [ASP].

[0159].The ionic liquid may be recycled back to the system for further use in extraction/separation of pollutants from wastewater and/or thereafter sent for regeneration to the regeneration unit.

25 [0160].The Final COD of the wastewater is found to be 904 ppm. Thus, it is observed that about 85.5% of organic compounds are separated from the wastewater in the present example, establishing the efficacy of the method and system of the present disclosure. A pictorial representation of the wastewater sample is provided in Figure 4B of the present disclosure.

30

EXAMPLE 7

[0161].The PTA wastewater for this example is obtained from RIL PTA Plant Patalaganga, and subjected to the instant process for separation or recovery of pollutants such as organic compound from the wastewater. The initial COD of the wastewater is 6252 ppm.

[0162].100 g of the PTA wastewater at a high temperature of around 150°C is cooled down to temperature of about 60°C to 65°C in the heat exchanging unit; precipitating pollutants such as solid waste. These precipitated solids are collected in the solid separation unit.

[0163].The solution from the solid separation unit is mixed with the 2.5 g of ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C to 55°C, pressure of about 1 atmosphere; for a time duration of about 30 minutes-35 minutes. The volume ratio of ionic liquid to wastewater is about 1:78. The pollutant such as organic acids like benzoic acid, p-toluic acid, terephthalic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid are extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit (M) is fed to the settling unit (S), where separation of layer comprising the hydrophobic ionic liquid and the recovered organic compounds takes place from layer comprising the aqueous wastewater. The layer comprising ionic liquid being hydrophobic in nature, gets separated from the layer comprising aqueous wastewater, because of density difference. In the present example, the density of ionic liquid is 0.882 gm/cc. The separation then occurs by normal sedimentation.

[0164].The separated aqueous wastewater may be fed to the aerobic treatment assembly [ASP].

[0165].The ionic liquid may be recycled back to the system for further use in extraction/separation of pollutants from wastewater and/or thereafter sent for regeneration to the regeneration unit.

[0166].The Final COD of the wastewater is found to be 983 ppm. Thus, it is observed that about 84.3% of organic compounds are separated from the wastewater in the present example, establishing the efficacy of the method and system of the present disclosure. A pictorial representation of the wastewater sample is provided in Figure 4C of the present disclosure.

EXAMPLE 8

[0167].The PTA wastewater for this example is obtained from RIL PTA Plant Patalaganga, and subjected to the instant process for separation or recovery of pollutants such as organic compound from the wastewater. The initial COD of the wastewater is 6252 ppm.

[0168].100 g of the PTA wastewater at a high temperature of around 150°C is cooled down to temperature of about 60°C to 65°C in the heat exchanging unit; precipitating pollutants such as solid waste. These precipitated solids are collected in the solid separation unit.

[0169].The solution from the solid separation unit is mixed with the 2.5 g of ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C to 55°C, pressure of about 1 atmosphere; for a time duration of about 30 minutes-35 minutes. The volume ratio of ionic liquid to wastewater is about 1:117. The pollutant such as organic acids like benzoic acid, p-toluic acid, terephthalic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid are extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit (M) is fed to the settling unit (S), where separation of layer comprising the hydrophobic ionic liquid and the recovered organic compounds takes place from layer comprising the aqueous wastewater. The layer comprising ionic liquid being hydrophobic in nature, gets separated from the layer comprising aqueous wastewater, because of density difference. In the present example, the density of ionic liquid is 0.882 gm/cc. The separation then occurs by normal sedimentation.

[0170].The separated aqueous wastewater may be fed to the aerobic treatment assembly [ASP].

[0171].The ionic liquid may be recycled back to the system for further use in extraction/separation of pollutants from wastewater and/or thereafter sent for regeneration to the regeneration unit.

[0172].The Final COD of the wastewater is found to be 1148 ppm. Thus, it is observed that about 81.6% of organic compounds are separated from the wastewater in the present example, establishing the efficacy of the method and system of the present disclosure. A pictorial representation of the wastewater sample is provided in Figure 4D of the present disclosure.

EXAMPLE 9

[0173].The PTA wastewater for this example is obtained from RIL PTA Plant Patalaganga, and subjected to the instant process for separation or recovery of pollutants such as organic compound from the wastewater. The initial COD of the wastewater is 6252 ppm.

[0174].100 g of the PTA wastewater at a high temperature of around 150°C is cooled down to temperature of about 60°C to 65°C in the heat exchanging unit; precipitating pollutants such as solid waste. These precipitated solids are collected in the solid separation unit.

[0175].The solution from the solid separation unit is mixed with the 2.5 g of ionic liquid Trihexyl (tetradecyl) Phosphonium chloride in the mixing unit [M] at temperature of about 50°C to 55°C, pressure of about 1 atmosphere; for a time duration of about 30 minutes-35 minutes. The volume ratio of ionic liquid to wastewater is about 1:156. The pollutant such as

organic acids like benzoic acid, p-toluic acid, terephthalic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid, isophthalic acid and orthophthalic acid are extracted/ recovered into the ionic liquid phase. The mixture from the mixing unit (M) is fed to the settling unit (S), where separation of layer comprising the hydrophobic ionic liquid and the recovered organic compounds takes place from layer comprising the aqueous wastewater. The layer comprising ionic liquid being hydrophobic in nature, gets separated from the layer comprising aqueous wastewater, because of density difference. In the present example, the density of ionic liquid is 0.882 gm/cc. The separation then occurs by normal sedimentation.

[0176].The separated aqueous wastewater may be fed to the aerobic treatment assembly [ASP].

[0177].The ionic liquid may be recycled back to the system for further use in extraction/separation of pollutants from wastewater and/or thereafter sent for regeneration to the regeneration unit.

[0178].The Final COD of the wastewater is found to be 1202 ppm. Thus, it is observed that about 80.77% of organic compounds are separated from the wastewater in the present example, establishing the efficacy of the method and system of the present disclosure. A pictorial representation of the wastewater sample is provided in Figure 4E of the present disclosure.

EXAMPLE 10

[0179].In this example, PTA wastewater is treated with ionic liquid Trihexyl (tetradecyl) Phosphonium chloride and HPLC component analysis is performed before and after the treatment of the wastewater with the ionic liquid to analyse the content of certain organic compounds in the wastewater before treatment with ionic liquid and after treatment with ionic liquid.

[0180].The process conditions are provided below.

1. Apparatus: HPLC column and round bottom flask
2. IL/wastewater ratio = 1:39,
3. Temperature = 50 °C,
4. Extraction time = 30 min,
5. Sedimentation time = 10 min.

[0181].The results of the HPLC component analysis are provided in tabulated form below in Table 1 of the present disclosure.

Table 1

COMPONENT	INITIAL (ppm)	FINAL (ppm)	% Reduction
Terephthalic Acid+4-carboxybenzoic acid (TA+4-CBA)	834	51.75	94
Benzoic Acid	394.7	4.4	98
Trimellitic Acid (TMA)	232.1	0	100
para-Toluic Acid (pTA)	554.9	3.3	99

[0182]. It is observed from the table above that the method and system of the present disclosure are able to separate pollutants such as Terephthalic Acid, 4- carboxybenzoic acid, Benzoic Acid, Trimellitic Acid and para-Toluic Acid in the range of 90 % to 100% from the wastewater, thereby establishing the high efficacy of the method and system of the present disclosure.

ADVANTAGES

[0183]. The present disclosure enables the separation or extraction or recovery of COD contributing pollutants such as organic compound in wastewater, using ionic liquid.

[0184]. The instant process of treatment of wastewater such as PTA wastewater, is carried out in less time when compared with the long hydraulic retention time involved in anaerobic digestion.

[0185]. The process of the present disclosure can replace or eliminate the cost intensive anaerobic digestion process, typically practiced in the PTA wastewater treatment.

[0186]. In the present process of treatment of PTA wastewater, none of the compounds are degraded into Biogas or Carbon dioxide, as is observed in anaerobic process.

[0187]. In the present process, pollutants such as COD contributing organic compounds are recovered back with water wash to the ionic liquid phase, hence net process yields are increased.

[0188]. The present disclosure relates to a process in which the ionic liquid is recovered (equilibrium quantities of small organics do not hamper the further cycle of using) without much loss of valuable ionic liquid.

[0189].The present process is not sensitive to changes in operating conditions such as pH, temperature, presence of toxic metals and high organic shock loadings, unlike in anaerobic digestion.

[0190].The present disclosure relates to a process of treatment of wastewater such as PTA wastewater, in which the sludge generated during aerobic process is very less.

[0191].In the present process, the water produced after instant treatment can be re-used for crude Terephthalic acid purification process.

[0192].The present disclosure is able to successfully overcome the various deficiencies of prior art and provide for a process for separation or extraction or recovery of pollutant such as organic compound.

[0193].The present disclosure relates to an separation or extraction process which is simple, cost-effective and takes lesser time, when compared with the long hydraulic retention time involved in API separator and air floatation methods.

[0194].The present disclosure relates to an ionic liquid extraction process which can replace or eliminate the cost intensive equipment used for stripping of NH₃/H₂S and API separator along with air floatation methods.

[0195].In the process of the present disclosure, the COD contributing pollutant such as hydrocarbon compound is recovered back by simply filtering and/or distilling the low density layer of the ionic liquid phase.

[0196].In the present disclosure, the ionic liquid that is used is recovered back (by simply distilling the hydrocarbon phase) without much loss of the ionic liquid and its extraction efficiency.

[0197].The process of the present disclosure is not sensitive to changes in conditions such as presence of pollutants like fine aggregates of colloidal asphaltene particles, emulsified hydrocarbons and high hydrocarbon shock loadings.

[0198].In the process of the present disclosure, the odor associated with NH₃/H₂S in is completely removed and the amount of sludge that is generated during aerobic process is lesser.

[0199].In the instant process, water produced after treatment is reused for various refinery operations.

[0200].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. Descriptions of

well-known/conventional methods and techniques are omitted so as to not unnecessarily obscure the embodiments herein.

[0201]. 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 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.

[0202]. 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.

[0203]. 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.

[0204]. 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.

[0205]. 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.

[0206]. 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:

5

Sl. No.	Reference No.	Description
1	100	System.
2	200	System.
3	St	Storage Unit.
4	D	Desalting Unit.
5	X	Heat Exchanging Unit.
6	M	Mixing Unit.
7	S	Settling Unit.
8	F1	Solid Separation Unit.
9	F2	Separation Unit.
10	IRU	Regeneration Unit.
11	ASP	Biological Treatment Assembly.
12	Stream A0	Connects Desalting Unit to Heat Exchanging Unit.
13	Stream A1	Connects Mixing Unit to Heat Exchanging Unit for receiving wastewater.
14	Stream A2	Connected to Mixing unit for entry of ionic liquid.
15	Stream A3	Connects Settling Unit to Separation Unit.
16	Stream A4	Connects Settling Unit to Biological Treatment Assembly.
17	Stream A5	Connects the stream 3 via stream 2 to Mixing Unit for ionic liquid recycle.
18	Stream A6	Connects the Separation Unit to Regeneration Unit.
19	Stream A7	Connected from Regeneration Unit for discharging treated wastewater from Biological Treatment Assembly for either tertiary treatment or internal reuse.
20	Stream A8	Connects Regeneration Unit via stream 2 to mixing Unit for ionic liquid recycle.
21	Stream A9	Connected from Regeneration Unit for discharging

		pollutants such as hydrocarbon.
22	Stream A9	Connected from Separation Unit for discharging solid waste.
23	Stream B1	Connects Heat Exchanging Unit to Storage Unit for receiving aqueous solution such as wastewater.
24	Stream B2	Connects Solid Separation Unit to Mixing Unit.
25	Stream B3	Connected to mixing unit for entry of ionic liquid
26	Stream B4	Connects separated ionic liquid from Settling Unit to stream 3 to enter Mixing Unit.
27	Stream B5	Connects the separated aqueous wastewater from the Settling Unit to Aerobic Treatment Assembly.
28	Stream B6	Connects Settling Unit to Regenerating Unit for ionic liquid regeneration.
29	Stream B7	Connected from the Aerobic Treatment Assembly for internal reuse / discharging to water bodies.
30	Stream B8	Connected from the Aerobic Treatment Assembly for discharging sludge.
31	Stream B9	Connects Heat Exchanging Unit to Solid Separation Unit.

We Claim:

1. A method for separating pollutant from wastewater, said method comprising acts of:
 - a) contacting wastewater with at least one phosphonium based ionic liquid and mixing to
5 obtain mixture;
 - b) incubating mixture of step a) to obtain upper layer comprising phosphonium based ionic liquid along with pollutant and lower layer comprising treated wastewater; and
 - c) separating the upper layer comprising phosphonium based ionic liquid along with pollutant from the lower layer comprising treated wastewater.
102. A system for separating pollutant from wastewater, the system comprising:
 - a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
 - b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit,
15 the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid; and
 - c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the
20 phosphonium based ionic liquid from the at least one mixing unit (M), and is configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater.
3. A system for recovery of pollutant from wastewater, the system comprising:
 - a) at least one heat exchanging unit (X) adapted to receive wastewater, wherein the at least one heat exchanging unit is configured to modulate temperature of the wastewater;
 - b) at least one mixing unit (M) fluidly connected to the at least one heat exchanging unit,
25 the at least one mixing unit is configured to receive the wastewater from the at least one heat exchanging unit and phosphonium based ionic liquid, and is configured to mix the wastewater and the phosphonium based ionic liquid;
 - c) at least one settling unit (S) fluidly connected to the at least one mixing unit, the at least one settling unit receives a mixture comprising the wastewater and the
30 phosphonium based ionic liquid from the at least one mixing unit (M), and is

configured to allow settling of the mixture to obtain upper layer comprising phosphonium based ionic liquid along with pollutant, and lower layer comprising treated wastewater; and

- 5 d) at least one regeneration unit (IRU) fluidly connected to the at least one settling unit, the at least one regeneration unit receives the upper layer comprising ionic liquid and pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.
4. The method as claimed in claim 1, wherein the upper layer of step c) is separated from the lower layer by decantation; wherein the upper layer of step c) is treated to recover the ionic liquid and the pollutant separately; wherein the treating is carried out by technique selected from group comprising solvent extraction, filtration and distillation or any combinations thereof; and wherein the treating is carried out in unit selected from group comprising separation unit [F2] and regeneration unit [IRU] or combination thereof.
- 10 5. The method as claimed in claim 1, wherein the contacting and the mixing is carried out in mixing unit [M]; the incubating of step b) is carried out in settling unit [S]; and wherein the contacting, mixing, incubating or separating is carried out at temperature ranging from about 10°C to about 100°C for a time period ranging from about 1 minute to about 120 minutes.
- 15 6. The system as claimed in claim 2, wherein at least one regeneration unit (IRU) is fluidly connected to the at least one settling unit, wherein the at least one regeneration unit is adapted to receive the upper layer comprising ionic liquid along with pollutant from the at least one settling unit, and is configured to separate the ionic liquid and the pollutant.
- 20 7. The system as claimed in claims 2 or 3, wherein the system comprises at least one solid separation unit (F1) configured in between the at least one heat exchanging unit (X) and the at least one mixing unit, wherein the at least one solid separation unit is configured to separate solid waste from the wastewater.
- 25 8. The system as claimed in claims 3 or 6, wherein the system comprises at least one separation unit (F2) configured in between the at least one settling unit and the at least one regeneration unit (IRU), wherein the at least one separation unit is configured to separate solid waste from the upper layer comprising phosphonium based ionic liquid and pollutant.
309. The system as claimed in claims 2 or 3, wherein the at least one settling unit is fluidly connected to at least one biological treatment assembly (ASP) to obtain the wastewater from the settling unit.

10. The system as claimed in claims 2 and 3, wherein the at least one mixing unit comprises an inlet port fluidly connected to a phosphonium based ionic liquid source through a first passage.
11. The system as claimed in claim 2, 3 or 6 comprises a bypass passage fluidly connected
5 between at least one of:
the at least one regeneration unit (IRU) and the at least one settling unit (S); and
the first passage.
12. The method as claimed in claim 4 or 5 or the system as claimed in claims 2-3 or 6-9, wherein
the system is operational in mode selected from group comprising batch mode, semi-
10 continuous mode and continuous mode, or any combinations thereof; the heat exchanging
unit [X] is a heat exchanger selected from group comprising shell heat exchanger, tube heat
exchanger and flash evaporator or any combinations thereof; the mixing unit [M] is selected
from group comprising stirred vessel reactor, plug flow reactor, static mixer, jet mixer and
pump mixer or any combinations thereof; the settling unit [S] is selected from group
15 comprising gravity settling vessel and centrifuge settler or combinations thereof; the
biological treatment assembly (ASP) is activated sludge assembly; the regeneration unit
[IRU] is selected from group comprising distillation column, filtration unit and extraction
column or any combinations thereof; and the solid separation unit [F1] and the separation unit
[F2] is selected from group comprising nustch filter, bag filter and press filter or any
20 combinations thereof.
13. The method as claimed in claim 1 or the system as claimed in claims 2 or 3, wherein the
wastewater is selected from group comprising industrial wastewater, PTA wastewater,
refinery wastewater and desalter wastewater.
14. The method as claimed in claim 1 or the system as claimed in claims 2 or 3, wherein the
25 pollutant is selected from group comprising organic compound, inorganic compound and
solid waste or any combinations thereof; wherein the organic compound is hydrocarbon
compound; and wherein the solid waste is selected from group comprising mud particle,
asphaltene, resin, silt and solid particulate matter or any combinations thereof.
15. The method or the system as claimed in claim 14, wherein the hydrocarbon is selected from
30 group comprising aliphatic hydrocarbon or aromatic hydrocarbon or combination thereof; and
wherein the hydrocarbon is selected from group comprising oil, benzoic acid, p-toluic acid,
terephthalic acid, 4-carboxy benzoic acid, trimellitic acid, acetic acid, 4-formyl benzoic acid,
isophthalic acid and orthophthalic acid or any combinations thereof.

16. The method as claimed in claim 1 or the system as claimed in claims 2 or 3, wherein the phosphonium based ionic liquid is selected from group comprising trihexyl (tetradecyl) phosphonium chloride and trihexyl (tetradecyl) phosphonium bromide, or combination thereof; and wherein volume ratio of the ionic liquid to the wastewater is ranging from about 1:30 to about 1:200, preferably about 1:39 to about 1:150.

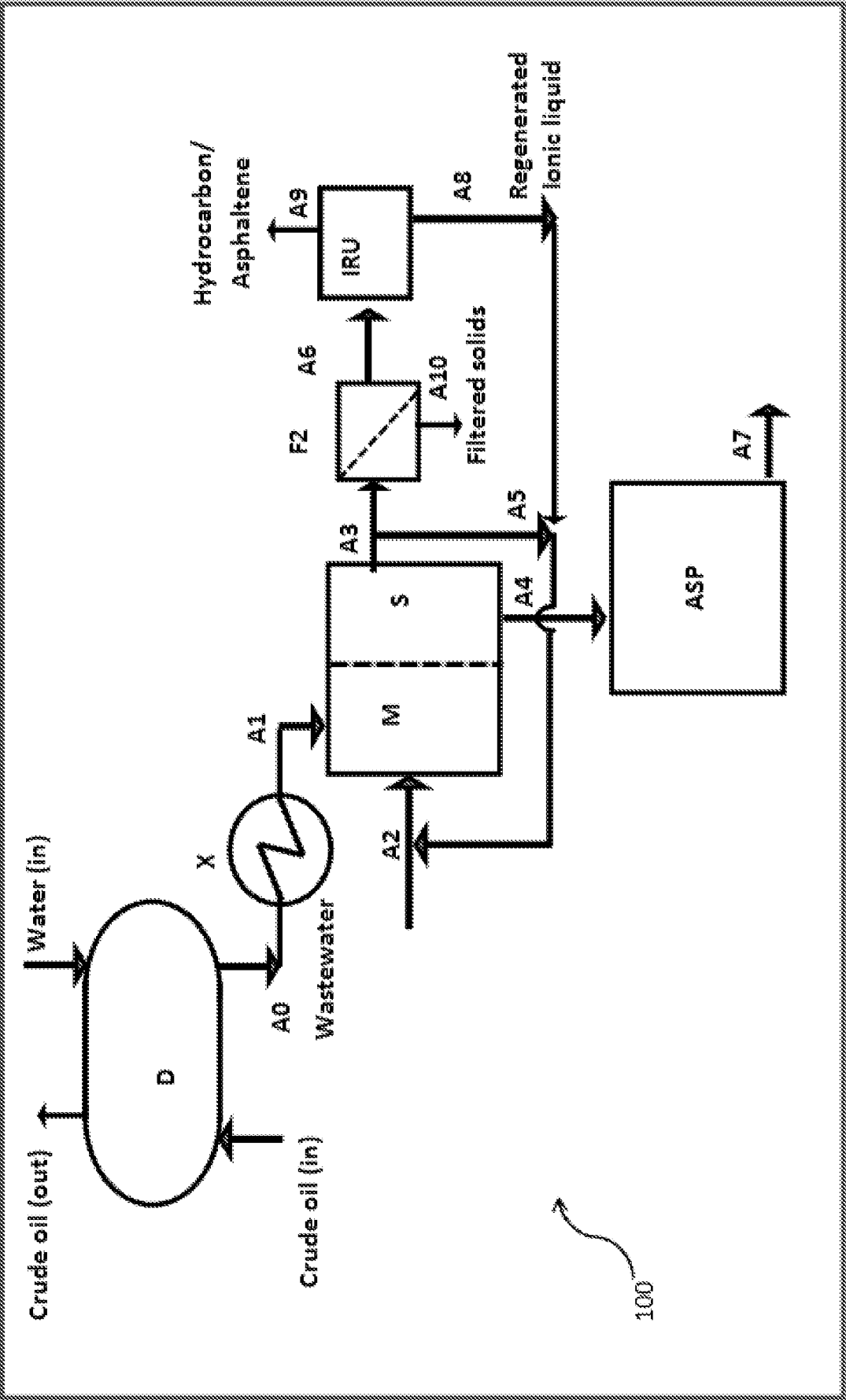


FIGURE 1

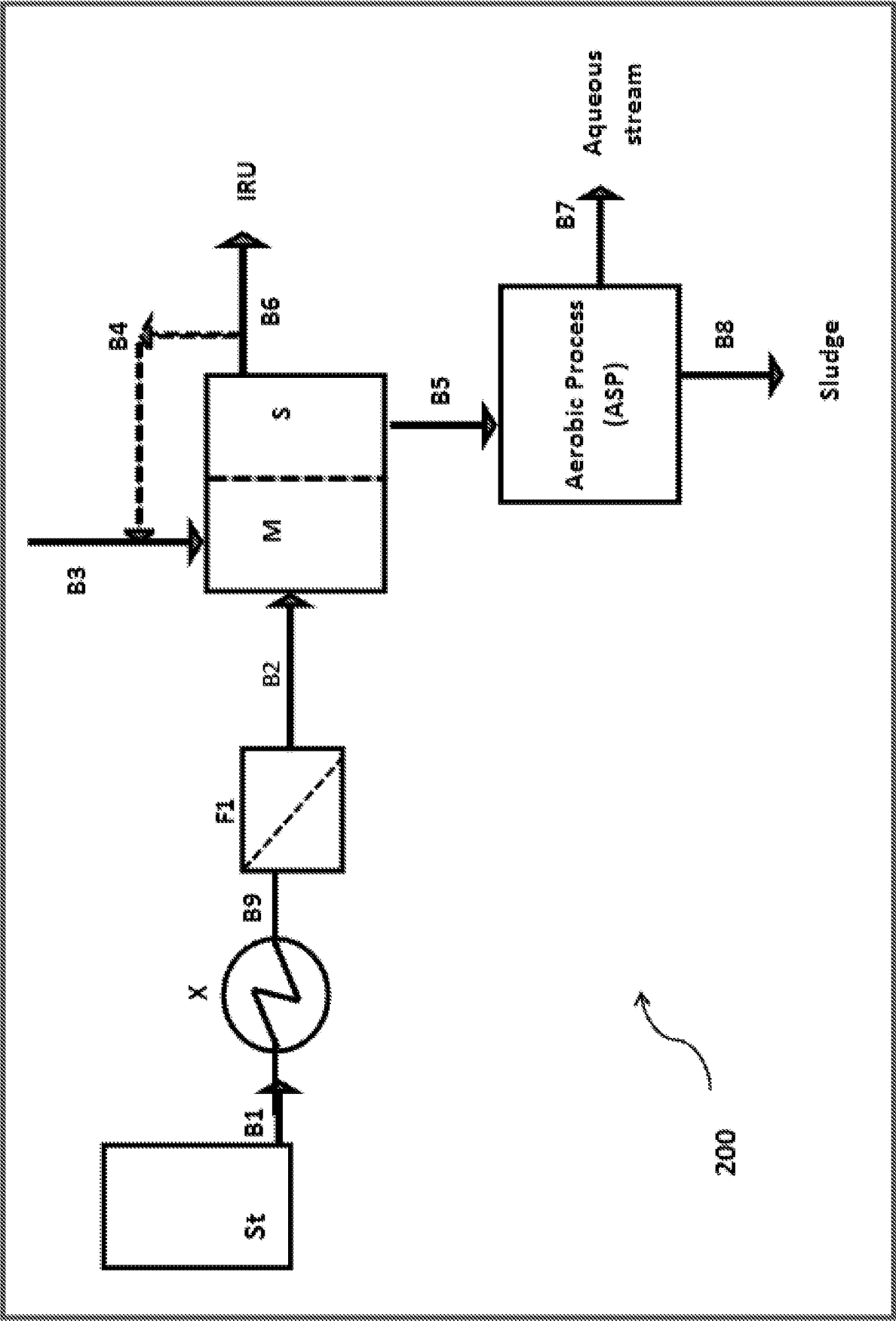


FIGURE 2

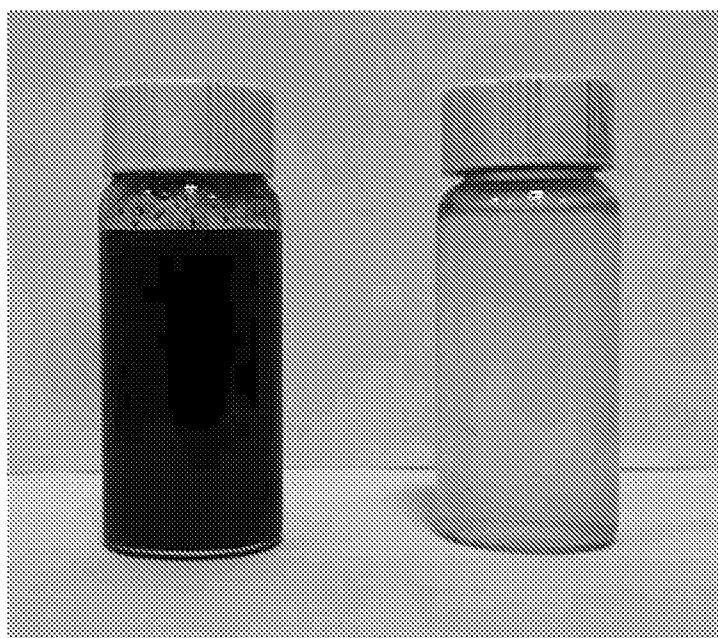


FIGURE 3(A)

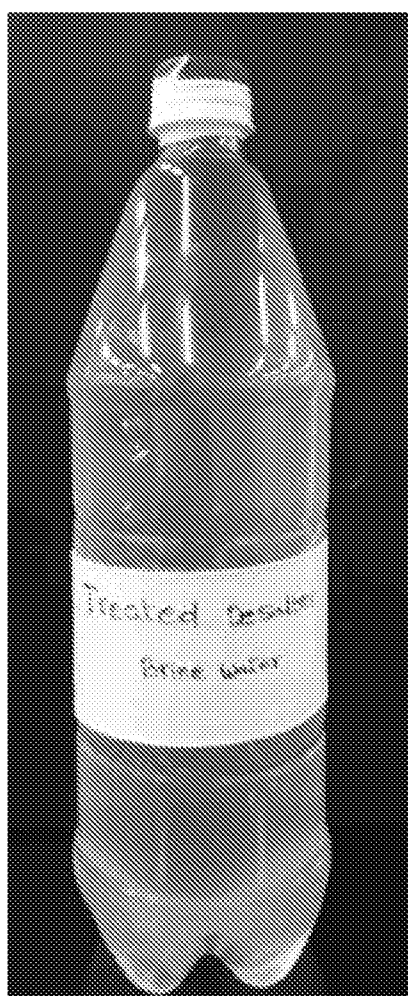


FIGURE 3(B)

A B C D E

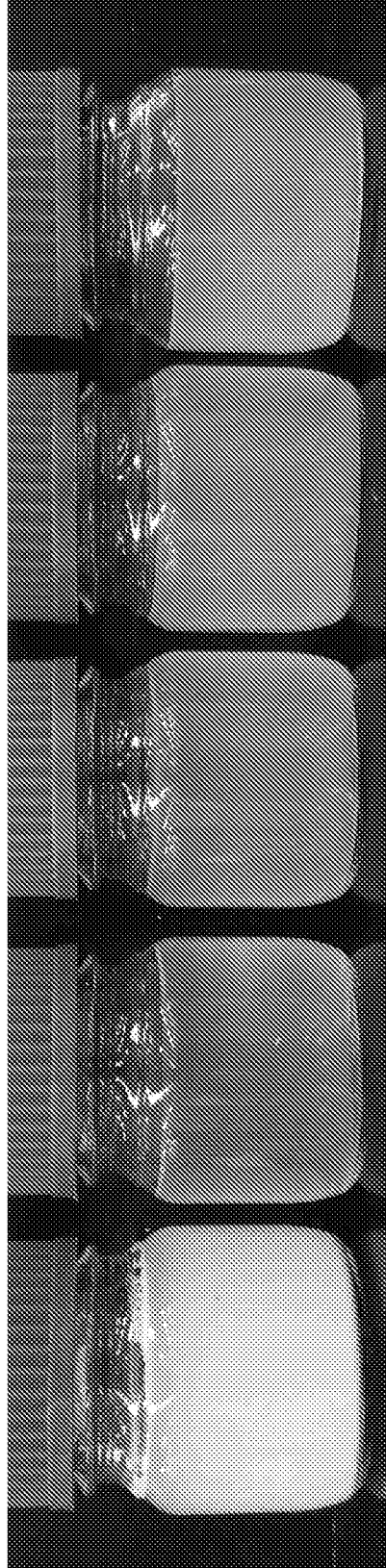


FIGURE 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2016/051220

A. CLASSIFICATION OF SUBJECT MATTER INV. C02F1/26 C02F1/68 ADD. C02F101/32 C02F101/34 C02F103/36 C02F1/00 C02F1/02		
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) C02F		
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, 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	CN 101 092 254 A (CHANGCHUN INST OF CHEMISTRY C [CN]) 26 December 2007 (2007-12-26) page 1, line 1 - page 9, line 25 claims 1-6; examples 1-11 & DATABASE WPI Week 200860 Thomson Scientific, London, GB; AN 2008-K08872 & CN 101 092 254 A (CHINESE ACAD SCI CHANGCHUN APPLIED CHEM) 26 December 2007 (2007-12-26) abstract ----- -/--	1-16
☒ Further documents are listed in the continuation of Box C.		
☒ See patent family annex.		
* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search		Date of mailing of the international search report
14 April 2016		25/04/2016
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Zsigmond, Zoltán

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2016/051220

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X	US 2011/155645 A1 (SERBAN MANUELA [US] ET AL) 30 June 2011 (2011-06-30)	2,3,6-12
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