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PROCESS FOR SYNERGISTIC CO-CONVERSION OF USED OILS TO VALUE ADDED PRODUCTS

Abstract

Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) are waste oils generated from Automotive Machines/Heavy Machinery, and Cooking/Frying respectively. These oils, unless recycled or refined using conventional methods, can no longer be used for their respective purposes. The present disclosure provides a process wherein synergistic co-conversion of ULO and UCO is done in a reactor vessel to reduce the impurity content of the ULO+UCO mixture and co-processing the heavier fraction of ULO+UCO mixture with residue feedstock in Delayed Coker Unit (DCU) to produce value added products while utilizing the lighter cut of ULO+UCO mixture in steam cracker to produce olefins and aromatics.

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Background/Summary

FIELD OF THE INVENTION

[0001] The present disclosure relates to a process for synergistic co-conversion of used oils to value added products. More particularly, the present disclosure relates to a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

BACKGROUND OF THE INVENTION

[0002] ULO is a petroleum based spent oil and has become unsuitable for its original purpose as it is subjected to high temperature and mechanical strain during running of the vehicle for stipulated time. It is a brown to black color liquid mixture consisting of low to high molecular weight (C.sub.16-C.sub.36) aliphatic and aromatic hydrocarbons viz polychlorinated biphenyl, chloro-dibenzofurans, alkylbenzenes, naphthalene, methylnaphthalenes, poly glycols or base oils termed as Lube Oil Base Stock (LOBS) of different grades depending on the applications, polyol esters, lubricative additives such ZDDP (zinc dialkyl thiophosphate, phosphate esters, thiophosphate esters as anti-wear, calcium based detergent additives such as calcium sulphonates, calcium phosphonates and decomposition products such as zinc thiophosphates, zinc pyro-polythiophosphates.

[0003] UCO is leftover cooking oil containing carcinogenic substances that results from the frying process. Furthermore, UCO contains high content of unsaturated aliphatic fatty acids which indicates high Total Acid Number (TAN). Used lubricating oil can be from motor vehicles, combustion, engines, gear boxes; Used Cooking Oil from food industry, hotels, restaurants and conventional residue feed such as reduced crude oil, vacuum residue, slop oil etc. from refineries.

[0004] The present disclosure relates to the development of a process for providing value addition to used oils by reducing and/or redistributing the impurity profiles and processing in delayed coking and steam cracking process units in a synergistic manner. ULO is reacted in a reactor vessel at an elevated temperature with fatty acids rich in UCO to mitigate the acidic content, via. formation of fatty acid glycol esters as well as redistribute the metal impurities selectively to the high boiling fraction of the obtained ULO+UCO reaction mixture. The mixture is fractionated into lighter fraction which is utilized in steam cracker process to produce olefins and aromatics while heavier fraction of the mixture is subjected to delayed coking process for production of value-added products. This process not only prevents Delayed Coking Unit (DCU) as well as steam cracker hardware from corrosion but also saves additional energy requirement in reboiler of prefractionation column by heat integrating reboiler of prefractionation column with hot Heavy Coker Gas Oil (HCGO) stream from Main Fractionator (MF) of DCU. This also prevents and/or mitigates fouling as well as deactivation in the hydrotreating based feed pretreatment catalyst(s) of steam cracker process.

[0005] US5248410A describes a process comprising passing a used petroleum derived lubricating oil to a reaction zone and coking at delayed coking reaction conditions. The reaction product comprises coke, hydrocarbon liquids and gas.

[0006] US 2022/0177785 A1 discloses systems and methods for producing one or more olefins using waste plastics and used lubricating oil.

[0007] EP0259378A1 discloses a process for purifying used lubricating oil wherein used lubricating oil is refined by treating the distillate of the same with small amount of caustic in

presence of specific amount of water. The resultant two phase mixture is separated from saline phase to obtain purified lubricating oil.

[0008] WO 2008/036696 A2 discloses a process for recovering used lubricating oil using clay and centrifugation wherein used lubricating oil is mixed with clay in a reactor at temp of 80-200° C. and is pumped through filter in order to recover oil free of contaminants.

[0009] WO 2019/116122 A1 describes the co-processing of used lubricating oil with conventional coker feedstock at Delayed Coker conditions to produce gas, liquid and coke which is of anode grade quality.

[0010] The present invention describes a process wherein ULO is reacted at an elevated temperature with fatty acids rich UCO to mitigate the acidic content, via. formation of fatty acid glycol esters as well as redistribute the metal impurities selectively to the high boiling fraction of the obtained ULO+UCO reaction mixture. The reaction mixture is fractionated into heavier fraction and lighter fraction, wherein the heavier fraction is subjected to delayed coking process for production of value-added products. The metals present in the reaction mixture will further be reduced due to deposition of the same on the coke produced from Delayed Coker producing liquid products with low metal contents. The lighter fraction of ULO+UCO reaction mixture is fed to steam cracker unit for production of high value petrochemicals such as light olefins and aromatics. The method of the present disclosure is advantageous as it takes care of contaminants of used oils by synergistic combination of UCO & ULO and also produces value added fuels along with petrochemicals.

[0011] US 2022/0177785 A1 describes about system and method wherein used lubricating oil is blended with waste plastic pyrolysis oil obtained from plastic pyrolysis process and resultant mixture is fractionated into lighter cut which is routed to steam cracker for olefins production while heavy cut is vacuum distilled to obtain lighter stream which is routed to hydro-processing for naphtha generation and naphtha again is fed to steam cracker while heavy par from vacuum column is recycled back to plastic pyrolysis process. The present invention utilizes used lubricating oil and used cooking oil using steam cracker and delayed coking processes. It does not involve vacuum distillation and hydro-processing processes for generation of naphtha. The invention takes care of contaminants of used oils unlike the prior art by synergistic combination of UCO & ULO and also produces value added fuels along with petrochemicals.

[0012] EP0259378A1 discloses process for purifying used lubricating oil wherein used lubricating oil is refined by treating the distillate of the same with small amount of caustic in presence of specific amount of water. The resultant two phase mixture is separated from saline phase to obtain purified lubricating oil. The present invention discloses a process where contaminants present in the UCO are neutralized by reacting it with ULO to produce low acid and low metal content mixture. The invention not only takes care of contaminants of used oils by synergistic combination of UCO & ULO but also produces value added fuels along with petrochemicals.

[0013] WO2008/036696 A2 discloses a process for recovering used lubricating oil using clay and centrifugation wherein used lubricating oil is mixed with clay in a reactor at temp of 80-200° C. and is pumped through filter in order to recover oil free of contaminants. The present invention discloses a process where contaminants present in the UCO are neutralized by reacting it with ULO to produce low acid and low metal content mixture. The invention not only takes care of contaminants of used oils by synergistic combination of UCO & ULO but also produces value added fuels along with petrochemicals.

[0014] In order to overcome the aforesaid problems, the present disclosure provides a process wherein ULO containing metal impurities is reacted in a reactor vessel at an elevated temperature with fatty acids rich UCO to mitigate the acidic content, via. formation of fatty acid glycol esters as well as redistribute the metal impurities selectively to the high boiling fraction of the obtained ULO+UCO reaction mixture thereby making it suitable for subjecting to synergistic processing in delayed coking and steam cracking process in an integrated manner for production of value-added

products. In other words, ULO and UCO undergo esterification reaction to form fatty acid glycol esters neutralizing the fatty acids of UCO making the ULO+UCO reaction mixture suitable for processing it in Delayed Coker and Steam Cracker process hardware. Without wishing to be bound by any theory, the inventors have also discovered that there is an effect of capture of the metals into the heavier boiling molecules from the metal and phosphorous containing moieties in the ULO by reaction with the heavier molecules of UCO. The process also involves heat integration of HCGO stream with reboiler of prefractionation column thereby saving additional energy requirement.

[0015] In the claimed process of the present disclosure, reaction between ULO and UCO would result in reduction of phosphorus, zinc and calcium content in ULO+UCO lighter fraction (boiling range below 200° C.) which otherwise is a poison for hydrotreating catalyst. The lighter fraction (boiling range below 200° C.) of ULO+UCO reaction mixture is fed to a steam cracker for petrochemicals production. The middle fraction (200-370° C.) of ULO is utilized as alternative for conventional quench oil. The heavier cut (boiling range above 200° C.) is fed along with residue feed to DCU for production of value-added fuels. In the process of the present disclosure, synergistic combination involving reaction of UCO and ULO lowers the impurity content and makes the reaction mixture suitable for processing in DCU. In the process of the present disclosure, heat integration of prefractionation column reboiler with HCGO from MF of DCU.

OBJECTIVES OF THE INVENTION

[0016] The primary object of the present disclosure is to develop a process wherein UCO & ULO is utilized in Delayed Coker and steam cracker processes for production of value-added fuels along with petrochemicals. Moreover, delayed coking of mixture in the process of the present disclosure causes further reduction in metal content as the metal gets deposited on the solid coke produced during delayed coking.

[0017] Another object of the present disclosure is to provide a process wherein contaminants are reduced by synergistic combination of used oils at a particular proportion to produce low metal and low acid mixture.

[0018] Still another objective of the present disclosure is to provide a process for direct processing of used oils after treatment in secondary conversion units such as DCU is cost effective route compared to conventional methods.

[0019] Another object of the present disclosure is to provide a process wherein processing of used oils along with residue feedstock is carried out hence, it indirectly reduces overall crude consumption for same throughput and thus, reduces overall crude oil import dependency.

[0020] The process of the present disclosure is advantageous as it provides a suitable pathway for proper utilization of the used oils such as used lubricating oil and used cooking oil in refineries instead of disposing in the environment. It reduces high levels of impurities in terms of phosphorus, metals in ULO, TAN content in UCO which otherwise is difficult to process directly in refineries. Hence, the claimed process is a cost-effective process for re-refining ULO/UCO and reduces dependence on crude oil import by providing alternative feedstock.

SUMMARY OF INVENTION

[0021] The present disclosure relates to a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

[0022] In a preferred embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products, the process comprising: [0023] (i) combining a Used Lubricating Oil (ULO) (1) containing metal and phosphorus impurities with a Used Cooking Oil (UCO) (2) containing acid impurities in a reactor vessel (3), wherein the ULO is reacted with the UCO to produce a reaction mixture (4); [0024] (ii) fractionating the reaction mixture (4) in a pre-fractionator column (5) into a lighter fraction (6) and a heavier fraction (7); [0025] (iii) subjecting the lighter fraction (6) and straight run naphtha stream (34) from Atmospheric Distillation Unit (ADU) to a hydrotreating unit (35) to obtain a low sulfur stream (36); [0026] (iv) routing the stream (36) to a steam cracker unit (37) to produce high value

petrochemicals (38); [0027] (v) subjecting the heavier fraction (7) and a residue feed (8) to a surge drum (9) to obtain a feed mixture (10), which is pumped using surge drum pump (11) as a primary feed stream (12) to the bottom of a main fractionator (MF) (13); [0028] (vi) mixing the primary feed stream (12) with an internal recycle in the main fractionator to obtain a secondary feed stream (14) and pumping the secondary feed stream (14) using a fractionator bottom pump (15) through a coker furnace (16); [0029] (vii) heating of the secondary feed stream (14) inside the coker furnace (16) to give a coker furnace effluent (17); [0030] (viii) thermally cracking the coker furnace effluent (17) inside a plurality of coke drums (19, 20) resulting into a coke drum effluent (21), which is routed to the MF (13) for product fractionation and solid petroleum coke which is removed after completion of coking cycle.

[0031] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight, preferably in the range of 0.3-3 by weight.

[0032] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the lighter fraction (6) of the reaction mixture (4) has lower phosphorus, metals (calcium and zinc) content compared to the ULO (1).

[0033] In another embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products, the process comprising: [0034] (i) fractionating the ULO (40) in a pre-fractionator column (41) into a lighter fraction (42) and a heavier fraction (43); [0035] (ii) subjecting the lighter fraction (42) and straight run naphtha stream (73) from Atmospheric Distillation Unit (ADU) to a hydrotreating unit (74) to obtain a low sulfur stream (75); [0036] (iii) routing the stream (75) to a stream cracker unit (76) to produce high value petrochemicals (77); [0037] (iv) combining the heavier fraction (43) with the UCO (44) containing acid impurities in a reactor vessel (45), wherein the heavier fraction is reacted with the UCO to produce a reaction mixture (46); [0038] (v) subjecting the reaction mixture (46) and a residue feed (47) to a surge drum (48) to obtain a feed mixture (49), which is pumped using a surge drum pump (50) as a primary feed stream (51) to the bottom of a main fractionator (MF) (52); [0039] (vi) mixing the primary feed stream (51) with an internal recycle in the main fractionator to obtain a secondary feed stream (53) and pumping the secondary feed stream (53) using a fractionator bottom pump (54) through a coker furnace (55); [0040] (vii) heating of the secondary feed stream (53) inside the coker furnace (55) to give a coker furnace effluent (56); [0041] (viii) thermally cracking the coker furnace effluent (56) inside a plurality of coke drums (58, 59) resulting into a coke drum effluent (60), which is routed to the MF (52) for product fractionation and solid petroleum coke which is removed after completion of coking cycle.

[0042] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the heavier fraction of ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight preferably in the range of 0.3-3 by weight.

[0043] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reactor vessel is operated at a temperature in the range of 25-200° C., pressure in the range of 1-5 bar and residence time in the range of 5-120 minutes.

[0044] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reactor can be selected either from continuous stirred tank reactor or plug flow reactor or batch reactor or fluidized bed reactor.

[0045] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reaction mixture

(4, 46) has lower Total Acid Number value compared to base mixture of ULO and UCO.

[0046] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the lighter fraction (6, 42) has a boiling range below 200° C. and the heavier fraction (7, 43) has a boiling point above 200° C.

[0047] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein stream cracker unit is operated at a temperature in the range of 750-950° C., pressure in the range of 0.5-2.0 bar, residence time in the range of 0.1-1.0 second, the steam to feed ratio is in the range of 0.2-1.4.

[0048] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the plurality of coke drums is operated at a temperature in a range of 460-520° C., pressure in a range of 1-5 bar and a coking cycle of 10-36 hours.

[0049] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the plurality of coke drums is operated in parallel to complete a coking cycle one after another, and the coke drum effluents is systematically passed into each of the plurality of coke drums through a switch valve to facilitate the coking cycle in each of the plurality of coke drums.

[0050] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein optionally ULO is fractionated into three fractions namely lighter fraction having a boiling range below 200° C., a middle fraction with boiling range of 200-370° C. and a heavier fraction having a boiling point above 370° C.

[0051] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the heavier fraction of ULO is mixed with the UCO in a reactor vessel to obtain the reaction mixture.

[0052] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the middle fraction is used as alternative quenching stream for quenching the coke drum effluent.

[0053] These and other features, aspects, and advantages of the present subject matter will be better understood with reference to the following description. This summary is provided to introduce a selection of concepts in a simplified form.

Description

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0054] The following figures form part of the present specification and are included to further illustrate aspects of the present disclosure. The disclosure may be better understood by reference to the figures in combination with the detailed description of the specific embodiments presented herein.

[0055] FIG. 1 is a flow diagram of a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

[0056] FIG. 2 is a flow diagram of an embodiment of a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

[0057] FIG. 3 is a flow diagram of another embodiment of a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

DETAILED DESCRIPTION OF THE INVENTION

[0058] Those skilled in the art will be aware that the present disclosure is subject to variations and modifications other than those specifically described. It is to be understood that the present

disclosure includes all such variations and modifications. The disclosure also includes all such steps of the process, features of the product, referred to or indicated in this specification, individually or collectively, and any and all combinations of any or more of such steps or features.

Definitions

[0059] For convenience, before further description of the present disclosure, certain terms employed in the specification, and examples are collected here. These definitions should be read in the light of the remainder of the disclosure and understood as by a person of skill in the art. The terms used herein have the meanings recognized and known to those of skill in the art, however, for convenience and completeness, particular terms and their meanings are set forth below.

[0060] The articles “a”, “an” and “the” are used to refer to one or to more than one (i.e., to at least one) of the grammatical object of the article.

[0061] The terms “comprise” and “comprising” are used in the inclusive, open sense, meaning that additional elements may be included. It is not intended to be construed as “consists of only”.

[0062] Throughout this specification, unless the context requires otherwise the word “comprise”, and variations such as “comprises” and “comprising”, will be understood to imply the inclusion of a stated element or step or group of element or steps but not the exclusion of any other element or step or group of element or steps.

[0063] The term “including” is used to mean “including but not limited to”. “Including” and “including but not limited to” are used interchangeably.

[0064] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the disclosure, the preferred methods, and materials are now described. All publications mentioned herein are incorporated herein by reference.

[0065] The present disclosure is not to be limited in scope by the specific embodiments described herein, which are intended for the purposes of exemplification only. Functionally equivalent products and methods are clearly within the scope of the disclosure, as described herein.

[0066] In an aspect, the present disclosure relates to a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products.

[0067] In an embodiment, the present disclosure provides a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products. In the process of the present disclosure, Used Lubricating Oil (1) containing metal and phosphorus impurities is synergistically combined with Used Cooking Oil (2) containing acid impurities in a reactor vessel (3) to obtain a ULO+UCO reaction mixture (4) wherein ULO is reacted at an elevated temperature with fatty acids rich UCO to mitigate the acidic content via formation of fatty acid glycol esters as well as redistribute the metal impurities selectively to the high boiling fraction of the obtained ULO+UCO reaction mixture (4). The reaction mixture (4) is fed to the pre-fractionator column (5) wherein it is fractionated into two fractions namely lighter fraction (6) and heavier fraction (7). The lighter fraction (6) along with straight run naphtha stream (34) from conventional Atmospheric Distillation Unit (ADU) is then routed to hydrotreating unit (35) for removal of sulfur impurities to obtain a low sulfur stream (36) suitable for Steam cracker unit. The stream (36) is then routed to Steam Cracker Unit (37) for production of high value petrochemicals such as ethylene, propylene, butylenes and aromatics (38). The heavier fraction (7) is then mixed with residue feed (8) in a surge drum (9) to obtain feed mixture (10) which is pumped using surge drum pump (11) to the bottom of Main Fractionator (MF) (13) as primary feed stream (12). The secondary feed stream (14), which is obtained from mixing of primary feed stream (12) & an internal recycle in main fractionator, is then pumped through coker furnace (16) using fractionator bottom pump (15). Heating of the secondary feed stream (14) to obtain coker furnace effluent (17). In other words, the secondary feed stream (14) is heated in coker furnace up to desired coking temperatures to obtain coker furnace effluent (17). The coker furnace effluent (17) is then diverted

to a plurality of coke drums (19, 20) using switch valve (18). The coke drums (19, 20) provide sufficient residence time for the thermal cracking of coker furnace effluent (17) to take place till the completion of coking reaction. The vapors of lighter hydrocarbons produced during thermal cracking, exits the coke drum. The Gas Oils are used as quenching stream for quenching the coke drum effluent (21) which is routed to the MF (13) for product fractionation and solid petroleum coke which is removed after completion of coking cycle. Two coke drums (19, 20) are operated in parallel in order to ensure smooth functioning of coking cycle. When coke drum (19) is full of coke, the coking cycle ends and the furnace outlet flow is then transferred from coke drum (19) to a parallel coke drum (20) to initiate its coking cycle, while coke removal process is initiated in the filled drum (19) which comprises of steaming, water cooling, coke cutting, and vapor heating and draining. The wash liquid (22) from the drums is discharged into a blow down section. The coke drum effluents (21) after quenching are again sent to Main fractionator (13), where it is separated and recovered. Heavy coker gas oil (HCGO) (23), Light coker gas oil (LCGO) (24) and Kerosene (25) are drawn off the fractionator at desired boiling temperature ranges using side strippers. HCGO pump around stream (31) from the main fractionator is then utilized as a heat integrating stream to reboiler (32) of Pre-fractionator column (5) to provide sufficient heat for ULO+UCO reaction mixture re-boiling while the cooled HCGO stream (33) is again routed back to MF. The wet gas (26) coming out of fractionator top goes to three phase separator (27) where gaseous hydrocarbons (39), water as aqueous phase (28) and un-stabilized naphtha as liquid phase (29) are separated with reflux (30) to the fractionator (13).

[0068] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products, wherein the ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight, preferably in the range of 0.3-3 by weight.

[0069] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products, wherein the lighter fraction (6) of the reaction mixture (4) has lower phosphorus, metals (calcium and zinc) content compared to the ULO (1).

[0070] In another embodiment of the present disclosure, there is provided a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products. In the process of the present disclosure, the Used Lubricating Oil (40) is fed to the Pre-fractionator column (41) wherein it is fractionated into two fractions namely lighter fraction (42) and heavier fraction (43). The lighter fraction (42) along with straight run naphtha stream (73) from conventional Atmospheric Distillation Unit (ADU) is then routed to hydrotreating unit (74) for removal of sulfur impurities to obtain a low sulfur stream (75) suitable for Steam cracker unit. The stream (75) is then routed to Steam cracker Unit (76) for production of high value petrochemicals (77) such as ethylene, propylene, butylenes and aromatics. The heavier fraction (43) from Pre-fractionator column (41) is synergistically combined with Used Cooking Oil (44) in a reactor vessel (45) wherein heavier fraction (43) is reacted at an elevated temperature with fatty acids rich UCO (44) to mitigate the acidic content via formation of fatty acid glycol esters to obtain the reaction mixture (46). The reaction mixture (46) is then mixed with residue feed (47) in a surge drum (48) to obtain feed mixture (49) which is pumped using surge drum pump (50) to the bottom of Main Fractionator (MF) (52) as primary feed stream (51). The secondary feed stream (53), which is obtained from mixing of primary feed stream (51) & internal recycle in main fractionator, is then pumped through coker furnace (55) using fractionator bottom pump (54), for achieving the desired coking temperature (usually between 460° C. and 520° C.) which also results in the partial vaporization and mild cracking of secondary feed stream (53) to obtain coker furnace effluent (56). In other words, the secondary feed stream (53) is heated in coker furnace upto desired coking temperatures to obtain coker furnace effluent (56). The coker furnace effluent is then diverted to a plurality of coke drums (58, 59) using switch valve (57). The coke drums provide sufficient residence time for the thermal cracking of coker furnace effluent to take place till the completion of coking reaction. The vapors of lighter hydrocarbons produced during thermal cracking, exits the

coke drum. The Gas Oils are used as quenching stream for quenching the coke drum effluent (60) which in turn terminates further thermal cracking to avoid coke formation in vapor. It enhances liquid yields and reduces coke yield. Two number of coke drums (58, 59) are operated in parallel in order to ensure smooth functioning of coking cycle. When coke drum (58) is full of coke, the coking cycle ends and the furnace outlet flow is then transferred from coke drum (58) to a parallel coke drum (59) to initiate its coking cycle, while coke removal process is initiated in the filled drum (58) which comprises of steaming, water cooling, coke cutting, and vapor heating and draining. The wash liquid (61) from the drums is discharged into the blow down section. The coke drum effluents (60) after quenching are again sent to Main fractionator (52), where it is separated and recovered. Heavy coker gas oil (HCGO) (62), Light coker gas oil (LCGO) (63) and Kerosene (64) are drawn off the fractionator at desired boiling temperature ranges using side strippers. HCGO pump around stream (70) from the main fractionator is then utilized as a heat integrating stream to reboiler (71) of Pre-fractionator column to provide sufficient heat for ULO re-boiling while the cooled HCGO stream (72) is again routed back to MF. The wet gas (65) coming out of Main fractionator top goes to three phase separator (66) where gaseous hydrocarbons (78), water as aqueous phase (67) and un-stabilized naphtha as liquid phase (68) are separated with reflux (69) to the Main fractionator (52).

[0071] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the heavier fraction of ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight preferably in the range of 0.3-3 by weight.

[0072] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reactor vessel is operated at a temperature in the range of 25-200° C., pressure in the range of 1-5 bar and residence time in the range of 5-120 minutes.

[0073] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reactor can be selected either from continuous stirred tank reactor or plug flow reactor or batch reactor or fluidized bed reactor.

[0074] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the reaction mixture (4, 46) has lower Total Acid Number value compared to base mixture of ULO and UCO.

[0075] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the lighter fraction (6, 42) has a boiling range below 200° C. and the heavier fraction (7, 43) has a boiling point above 200° C.

[0076] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein stream cracker unit is operated at a temperature in the range of 750-950° C., pressure in the range of 0.5-2.0 bar, residence time in the range of 0.1-1.0 second, the steam to feed ratio is in the range of 0.2-1.4.

[0077] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the plurality of coke drums is operated at a temperature in a range of 460-520° C., pressure in a range of 1-5 bar and a coking cycle of 10-36 hours.

[0078] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the plurality of coke drums is operated in parallel to complete a coking cycle one after another, and the coke drum effluents is systematically passed into each of the plurality of coke drums through a switch valve to facilitate the coking cycle in each of the plurality of coke drums.

[0079] In an embodiment of the present disclosure, there is provided a process for synergistic co-

conversion of used oils to value added products as described herein, wherein optionally ULO is fractionated into three fractions namely lighter fraction having a boiling range below 200° C., a middle fraction with boiling range of 200-370° C. and a heavier fraction having a boiling point above 370° C.

[0080] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the heavier fraction of ULO is mixed with the UCO in a reactor vessel to obtain the reaction mixture.

[0081] In an embodiment of the present disclosure, there is provided a process for synergistic co-conversion of used oils to value added products as described herein, wherein the middle fraction is used as alternative quenching stream for quenching the coke drum effluent.

[0082] In another embodiment of the present disclosure, there is provided a process for synergistic co-conversion of Used Lubricating Oil (ULO) and Used Cooking Oil (UCO) to value added products. In the process of the present disclosure, the Used Lubricating Oil (79) is fed to the Pre-fractionator column (80) wherein it is fractionated into three fractions namely lighter fraction (81) with boiling range below 200° C., middle fraction (112) with boiling range of 200-370° C. and heavier fraction (82) with boiling range above 370° C. The lighter fraction (81) along with straight run naphtha stream (114) from conventional Atmospheric Distillation Unit (ADU) is then routed to hydrotreating unit (115) for removal of sulfur impurities to obtain a low sulfur stream (116) suitable for Steam cracker unit. The stream (116) is then routed to Steam cracker Unit (117) for production of high value petrochemicals such as ethylene, propylene, butylenes and aromatics (118). The heavier fraction (82) from Pre-fractionator column (80) is synergistically combined with Used Cooking Oil (83) in a reactor vessel (84) wherein heavier fraction (82) is reacted at an elevated temperature with fatty acids rich UCO (83) to mitigate the acidic content via. formation of fatty acid glycol esters to obtain the reaction mixture (85). The reaction mixture (85) is then mixed with residue feed (86) in a surge drum (87) to obtain feed mixture (88) which is pumped using surge drum pump (89) to the bottom of Main Fractionator (MF) (91) as primary feed stream (90). The secondary feed stream (92), which is obtained from mixing of primary feed stream (90) & internal recycle in main fractionator, is then pumped through coker furnace (94) using fractionator bottom pump (93), for achieving the desired coking temperature (usually between 460° C. and 520° C.) which also results in the partial vaporization and mild cracking of secondary feed stream (92) to obtain coker furnace effluent (95). In other words, the secondary feed stream (92) is heated in coker furnace upto desired coking temperatures to obtain coker furnace effluent (95). The coker furnace effluent is then diverted to a plurality of coke drums (97, 98) using switch valve (96). The coke drums provide sufficient residence time for the thermal cracking of coker furnace effluent to take place till the completion of coking reaction. The vapors of lighter hydrocarbons produced during thermal cracking, exits the coke drum. The middle fraction (112) of ULO is utilized as alternative quenching stream for quenching the coke drum effluent (99) to obtain quenched coke drum effluent (113) which in turn terminates further thermal cracking to avoid coke formation in vapor line. It enhances liquid yields and reduces coke yield. Two number of coke drums (97, 98) are operated in parallel in order to ensure smooth functioning of coking cycle. When coke drum (97) is full of coke, the coking cycle ends and the furnace outlet flow is then transferred from coke drum (97) to a parallel coke drum (98) to initiate its coking cycle, while coke removal process is initiated in the filled drum (97) which comprises of steaming, water cooling, coke cutting, and vapor heating and draining. The wash liquid (100) from the drums is discharged into a blow down section. The coke drum effluents (99) after quenching are again sent to Main fractionator (91), where it is separated and recovered. Heavy coker gas oil (HCGO) (101), Light coker gas oil (LCGO) (102) and Kerosene (103) are drawn off the fractionator at desired boiling temperature ranges using side strippers. HCGO pump around stream (109) from the main fractionator is then utilized as a heat integrating stream to reboiler (110) of Pre-fractionator column to provide sufficient heat for ULO re-boiling while the cooled HCGO stream (111) is again routed back to MF. The wet gas (104)

coming out of Main fractionator top goes to three phase separator (105) where gaseous hydrocarbons (119), water as aqueous phase (106) and un-stabilized naphtha as liquid phase (107) are separated with reflux (108) to the Main fractionator (91).

[0083] In an embodiment of the present disclosure, the operating temperature for delayed coking drums varies from 460-520° C. with pressure from 1-5 bar and minimum of 10-36 hours cycle time. Temperature of HCGO stream coming out of Main fractionator is 270-390° C.

[0084] In an embodiment of the present disclosure, Steam cracker feed pretreatment hydrotreating unit for obtaining hydrotreated feed for Steam cracker unit is operated at temperature in the range of 300-360° C. at a pressure of 10-25 bar.

[0085] In an embodiment of the present disclosure, the obtained reaction mixture can either be treated with adsorbents or catalysts or additives to further reduce the metal/acidic impurities.

[0086] In yet another embodiment of the present disclosure, instead of UCO we can either utilize vegetable oils or palmitic acid or linoleic acid or oleic acid or other sources having reacting compounds similar to UCO or combination(s) thereof.

[0087] In yet another embodiment of the present disclosure, instead of ULO we can either utilize used industrial lubricants or used metal working fluids or used synthetic lubricants or used transformer oils or used hydraulic oils or used turbine oils or other sources having reacting compounds similar to ULO or combination(s) thereof.

[0088] Although the subject matter has been described in considerable detail with reference to certain preferred embodiments thereof, other embodiments are possible.

EXAMPLES

[0089] The disclosure will now be illustrated with working examples, which is intended to illustrate the working of disclosure and not intended to take restrictively to imply any limitations on the scope of the present disclosure. Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this disclosure belongs. Although methods and materials similar to or equivalent to those described herein can be used in the practice of the disclosed methods, the exemplary methods, devices and materials are described herein. It is to be understood that this disclosure is not limited to particular methods, and experimental conditions described, as such methods and conditions may vary.

Example 1: Heat Integration

[0090] The Pre-fractionator column bottom required temperatures up to 210° C. for re-boiling the ULO feed. The integration of DCU involves initial preheating of ULO feed up to desired boiling cut temperature using one of the product streams of DCU Main fractionator i.e., HCGO pump around which leaves the Main fractionator at around 360° C. Here, we are utilizing HCGO coming out of the Main fractionator as a stream which will preheat the ULO feed to its desired boiling fraction temperature of above 200° C., thus the amount of energy supplied by the steam for re-boiling of ULO feed will be reduced as compared to earlier. Heat saving calculations were performed by taking hot HCGO (Specific Heat Capacity ~2.2 KJ/KgK) pump around of 0.228 MMTPA (considering 1 MMTPA DCU) with inlet temperature as 360° C. and ULO feed (Specific Heat Capacity ~1.755 KJ/KgK) of capacity 1 MMTPA with inlet temperature as 150° C. Heat required for re-boiling 1 MMTPA ULO was ~2.2E+10 Kcal/year while heat which can be supplied by hot HCGO pump around for re-boiling ULO was around 1.78E+10 Kcal/year. Thus, the heat required will be reduced by 81% using this integration. Considering the calorific value of Fuel oil as 9665 Kcal/Kg, the fuel oil saved (which could have been burned in supplying 1.78E+10 Kcal/year energy without this integration) was around 1.84 kTA which in turn reduces CO₂ emissions of 5.8 kTA. This way, we can utilize HCGO pump around as a heat integrating fluid.

Example 2: Reaction of ULO and UCO

[0091] Used lubricating oil were arranged from Automotive Oil Department, R&D Centre Faridabad, India while in-house used cooking oil and residue feed were arranged from one of the Indian Oil refineries and the properties were analyzed and same are provided in Table-1 below.

TABLE-US-00001 TABLE 1 Properties of ULO, ULO lighter fraction (boiling range below 200° C.), ULO heavier fraction (boiling range above 200° C.), UCO and Residue feed Used Used Lubricating ULO ULO Cooking Oil lighter heavier Oil Residue Feed Properties (ULO) fraction fraction (UCO) Feed TAN, mg 3.12 1.2 3.6 10.28 <0.5 KOH/gm CCR, wt % 0.5 <0.1 0.65 0.36 4.95 Nitrogen, wt % 0.1 0.04 0.115 <0.5 <0.5 Sulfur, ppmw 2500 1000 2875 22 5200 Ca, ppmw 834 100 963 <2 <2 Fe, ppmw 9 <5 11 <2 12 Mg, ppmw 41 <5 46 <2 <2 Na, ppmw 5 <5 6 <2 <2 P, ppmw 294 90 345 <2 <2 Zn, ppmw 306 42 372 <2 <2 Ni, ppmw <2 <2 <2 <2 15 V, ppmw <2 <2 <2 <2 7 Si, ppmw <10 <10 <10 <2 <2 Fatty Acid, wt % C12:0 NIL NIL NIL 0.4 NIL C14:0 1.2 C16:0 39.5 C18:0 0.8 C18:1 44.1 C18:2 10.6 Distillation (ASTM D2887) 5 110 44 199 434 333 10 127 66 236 522 353 30 256 109 338 594 397 50 381 125 422 603 434 70 451 142 473 610 489 90 523 179 535 616 577 95 555 206 568 619 610 100 655 291 673 664 647

[0092] The ULO and UCO as provided in Table-1 were mixed in different proportions and reactions were carried out at different operating temperatures simulating the surge drum conditions as indicated in Table-2. TAN of the base mixture and reaction mixture were compared, and it was found that TAN, metal content of the reaction mixture reduces. Further, from the experiments, it is observed that TAN content of reaction mixture having different compositions of ULO and UCO decreases with increase in operating temperature. It appears to be because as temperature increases, reaction between fatty acids of UCO and polyglycols of ULO increases, and furthermore, decarboxylation of aliphatic fatty acids starts above 150° C. which may also be the factor reduction of TAN. Further, presence of detergents additives such as calcium sulphonates, phosphonates may act as a base for neutralizing the additional acidic content of UCO. From the below Table 2, it can be deduced that ULO (75 wt %)+UCO (25 wt %) is the optimized composition for the lowest TAN content. The TAN content of base mixtures and reaction mixtures are provided in Table-2 below:

TABLE-US-00002 TABLE 2 TAN distribution of reaction mixture at different temperature (in degree Celsius) and composition ULO and UCO ULO and UCO Feed (Base mixture) (Reaction Mixture) Composition, wt % 50 + 50 50 + 50 Pressure, Kg/cm.sup.2g 1 1 1 1 1 Temperature° C. 30 50 100 150 200 Residence Time, min 60 60 60 60 60 TAN 6.95 5.29 4.26 2.69 2.0 Composition, wt % 75 + 25 75 + 25 Pressure, Kg/cm.sup.2g 1 1 1 1 1 Temperature° C. 30 50 100 150 200 Residence Time, min 60 60 60 60 60 TAN 3.51 3.13 2.96 2.05 1.2 Composition, wt % 25 + 75 25 + 75 Pressure, Kg/cm.sup.2g 1 1 1 1 1 Temperature° C. 30 50 100 150 200 Residence Time, min 60 60 60 60 60 TAN 8.61 7.24 6.41 5.15 4.13

Example 3: Reduction of Phosphorus, Metal (Zinc, Calcium) Content in ULO Lighter Fraction (Boiling Range Below 200° C.)

[0093] Experiments were conducted using 75:25 wt:wt mixture of neat ULO and neat UCO at 200° C. temperature and 1 Bar followed by fractionation of ULO+UCO reaction mixture into lighter (boiling range below 200° C.) and heavier (boiling range above 200° C.) fractions, it was found that phosphorus, metal (calcium, zinc) content reduces to <5 ppm in lighter fraction (boiling range below 200° C.) of ULO+UCO reaction mixture compared to lighter fraction (boiling range below 200° C.) of neat ULO as shown in Table 3. It appears to be due to the interaction of fatty acids of UCO with impurities like metal phosphonates of ULO resulting in the metal impurities shift due to increase in the overall boiling point of the reacted compounds.

TABLE-US-00003 TABLE 3 Phosphorus and metal (calcium, zinc) content in the reaction mixture Reaction Mixture (ULO + UCO) (75:25) ULO and Neat ULO UCO Feed Metal Lighter Heavier Reaction Lighter Heavier Properties ULO fraction fraction mixture fraction fraction Ca, ppmw 834 100 963 626 <5 695 Fe, ppmw 9 <5 11 7 <5 7.5 Mg, ppmw 41 <5 46 30 <5 34 Na, ppmw 5 <5 6 <5 <5 <10 P, ppmw 294 90 345 221 <5 245 Zn, ppmw 306 42 372 230 <5 255 Ni, ppmw <2 <5 5 <2 <5 <10 V, ppmw <2 <5 <5 <2 <5 <10 Si, ppmw 24 15 <10 18 <5 20

Example 4: Delayed Coking of ULO+UCO Reaction Mixture with Residue Feedstock

[0094] Experiments simulating the delayed coker reactions were conducted in a lab scale Micro-Coker experimental set up at temperature of 486° C. and 1 Bar pressure using residue feed of

Table-1 and 2 wt % blending of optimized reaction mixture ULO (75 wt %)+UCO (25 wt %) and products yields are provided in Table 4. From these, it is observed that liquid yields increase, and coke yield decreases with addition of used oils in comparison with the base case by 0.40 wt % and 0.30 wt % respectively.

TABLE-US-00004 TABLE 4 Products yields of Base case and optimal blend. Residue (98 wt %) + Residue (100%) 2 wt % UCO (25) + Δ yields Feed (Base Case) ULO (75) (2 wt %) Off Gas 9.91 9.81 -0.10 Coker 16.22 16.12 -0.1 Naphtha Coker 18.60 18.72 +0.12 Kerosene Light Gas 26.14 26.37 +0.23 Oil Heavy 5.21 5.41 +0.20 Gas Oil Coker 4.71 4.66 -0.05 Fuel Oil Coke 19.22 18.91 -0.30

Example 5: Steam Cracking of ULO+UCO Lighter Fraction (Boiling Range Below 200° C.) for Light Olefins and Aromatics

[0095] Considering total metal content limitations in Steam Cracker feed pretreatment hydrotreating unit feed blend to be 1.5 ppmw max and fresh ULO and UCO intake to be 75 & 25 kTA respectively, Maximum 21 kTA ULO+UCO lighter fraction along with 2.3 MMTPA Straight Run Naphtha feed from conventional atmospheric distillation unit can be routed to Steam cracker unit for light olefins and aromatics production. Additional ~16 kTA chemicals (~0.9 wt % increase in overall chemical yields) produced by routing ULO+UCO lighter fraction (boiling range below 200° C.) in Steam Cracker Unit compared to conventional process. The yields of the same are provided in Table-6.

TABLE-US-00005 TABLE 6 Steam Cracker yields Steam Cracker Unit Conv. Steam Feed with Cracker Unit ULO + UCO feed, delta Feed, kTA kTA yields, kTA Hydrogen 25.29 25.51 0.22 Ethylene 719.55 726.00 6.45 Propylene 437.23 441.20 3.97 Butenes 292.79 295.43 2.64 Benzene 114.50 115.58 1.07 Toluene 113.00 114.06 1.06 Xylenes + 63.38 63.98 0.59 EB Styrene 17.91 18.09 0.18

Claims

1. A process for synergistic co-conversion of used oils to value added products, the process comprising: (i) mixing a Used Lubricating Oil (ULO) comprising metal and phosphorus impurities with a Used Cooking Oil (UCO) comprising acid impurities in a reactor, wherein the ULO is reacted with the UCO to produce a reaction mixture; (ii) fractionating the reaction mixture in a pre-fractionator column into a lighter fraction and a heavier fraction; (iii) sending the lighter fraction and a straight run naphtha stream from Atmospheric Distillation Unit (ADU) to a hydrotreating unit to obtain a low sulfur stream; (iv) routing the low sulfur stream to a steam cracker unit to produce high value petrochemicals; (v) mixing the heavier fraction and a residue feed in a surge drum to obtain a feed mixture, and pumping the feed mixture using a surge drum pump as a primary feed stream to a bottom of a main fractionator (MF); (vi) mixing the primary feed stream with an internal recycle in the main fractionator to obtain a secondary feed stream and pumping the secondary feed stream using a fractionator bottom pump through a coker furnace; (vii) heating the secondary feed stream inside the coker furnace to obtain a coker furnace effluent; and (viii) thermally cracking the coker furnace effluent inside a plurality of coke drums to obtain a coke drum effluent and routing the coke drum effluent to the main fractionator for fractionating a product and solid petroleum coke, wherein the solid petroleum coke is removed after completion of a coking cycle.

2. The process as claimed in claim 1, wherein the ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight.

3. The process as claimed in claim 1, wherein the lighter fraction of the reaction mixture has lower phosphorus, calcium and zinc compared to the ULO.

4. The process as claimed in claim 1, wherein the reactor is operated at a temperature in a range of 25-200° C., at a pressure in a range of 1-5 bar and at a residence time in a range of 5-120 minutes.

5. The process as claimed in claim 1, wherein the reactor is a continuous stirred tank reactor, a plug flow reactor, a batch reactor or a fluidized bed reactor.
6. The process as claimed in claim 1, wherein the reaction mixture has a lower Total Acid Number (TAN) compared to the mixture of ULO and UCO.
7. The process as claimed in claim 1, wherein the lighter fraction has a boiling point below 200° C., and the heavier fraction has a boiling point above 200° C.
8. The process as claimed in claim 1, wherein the steam cracker unit is operated at a temperature in a range of 750-950° C., at a pressure in a range of 0.5-2.0 bar, at a residence time in a range of 0.1-1.0 seconds, and wherein the steam to the low sulfur stream ratio is in a range of 0.2-1.4.
9. The process as claimed in claim 1, wherein the plurality of coke drums is operated at a temperature in a range of 460-520° C., at a pressure in a range of 1-5 bar, and at the coking cycle of 10-36 hours.
10. The process as claimed in claim 1, wherein the plurality of coke drums is operated in parallel to complete the coking cycle one after another, and the coke drum effluents is systematically passed into each of the plurality of coke drums through a switch valve to facilitate the coking cycle in each of the plurality of coke drums.
11. A process for synergistic co-conversion of used oils to value added products, the process comprising: (i) fractionating a Used Lubricating Oil (ULO) comprising metal and phosphorus impurities in a pre-fractionator column into a lighter fraction and a heavier fraction; (ii) subjecting the lighter fraction and a straight run naphtha stream from Atmospheric Distillation Unit (ADU) to a hydrotreating unit to obtain a low sulfur stream; (iii) routing the low sulfur stream to a steam cracker unit to produce high value petrochemicals; (iv) reacting the heavier fraction with Used Cooking Oil (UCO) comprising acid impurities in a reactor to produce a reaction mixture; (v) sending the reaction mixture and a residue feed to a surge drum to obtain a feed mixture, and pumping the feed mixture using a surge drum pump as a primary feed stream to a bottom of a main fractionator; (vi) mixing the primary feed stream with an internal recycle in the main fractionator to obtain a secondary feed stream and pumping the secondary feed stream using a fractionator bottom pump through a coker furnace; (vii) heating the secondary feed stream inside the coker furnace to obtain a coker furnace effluent; and (viii) thermally cracking the coker furnace effluent inside a plurality of coke drums to obtain a coke drum effluent and routing the coke drum effluent to the main fractionator for fractionating a product and solid petroleum coke, wherein the solid petroleum coke is removed after completion of a coking cycle.
12. The process as claimed in claim 11, wherein the heavier fraction of ULO and the UCO are mixed in a ratio ranging from 0.1 to 10 by weight.
13. The process as claimed in claim 11, wherein the reactor is operated at a temperature in a range of 25-200° C., at a pressure in a range of 1-5 bar and at a residence time in a range of 5-120 minutes.
14. The process as claimed in claim 11, wherein the reactor is a continuous stirred tank reactor, a plug flow reactor, a batch reactor or a fluidized bed reactor.
15. The process as claimed in claim 11, wherein the steam cracker unit is operated at a temperature in a range of 750-950° C., at a pressure in a range of 0.5-2.0 bar, at a residence time in a range of 0.1-1.0 seconds, and wherein the steam to the low sulfur stream ratio is in a range of 0.2-1.4.
16. The process as claimed in claim 11, wherein the plurality of coke drums is operated at a temperature in a range of 460-520° C., at a pressure in a range of 1-5 bar, and at the coking cycle of 10-36 hours.
17. The process as claimed in claim 11, wherein the plurality of coke drums is operated in parallel to complete the coking cycle one after another, and the coke drum effluents is systematically passed into each of the plurality of coke drums through a switch valve to facilitate the coking cycle in each of the plurality of coke drums.
18. The process as claimed in claim 11, further comprising fractionating the ULO into a middle

fraction.

19. The process as claimed in claim 18, wherein the lighter fraction has a boiling point below 200° C., the middle fraction has a boiling point in a range of 200-370° C., and the heavier fraction has a boiling point above 370° C.

20. The process as claimed in claim 18, wherein the middle fraction is used as a quenching stream for quenching the coke drum effluent.
