



- (51) **International Patent Classification:** Not classified
- (21) **International Application Number:** PCT/IN2012/000093
- (22) **International Filing Date:** 10 February 2012 (10.02.2012)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:** 402/MUM/2011 11 February 2011 (11.02.2011) IN
- (71) **Applicant (for all designated States except US):** **RELIANCE INDUSTRIES LTD.** [IN/IN]; 3rd Floor, Maker Chamber-IV, 222, Nariman Point, Mumbai 400 021, Maharashtra (IN).
- (72) **Inventors; and**
- (75) **Inventors/Applicants (for US only):** **MARVE, Mahesh** [IN/IN]; C 202, Mahavir Sadhana Society, Plot 18, Sector 14, Off Palm Beach Road, Sanpada, Navi Mumbai 400 705, Maharashtra (IN). **SALGARKAR, Suyog** [IN/IN]; Vyas Nagar, Naldurg, Tal: Tuljapur, Dist. Osmanabad 413 602, Maharashtra (IN). **MALVANKAR, Manthan** [IN/IN]; "Gulmohar", Swapnavihar Park-10, Bapunagar Road, Surendranagar 363 001, Gujarat (IN). **PAREKH, Amit** [IN/IN]; Flat No. 501, Building A-1, Shubham Residency, New Pal Road, Surat 395 009, Gujarat (IN). **RAYAN, Vinod** [IN/IN]; 478, George Road, Ganesapuram, Tuticorin 628003 (IN). **YADAV, Ashwani** [IN/IN]; H. No# 581-582, Sec-20, Part-2, Panchkula 134009, Haryana (IN). **BISHT, Harender** [IN/IN]; Village-Haripur Navada, P.O. IIP Mohkampur, Dehradun 248005, Uttarkhand (IN). **YADAV, Manoj** [IN/IN]; c/o. Dr. V.P. Yadav, Model Town, Old Court Road, Rewari 123401 (IN). **MANDAL, Sukumar** [IN/IN]; House No. 971, Sector-8, Faridabad, Haryana 121006 (IN). **DAS, Asit** [IN/IN]; Flat No.401,

Group Housing-11, Indian Oil Apartments, Sector-46, Faridabad 121003 (IN).

- (74) **Agent:** **MOHAN, Dewan;** R. K. Dewan & Company, Trade Mark & Patent Attorneys, Podar Chambers, S.A.Brelvi Road, Fort, Mumbai 400 001, Maharashtra (IN).

- (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, 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, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, 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, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- as to the identity of the inventor (Rule 4.17(i))
- of inventorship (Rule 4.17(iv))

Published:

- without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) **Title:** A PROCESS FOR IMPROVING AROMATICITY OF HEAVY AROMATIC HYDROCARBONS

(57) **Abstract:** The present disclosure provides a process for producing paraffin extracted clarified slurry oil (raffinate) with improved aromaticity from the feed stock such as clarified slurry oil(CSO). The obtained paraffin extracted clarified slurry oil with improved aromaticity is suitable for a variety of industrial applications such as it can be used as a valuable feedstock for producing carbon black.



A PROCESS FOR IMPROVING AROMATICITY OF HEAVY AROMATIC HYDROCARBONS

FIELD OF THE DISCLOSURE

The present disclosure relates to a process for producing raffinate with improved aromaticity.

DEFINITIONS OF TERMS USED IN THE SPECIFICATION

The term “fluid catalytic cracking (FCC)” used in the specification means the conversion process used in petroleum refineries to convert the high-boiling, high-molecular weight hydrocarbon fractions of petroleum crude oils to more valuable gasoline, olefinic gases and other products.

The term “aromaticity” used in the specification means chemical property in which a conjugated ring of unsaturated bonds, lone pairs, or empty orbitals exhibit a stabilization stronger than would be expected by the stabilization of conjugation alone.

The term “raffinate” as used in the specification means paraffin extracted clarified slurry oil.

The acronym “BMCI” means Bureau of Mines Correlation Index.

BACKGROUND

Carbon black feed stock (CBFS) is a heavy hydrocarbon mix (C_{20} to C_{50}) which is the key raw material in manufacturing carbon black. Carbon black finds extensive use in the rubber industry as a reinforcing agent in rubber products such as tyres, tubes, conveyer belts, cables and other mechanical rubber goods. CBFS is also used as heating fuel oil in several industrial units. Carbon black is obtained by the partial combustion and thermal decomposition of highly aromatic hydrocarbon oils under controlled conditions. Some of the most important feedstocks used for producing carbon black include: clarified slurry oil (CSO) obtained from fluid catalytic cracking of gas oils, ethylene cracker residue from naphtha steam cracking and coal tar oils.

The presence of paraffins in heavy aromatic hydrocarbon fractions (boiling above 300 °C) substantially reduces their suitability for certain applications such as production of carbon black, anode coke, needle coke, and asphaltene stabilization in delayed coker feedstock. Therefore, lower the amount of paraffins in the heavy aromatic hydrocarbon fractions higher is the value of such feedstocks for the above mentioned applications. Another important characteristic is the Bureau of Mines Correlation Index (BMCI), wherein, carbon black feedstock must have a high BMCI to be able to offer a high yield of carbon black; therefore, heavy aromatic hydrocarbon feedstock used to obtain the CBFS should have a high BMCI. The BMCI is indicative of the aromaticity in aromatic hydrocarbons. Feedstocks having a high BMCI give a higher yield of carbon black with minimum heat input hence reducing the cost of

manufacturing. Also, the feedstock for carbon black should have low sulfur content, as sulfur adversely affects the product quality, leads to lower yield and corrodes the equipment.

The BMCI value for CBFS should be more than 132; whereas, BMCI value of CSO obtained at FCC plant is in the range of 110 – 130, typically less than 126, depending on the conversion in the FCC unit. Higher conversion leads to higher BMCI. Therefore, there is felt a need to increase the BMCI value of CSO above 132 before CSO can be used as a CBFS feedstock for manufacturing Carbon Black. Further, there is also felt a need to reduce the paraffin content of CSO to enhance the applicability of the feedstock.

In the past several processes have been worked to increase the BMCI value of CSO, which include:

Vacuum distillation of CSO:

Vacuum distillation of CSO separates light cycle oil (LCO) range components from CSO. Several modifications in the vacuum distillation unit such as incorporation of a CSO flasher, although helped in improving the flash point of CSO, no improvement in the BMCI value was observed.

Extraction of CSO using Furfural or NMP as solvent:

Solvent extraction using NMP or Furfural was found to be unsuitable for CSO having very high aromatic content as clear separation of the raffinate and the extract was very difficult, due to the high aromaticity.

Solvent de-asphalting:

The process involves removing asphaltic material from clarified slurry oil (CSO) through the extractive or precipitant action of solvents.

Some representative patent documents which disclose solvent de-asphalting process are discussed herein below.

US2002005374 discloses a process for upgrading a non-hydrotreated feedstream which comprises solvent deasphalting the feedstream to obtain a first product stream comprising deasphalted oil and a second product stream comprising an asphalt product; slurry hydroprocessing the asphalt product to obtain a hydroprocessed product; and separating an upgraded oil from the hydroprocessed product and unconverted asphaltene bottoms.

US20090166253 disclose systems and methods for processing one or more hydrocarbons for selectively separating to provide one or more light deasphalted oils (DAO) which can be cracked to provide hydrocarbon products. The method comprises: combining the feedstock comprising heavy oils, light oils, and asphaltenes with one or more solvents to provide a first mixture; separating the asphaltenes from the first mixture to provide a second mixture comprising solvent, heavy deasphalted

oils, and light deasphalted oils; selectively separating the heavy deasphalted oils from the second mixture to provide a third mixture comprising the solvent and light deasphalted oils; and selectively separating the solvent from the third mixture to give light deasphalted oils.

US2010243518 discloses integrated slurry hydrocracking (SHC) and solvent deasphalting (SDA) methods for making slurry hydrocracking (SHC) distillates. The method involves subjecting SHC gas oil to the SDA process to obtain de-asphalted oil (DAO) and an SDA pitch, wherein, at least a portion of the DAO is recycled to the SHC reaction zone.

US20090166266 discloses a method for dewatering and deasphalting a crude oil that comprises hydrocarbons, asphaltenes and water with one or more solvents.

The feed as employed in the presently known deasphalting processes is usually a vacuum residue or atmospheric residue or crude oil with an asphaltene content in excess of 5wt %. It is known that the presently known deasphalting process cannot be carried out if the asphaltene content in the input stream is lower than 5 wt %.

Another shortcoming of the known deasphalting processes is that the residue fraction(asphalt) as resulting from these processes is solid at room temperature and therefore it poses significant difficulty in transportation.

Furthermore, for the presently known deasphalting processes to be economical the minimum limit for the DAO yield is 40% and the yields lower than this threshold render the process economically un-feasible.

Still furthermore, the presently known deasphalting processes are silent on further value addition in the properties of the resultant deasphalted products such as improved aromaticity and higher BMCI value.

Accordingly, there is felt a need for developing a new process that extracts paraffinic material from CSO (clarified slurry oil) leading to produce raffinate with improved aromaticity and BMCI.

OBJECTS

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

An object of the present disclosure is to provide a paraffin extraction process that is suitable for a feed with low asphaltene content such as clarified slurry oil.

Another object of the present disclosure is to provide a process for improving the aromaticity of heavy aromatic hydrocarbons.

Still another object of the present disclosure is to provide a process for improving the aromaticity of clarified slurry oil (CSO).

Yet another object of the present disclosure is to provide a process for reducing the paraffin content of clarified slurry oil.

Still another object of the present disclosure is to provide a process which gives clarified slurry oil having Bureau of Mines Correlation Index (BMCI) greater than 132.

A further object of the present disclosure is to provide a process for improving the aromaticity of clarified slurry oil, which gives a useful by-product such as extracted paraffin rich oil.

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

SUMMARY

- In accordance with the present disclosure there is provided a process for producing raffinate with improved aromaticity; said process comprising the following steps:
 - mixing CSO feedstock having a BMCI ranging between 110 and 130 with a solvent in an apparatus to obtain an oil-solvent mixture;

- heating the oil-solvent mixture at a temperature ranging between 50 and 200 °C to obtain a heated oil-solvent mixture;
- vigorously agitating the heated oil-solvent mixture for a time period ranging between 0.5 and 2 hours to obtain an oil-solvent dispersion;
- allowing the dispersion to separate into paraffin rich phase and raffinate phase .
- separating the raffinate phase from the paraffin rich phase to obtain raffinate with aromatics content of at least 90 wt % and a BMCI of at least 132.

In accordance with another embodiment of the present disclosure the process further comprises heating the separated paraffin rich phase at a temperature ranging between 40 and 80 °C to remove solvent for recycling.

Typically, the solvent is at least one selected from the group consisting of C₂ to C₇ hydrocarbons and C₃ to C₇ ketones.

In accordance with another embodiment of the present disclosure the solvent is at least one selected from the group consisting of C₂ to C₇ alkanes, C₂ to C₇ alkenes and C₃ to C₇ ketones.

Typically, the proportion of the solvent to oil ranges between 4:1 and 10:1

Typically, the heating is carried out at a pressure ranging between 10 and 50 kg/cm².

Typically, the mixing of heated oil-solvent mixture is carried out by using a static mixer or mechanical stirrer at a temperature ranging between 50 to 200 °C and at a pressure ranging between 10 and 50 kg/cm².

Typically, the agitation of heated oil-solvent mixture is carried out at a speed ranging between 500 to 3000 rpm to ensure proper mixing.

Typically, the pressure drops across static mixer is in the range of 1 to 10 kg/cm²(g) to ensure proper mixing.

In accordance with another aspect of the present disclosure there is provided raffinate with aromatics content of at least 90 wt % and having a BMCI of at least 132, obtained by the process of the present disclosure.

DETAILED DESCRIPTION

The embodiments herein and the various features and advantageous details thereof are explained with reference to the non-limiting embodiments in the following description. Descriptions of well-known components and processing techniques are omitted so as to not unnecessarily obscure the embodiments herein. The examples used herein 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 examples should not be construed as limiting the scope of the embodiments herein.

The description herein after, of the specific embodiments will so fully reveal 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 herein 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.

The present disclosure envisages a novel process for producing raffinate (paraffin extracted clarified slurry oil) with improved aromaticity by extracting paraffin from feedstock such as clarified slurry oil (CSO). Further, the present disclosure also aims at reducing the paraffin content of clarified slurry oil. The paraffin extracted clarified slurry oil (raffinate) so obtained has a high Bureau of Mining Correlation (BMCI), i.e. at least 132, which makes it suitable for applications like raw material for carbon black production, anode coke production, needle coke production, and as a diluent for improving asphaltene stability of delayed coker feedstock. The process of the present

disclosure also provides an extract (paraffin rich oil) which comprises approximately 50-90 % of the total paraffin content of the clarified slurry oil feedstock. This by-product can be used as a feed in fluid catalytic cracking (FCC) process and hydrocracking process, as a lube oil base stock and as a thermic fluid.

The process for preparing raffinate (paraffin extracted clarified slurry oil) with improved aromaticity from clarified slurry oil in accordance with the present disclosure is described herein below.

In the first step, clarified slurry oil feedstock having a BMCI of 110 to 130 is mixed with a solvent in an apparatus to obtain an oil-solvent mixture. The solvent used is at least one selected from the group consisting of C_2 to C_7 hydrocarbons and C_3 to C_7 ketones. In one of the preferred embodiment the solvent used is a light hydrocarbon selected from the group consisting of C_2 to C_7 alkanes and C_2 to C_7 alkenes. Typically, the structure of the hydrocarbon can be linear, branched (iso), and/ or cyclic.

The clarified slurry oil is highly aromatic; thus, it is easier to separate out the paraffins from the slurry oil on the basis of its solubility in the light hydrocarbons, ketones or their mixtures. Depending on the process operating conditions and/or the final applicability of the raffinate from clarified slurry oil and the by-product i.e., paraffinic rich oil a suitable solvent or a mixture of solvents can be used in the process of the present disclosure for improving the aromatic content and reducing the

paraffinic content. E.g. propylene or ethylene may be added to improve the selectivity towards the by-product i.e. paraffinic rich oil.

The solvent to oil ratio used is typically in the range of 4:1 to 10: 1. The solubilization of the solvent in the slurry oil is typically carried out continuously in vessel or on-line which is maintained at a pressure in the range of 10 – 50 kg/cm² to obtain an oil-solvent mixture.

In the second step, the oil-solvent mixture is heated at a temperature in the range of 50 to 200 °C to obtain a heated oil-solvent mixture. The process temperature can be varied depending on type of the solvent and % of paraffinic oil lift required. In the next step, the heated oil-solvent mixture is agitated vigorously for 0.5 to 2 hours while maintaining the temperature and pressure conditions in the autoclave. Alternatively, mechanical devices like static mixer can be used to ensure intimate mixing. The agitator speed is typically in the range of 500 to 3000 rpm. The obtained oil-solvent dispersion is allowed to cool and separate to obtain biphasic mixture containing extract (paraffin rich phase) and raffinate phase.

In the next step, the extract i.e, paraffin rich oil and the raffinate phase comprising aromatic rich slurry oil are separated.

The paraffin rich oil can be subsequently heated at a temperature in the range of 40 to 80 °C to remove solvent which is recycled as a solvent. The paraffin rich oil thus obtained comprises approximately 50 to 90 wt% of the total paraffins content of the

clarified slurry oil feedstock. The paraffin rich oil thus obtained as a by-product of the process can be suitably used as: a feedstock for fluid catalytic cracking (FCC) with or without hydrotreating to subsequently obtain FCC products; a feedstock in hydrocracking process for obtaining high quality diesel and other derivative products; as a lubricating oil base stock; and as a thermic fluid for heat transfer applications. The paraffin rich oil yield can be varied in the range of 15 - 30 wt % of clarified slurry oil (CSO) feedstock by manipulating the operating temperature between 50 and 85°C and varying solvent to oil ratio.

The raffinate phase (fraction) of clarified slurry oil obtained by the process of the present disclosure is characterized by aromatics content of at least 90 wt %. i.e. the aromatic content of the raffinate fraction of clarified slurry oil is at least 5 – 10 wt % more than the aromatic content of the clarified slurry oil feedstock.

Further, the BMCI of the raffinate is found to be at least 132 which is higher than the BMCI of clarified slurry oil feedstock.

When propane was used as a solvent, in the raffinate thus obtained, it was observed that the aromatic content was increased by 6 wt %, the API (American Petroleum Institute) gravity was increased by 2 units, and the mean boiling temperature was increased by 8°C, in comparison with the clarified slurry oil feedstock. Further, the BMCI, estimated by gravity and distillation method, was increased from 127 to 134.

The raffinate thus obtained is a valuable feedstock for processes including: feedstock for producing carbon black which is extensively used in the tyre and ink industry; feedstock for producing anode coke which is used in manufacturing electrodes in aluminum industries; feedstock for producing needle coke which is used in manufacturing electrodes for high temperature applications in steel industries; and as a diluent for improving the asphaltene stability of delayed coker feedstock, as higher aromaticity in coker and visbreaker feed improves the asphaltene stability and helps to reduce the coking rates in furnace tubes thus giving an improved run length of coker.

Therefore, the process of the present disclosure, i.e., separation of paraffin rich oil and aromatic rich raffinate by the solvent extraction of clarified slurry oil feedstock, improves the economic benefits of both the products (raffinate) and the by-product (paraffin rich oil), by making them more suitable for a variety of industrial applications.

The disclosure will now be described with respect to the following examples and illustrations which do not limit the scope and ambit of the disclosure in anyway and only exemplify the disclosure.

EXAMPLE:

55 gms of clarified slurry oil (CSO) feedstock was mixed with propane, in a propane to oil ratio of 6: 1, in an autoclave. The oil-solvent mixture was heated to 85 °C at a

pressure of 33kg/cm² and the resultant mixture was stirred for one hour at 1000 rpm while maintaining the temperature and pressure conditions. The stirring and heating was stopped and the resultant dispersion was allowed to settle under gravity for one hour, thus allowing the separation of a paraffin rich phase (extract) and a aromatic rich phase (raffinate) which is a heavier fraction. The paraffin rich phase (extract) was decanted out from the top and was separately heated to 50°C to remove propane. The samples of the paraffin rich phase (extract) were tested in Advanced Cracking Evaluation (ACE) reactor for crack-ability. The aromatic rich phase (raffinate) was subsequently obtained after decanting. The extract and raffinate were analyzed for viscosity, density, High Temperature Simulated Distillation and SARA (Saturates, Asphaltenes, Resins and Aromatics) analysis. The SARA analysis was done using TLC-FID analyzer. The properties of clarified slurry oil feedstock, raffinate and extract are illustrated in **TABLE 1**.

TABLE 1: Properties of clarified slurry oil feedstock (CSO), raffinate and extract

	Units	CSO	Raffinate	Extract	Specification for use as carbon black feedstock CBFS
Average Yield (for 3 consecutive runs)	wt %	100	82	18	--
Specific gravity at 15°C	--	1.0836	1.10	1.01	Maximum 1.10
API gravity	--	-0.917	-2.86	8.60	Maximum -2.9
BMCI (by gravity & distillation method)	--	127	134	94.65	Minimum 132
Sulfur Content	wt %	1.458	1.65	0.278	Maximum 3
Saturates	wt %	11.65	4.94	31.93	--
Aromatics	wt %	85.83	91.69	66.51	--
Asphaltenes	wt %	0.47	0.78	0.16	Maximum 6
Catalyst Regeneration Reformers (CCR)	wt %	12.52	15.25	0.07	--

The data reported in the **TABLE 1** is for samples having 18 wt % paraffin rich oil (Extract) and 82 % aromatic rich phase (raffinate). The data presented is for a typical set of properties and not to be considered as limiting in any way the process as such.

The BMCI was calculated using the following equation:

$$\text{BMCI} = (48640/T) + (473.7 * \text{specific gravity}) - 456.8$$

$$\text{where, } T (^{\circ}\text{K}) = 273 + (T_{10} + T_{30} + T_{50} + T_{70} + T_{90})/5$$

It was observed that the aromatic content of the raffinate was 6 wt % higher than the clarified slurry oil (CSO) feedstock. Further, the corresponding API gravity of raffinate was increased by 2 units and the BMCI value calculated by gravity and distillation method was increased from 127 to 134, in comparison with the feedstock. A higher density and lower average boiling point is desired for improving the BMCI. Still further, the propane extraction process removed more than 50 % of saturates from the feedstock, as, in the raffinate obtained. The experiment was carried out in a single-stage mixer settler lab autoclave unit. The extract yield and its saturate content are expected to improve further in a continuous multi-stage extraction process having special internals for better mixing and settling. The extract obtained by the extraction process of the present disclosure has low Conradson Carbon Residue (CCR) and Asphaltenes content, which makes the extract suitable as a FCC feed with or without hydrotreating, as a hydrocracker feed, as lube oil base stock, and as thermic fluid for heat transfer applications.

The clarified slurry oil feedstock (CSO), raffinate and extract were analyzed in a gas chromatograph (High temperature Simdist, D7169). The analysis is illustrated in TABLE 2.

TABLE 2: High temperature Simdist temperature analysis of clarified slurry oil feedstock (CSO), raffinate and extract

Recovered Mass %	Temperature (°C)		
	CSO	Raffinate	Extract
Initial Boiling Point (IBP)	223	229	148.5
5	313.5	320	265
10	345	347	311.5
20	363.5	365.6	352.5
30	378	380.5	368.5
50	406	409	395
70	440	447	421.5
80	467	476	439.5
90	517	542	469.5
95	582.5	601.5	493.5
Final Boiling Point (FBP)	693	696	617.5
$T = (T_{10} + T_{30} + T_{50} + T_{70} + T_{90})/5$	417.2	425.1	393.2

Further, the crack-ability of extract was studied in an ACE reactor; the data was generated at base conditions of 545°C and compared with corresponding conversion selectivity plots of hydrotreated vacuum gas oil (VGO) feedstock. The extract showed a much lower conversion than hydrotreated (HDT) VGO, 40 - 45 wt % vis-à-vis 70 - 80 wt %, at different catalyst to oil ratio. This is consistent with higher aromatics

content of extract and reflected in lower UOP K. Higher aromatics also result in higher coke make. Since, the CCR and Asphaltenes content of extract are within the limits of hydrotreater feed requirement, it is possible to process the extract in hydrotreater for aromatics saturation and UOP K improvement. KBC VGO-HT Kinetic model estimates showed aromatics saturation in extract from 65 % to 50 % by wt and UOPK factor improvement from 10.4 to 10.7. Extract as such shows a conversion of approximately 41 wt % (at 216 °C) and approximately 66 wt % (at 370 °C). Hydrotreating improves the conversion to approximately 47 wt % (at 216 °C) and approximately 77 wt % (at 370 °C). This shows substantial potential for upgrading the extract through VGO-HT and FCC. TABLE 3 illustrates yields estimates of products of extract and hydrotreated (HDT) extract in FCC by KBC Simulation Kinetic model.

TABLE 3: Yield of products by cracking extract obtained by process of the present disclosure in FCC

Product	Unit	Base	Base & Extract	Base & HDT Extract	100% Extract	100% HDT Extract
Dry Gas	wt %	5.01	4.98	4.96	3.13	1.72
Propylene	wt %	9.50	9.44	9.46	5.47	6.97
Total C ₃ + C ₄	wt %	20.24	20.08	20.13	9.07	12.62
Total Naphtha	wt %	37.32	37.05	37.10	18.67	22.20
Light Cycle Oil	wt %	15.11	15.24	15.19	24.21	20.41
Clarified Oil	wt %	7.50	7.89	7.85	34.15	30.68
Coke	wt %	5.32	5.32	5.32	5.30	5.39
Conversion	wt %	77.39	76.87	76.96	41.65	47.33
Total		100	100	100	100	100

TECHNICAL ADVANTAGES

A process for improving the aromaticity of heavy aromatic hydrocarbons as described in the present disclosure has several technical advantages including but not limited to the realization of:

- the aromatic content of clarified slurry oil feedstock can be increased by 5 – 10 wt.%;
- the BMCI of paraffin extracted clarified slurry oil(raffinate) is at least 132;
- the paraffin content of raffinate is substantially reduced;
- the API gravity of raffinate is increased; and
- the applicability and thus the economic benefit of the raffinate and extract are improved.

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

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

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

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

Claims:

1. A process for producing raffinate with improved aromaticity; said process comprising the following steps:
 - a. mixing clarified slurry oil feedstock having a BMCI ranging between 110 and 130 with a solvent in an apparatus to obtain an oil-solvent mixture;
 - b. heating the oil-solvent mixture at a temperature ranging between 50 and 200 °C to obtain a heated oil-solvent mixture;
 - c. vigorously agitating the heated oil-solvent mixture for a time period ranging between 0.5 and 2 hours to obtain an oil-solvent dispersion;
 - d. allowing the dispersion to separate into paraffin rich phase and raffinate phase .
 - e. separating the raffinate phase from the paraffin rich phase to obtain raffinate with aromatics content of at least 90 wt % and a BMCI of at least 132.
2. The process as claimed in claim 1, further comprises heating the separated paraffin rich phase at a temperature ranging between 40 and 80 °C to remove solvent.
3. The process as claimed in claim 1, wherein the solvent is at least one selected from the group consisting of C₂ to C₇ hydrocarbons and C₃ to C₇ ketones.

4. The process as claimed in claim 1, wherein the solvent is at least one selected from the group consisting of C₂ to C₇ alkanes, C₂ to C₇ alkenes and C₃ to C₇ ketones.
5. The process as claimed in claim 1, wherein the proportion of the solvent to oil ranges between 4: 1 and 10: 1.
6. The process as claimed in claim 1, wherein the heating is carried out at a pressure ranging between 10 and 50 kg/cm².
7. The process as claimed in claim 1, wherein the agitation of heated oil-solvent mixture is carried out at a temperature ranging between 50 and 200 °C and at a pressure ranging between 10 and 50 kg/cm².
8. The process as claimed in claim 1, wherein the agitation of heated oil-solvent mixture is carried out at a speed ranging between 500 and 3000 rpm.
9. The process as claimed in claim 1, wherein the step c is carried out in a static mixer.
10. Raffinate with aromatics content of at least 90 wt % and having a BMCI of at least 132, obtained by the process as claimed in any of preceding claims.