
Supplementary data for:

**Production of Clean Fuels by Catalytic Hydrotreating a Low
Temperature Coal Tar Distillate in a Pilot-Scale Reactor**

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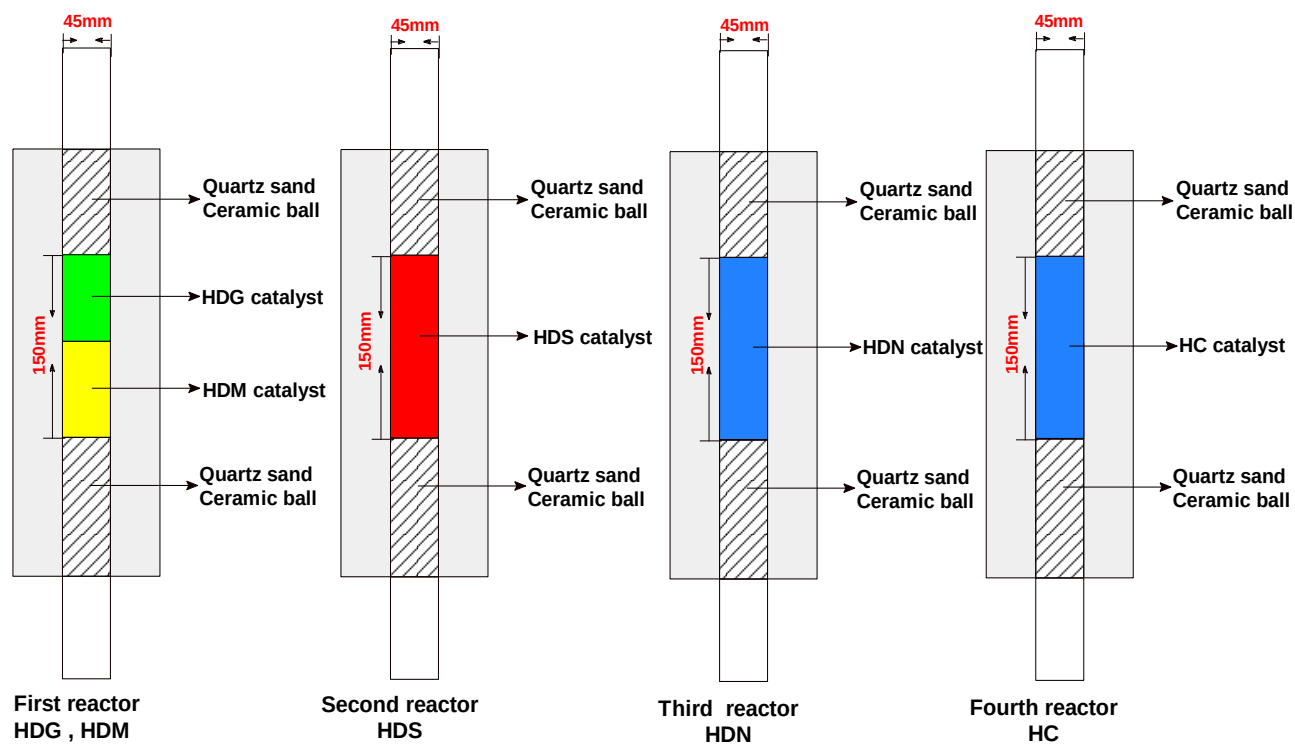


Fig.S1. The packing structures of catalysts in different reactors

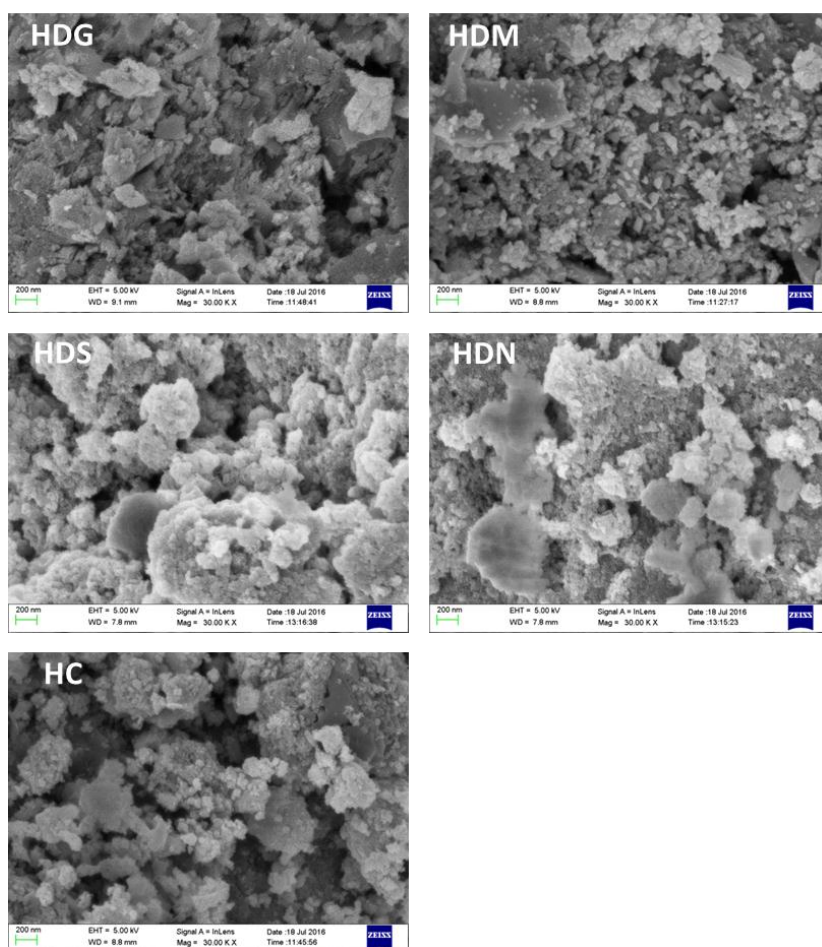


Fig. S2. The image of SEM under 200 nm of all catalysts

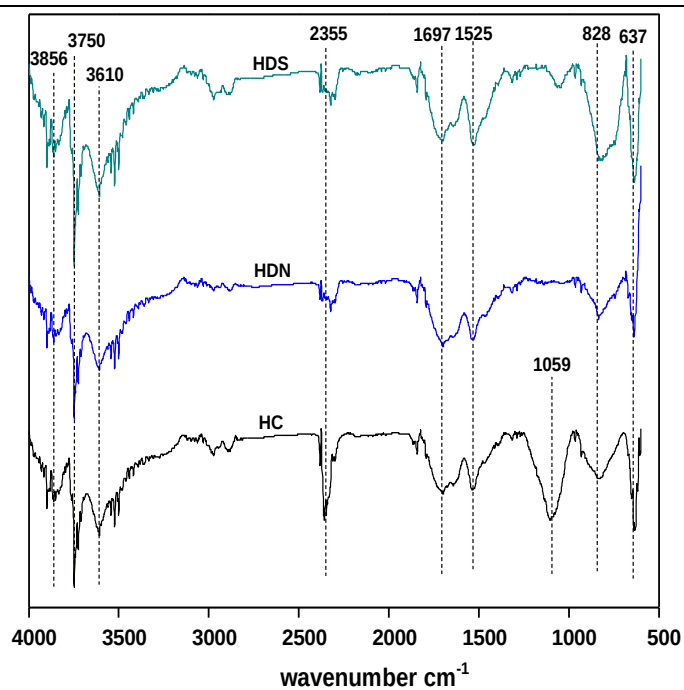


Fig. S3. FT-IR spectra of the HDS、HDN and HC catalysts

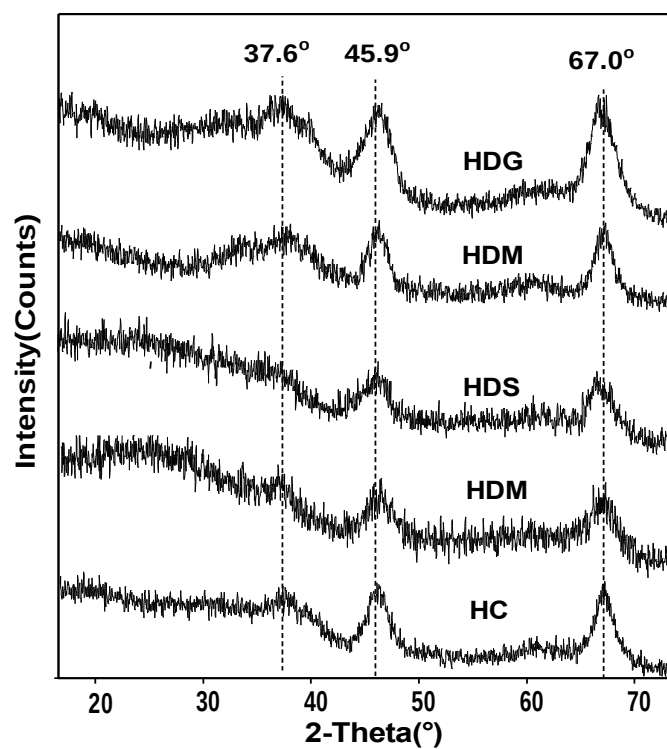


Fig. S4. X-ray diffraction patterns of all the hydrogenation catalysts

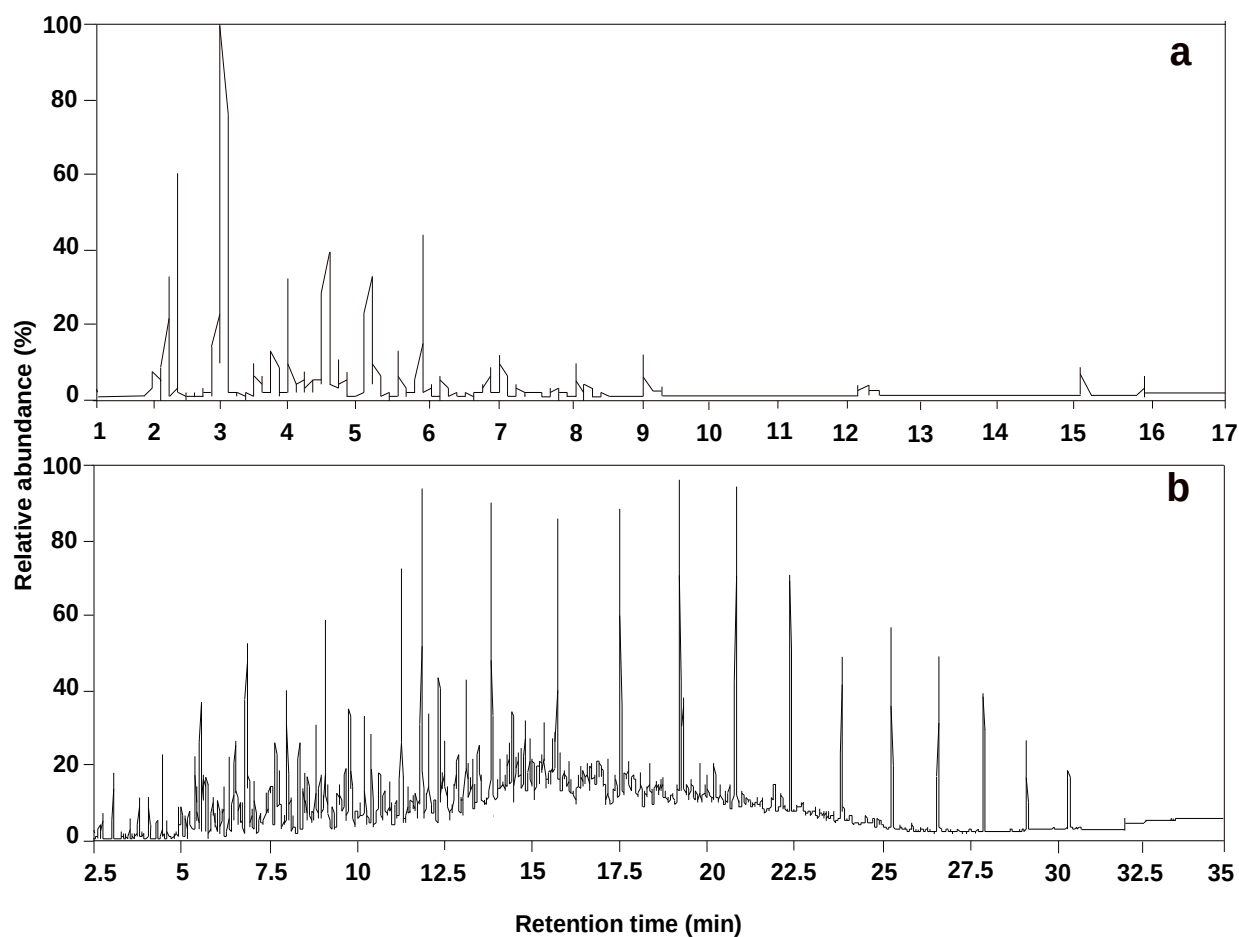


Fig. S5. Total ion chromatogram of the gasoline fraction (a) and diesel fraction (b)

Table S1 Identification of specific compounds of coal tar distillate by GC–MS.

PN^a	Compound	RT^b(min)	PA^c (%)	PN	Compound	RT(min)	PA (%)
1	Phenol	12.26	0.79	56	3-(2-Methyl-propenyl)-1H-indene	44.27	0.38
2	o-Creso	15.71	1.53	57	1,4,5-Trimethylnaphthalene	44.53	0.8
3	2,3,4-Trimethyl-2-cyclopenten-1-one	15.96	0.66	58	2,3,6-Trimethylnaphthalene	45.48	0.65
4	p-Cresol	16.84	1.31	59	2,3,6-Trimethylnaphthalene	45.62	0.43
5	o-Cresol	16.89	4.12	60	1,4,6-Trimethylnaphthalene	46.47	0.96
6	2,6-Xylenol	18.38	0.33	61	Fluorene	47.44	0.6
7	Bp-Allyltoluene	20.7	0.6	62	1,4,5-Trimethylnaphthalene	47.82	0.7
8	2,4-Xylenol	21.07	1.76	63	1-Allylnaphthalene	48.53	0.37
9	2,6-Xylenol	21.17	2.17	64	1-Nonadecene	48.88	0.76
10	p-Ethylphenol	22.33	0.57	65	1,4,5-Trimethylnaphthalene	49	0.7
11	2,6-Xyleno	22.42	2.53	66	1-Allylnaphthalene	49.11	0.37
12	Naphthalene	22.67	1.6	67	1-Nonadecene	49.24	0.76
13	2,3-Xylenol	22.93	0.61	68	n-Heptadecane	49.34	1.37
14	1-Methyl-3-(1-methyl-2-propenyl)benzene	23.09	0.69	69	[1,1'-Biphenyl]-4-carboxaldehyde	49.81	0.33
15	3-Methyl-1-phenyl-2-butene	23.72	0.33	70	2-Methyl-1-naphthol	49.88	0.33
16	3,4-Xylenol	24.02	0.53	71	1,2,3,6,7,8-Hexahydro-as-indacene	50	0.6
17	n-Dodecane	24.2	0.51	72	9-Methylfluorene	54.01	0.38
18	2,4,6-Trimethylphenol	24.32	0.6	73	1-Methylfluorene	54.47	0.53
19	p-Cumenol	26.21	0.61	74	1-Nonadecene	54.62	0.41
20	6-Ethyl-o-cresol	26.43	0.51	75	1,2-Dimethylnaphtho[2,1-b]furan	54.85	0.42
21	6-Ethyl-m-cresol	26.8	0.92	76	n-Heneicosane	55.04	1.92
22	3-Methyl-5-ethylphenol	27.12	0.45	77	2,6,10-Trimethyldodecane	55.34	0.75
23	2-Ethyl-4-methylphenol	28.26	1.75	78	1,2,3,4-Tetramethylnaphthalene	56.13	1.08
24	2,4,6-Trimethylphenol	28.57	0.49	79	1,2-Dimethylnaphtho[2,1-b]furan	56.48	0.41
25	2,4,5-Trimethylphenol	28.91	0.39	80	(7E)-7-Methyl-7-heptadecene	56.69	0.34
26	4,7-Dimethylindan	29.03	0.38	81	3,7,11-Trimethyl-1-dodecanol	57.29	0.46
27	1-Methylnaphthalene	29.7	1.35	82	Phenanthrene	58.34	0.77
28	n-Tridec-1-ene	30.15	0.41	83	Phenanthrene	58.87	0.45
29	1,4-Dihydro-1,4-methanonaphthalene	30.72	1.54	84	1-Nonadecene	60.08	0.43
30	2,5,5-Trimethyl-3-phenyl-cyclohexano	31.07	0.37	85	Heneicosane	60.47	2.1

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31	6-Isopropyl-m-cresol	31.62	0.5	86	n-Nonadecanol-1	60.72	0.38
32	p-Ethylbenzaldehyde	31.78	0.84	87	2-Methyl-9,10-dihydroanthracene	61.1	0.41
33	1-Isopropenyl-2-isopropylbenzene	32.03	0.38	88	4-Methylphenanthrene	64.42	0.42
34	5-Hydroxyhydrindene	33.27	0.92	89	2-Methylanthracene	64.69	0.34
35	1,5,6,7-Tetramethylbicyclo[3.2.0]hept a-2,6-diene	33.98	0.77	90	9-Methylanthracene	65.12	0.47
36	p-Cumic aldehyde	34.83	0.51	91	1-Nonadecene	65.29	0.69
37	[(1E,3E)-1-Methyl-1,3-pentadienyl]be nzene	34.96	0.45	92	n-Heneicosane	65.65	2.79
38	2,3-Dimethylnaphthalene	36.1	0.53	93	1-Nonadecene	70.28	0.45
39	1-Isopropyl-3,5-dimethylbenzene	36.31	0.58	94	n-Heneicosane	70.6	2.72
40	2-(2-Methylallyl)phenol	36.46	0.46	95	1-Nonadecene	70.84	0.42
41	1-Pentadecene	36.62	0.39	96	7-Butyl-1-hexylnaphthalene	75.04	1.26
42	2,6-Dimethylnaphthalene	36.73	0.96	97	n-Heneicosane	75.34	2.83
43	n-Tetradecane	37.14	1.29	98	1-Nonadecene	79.6	0.45
44	2,3-Dimethylnaphthalene	37.66	1.08	99	n-Eicosane	79.87	4.4
45	1,5-Dimethylnaphthalene	37.86	1.31	100	1-Heptacosanol	83.99	0.51
46	6-Methyl-4-indanol	38.11	0.51	101	n-Heneicosane	84.23	3.21
47	6-Methyl-4-indanol	38.62	0.33	102	Hexatriacontane	88.41	2.66
48	2,3-Dimethylnaphthalene	38.83	1.35	103	Hexatriacontane	92.44	2.18
49	1,5,6,7-Tetramethylbicyclo[3.2.0]hept a-2,6-diene	39.97	1.07	104	Hexatriacontane	96.44	1.44
50	1-[(1E)-1-Butenyl]-4-methoxybenzene	40.79	0.51	105	Hexatriacontane	99.41	0.62
51	Oxalic acid, decyl 2-ethylhexyl ester	41.04	0.56	106	Tetrapentacontane	101.1	0.37
52	p-Diisopropylbenzene	41.12	0.35	107	9-Cedranone	102.18	0.6
53	(7a-Isopropenyl-4,5-dimethyloctahydr oinden-4-yl)methanol	41.57	1	108	1-(2,5-Bis-methoxymethoxy-phenyl)-3,7,11-trimethyl- dodeca-2,6,10-triene	102.42	0.35
54	Pentadecane	43.37	1.35	109	5-(7a-Isopropenyl-4,5-dimethyl-octahydroinden-4-yl)- 3-methyl-pent-2-en-1-ol	102.66	0.6
55	1,4,6,7-Tetramethyl1,2,3,4-tetrahydro naphthalene	44.09	0.92	110	Tetrapentacontane	103.25	1.06
56	3-(2-Methyl-propenyl)-1H-indene	44.27	0.38	111	3-(2-Methyl-propenyl)-2H-indene	94.99	1.47

^a PN-Peak number; ^b RT- Retention time; ^c PA-Peak area

Table S2 Identification of specific compounds of product by GC–MS.

PN	Compound	RT(min)	PA (%)	PN	Compound	RT(min)	PA(%)
1	o-Xylene	4.53	0.26	68	1,2,3,4-tetrahydro-2,7-dimethyl- Naphthalene	23.14	0.36
2	1,3,5-trimethyl- cyclohexane	4.67	0.47	69	1,2,3,4-tetrahydro-2,7-dimethyl-Naphthalene	23.28	0.27
3	1,3,5-trimethyl- cyclohexane	4.74	0.27	70	2-methyl-, cis-1,1'-Bicyclohexyl	23.64	0.15
4	1,3,5-trimethyl- cyclohexane	4.8	0.34	71	2-cyclohexen-1-yl-Benzene	24.56	0.4
5	1-Ethyl-4-methylcyclohexane	4.96	2.62	72	2',4',5'-Trifluoroacetophenone	24.75	0.17
6	p-Xylene	5.06	0.49	73	1,2,3,4-tetrahydro-5,6-dimethyl-Naphthalene	25.44	1.95
7	Nonane	5.14	0.34	74	Tetradecane	25.96	2.05
8	1-ethyl-4-methyl- trans- cyclohexane	5.42	1.53	75	(1,4-Dimethylpent-2-enyl)benzene	26.54	0.17
9	1-ethyl-4-methyl-trans-cyclohexane	5.47	0.44	76	5-Isopropyl-2-methylphenethyl acetate	26.76	0.2
10	(1-methylethyl)-cyclohexane	5.72	0.71	77	3-Ethyl-3-phenyl-1-pentene	27.16	0.17
11	propyl-cyclohexane	6.04	1.79	78	Hexadecane	28.52	0.55
12	1-ethyl-2,3-dimethyl-cyclohexane	6.22	0.3	79	Methyl-4-methoxy-4,8,12,16-tetramethylheptadecanoate	29.23	0.13
13	Trans-1,4-diethylcyclohexane	6.49	0.22	80	2,5,5,8a-Tetramethyl-4-methylene4H-chromene	29.29	0.65
14	octahydro-1H-Indene	6.71	0.67	81	1,2,3,4-tetrahydro-1,6,8-trimethyl-Naphthalene	29.4	0.57
15	1-ethyl-3-methyl-benzene	6.89	1.42	82	Pentadecane	30.13	2.03
16	Mesitylene	7.08	0.51	83	Dibenzofuran	30.41	0.78
17	1-methyl-4-(1-methylethyl)-trans-cyclohexane	7.22	0.38	84	1,2,3,4-tetrahydro-1-methyl-8-(1-methylethyl)-Naphthalene	31.2	0.44
18	1,2,3-trimethyl-benzene	7.43	0.48	85	4-methyl-4-phenyl-2-Cyclohexen-1-one	31.47	0.15
19	octahydro-1H-Indene	7.84	1.5	86	1,4-Dimethyl-2-cyclohexylbenzene	31.81	0.2
20	Mesitylene	7.92	0.79	87	5,5-Dibutylnonane	32.45	0.16
21	cyclohexylmethyl isohexyl ester	8.16	0.66	88	Fluorene	33	0.28

22	1-(1-methylcyclohexyl)- Ethanone	8.29	0.38	89	Hexadecane	34.06	2.2
23	3.beta.-Methyl-trans-hexahydrophthalide	8.44	0.63	90	4-methyl-Dibenzofuran	34.54	0.56
24	4-methyl-1-(1-methylethyl)-cyclohexane	8.54	0.3	91	Hexadecane	34.87	0.16
25	(2-methyl-1-propenyl)-cyclohexane	8.68	0.42	92	4-methyl- Dibenzofuran	35.04	0.59
26	(1-methylpropyl)-cyclohexane	8.98	0.45	93	4-methyl- Dibenzofuran	35.38	0.18
27	butyl-cyclohexane	9.24	1.11	94	2,6,10,14-tetramethyl-Pentadecane	35.71	0.67
28	Indane	9.37	0.74	95	Decyl- cyclohexane	35.88	0.21
29	1-butyl-cyclohexene	9.57	1.6	96	1,2,3,4,5,6,7,8-octahydro-Anthracene	36.81	0.24
30	1-methyl-4-(2-hydroxyethyl)-cyclohexane	9.76	0.49	97	1,2,3,4-Tetrahydro-3-isopropyl-5-methyl-1-oxonapht halene	37	0.13
31	4-methyl-1-(1-methylethyl)-cyclohexene	9.76	0.49	98	1,2,3,4,5,6,7,8-octahydro-Phenanthrene	37.18	0.22
32	2-methyl-phenol	10.11	0.32	99	4-methyl- 9H-Fluorene	37.62	0.12
33	decahydro-naphthalene	10.23	0.12	100	Heptadecane	37.81	2.51
34	1-methyl-3-(1-methylethyl)- benzene	10.29	0.34	101	2,6,10,14-tetramethyl-Pentadecane	37.97	1.15
35	octahydro-5-methyl-1H-Indene	10.56	0.93	102	1,2,3,4,5,6,7,8-octahydro-Anthracene	38.22	0.31
36	1,2-Dimethyl-4-trifluoroacetoxycyclohexane	11.57	0.44	103	4-(2-phenylethenyl)-, (E)- Phenol	38.93	0.32
37	2-hexyl-1-Decanol	12.07	0.74	104	1,2,3,4,5,6,7,8-octahydro-2-methyl, (R)- Anthracene	39.22	0.27
38	2-methyl- trans-Decalin	12.51	0.76	105	2-Cyclohexylnonadecane	39.71	0.18
39	4-ethynyl-1,7,7-trimethyl-Bicyclo[2.2.1]hepta n-2-one	12.71	0.14	106	1,2,3,4,5,6,7,8-octahydro-2-methyl, (R)- Anthracene	40.12	0.14
40	decahydro-2-methyl-naphthalene,	13.19	0.49	107	9-Methyl-S-octahydroanthracene	40.42	0.25
41	2-methyl-trans-Decalin	13.19	0.38	108	Octadecane	41.55	2.68
42	1-methyl-2-(2-propenyl)-Benzene	13.76	0.77	109	Hexadecane, 2,6,10,14-tetramethyl-	41.72	0.33
43	1-Phenyl-1-butene	14.29	0.96	110	2-amino-4,6-dimethyl-5H-[1]Pyrindine-3,7-dicarboni trile	43.15	0.19
44	Bicyclopentyl-1'-en-1-ol	14.49	0.12	111	Heneicosane	45.2	2.63
45	1,2,3,4-tetrahydro- Naphthalene	14.91	2.44	112	2-butyl-1-hexyl-2,3-dihydro- 1H-Indene	45.4	0.13

46	decahydro-1,1-dimethyl-Naphthalene	15.04	0.32	113	p-Dicyclohexylbenzene	46.17	0.14
47	decahydro-2,6-dimethyl- Naphthalene	15.63	0.39	114	1,1,2,2,3,3-Hexamethylindane	46.49	0.29
48	2,3-dihydro-1,6-dimethyl-1H-Indene,	16.03	1.08	115	undecyl-cyclohexane	47.17	0.13
49	decahydro-2,6-dimethyl-Naphthalene	16.14	0.12	116	Heneicosane	48.6	3.09
50	2-Ethyl-2,3-dihydro-1H-indene	16.26	0.21	117	10,18-Bisnorabieta-8,11,13-triene	49.69	0.5
51	2,3-dihydro-1,6-dimethyl-1H-Indene	16.48	0.56	118	2-butyl-3-hexyl-1,2,3,4-tetrahydro-Naphthalene	50.14	0.22
52	Dodecane	16.74	1.17	119	2,5-Di(trifluoromethyl)benzoic acid	50.55	0.17
53	1,2,3,4-tetrahydro-2-methyl-Naphthalene	17.35	1.54	120	Heneicosane	51.79	3.26
54	1,2,3,4-tetrahydro-1-methyl-Naphthalene	17.72	1.07	121	Tetrapentacontane	52.68	0.12
55	Bicyclo[4.2.1]nona-2,4,7-triene	18.15	0.46	122	Tetracosane	53.66	0.14
56	Cyclohexane	18.37	0.25	123	Heneicosane	54.81	3.25
57	Cyclododecene	18.5	0.2	124	Octatriacontyl pentafluoropropionate	56.56	0.2
58	2,3-dihydro-4,7-dimethyl-1H-Indene	18.84	0.44	125	Heneicosane	57.69	3.16
59	1,2,3,4-tetrahydro-5-methyl-Naphthalene	19.66	1.3	126	Dotriacontane	59.11	0.15
60	1,1'-oxybis- Octane	20.02	0.2	127	Tetracosane	60.38	2.51
61	1-(1-methylethenyl)-3-(1-methylethyl)-Benzene	20.24	0.17	128	Triacontane	61.77	0.14
62	2,3-dihydro-4,7-dimethyl-1H-Indene	20.31	0.4	129	Tetracosane	62.98	1.98
63	1,2,3,4-tetrahydro-5-methyl- Naphthalene	20.86	1.24	130	Tetracosane	72.53	1.14
64	Tridecane	21.46	1.01	131	Tetratriacontane	74.42	0.13
65	1,2,3,4-tetrahydro-2,6-dimethyl-Naphthalene	22.03	0.53	132	Tetratriacontane	75.8	0.56
66	1,2,3,4-tetrahydro-2,6-dimethyl- Naphthalene	22.18	0.64	133	Dotriacontane	76.09	0.2
67	2,3-dihydro-1,1,3-trimethyl-1H-Indene	22.36	0.68	134	Tetrapentacontane	77.35	0.13

Table S3 GC–MS analysis of diesel fraction

Retention time (min)	Peak area (%)	Formula	Compound name
2.533	1.25	C ₈ H ₁₆	1-ethyl-2-methyl cyclopentane
2.563	1.00	C ₈ H ₁₆	1-ethyl-2-methyl cyclopentane
2.642	5.73	C ₈ H ₁₆	1,2-dimethyl cyclohexane
2.716	9.01	C ₈ H ₁₆	1,3-dimethyl cyclohexane
2.995	4.37	C ₈ H ₁₆	1,2-dimethyl cyclohexane
3.042	16.06	C ₈ H ₁₆	Ethyl-cyclohexane
3.267	2.00	C ₉ H ₁₈	1,2,4-trimethyl cyclohexane
3.317	0.94	C ₉ H ₁₈	1,3,5-trimethyl cyclohexane
3.399	2.61	C ₈ H ₁₀	1-ethyl Benzene
3.706	6.39	C ₈ H ₁₀	1,3-dimethyl Benzene
4.034	1.50	C ₈ H ₁₀	1-ethyl Benzene
4.455	0.80	C ₉ H ₁₈	1,2,4-trimethyl cyclohexane
4.502	1.33	C ₉ H ₁₈	1,3,5-trimethyl cyclohexane
4.767	8.58	C ₉ H ₁₈	1-ethyl-3-methyl cyclohexane
4.886	2.16	C ₈ H ₁₀	1,2-dimethyl Benzene
4.899	0.93	C ₉ H ₂₀	Nonane
4.968	6.34	C ₉ H ₁₈	1-ethyl-3-methyl cyclohexane
5.116	1.29	C ₉ H ₁₈	1-ethyl-3-methyl cyclohexane
5.284	2.49	C ₉ H ₁₈	Butyl cyclohexane
5.342	8.20	C ₉ H ₁₈	Butyl cyclohexane
6.192	1.33	C ₁₀ H ₂₂	2-methyl-3-ethyl heptane
6.858	0.90	C ₉ H ₁₂	Propylbenzene
6.911	1.73	C ₉ H ₁₆	1-isobutyl-1-cyclopentene
7.198	2.98	C ₉ H ₁₂	1-ethyl-3-methyl Benzene
7.535	1.69	C ₉ H ₁₆	Trans-indene six hydrogen
8.201	0.72	C ₉ H ₁₂	1,2,3-trimethyl Benzene