Supplementary material

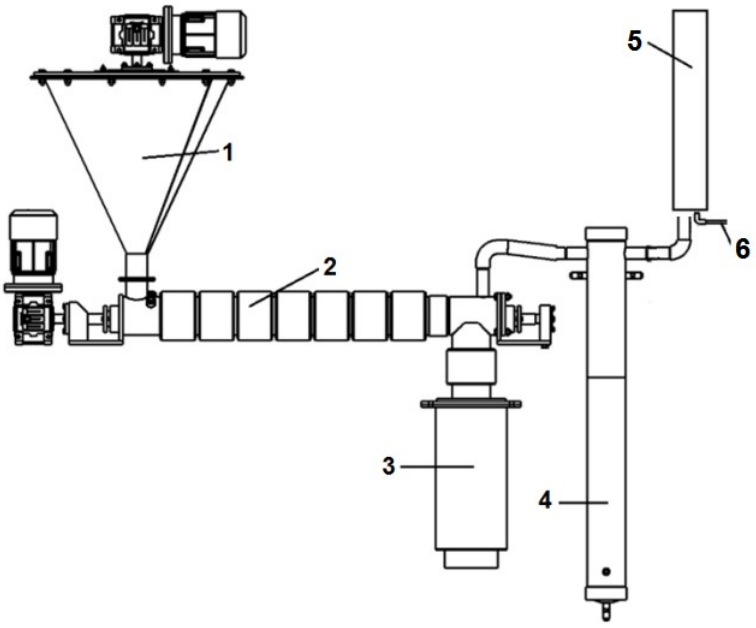


Figure S 1. – Scheme of the pyrolysis unit, where *1* is a dispenser; *2* is a reactor with heating elements; *3* is a solid carbon discharge tank; *4* is a condenser; *5* is an exhaust pipe; *6* is an afterburner

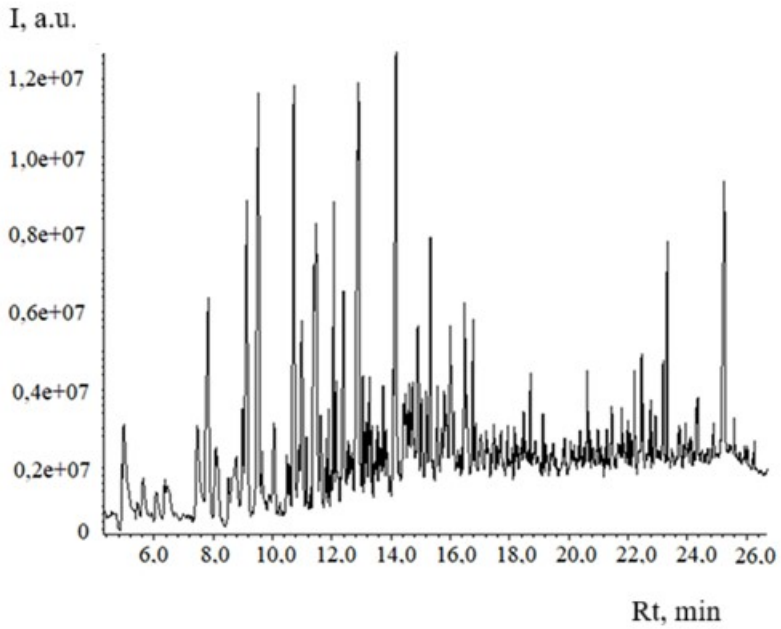


Figure S 2. – GC-MS chromatogram of chloroform solution of pyrolysis oil (pyrolysis oil: chloroform =1:100)

Urals brand oil analysis

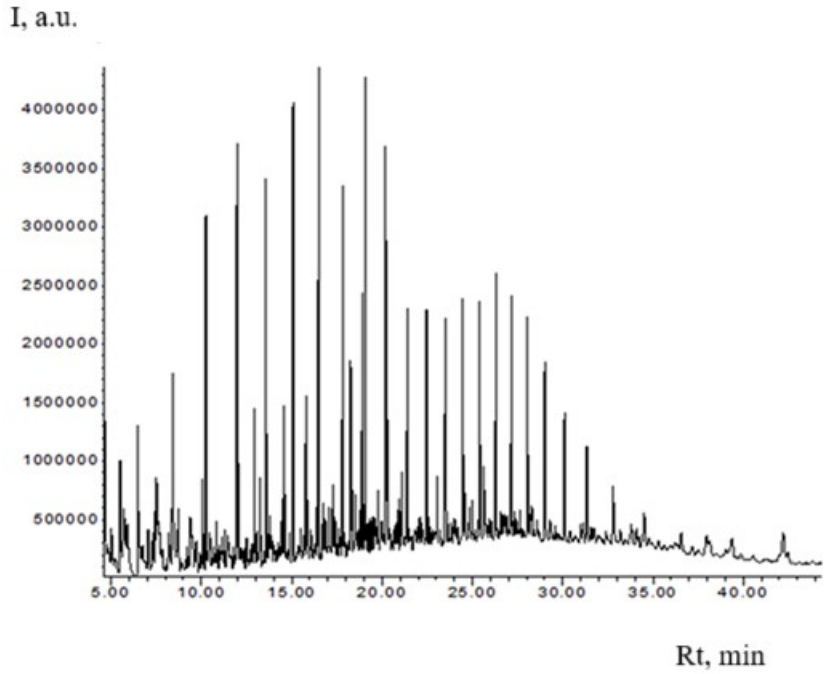
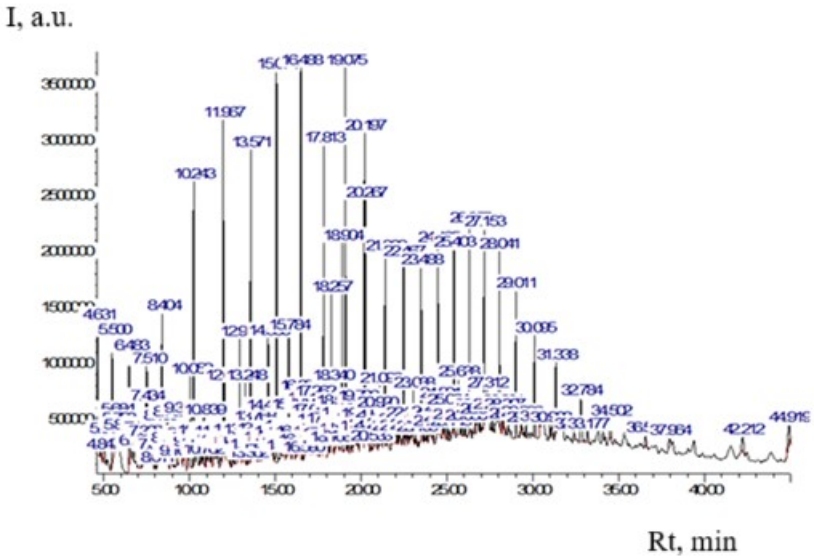
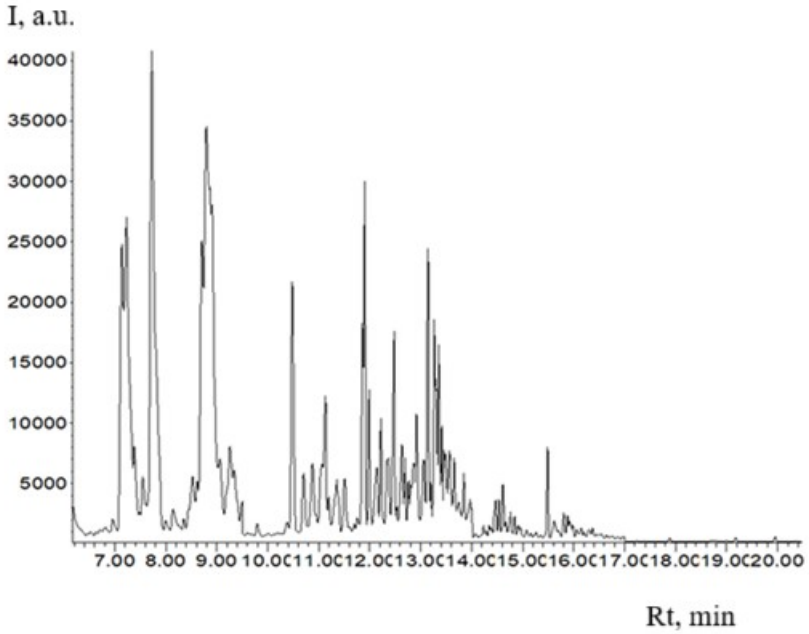


Figure S 3 – GC-MS chromatogram of hexane solution of Urals oil (after deasphalting)



a)



b)

Figure S 4. – GC-MS chromatogram of hexane solution of Urals oil after extraction with DMSO (a); DMSO re-extract hexane solution on SIM mode (b)

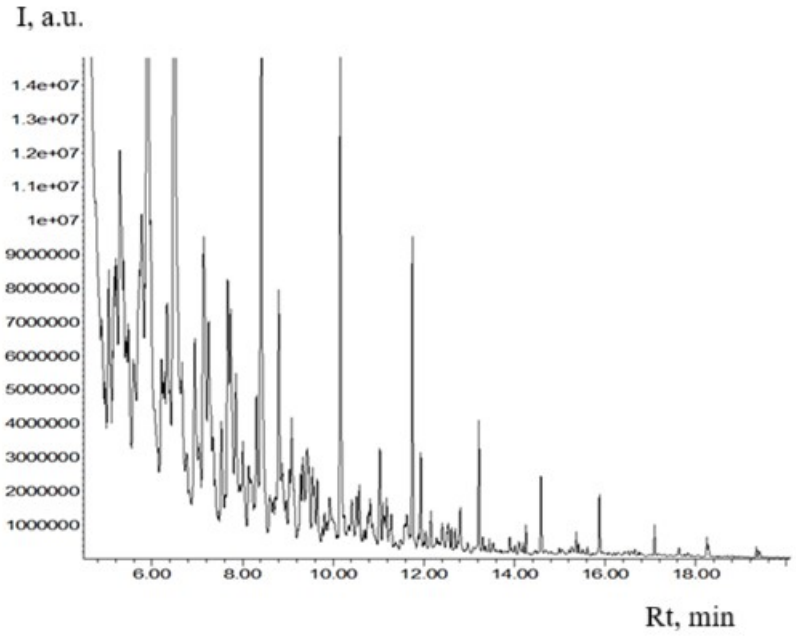


Figure S 5. – GC-MS chromatogram of hexane solution of Urals gasoline fraction

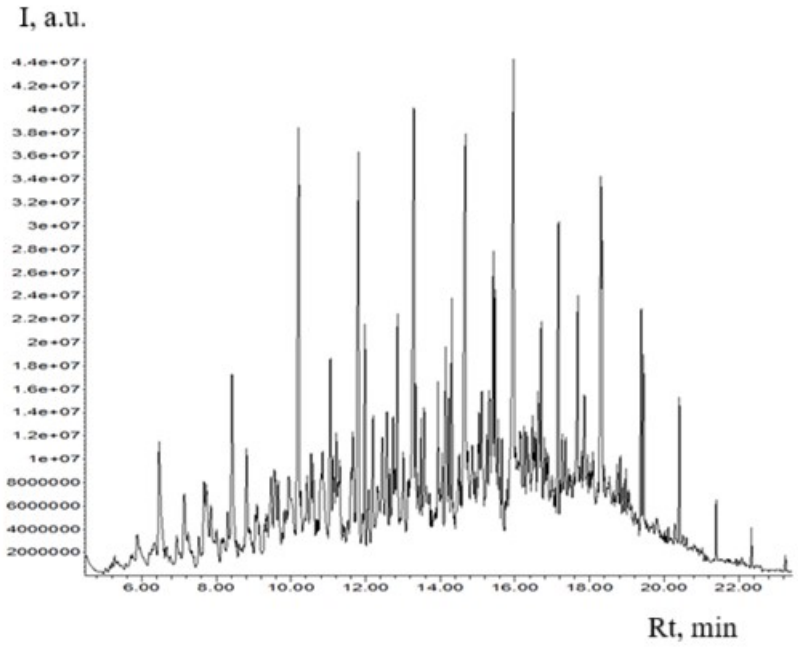


Figure S 6. – GC-MS chromatogram of hexane solution of Urals diesel fraction

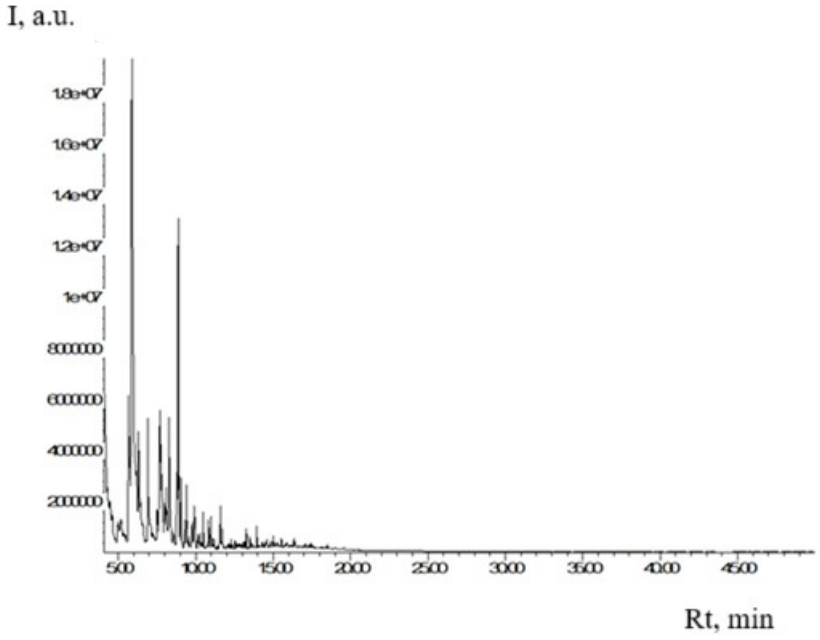


Figure S7. – GC-MS chromatogram of diesel oil after extraction with DMSO (DMSO re-extract hexane solution)

Table S1. – Composition of alkanes and naphthenes in Urals oil and its fractions

Rt, min	Compound	Urals oil	Gasoline fraction	Diesel fraction
5,051	Heptane, 2,6-dimethyl-	+	+	+

5,209	Cyclohexane, ethyl-	+	+	+
5,291	Cyclohexane, 1,1,3-trimethyl-	+	+	+
5,477	Cyclooctane, methyl-	+	+	+
5,772	Octane, 2-methyl-	+	+	+
6,212	Cyclopentane, 1-methyl-2-propyl-	+	+	+
6,494	Nonane	+	+	+
7,14	Nonane, 3-methyl-	+	+	+
7,34	Cyclooctane, 1,2-dimethyl-	+	+	+
7,731	Nonane, 2-methyl-	+	+	+
7,855	Nonane, 3-methyl-	+	+	+
8,412	Decane	+	+	+
8,797	Decane, 4-methyl-	+	+	+
9,037	Cyclohexane, (2-methylpropyl)-	+	+	+
9,086	Cyclodecane, methyl-	+	+	+
9,285	1-Ethyl-2,2,6-trimethylcyclohexane	+	+	+
9,539	Decane, 2-methyl-	+	+	+
9,649	Decane, 3-methyl-	+	+	+
10,158	Undecane	+	+	+
10,412	Undecane, 5-methyl-	+	+	+
10,577	Decane, 3,7-dimethyl-	+	+	+
10,79	Cyclohexane, pentyl-	+	+	+
11,1	Undecane, 4-methyl-	+	+	+
11,175	Undecane, 2-methyl-	+	+	+
11,746	Dodecane	+	+	+
11,931	Undecane, 3,6-dimethyl-	+	+	+
12,158	Cyclohexane, 2-butyl-1,1,3-trimethyl-	+	+	+
12,612	Dodecane, 4-methyl-	+	+	+
12,694	Dodecane, 2-methyl-	+	+	+
12,804	Octane, 2,6-dimethyl-	+	+	+
12,969	3-Tetradecene, (E)-	+	+	+
13,093	Cyclotetradecane	+	+	+
13,217	Tridecane	+	+	+
13,444	Tridecane, 6-methyl-	+	+	+
14,014	Tridecane, 4-methyl-	+	+	+
14,585	Tetradecane	+	+	+
15,87	Pentadecane	+	n.d.	+
17,094	Hexadecane	+	n.d.	+
18,242	Heptadecane	+	n.d.	+
19,342	Octadecane	+	n.d.	+
19,41	Hexadecane, 2,6,10,14-tetramethyl-	+	n.d.	+
20,386	Hexadecane	+	n.d.	+
21,376	Heneicosane	+	n.d.	+
22,332	Hentriacontane	+	n.d.	n.d.
24,119	Tetratetracontane	+	n.d.	n.d.
24,951	Hentriacontane	+	n.d.	n.d.
25,762	Hentriacontane	+	n.d.	n.d.
26,539	Hentriacontane	+	n.d.	n.d.

*n.d. – not detected

TPO Gasoline and diesel fractions before hydrotreating

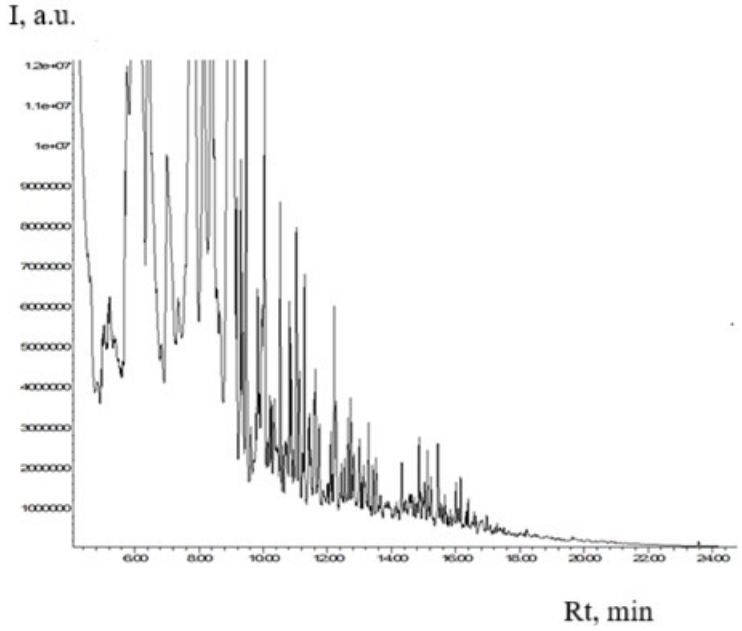


Figure S 8. – GC-MS chromatogram of hexane solution of TPO gasoline fraction

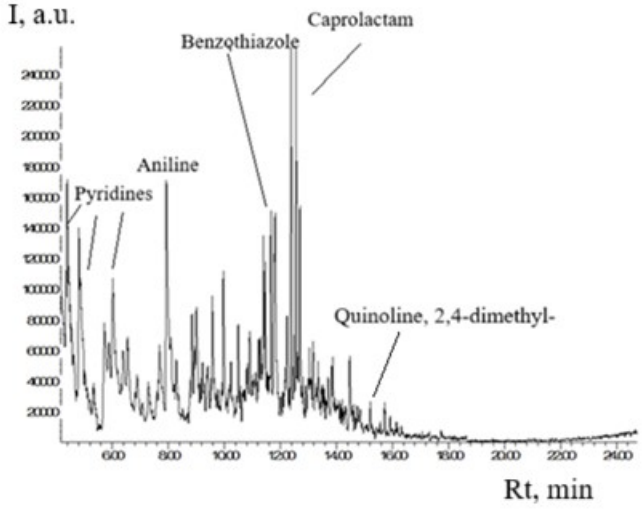


Figure S 9. – GC-MS chromatogram of water-soluble substances extracted from TPO gasoline fraction

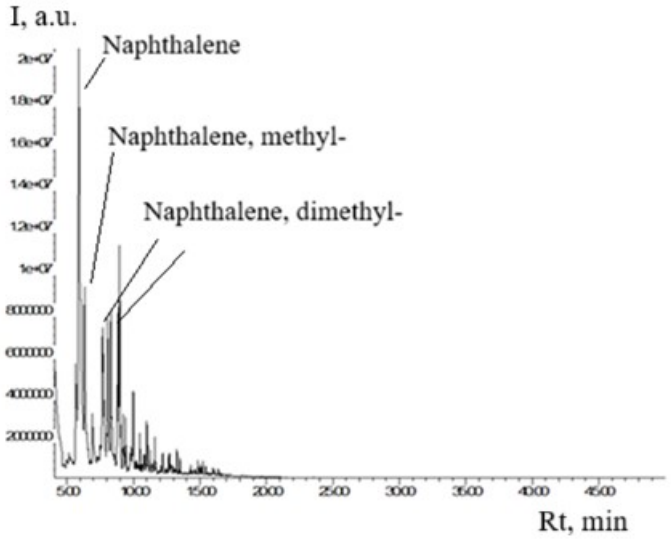


Figure S 10. – GC-MS chromatogram of DMSO re-extract hexane solution of TPO gasoline fraction

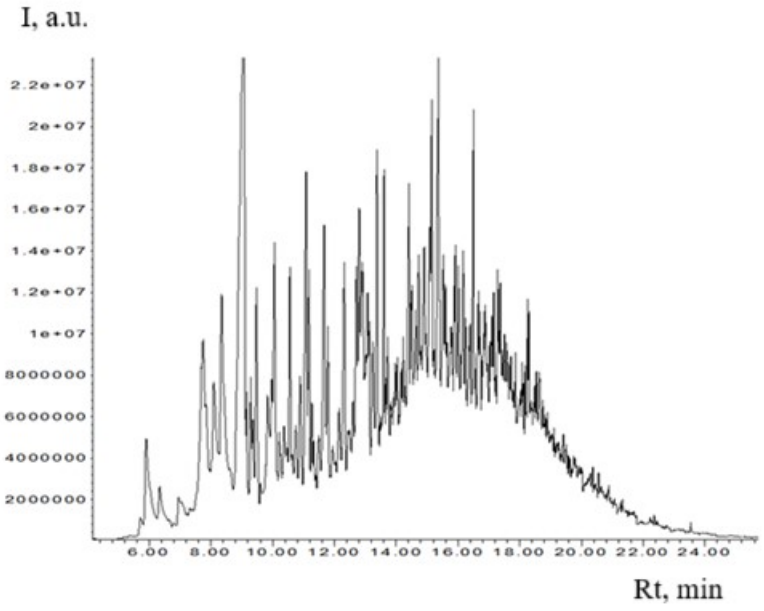


Figure S 11. – GC-MS chromatogram of hexane solution of TPO diesel fraction

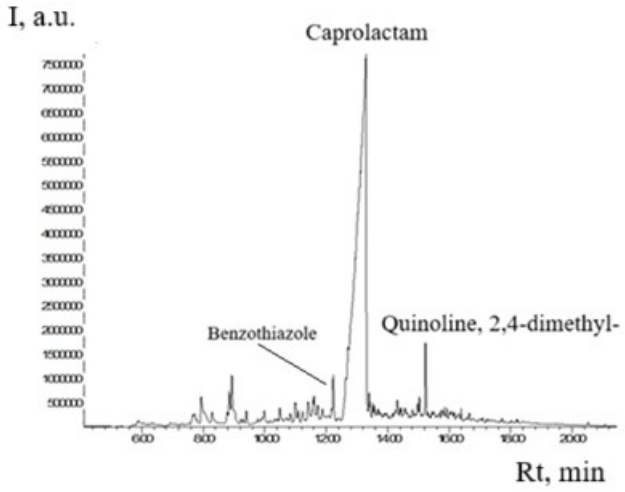
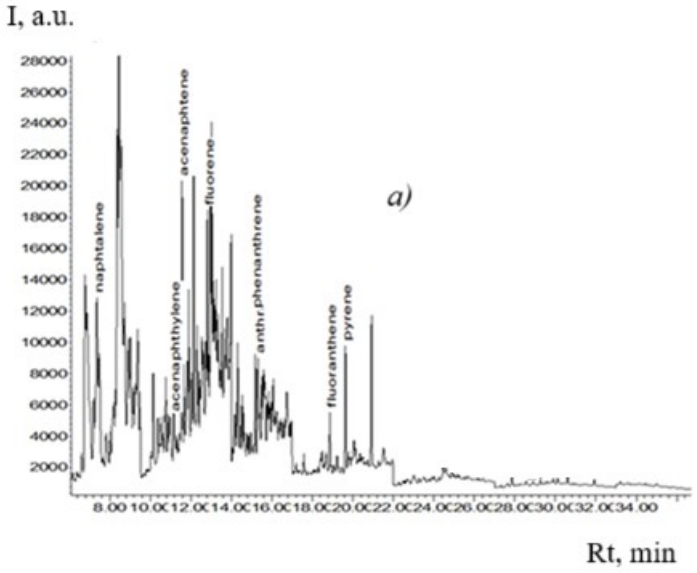


Figure S 12. – GC-MS chromatogram of water-soluble substances extracted from TPO diesel fraction



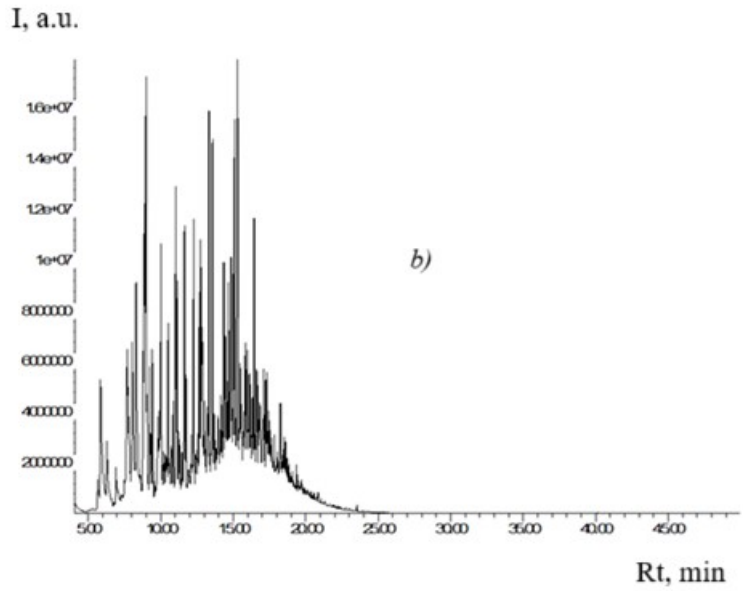


Figure S 13. – GC-MS chromatogram of DMSO re-extract hexane solution of TPO diesel fraction (SIM-*a*; SCAN - *b*)

Hydrotreating with Pt catalyst

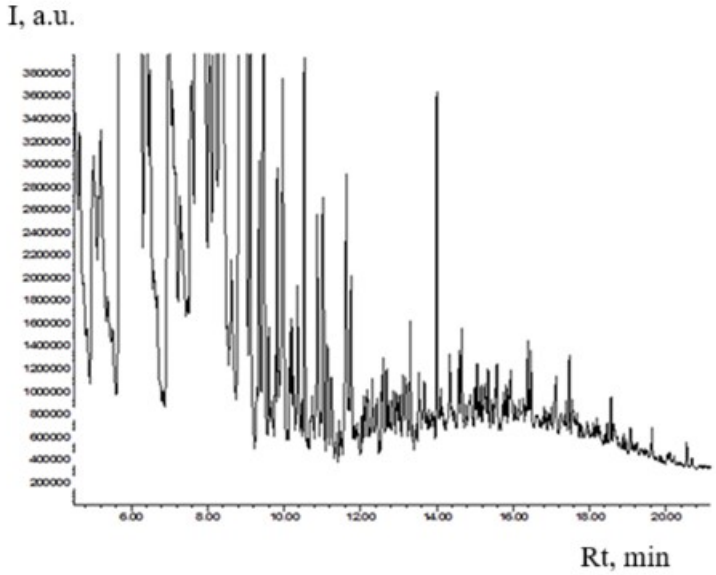


Figure S 14 – GC-MS chromatogram of gasoline fraction of pyrolysis oil after hydrotreating with Pt catalyst

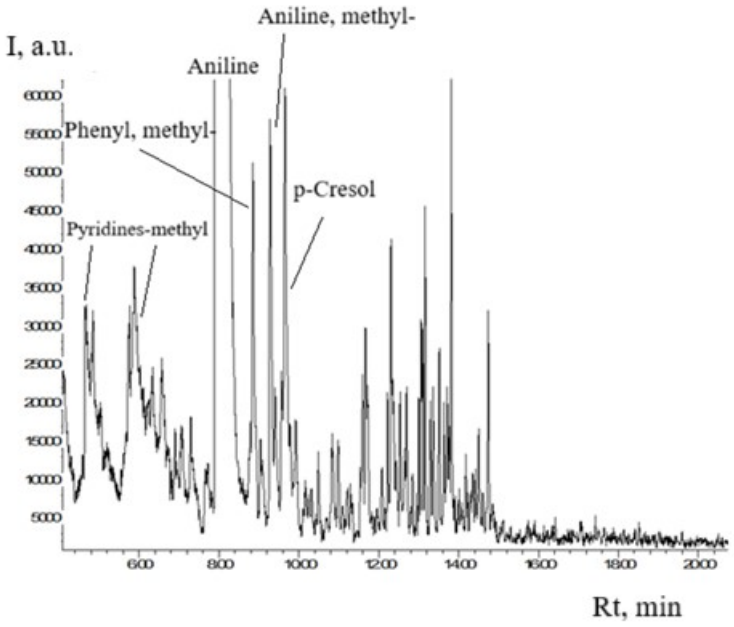


Figure S 15. – GC-MS chromatogram of water-soluble substances extracted from TPO gasoline fraction after hydrotreating with Pt catalyst

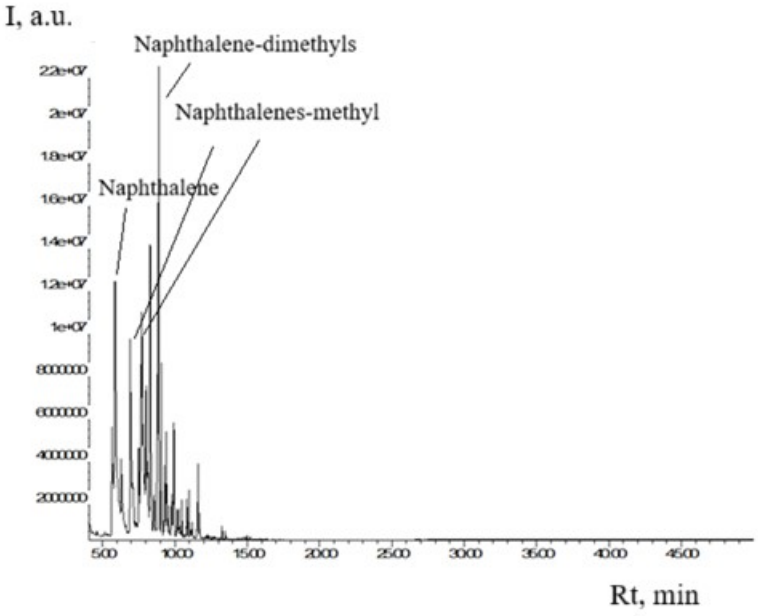


Figure S 15. – GC-MS chromatogram of DMSO re-extract hexane solution of TPO gasoline fraction after hydrotreating with Pt catalyst

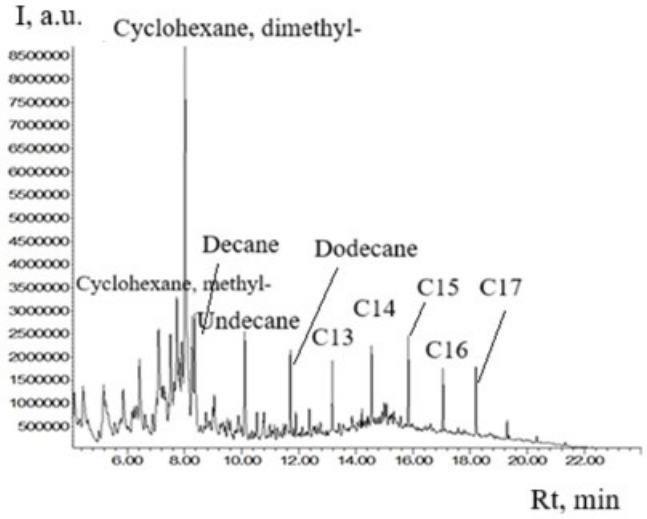


Figure S 16. – GC-MS chromatogram of concentrated hexane solution of TPO gasoline fraction after hydrotreating with Pt catalyst after oleum treatment

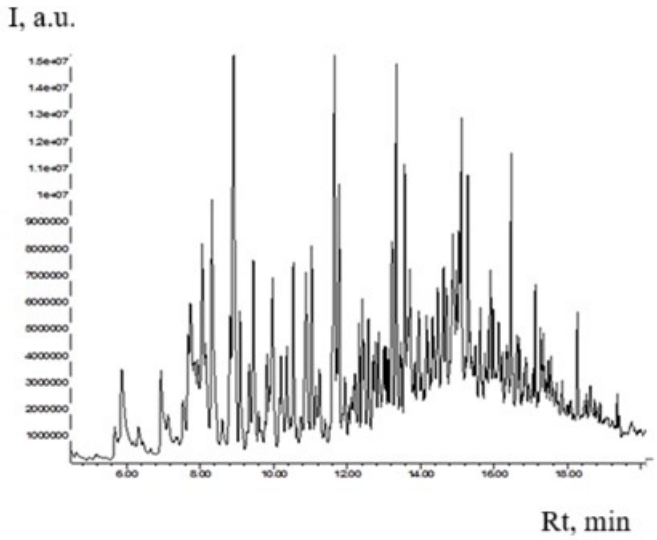


Figure S 17. – GC-MS chromatogram of concentrated hexane solution of TPO diesel fraction after hydrotreating with Pt catalyst

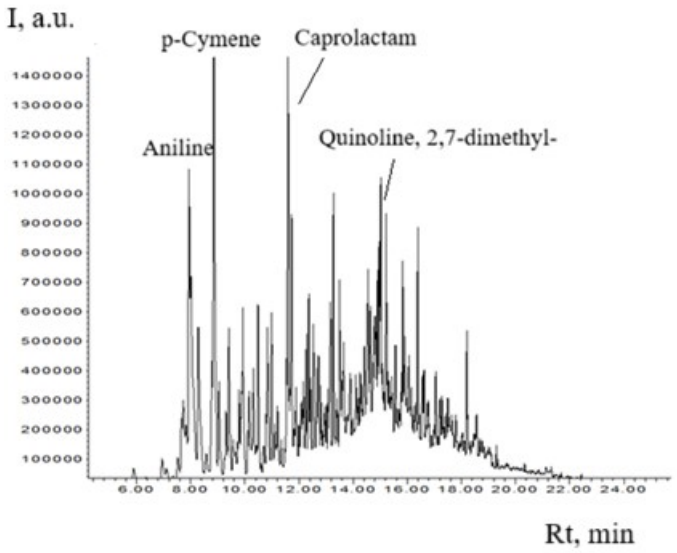
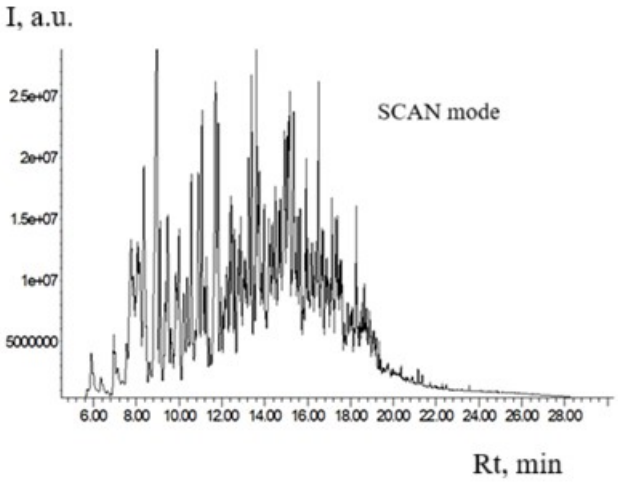


Figure S 18. – GC-MS chromatogram of water-soluble substances extracted from TPO diesel fraction after hydrotreating with Pt catalyst



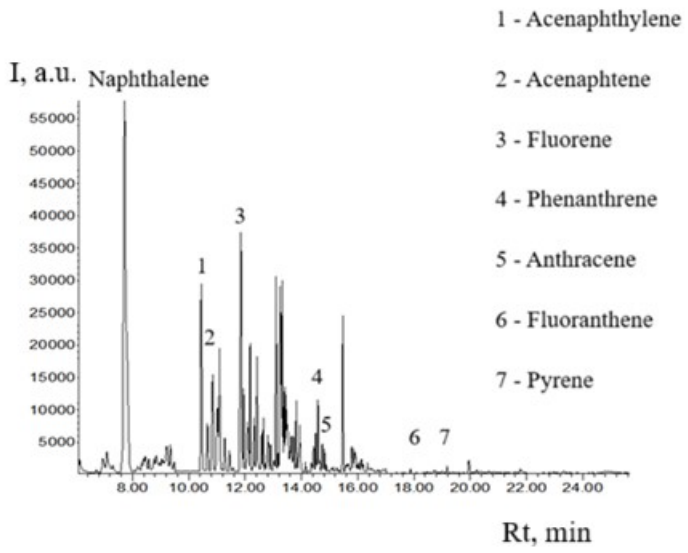


Figure S 19. – GC-MS chromatogram of DMSO re-extract hexane solution of TPO diesel fraction after hydrotreating with Pt catalyst (SCAN and SIM modes)

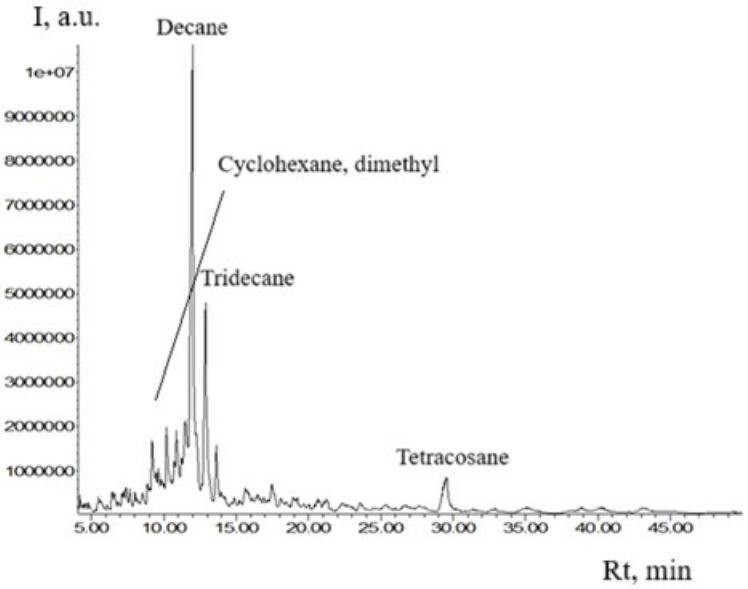


Figure S 20. – GC-MS chromatogram of concentrated hexane solution of TPO diesel fraction after hydrotreating with Pt catalyst after oleum treatment

Hydrotreating with NiMo catalyst

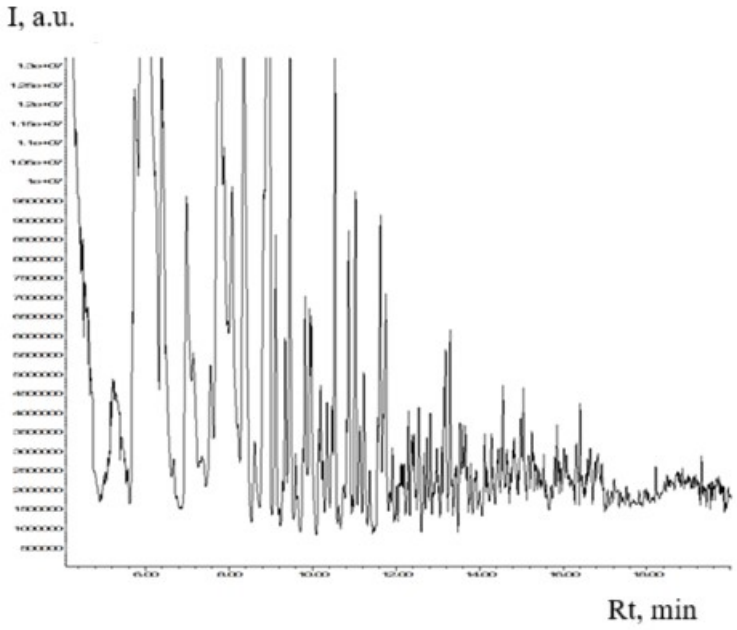


Figure S 21 – GC-MS chromatogram of gasoline fraction of pyrolysis oil after hydrotreating with NiMo catalyst

No water-soluble compounds were found.

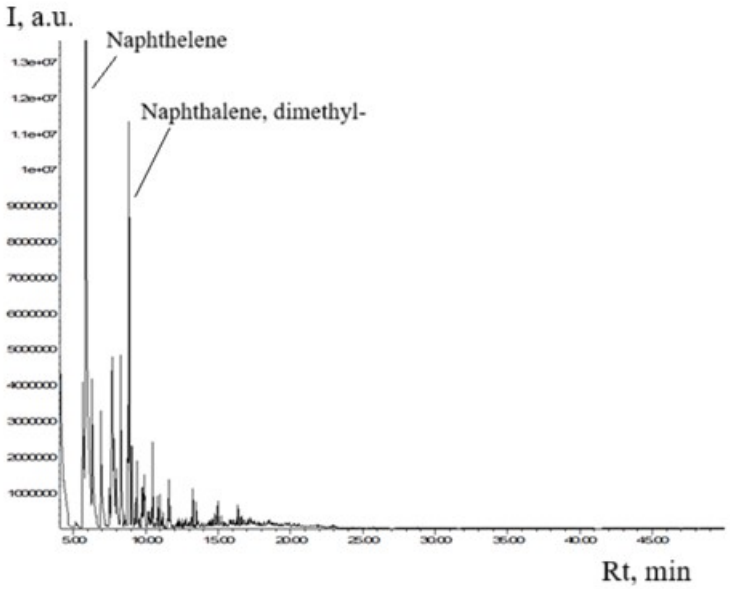


Figure S 22. – GC-MS chromatograms of DMSO re-extract hexane solution of TPO gasoline fraction after hydrotreating with NiMo catalyst (SCAN mode)

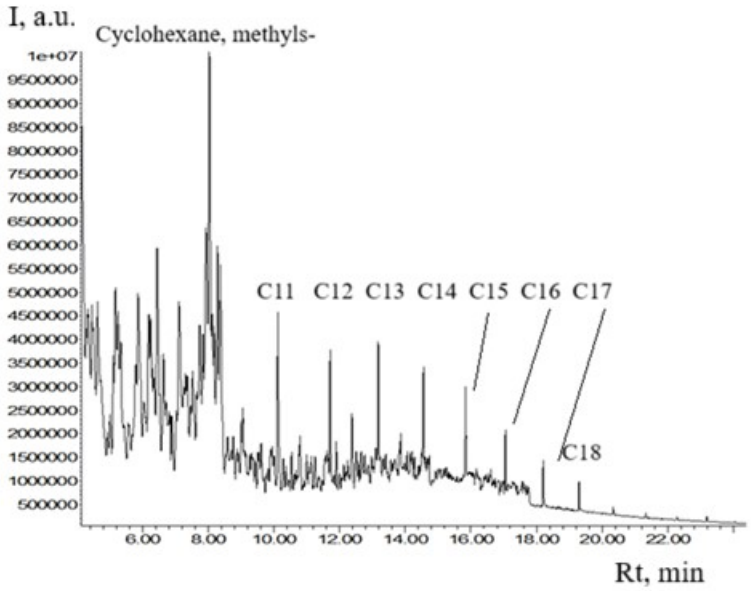


Figure S 23. – GC-MS chromatogram of concentrated hexane solution of TPO gasoline fraction after hydrotreating with NiMo catalyst after oleum treatment

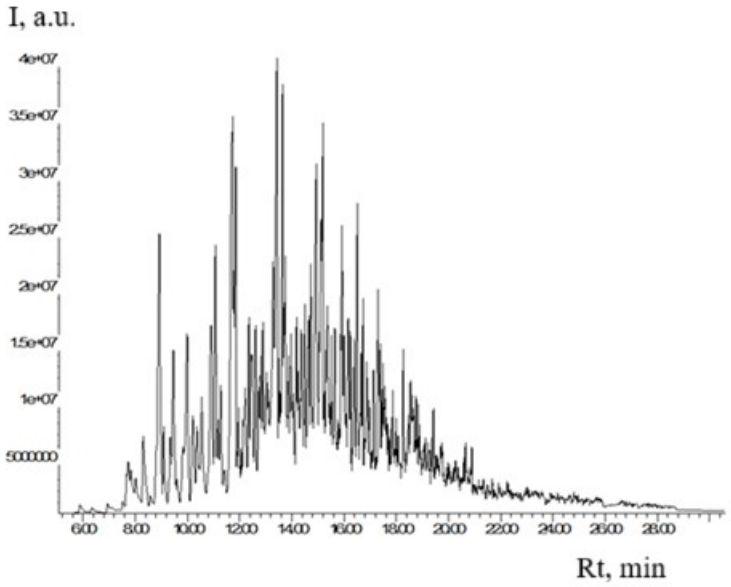


Figure S 24 – GC-MS chromatogram of diesel fraction of pyrolysis oil after hydrotreating with NiMo catalyst

No water-soluble compounds were found.

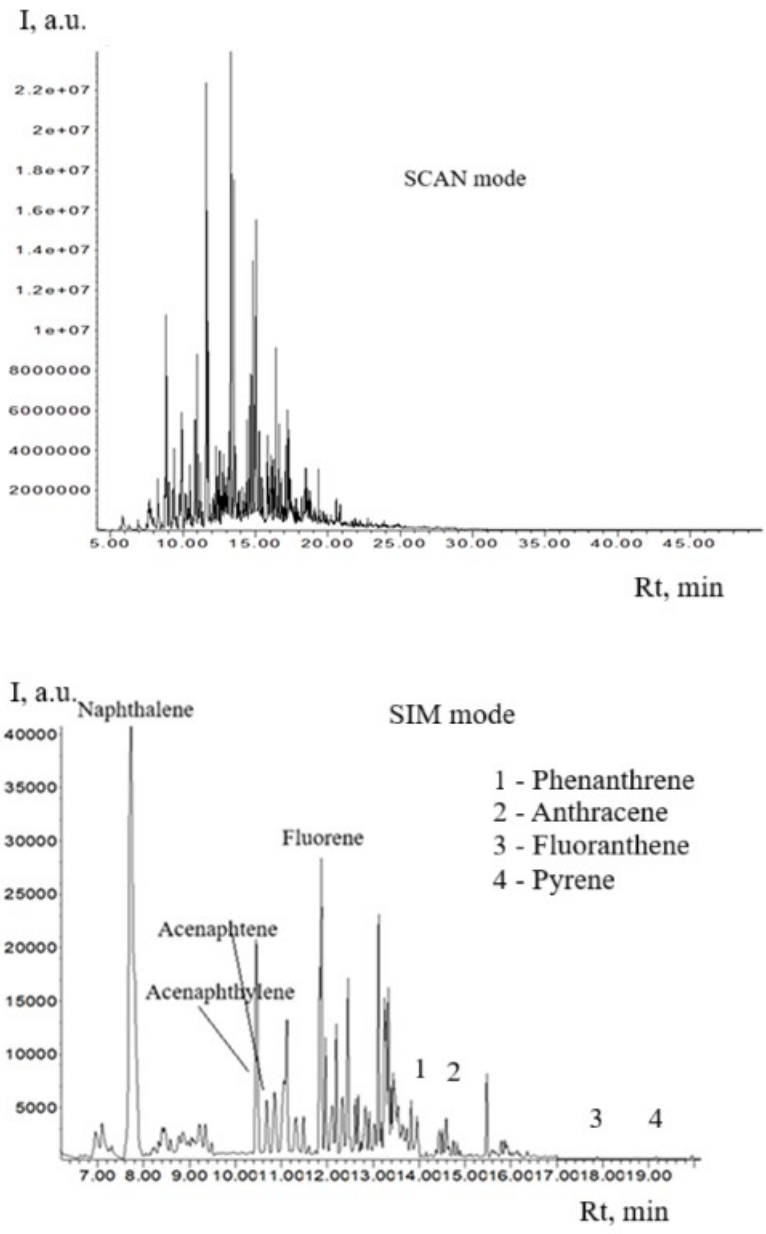


Figure S 25 – GC-MS chromatograms of DMSO re-extract hexane solution of TPO diesel fraction after hydrotreating with NiMo catalyst (SCAN and SIM modes)

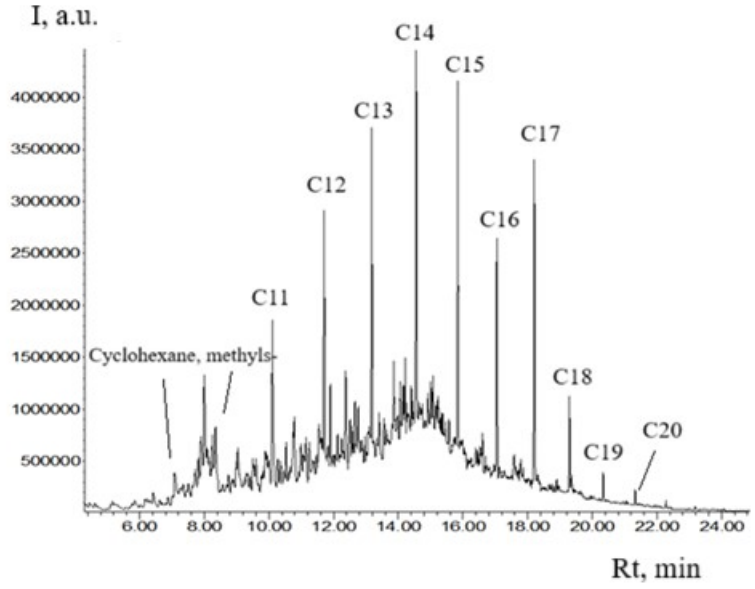


Figure S 26. – GC-MS chromatogram of concentrated hexane solution of TPO diesel fraction after hydrotreating with NiMo catalyst after oleum treatment

Table S2. Comparison of the hydrotreated TPO diesel fraction (NiMo catalyst) with commercial diesel fuel standards

Property	Hydrotreated TPO (NiMo)	EN 590 Limit	ASTM D975 (D2) Typical Spec	Test Method / Comment
Density at 15°C (kg/m³)	889.3 ± 0.5	820-845	850 max (approx.)	Exceeds limit. High density indicates high aromaticity.
Sulfur Content (wt%)	0.0432 ± 0.0021	≤ 0.0010 (S10)	≤ 0.0015	Exceeds limit by >40x. Major barrier for direct use.
Polycyclic Aromatics (PAHs) (wt%)	0.200 ± 0.007	≤ 8 (v/v%) / ≤ 11 (v/v%)*	Not specified	Meets EN 590 PAH limit in wt%*.
Flash Point	60.0 ± 1.7	≥ 55	≥ 52	Meets/Exceeds

Property	Hydrotreated TPO (NiMo)	EN 590 Limit	ASTM D975 (D2) Typical Spec	Test Method / Comment
(°C)				requirement.
Heating Value (MJ/kg)	43.4 ± 1.2	~45.5 (min. cetane index proxy)	~42.7 (min)	Satisfactory/Comparable.
Iodine Number (g I_2/100 g)	5.3 ± 0.3	Not specified	Not specified	Indicates high saturation.
Acid Number (mg KOH/g)	<0.06	Not specified	≤ 0.1 (D975)	Meets cleanliness spec.

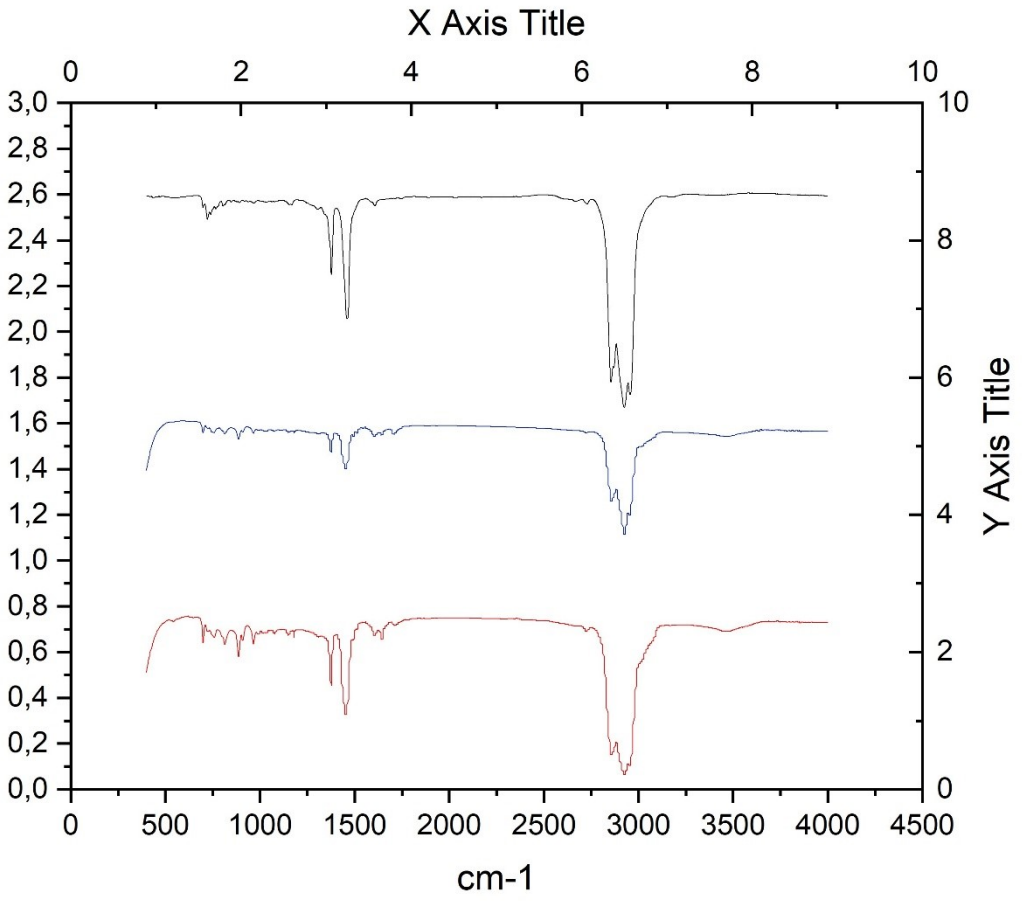


Fig. S 27. FTIR spectra of raw tire pyrolysis oil (TPO), of the hydrotreated diesel fraction (Pt- and NiMo/Al_2O_3 catalyst).