Da Vinci
LABORATORY SOLUTIONS

DVLS DHA Solutions

Automated Solutions for Detailed Hydrocarbon Analysis

DVLS DHA Analyzers

Da Vinci Laboratory Solutions offers various automated solutions for a Detailed Hydrocarbon Analysis (DHA) to determine the individual hydrocarbon components in light petroleum streams such as naphtha, reformate and gasoline. The compositional data will assist refinery plant managers to optimize their refinery processes, comply with product specifications and meet with environmental regulations.

Key Benefits

- **High Quality GC Hardware**
  All DHA Analyzers are based upon the flexible, reliable Agilent 8890 GC configured with dedicated columns, injection ports and detectors.
- **ASTM Compliance**
  The DHA analyzers comply with the ASTM test methods D5134, D6729, D6730, D6733 and D7900 to determine hydrocarbons and oxygenates in light petroleum streams.
- **Proven software platform**
  The analyzers include the PetroReporter software for data processing and reporting of the properties of petroleum streams. PetroReporter is successfully used by a global installed base of leading oil refineries.
- **Universal setup**
  Analyst could also use PetroReporter to process and report data for SimDist, FAME and Gas Calculation applications in addition to DHA. They can use the universal software for various applications.
- **High level of Automation**
  PetroReporter automates the settings per sample type to provide a correct sample identification. User-friendly editors can be used to customize your settings.
- **Accurate characterization of crude oils**
  To improve the boiling point characterization of crude oils the DVLS PetroReporter merges High Temp SimDist with the DHA data.
- **Application Guarantee**
  Each analyzer is tested according to the in-house testing procedures to check the system performance and to verify the analyzer specification by a reference sample test. Factory Acceptance Test will be scheduled upon request.

Automated Solutions for Detailed Hydrocarbon Analysis

High Quality GC Hardware

Each DVLS DHA analyzer is based upon the ultra-modern Agilent 8890 Gas Chromatograph (GC) with built-in intelligence and electronic pneumatic control (EPC).
The Agilent Gas Chromatograph is configured for a test method with the required hardware and software components:

- Flame Ionization Detector (FID) with high scanning rate
- Split/Splitless injection port to split the sample for maximum detection and load ability of the column
- Cryogenic mode (N_2 or CO_2)
- 50 or 100 meter DHA analytical column
- Calibration, reference or quality control samples
- PetroReporter software

Figure One: DHA Hardware configuration

ASTM Compliance

Sample Scope	Sample Range (% mass)	Determine Boiling Range	Test Method
Olefin-free (<2 % liquid volume) liquid hydrocarbon mixtures including virgin naphtha, reformates and alkylates	0.01—30	Up to 250°C	ASTM D5134
Spark-ignition engine fuel blends containing oxygenates	0.01—30	Up to 225°C	ASTM D6729
Naphtha, reformates and alkylates			
Spark-ignition engine fuel blends containing oxygenates	0.01—30	Up to 225°C	ASTM D6730
Naphtha, reformates and alkylates			
Spark-ignition engine fuel blends containing oxygenates	0.01—15	Up to 225°C	ASTM D6733
Naphtha, reformates and alkylates			
Stabilized crude oil	0.01—30	Up to 174°C	ASTM D7900

Automation of Analysis Results

Universal Software Tool

The Agilent 8890 GC is controlled by Agilent OpenLab software. The DVLS PetroReporter software automates the data processing and reporting for various DHA applications. After data processing PetroReporter creates the required DHA reports.
Thanks to the universal setup the analyst could also use PetroReporter to process and report data for SimDist, FAME and Gas Calculation applications.

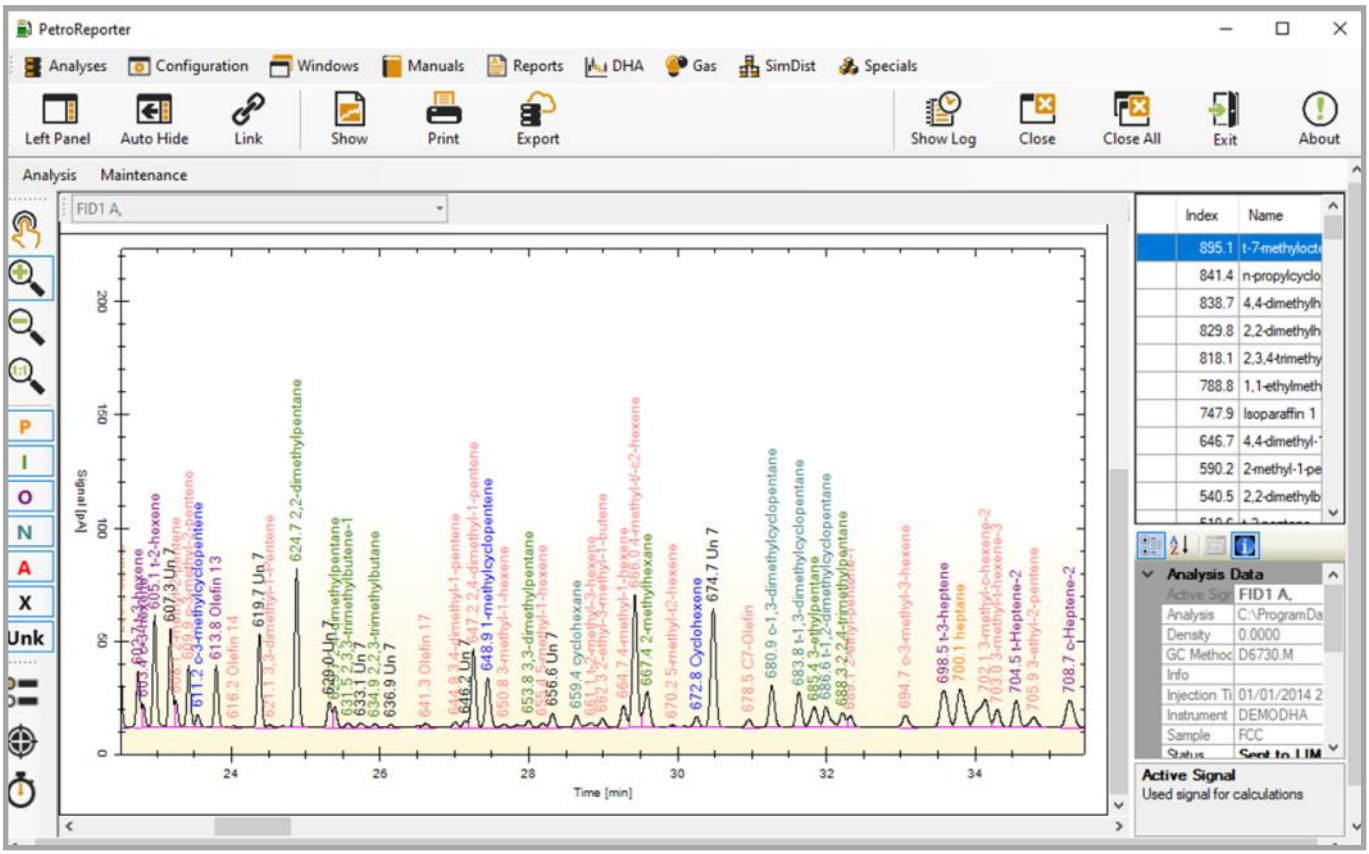


Figure Two: PetroReporter Analysis Screen

Multi CDS Compatibility

DVLS PetroReporter is compatible with following chromatographic data systems of major suppliers including:

- OpenLAB 2.x
- OpenLAB Chemstation
- OpenLAB EZChrom
- Other CDS interfaces on request such as:
  - Atlas
  - Chromeleon
  - Clarity
  - Compass
  - Totalchrom

Client/Server or Standalone Configuration

PetroReporter can be used either stand-alone or in a network configuration. The client/ server architecture of the software allows to process the analysis data from any PC workstation.

- Method selection by application
- Selection of instruments connected to PetroReporter
- Authorization level selection

DVLS PetroReporter

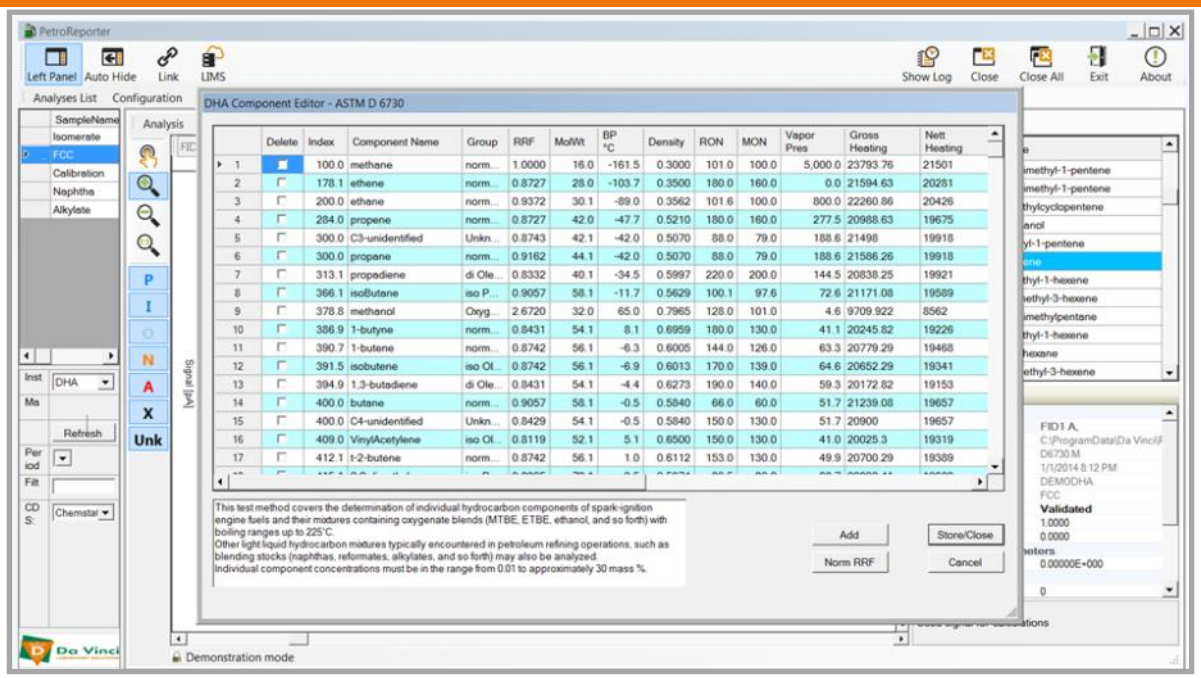


Figure Three: Component Editor for DHA ASTM D6730

Predefined Settings

PetroReporter includes predefined sample settings, component tables and formulas to provide a correct sample identification. Each peak is identified using the Kovats Retention Indices (RI). The RI of unknown peaks are calculated from:

- the retention time of the unknown peak
- the retention times of the n-paraffins eluting before and after the unknown peak. Additional primary components could be used to finetune the chromatogram.

PetroReporter compares the calculated RI with the component tables to identify the component.

User-Friendly Editors

One of the editors is the Graphical Editor to set your preferences for the colours and fonts of the graphs as displayed in Figure Four. Use the Component Group Editor to assign colours to each group. This will allow you to see at a glance the peak identification in the chromatogram.

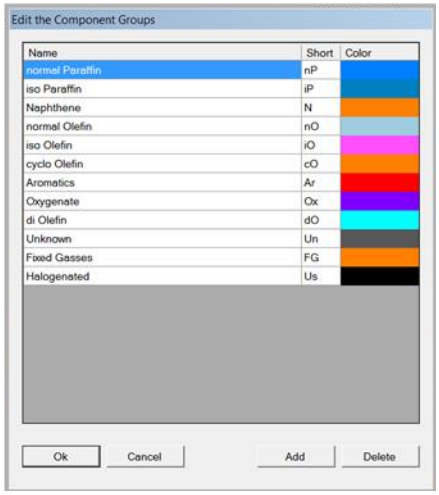


Figure Four: Component Group Editor

Extensive Report Options

The PetroReporter software assists the analysts in reporting the petrochemical properties:

- Chromatogram plot of the peak labels over a user selectable time interval
- Front End DHA data for a merge with SimDist data to improve the Boiling Point plot of a crude oil analysis
- Individual hydrocarbons & group types
- Oxygenates
- PIONA report
- TBP distribution
- Properties summary:
  - Bromine Number
  - Gross and Nett Heat of Combustion of liquid
  - Reid Vapor Pressure
  - RON and MON values
  - Specific Gravity

Automation of Analysis Results

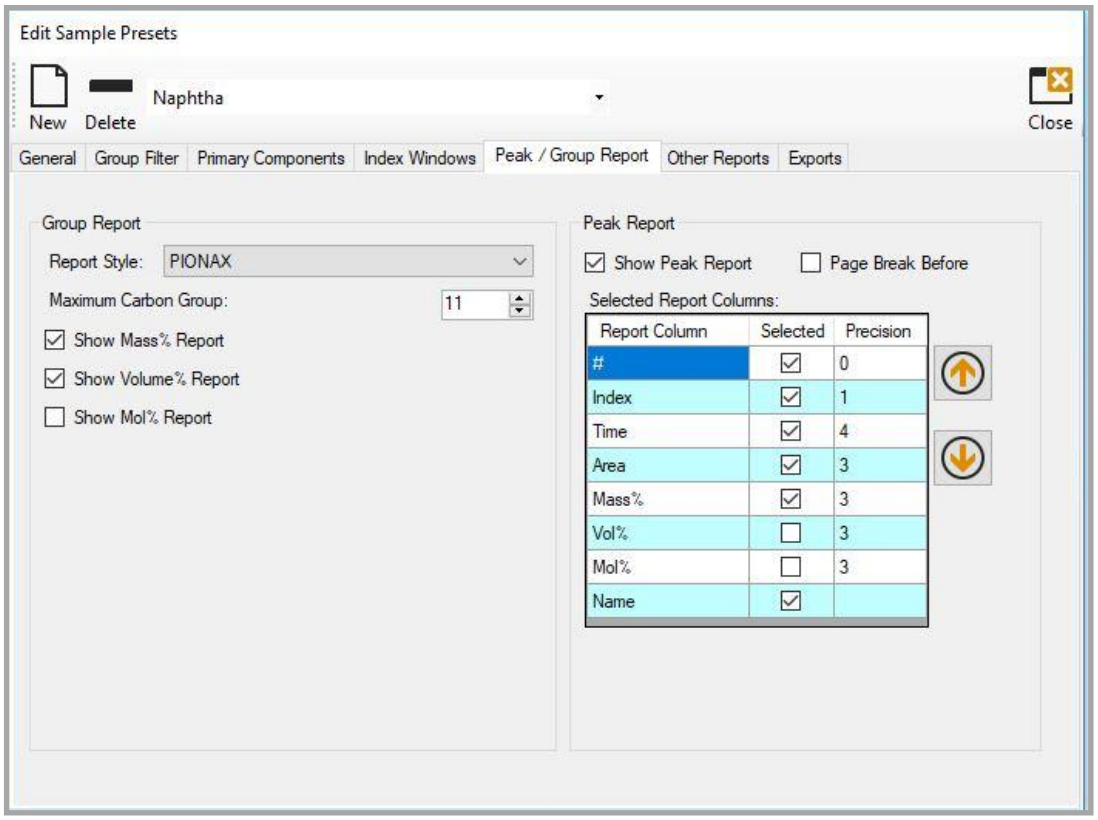
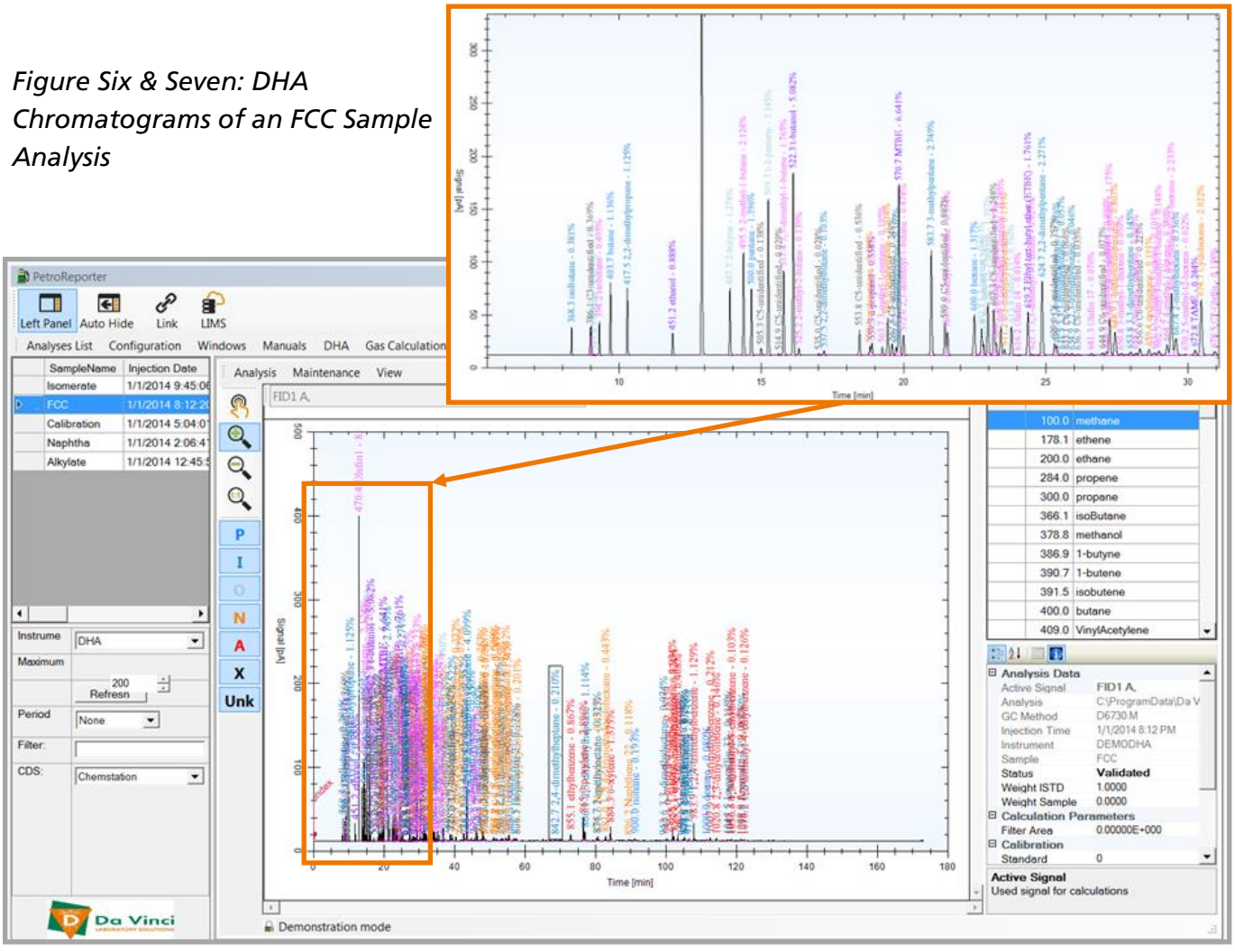


Figure Five: Editing the Sample Settings for a Naphtha sample

Figure Six & Seven: DHA Chromatograms of an FCC Sample Analysis



Improved Crude Oil Analysis

Reporting accurate SimDist data on the light hydrocarbons in crude oil is a challenge due to the quenching effects of the crude oil solvent. The solution is merging the Detailed Hydrocarbon Data (DHA) data with the SimDist results as standardized in the test method ASTM D7900. Using PetroReporter you can set the SimDist-DHA merge point and improve the front-end analysis of a crude oil.

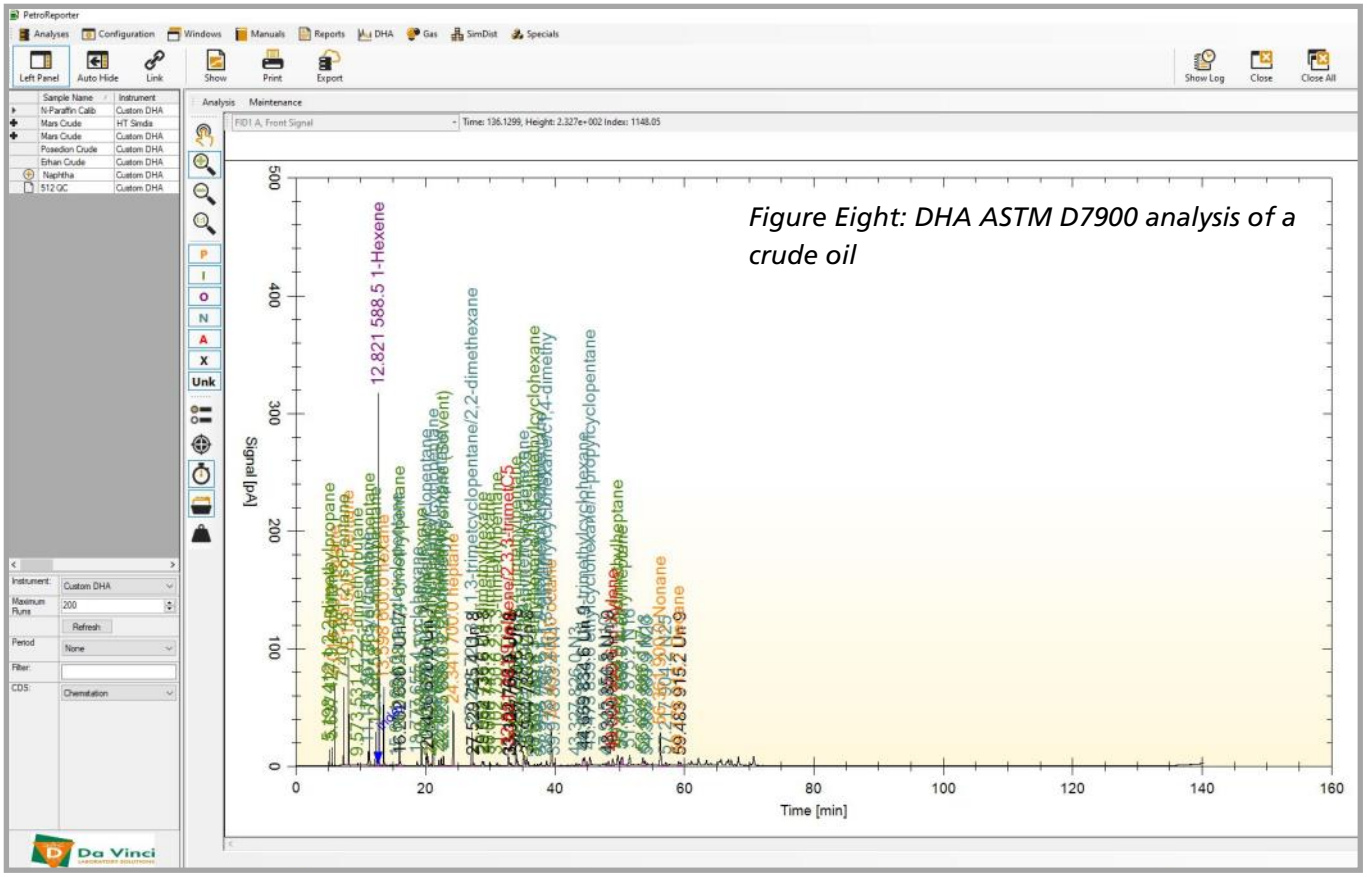


Figure Eight: DHA ASTM D7900 analysis of a crude oil

Merging DHA—SimDist

The first two minutes of the Boiling Point plot of the SimDist ASTM D7169 analysis are replaced by the DHA ASTM D7900 data. The DHA ASTM D7900 analysis is used to identify the individual components up to n-Nonane.

The SimDist-DHA merge point can be chosen at the commonly used n-Nonane elution time or any different time using the PetroReporter software.

Figure Nine: SimDist ASTM D7169—DHA ASTM D7900 Merge analysis of a crude oil

Sample Preset	Crude Oil Merge	Bottle	108
Method	D7169_Ambient.M	Sample Weight	0.2693
Analyst	SYSTEM	Solvent Weight	10.1296
		ISTD Weight	-

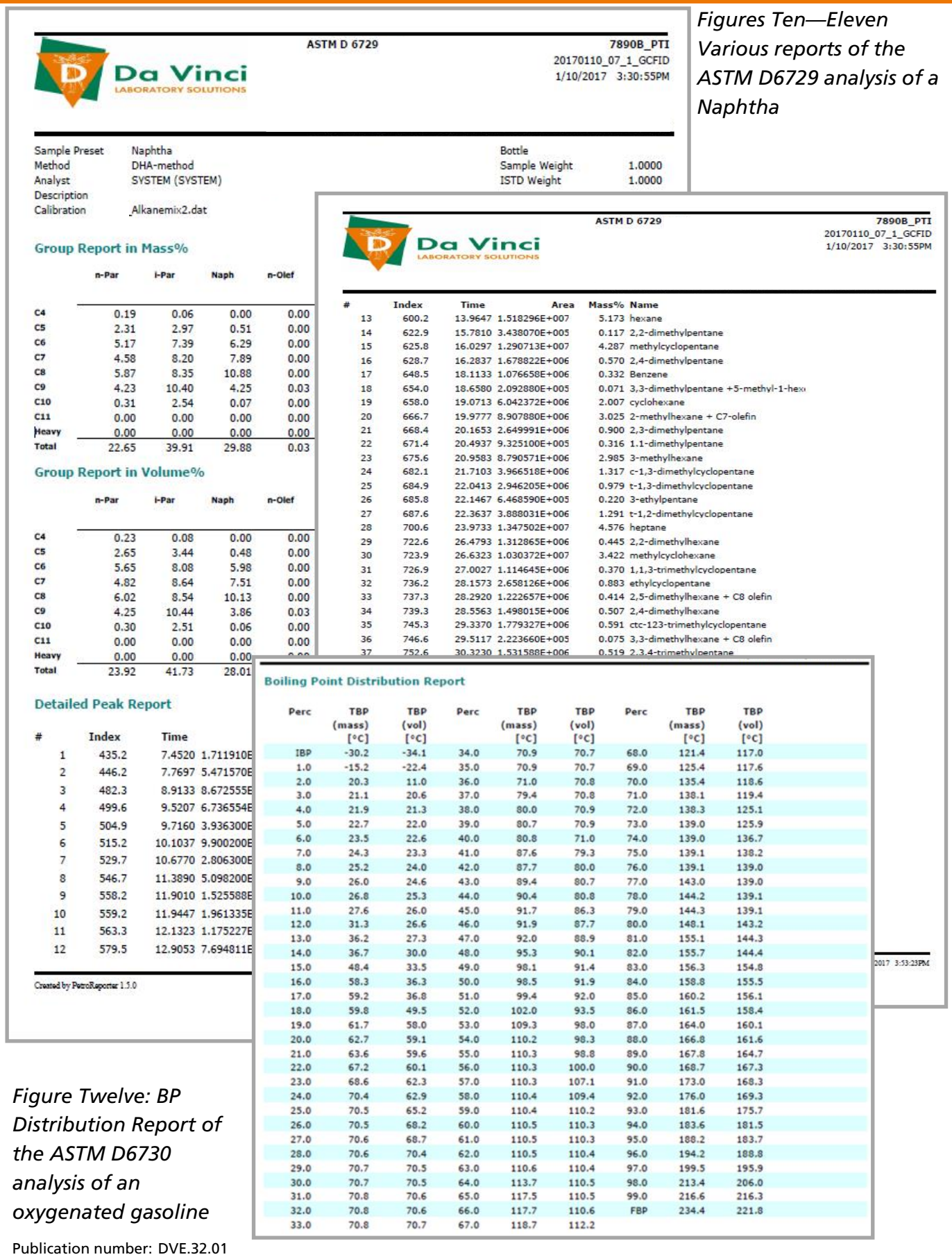
Channel	Carbon
BPCalibration	C:\ProgramData\Da Vinci\PetroReporter\Simdist\India data\Simdist\F-001-102-BP CALIB.D
Blank	C:\ProgramData\Da Vinci\PetroReporter\Simdist\India data\Simdist\F-012-101-[Solvent]Blank.D
Response Factor	C:\ProgramData\Da Vinci\PetroReporter\Simdist\India data\Simdist\F-005-104-5010 Ref.D
DHA	C:\ProgramData\Da Vinci\PetroReporter\Simdist\India data\DHA\D_22082018\s220818 2018-08-22 11-14-39\F-003-103-Mars Crude.D
Start Elution Time	0.236 min
End Elution Time	25.683 min
Total Area	2.8637e+006
Merge Results	DHA 13.4 SimDist 10.5 [mass%] at [151.0 °C]
SimDist Recovery	85.3 mass%
Response Factor	7.7167e-007
Found Recovery	98.7 mass%
Used Recovery	98.7 mass%

DHA Data

TBP Distribution Report

Rec mass%	BP °C	Rec mass%	BP °C	Rec mass%	BP °C	Rec mass%	BP °C
IBP	-2.2	25.0	223.0	50.0	365.7	75.0	516.4
1.0	21.1	26.0	229.0	51.0	371.1	76.0	523.5
2.0	35.9	27.0	234.6	52.0	377.2	77.0	530.7
3.0	62.8	28.0	241.5	53.0	382.8	78.0	538.1
4.0	69.0	29.0	247.9	54.0	389.0	79.0	545.6
5.0	89.5	30.0	254.0	55.0	394.7	80.0	553.4
6.0	94.3	31.0	259.6	56.0	400.8	81.0	561.1
7.0	99.2	32.0	265.1	57.0	406.4	82.0	568.9
8.0	111.0	33.0	270.8	58.0	412.0	83.0	576.8
9.0	119.2	34.0	276.1	59.0	417.7	84.0	584.8
10.0	123.9	35.0	282.2	60.0	423.1	85.0	593.1
11.0	133.3	36.0	287.6	61.0	428.7	86.0	601.6
12.0	139.7	37.0	293.8	62.0	434.3	87.0	610.1
13.0	147.8	38.0	299.4	63.0	440.0	88.0	618.8
14.0	152.1	39.0	303.6	64.0	445.8	89.0	627.8
15.0	158.3	40.0	309.4	65.0	451.8	90.0	636.1
16.0	164.4	41.0	315.3	66.0	457.9	91.0	644.5
17.0	173.1	42.0	319.7	67.0	464.3	92.0	653.0
18.0	176.7	43.0	325.8	68.0	470.5	93.0	661.0
19.0	181.8	44.0	331.0	69.0	476.8	94.0	670.6
20.0	187.4	45.0	337.1	70.0	483.2	95.0	680.3
21.0	192.2	46.0	343.3	71.0	489.7	96.0	690.1
22.0	200.8	47.0	348.6	72.0	496.3	97.0	700.1
23.0	210.0	48.0	354.4	73.0	502.9	98.0	710.1
24.0	216.8	49.0	359.7	74.0	509.5		

DHA Data Reports



ASTM D 6729

7890B_PTI
20170110_07_1_GCFID
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Sample Preset	Naphtha	Bottle	
Method	DHA-method	Sample Weight	1.0000
Analyst	SYSTEM (SYSTEM)	ISTD Weight	1.0000
Description			
Calibration	_Alkanemix2.dat		

Group Report in Mass%

	n-Par	i-Par	Naph	n-Olef
C4	0.19	0.06	0.00	0.00
C5	2.31	2.97	0.51	0.00
C6	5.17	7.39	6.29	0.00
C7	4.58	8.20	7.89	0.00
C8	5.87	8.35	10.88	0.00
C9	4.23	10.40	4.25	0.03
C10	0.31	2.54	0.07	0.00
C11	0.00	0.00	0.00	0.00
Heavy	0.00	0.00	0.00	0.00
Total	22.65	39.91	29.88	0.03

Group Report in Volume%

	n-Par	i-Par	Naph	n-Olef
C4	0.23	0.08	0.00	0.00
C5	2.65	3.44	0.48	0.00
C6	5.65	8.08	5.98	0.00
C7	4.82	8.64	7.51	0.00
C8	6.02	8.54	10.13	0.00
C9	4.25	10.44	3.86	0.03
C10	0.30	2.51	0.06	0.00
C11	0.00	0.00	0.00	0.00
Heavy	0.00	0.00	0.00	
Total	23.92	41.73	28.01	

Detailed Peak Report

#	Index	Time	
1	435.2	7.4520	1.711910E
2	446.2	7.7697	5.471570E
3	482.3	8.9133	8.672555E
4	499.6	9.5207	6.736554E
5	504.9	9.7160	3.936300E
6	515.2	10.1037	9.900200E
7	529.7	10.6770	2.806300E
8	546.7	11.3890	5.098200E
9	558.2	11.9010	1.525588E
10	559.2	11.9447	1.961335E
11	563.3	12.1323	1.175227E
12	579.5	12.9053	7.694811E

Created by PetroReporter 1.5.0

ASTM D 6729

7890B_PTI
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#	Index	Time	Area	Mass%	Name
13	600.2	13.9647	1.518296E+007	5.173	hexane
14	622.9	15.7810	3.438070E+005	0.117	2,2-dimethylpentane
15	625.8	16.0297	1.290713E+007	4.287	methylcyclopentane
16	628.7	16.2837	1.678822E+006	0.570	2,4-dimethylpentane
17	648.5	18.1133	1.076658E+006	0.332	Benzene
18	654.0	18.6580	2.092880E+005	0.071	3,3-dimethylpentane +5-methyl-1-hexe
19	658.0	19.0713	6.042372E+006	2.007	cyclohexane
20	666.7	19.9777	8.907880E+006	3.025	2-methylhexane + C7-olefin
21	668.4	20.1653	2.649991E+006	0.900	2,3-dimethylpentane
22	671.4	20.4937	9.325100E+005	0.316	1,1-dimethylpentane
23	675.6	20.9583	8.790571E+006	2.985	3-methylhexane
24	682.1	21.7103	3.966518E+006	1.317	c-1,3-dimethylcyclopentane
25	684.9	22.0413	2.946205E+006	0.979	t-1,3-dimethylcyclopentane
26	685.8	22.1467	6.468590E+005	0.220	3-ethylpentane
27	687.6	22.3637	3.888031E+006	1.291	t-1,2-dimethylcyclopentane
28	700.6	23.9733	1.347502E+007	4.576	heptane
29	722.6	26.4793	1.312865E+006	0.445	2,2-dimethylhexane
30	723.9	26.6323	1.030372E+007	3.422	methylcyclohexane
31	726.9	27.0027	1.114645E+006	0.370	1,1,3-trimethylcyclopentane
32	736.2	28.1573	2.658126E+006	0.883	ethylcyclopentane
33	737.3	28.2920	1.222657E+006	0.414	2,5-dimethylhexane + C8 olefin
34	739.3	28.5563	1.498015E+006	0.507	2,4-dimethylhexane
35	745.3	29.3370	1.779327E+006	0.591	ctc-123-trimethylcyclopentane
36	746.6	29.5117	2.223660E+005	0.075	3,3-dimethylhexane + C8 olefin
37	752.6	30.3230	1.531588E+006	0.519	2,3,4-trimethylpentane

2017 3:53:23PM

Boiling Point Distribution Report

Perc	TBP (mass) [°C]	TBP (vol) [°C]	Perc	TBP (mass) [°C]	TBP (vol) [°C]	Perc	TBP (mass) [°C]	TBP (vol) [°C]
IBP	-30.2	-34.1	34.0	70.9	70.7	68.0	121.4	117.0
1.0	-15.2	-22.4	35.0	70.9	70.7	69.0	125.4	117.6
2.0	20.3	11.0	36.0	71.0	70.8	70.0	135.4	118.6
3.0	21.1	20.6	37.0	79.4	70.8	71.0	138.1	119.4
4.0	21.9	21.3	38.0	80.0	70.9	72.0	138.3	125.1
5.0	22.7	22.0	39.0	80.7	70.9	73.0	139.0	125.9
6.0	23.5	22.6	40.0	80.8	71.0	74.0	139.0	136.7
7.0	24.3	23.3	41.0	87.6	79.3	75.0	139.1	138.2
8.0	25.2	24.0	42.0	87.7	80.0	76.0	139.1	139.0
9.0	26.0	24.6	43.0	89.4	80.7	77.0	143.0	139.0
10.0	26.8	25.3	44.0	90.4	80.8	78.0	144.2	139.1
11.0	27.6	26.0	45.0	91.7	86.3	79.0	144.3	139.1
12.0	31.3	26.6	46.0	91.9	87.7	80.0	148.1	143.2
13.0	36.2	27.3	47.0	92.0	88.9	81.0	155.1	144.3
14.0	36.7	30.0	48.0	95.3	90.1	82.0	155.7	144.4
15.0	48.4	33.5	49.0	98.1	91.4	83.0	156.3	154.8
16.0	58.3	36.3	50.0	98.5	91.9	84.0	158.8	155.5
17.0	59.2	36.8	51.0	99.4	92.0	85.0	160.2	156.1
18.0	59.8	49.5	52.0	102.0	93.5	86.0	161.5	158.4
19.0	61.7	58.0	53.0	109.3	98.0	87.0	164.0	160.1
20.0	62.7	59.1	54.0	110.2	98.3	88.0	166.8	161.6
21.0	63.6	59.6	55.0	110.3	98.8	89.0	167.8	164.7
22.0	67.2	60.1	56.0	110.3	100.0	90.0	168.7	167.3
23.0	68.6	62.3	57.0	110.3	107.1	91.0	173.0	168.3
24.0	70.4	62.9	58.0	110.4	109.4	92.0	176.0	169.3
25.0	70.5	65.2	59.0	110.4	110.2	93.0	181.6	175.7
26.0	70.5	68.2	60.0	110.5	110.3	94.0	183.6	181.5
27.0	70.6	68.7	61.0	110.5	110.3	95.0	188.2	183.7
28.0	70.6	70.4	62.0	110.5	110.4	96.0	194.2	188.8
29.0	70.7	70.5	63.0	110.6	110.4	97.0	199.5	195.9
30.0	70.7	70.5	64.0	113.7	110.5	98.0	213.4	206.0
31.0	70.8	70.6	65.0	117.5	110.5	99.0	216.6	216.3
32.0	70.8	70.6	66.0	117.7	110.6	FBP	234.4	221.8
33.0	70.8	70.7	67.0	118.7	112.2			

Figures Ten—Eleven Various reports of the ASTM D6729 analysis of a Naphtha

Figure Twelve: BP Distribution Report of the ASTM D6730 analysis of an oxygenated gasoline

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