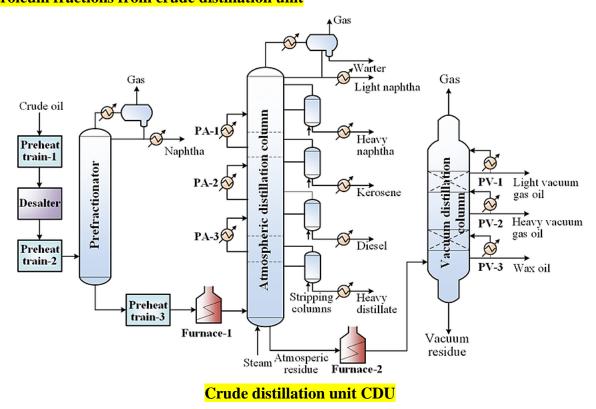
#### Properties of Petroleum & Natural Gas Petroleum fractions from crude distillation unit



## 1- Overhead Gases (Less than 20°C)

- ✓ Natural Gas (C₁ plus traces of other gases like C₂)
- ✓ LPG : liquefied petroleum gases (C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub>)
- > For transportation, these gases are liquefied through **pressurizing**.
- LPG is colorless liquid
- Pure LPG has no smell, but for safety an odorant agent, a mercaptan, is added to aid detection at very low concentrations.
- The heating value of LPG on a volume basis is significantly higher (propane, 95 MJ/m<sup>3</sup>; butane, 121 MJ/m<sup>3</sup>) compared with that of natural gas (38 MJ/m<sup>3</sup>).
- LPG as a liquid is 250 times denser than LPG as vapor, so a large quantity can be stored in a relatively small spherical or cylindrical vessels.
- LPG uses in central heating, space heating, and hot water supply, as well as in a large number of appliances, such as ovens, and stoves.
- The low sulfur and very low levels of nitrogen oxides (NO<sub>x</sub>) emissions during its combustion make LPG a most environmentally friendly source of energy.
- > Automotive LPG, or auto-gas, refers to the LPG used in automotive applications.
- The disadvantage is that LPG has a lower heating value per unit volume, and thus the vehicle has to refuel more frequently.

2- Naphtha cut (C<sub>5</sub>-C<sub>10</sub>) (Sp.gr. 0.620-0.735 g/cm<sup>3</sup>)

Total naphtha TN is **the lightest liquid** distillate of crude oil boiling between **38°C to 180°C**.

Naphtha cut may be classified by its boiling range or by its end use:

✓ Light straight run (LSR) naphtha (C₅ to 80°C), highly paraffinic (greater than 80 vol %), has a low RON of approximately 60, and feedstock for isomerization unit to make a light gasoline (RON 80).

Note: Isomerate is a very useful blend component used to reduce high aromatic content of gasoline blending in gasoline pool.

LSR naphtha specifications

Property	Units	Limit	Value	Test method
Color, saybolt			+20	ASTM D 156
Density	kg/L	Min.	0.645	ASTM D 1298
•	0	Max.	0.700	
Distillation				ASTM D 86
IBP			Report	
10 vol %	°F	Max.	131	
50 vol %	°F	Max.	149	
90 vol %	°F	Max.	239	
End point	°F	Max.	320	
Lead content	ppb	Max.	50	IP 224
PONA				Chromatography
Paraffins	Vol %	Min.	80	
Olefins	Vol %	Max.	1.0	
Naphthene	Vol %	Max.	18.0	
Aromatics	Vol %	Max.	5.0	
Sulfur	Wt %	Max.	0.03	ASTM D 1266
Vapor pressure, Reid	kPa @100°F	Max.	91	ASTM D 323

✓ Wide straight run (WSR) naphtha ( $C_7$ -180°C), the heaviest part is used as a feedstock

for the **catalytic reforming** unit for the production of **reformate** (high gasoline **RON 98**).

#### WSR naphtha specifications

Property	Units	Limit	Value	Test method
Color, Saybolt			Report	ASTM D 156
Density	kg/L	Min.	0.690	ASTM D 1298
•		Max.	0.735	
Distillation				ASTM D 86
IBP			Report	
10 vol %	°F	Min.	109	
		Max.	210	
50 vol %	°F	Min.	174	
		Max.	270	
90 vol %	°F	Min.	230	
		Max.	351	
End point	°F	Max.	399	
Lead content	ppb	Max.	200	IP 224
Olefins	Vol %	Max.	1.0	ASTM D 1319
or				
Bromine number		Max.	1.0	ASTM D 1159
PONA			Report	
Sulfur	Wt %	Max.	0.07	ASTM D 1266
Vapor pressure, Reid	kPa @100°F	Max.	75	ASTM D 323

- ✓ Petrochemical naphtha (C<sub>5</sub>-C<sub>6</sub>)
- Straight run & hydrocracker naphtha blend.
- Major petrochemical feedstock, highly paraffinic (minimum 70 vol %) and low aromatic content (less than 11 vol %).

## Petrochemical naphtha specifications

Property	Units	Limit	Value	Test method
Color, Saybolt		Min.	+20	ASTM D 156
Density, 60/60°F	kg/L	Min.	0.680	ASTM D 1298
•	-	Max.	0.725	
Distillation				ASTM D 86
IBP			Report	
10 vol %	°F	Min.	Report	
		Max.		
50 vol %	°F	Min.	122	
		Max.	248	
90 vol %	°F	Min.	167	
		Max.	320	
End point	°F	Max.	356	
Lead content	ppb	Max.	200	IP 224
Olefins	Vol %	Max.	1.0	ASTM D 1319
PONA				
Paraffins	Vol %	Min.	70	Chromatography
Olefins	Vol %	Max.	1.0	
Naphthene	Vol %		Report	
Aromatics	Vol %		Report	
Sulfur	Wt %	Max.	0.07	ASTM D 1266
Vapor pressure, Reid	kPa @100°F	Max.	91	ASTM D 323

## **3-** Gasoline (C<sub>5</sub> - C<sub>11</sub>) 40-200°C finished product

- Volatile flammable liquid hydrocarbon blend used as a fuel in spark- internal combustion engines ICE.
- Blended gasoline is a mixture of n-butane, reformate, isomerate, alkylate, gasoline form catalytic cracker, and coker gasoline.
- Straight run gasoline cut contains: 50 percent alkanes (n and iso paraffins), 40 percent cyclic alkanes (naphthenes) and 10 percent aromatics.
- Flash point: -45°C.
- Auto-ignition temperature: 495°F (257°C).
- Vapor density: 3 to 4 times that of air.
- Viscosity: Slightly less than water

## Gasoline is classified by octane ratings into three grades:

- Regular gasoline: Gasoline having antiknock index, i.e. RON, greater than or equal to 85 and less than 88.
- Mid-grade gasoline: RON: 88 to 90
- > **Premium or super gasoline**: RON greater than 90.

#### Properties of Petroleum & Natural Gas Gasoline Blend components

Property	Units	N-Butane	Isomerate	Light cat naphtha	Heavy cat naphthas	Cat reformate	Alkylate	Coker light naphtha	MTBE	LSR
SG (specific gravity)		0.5844	0.641	0.7083	0.8441	0.7811	0.700	0.69	0.74	0.667
RON		95	84	92.9	95.0	96.4	96.0	74	116.0	68.0
MON		92	81.3	81.3	80.4	84.8	94.0	68.8	100	63
RVP	lb/in <sup>2</sup>	51.92	13.5	8.4	0.4	9.5	6.2	13.1	9	10.1
Aromatics	Vol %	0	0	15	59	62.5	0	8	0.6	2.4
Olefins	Vol %	0	0	35	10	1	0	56	0	0

- 4- Kerosene cut (C<sub>10</sub> C<sub>16</sub>) (Sp.gr. 0.720-0.830 g/cm<sup>3</sup>)
- ➢ Kerosene cut boiling between 174 and 260°C.
- ▶ Kerosene is **heavier** than naphtha and gasoline cut but **lighter** than diesel cut.

Physical Description: A pale yellow or clear oily liquid.

## **Chemical compositions:**

- **35%** paraffins, **60%** naphthenes, and **15%** aromatics.
- Flash point: 100°F-165°F (38-74°C).
- Auto-ignition temperature: 444°F (229°C).
- Vapor density: 4.5 times that of air.
- Smoke point (17 mm) minimum.
- Pour point: 0°F (-18°C).
- Kerosene used in space heaters, cook stoves, and suitable for use as a light source.
- Kerosene used in aircrafts is called "aviation turbine fuel ATF." Kerosene was considered as aviation fuel because of:
- **High flash point**: allowed safer handling, transportation, and storage of fuel.
- Lower volatility compared with that of naphtha.
- Very low freezing point, allowing planes to fly at high altitudes.

Three main grades of turbine fuels are in use for civil commercial aircrafts:

- Jet A-1
- Jet A
- Jet B

**Jet A-1** is a kerosene cut: has a minimum flash point of 100°F and a maximum freezing point of (-47°C) (-52.6°F). Jet A-1 meets the specifications of ASTM D 1655.

**Jet A** is identical to Jet A-1: with a higher freezing point (-40°C).

Jet B is a wide-cut distillate fuel containing naphtha and kerosene fractions.

• It can be used as an alternative to Jet A-1, but it has a lower flash point and higher flammability. It is more difficult to handle. It is used in very cold weather operations. It is generally produced to Canadian specifications CAN/CGSB 3.23.

The major **difference between military fuels and commercial fuels is the use of additives**, such as anti-icing, corrosion inhibitors, lubricity improvers, antioxidants, thermal stability improvers, and conductivity improvers.

**JP-4:** blend of **60 % (vol%)** LSR naphtha and medium straight run naphtha, and **40 % straight run** kerosene. JP-4 has corrosion inhibitor and anti-icing additives.

JP-4 meets the requirements of U.S. military specifications MIL-DTL-5624U grade JP-4. It also meets requirements of British specifications DEF STN 91-88 AVTAG/FSII.

JP-4 can be considered the military equivalent of Jet B.

**JP-5**: is a **high flash point kerosene** meeting the requirements of U.S. military specifications MIL-DTL-5624U grade JP-5. JP-5 also meets the requirements of British specifications DEF STN 91-87 AVTUR /FSII.

JP-5 is mainly used by the U.S. Navy for its aircrafts based on aircraft carriers.

Its high flash point provides a higher degree of safety in fuel handling.

**JP-7:** is a highly refined, high thermal stability fuel developed in the 1960s to meet the high heat sink demand of supersonic air crafts and missiles.

- It is thermally stable to **550°F**.
- It has high flash, very low aromatic content (maximum 5%), a high hydrogen content, and a high heat of combustion.
- It is a blend of kerosene coming from hydrocracker and straight run desulfurized kerosene for HDS process.
- 5- Atmospheric Gasoil (LGO and HGO) (boiling range 200-340°C) (C<sub>11</sub> C<sub>20</sub>)
- Physical Description: A yellow viscous liquid used for compression ICE
- Chemical composition: 30% (paraffins), 45% (naphthenes) and 25% aromatics.
- AGO must go through a distillate hydrotreater unit to remove sulphur.
  - ✓ Diesel (blend of different HCBN in the AGO boiling range) is blended from the straight run diesel (LAGO) and heavy kerosene from CDU, HDS diesel, diesel from hydrocracker, HT LCO from FCCU, and HT coker gasoil.
- The quality of diesel fuels can be **expressed as cetane number or cetane index**.
- The cetane number (CN) is expressed in terms of the volume percent of cetane ( $C_{16}H_{34}$ ) which has high ignition (CN = 100) in a mixture with HMN ( $C_{16}H_{34}$ ) which has low ignition quality (CN = 0).

#### Properties of Petroleum & Natural Gas Diesel Blends components

Property	Units	SRD	Kero	LCO	Hydrocracker diesel	Coker diesel
Specific gravity		0.8495	0.786	0.8825	0.8488	0.879
Sulfur	Wt %	1.29	0.103	0.24	0.036	0.79
Pour point	°F	10.4	-71	-13	40	38.1
Cetane index		50.6			55	
Diesel index		55.3	64	30.2		30
50% ASTM distillation	°F	547	372	541	596	612
95% ASTM distillation	°F	626	433	664	710	711

SRD = Straight run diesel ex crude distillation; Kero = Kerosenes; LCO = Light cycle gas oil ex FCCU unit.

## **Diesel Blends Specifications**

						Grades	5				
Property	Limit	1	2	3	4	5	6	7	8	9 (1)	10 (2)
Accelrated stability;											
Total insolubles, mg/100 mL	Max.	2.5	2.5		1.5	1.5	2.5				
Acid number, mg KOH/100g;	Max.										
Strong		Nil	Nil	Nil			Nil	Nil	Nil	Nil	
Total		0.5	0.5	0.3	0.3	0.3	0.25	0.2	0.2	0.5	
Appearance visual, 20–25°C								Clear	Clear		Clear and brig
Ash, mass %	Max.	0.01	0.01	0.01	0.005	0.005	0.01	0.01	0.01	0.02	0.01
Color, ASTM	Max.	3.0	3.0	3.5	3.0	3.0	3.0	2.0	2.0		1.5
Carbon residue, ramesbottom;											
On 10 % distillation residue, mass %	Max.	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20		0.35
Conradson carbon	Max.									2.0	
Cetane index	Min.			47	46	46	50	48	48		41
Corrosion, Cu, strip, 3 h at 100°C,	Max.	1	1	1	1	1	2	1	1		18
Classification											
Demulsification Time, Min	Max.				10	10	10				
Density at 15°C, kg/L	Min.			0.820				0.820	0.820	0.850	
	Max.			0.880				0.860	0.860	0.900	0.876
Diesel index	Min.	45	45								
Cloud point, °C	Max.			-4	-1	-12		+1	-7		
CFPP								-11	-19		-12
Distillation, recovered at 350°C Vol %	Min.			85				95	95		95
Distillation, recovered at 366°C Vol %	Min.	90	90								
End Point, °C	Max.				385	385					
Flash point, Penskey-Martein,											
Closed cup, °C	Min.	60	60	61	60	60	60	60	60	60	52
Pour point, °C	Max.	+6	0	-6	-6	-18	-3			3	
Sediment by extraction, mass %	Max.	0.05	0.05							0.1	
Sediment and water by centrifuge, mass %				0.01			0.03	0.01	0.01	0.2	0.05
Sulfur, mass %	Max.	1.0	1.0	1.0	1.0	0.4	1.0	0.19	0.19	1.6	0.0015
Thermal value, gross, MJ/kg	Min.									44.2	
Viscosity, kinematic At 38°C, cSt											
······,	Min	2.0	2.0	1.7	1.7	1.7	1.5	2.0	2.0	3.0	1.9
	Max.	7.5	7.5	4.3	4.3	4.3	6.0	4.0	4.0	9.0	4.1
Water by distillation	Max.	0.05	0.05				0.05			0.10	
Conductivity, pS/M	Min.									50.00	
Lubricity(3) 60°C, Micron	Max.										520

#### **Diesel grades:**

**No.1** diesel (Super-diesel) which has **cetane number of 45** and it is used in high speed engines, trucks and buses.

No.2 diesel has CN: 40.

**No.4 a heavy distillate fuel** or blend of distillate and residual oil, for use in low and medium speed diesel engines with lower cetane numbers.

- 6- Fuel Oil (LFO and HFO) C20+
- The term fuel oil includes any <u>liquid fuel</u> that is burned in a furnace or <u>boiler</u> to generate heat (<u>heating oils</u>), or used in an <u>engine</u> to generate power (as <u>motor fuels</u>)
  - ✓ **Physical Description:** Very viscous, dark liquid.
  - ✓ Chemical composition: 15% (paraffins), 15% polar compounds, containing nitrogen, oxygen, or sulfur, 25% aromatics, 45% (naphthenes).
  - $\checkmark$  Viscosity: 180 cSt to 450 cSt at 120°F.
  - ✓ Flash point above 65°C (150°F)

#### **Fuel oil specifications**

Property	Units	1	2	3	4	5	6
Ash	Mass %, Max.	0.1	0.1	0.1	0.1	0.1	0.25
Carbon residue micro	Mass %	15.0			15.0	15.0	20.0
Density, 15°C	kg/L, Max.	0.980	0.980	0.991	0.990	0.985	0.990
Elements, trace	mg/kg, Max.						
Vanadium		55				550	
Aluminum						30	
Sodium		25					
Explosiveness	Vol %, Max.				50		
Flash point, Penskey Martin							
Closed cup	°C, Min.	66	66	66	66	66	60
Pour point	°C, Max.	24	21	-9	20	12	21
Fluidity			Fluid at 0°C				Fluid at 15°
Pumpability, viscosity, 9°C	Poise, Max.			20			
Sediment by extraction	Mass %, Max.	0.1	0.12		0.12	0.15	
Stability							
ASTM spot test rating	Max.	2	2	2	2	2	2
Compatibility							
ASTM spot test rating	Max.				2		
Sulfur	Mass %, Max.	2.8	3.5	3.5	3.5	3.5	4.00
Thermal stability rating					No. 1 tube		
Thermal value gross	MJ/kg, min.	43.03					
	Btu/lb					18300	
Total sediment	Mass %, Max.	0.15	0.15	0.15	0.15	0.15	
Viscosity, kinematic, 50°C	cSt, Max.	180	80	75	48	180	380
	cSt, Min.			11.8			
Water by distillation	Vol %, Max.	0.5	0.5	0.5	0.5	0.5	
Water and sediment by							
Centrifuge	Vol %, Max.						0.6

## 7- Atmospheric residue AR: Reduced crude residue RCR

- **RCR** have boiling points above (450°C).
- These cuts cannot be vaporized in the atmospheric distillation tower because they begin to **crack or break down**.
- Atmospheric bottoms is sent to a secondary distillation tower, the vacuum distillation unit.

#### 8- Vacuum residue VR

Vacuum residue from crude oil distillation can be split into: 50-60 wt% saturates and aromatic, 25 wt% resins, and 20 wt% asphaltenes. Asphaltenes are high-molecular compounds insoluble in n-hexane and n-pentane

#### Disadvantages of asphaltenes in crude oil

- block the **pores of rock formations**, well heads and surface processing equipment.
- **Transportation problems** because they increase gravity and viscosity of crude oils.
- Coke formation and metal deposition on catalyst surface causing catalyst deactivation.

## Properties of Petroleum & Natural Gas Physical Properties of Petroleum hydrocarbons

Compound	Form	nula	N <sub>C</sub> A	T <sub>M</sub> , ℓ °C	т <sub>ь</sub> , °С	SG, at 60°F	$d_{20}$ , g/cm <sup>3</sup>	n20	7 <sub>€</sub> , °C	P <sub>C</sub> , bar	V <sub>C</sub> , cm <sup>3</sup> /mol	Zc	ω
Paraffins													
Methane Ethane	CH4			5.0 -182.5 0.1 -182.5					-82.59 32.17	45.99 48.72	98.65 145.48	0.2864 0.2792	0.0115 0.0995
Propane	C2H C3H			-182.3 1.1 - 187.3					96.68	48.72	200.14	0.2792	0.0995
n-Butane	C4H	10	4 5	8.1 -138.3	3 -0.5	5 0.5849	0.5791	1.3326	151.97	37.96	255.09	0.2740	0.2002
n-Pentane	C <sub>5</sub> H			2.2 -129.				1.3575	196.55	33.70	313.05	0.2702	0.2515
n-Hexane n-Heptane	C <sub>6</sub> H		6 8 7 10	5.2 –95.3 0.2 –90.0			0.6605	1.3749 1.3876	234.45 267.05	30.25 27.40	371.22 427.88	0.2661 0.2610	0.3013 0.3495
n-Octane	C7H C8H		8 11					1.3974	295.55	24.90	427.88	0.2561	0.3996
n-Nonane	C <sub>9</sub> H	20	9 12	3.3 -53.	5 150.8	8 0.7220	0.7180	1.4054	321.45	22,90	543.67	0.2519	0.4435
n-Decane	C10		10 14					1.4119	344.55	21.10	599.58	0.2463	0.4923
n-Undecane n-Dodecane	C11		11 15 12 17				0.7400	1.4151 1.4195	365.85 384.85	19.50 18.20	658.69 715.67	0.2418 0.2381	0.5303 0.5764
n-Tridecane	C <sub>12</sub> C <sub>13</sub>	H <sub>28</sub>	13 18				0.7485	1.4235	401.85	16.80	774.60	0.2319	0.6174
n-Tetradecane	C14	H <sub>30</sub>	14 19	3.4 5.9	9 253.6	6 0.7665	0.7627	1.4269	419.85	15.70	829.82	0.2261	0.6430
n-Pentadecane	C <sub>15</sub> 1		15 21					1.4298	434.85	14.80	888.49	0.2234	0.6863
n-Hexadecane	C16		16 22 17 24					1.4325 1.4348	449.85 462.85	14.00 13.40	944.33 999.83	0.2199 0.2189	0.7174 0.7697
n-Heptadecane n-Octadecane	C <sub>17</sub> ] C <sub>18</sub> ]		18 25				0.7765	1.4348	402.85	12.70	1059.74	0.2189	0.8114
n-Nonadecane	C19	H40	19 26					1.4388	484.85	12.10	1119.82	0.2150	0.8522
n-Eicosane	C <sub>20</sub>	H42	20 28				0.7871	1.4405	494.85	11.60	1169.50	0.2125	0.9069
n-Heneicosane	C <sub>21</sub> ]		21 29				0.7906	1.4440	504.85	11.10	1229.41	0.2110	0.9420
n-Docosane isobutane (2-Methylpropane)	C <sub>22</sub> ] C <sub>4</sub> H		22 31 4 5	).6 44.0 3.1 –159.0			0.7929	1.4454	513.85 134.99	10.60 36.48	1289.49 262.71	0.2089 0.2824	0.9722 0.1808
isopentane (2-Methylbutane)	C <sub>5</sub> H			2.2 -159.9				1.3537	187.28	33.81	305.84	0.2701	0.2275
2-Methylpentane	C <sub>6</sub> H		6 8	5.2 -95.3				1.3715	224.35	30.05	371.22	0.2661	0.2774
2-Methylhexane	C7H		7 10					1.3849	257.22	27.34	421.00	0.2610	0.3277
2-Methylheptane 2,2,4-Trimethylpentane (isooct	C <sub>8</sub> H		8 11- 8 11-					1.3949 1.3915	286.49 270.81	24.84 25.68	487.78 467.81	0.2604 0.2656	0.3772 0.3022
2-Methyloctane	ane) C <sub>8</sub> H C <sub>9</sub> H		9 12					1.4031	313.60	22.90	541.27	0.2541	0.4212
2-Methylnonane	C10		10 14				0.7266	1.4100	336.85	21.20	582.70	0.2436	0.4723
Ol-fra													
Olefins Ethene (Ethylene)	C <sub>2</sub> H	r.	2 2	8.1 -169,3	2 -103.3	7 0.1388	2		9.19	50.40	131.00	0.2813	0.0865
Propene (Propylene)	C <sub>2</sub> H			2.1 -185.			0.5111		92.42	46.65	188.36	0.2813	0.1398
1-Butene	C <sub>4</sub> H	I8		5.1 -185.4					146.80	40.43	239.24	0.2770	0.1905
1-Pentene	C <sub>5</sub> H			0.1 -165.				1.3715	191.63	35.13	295.10	0.2683	0.2312
1-Hexene	C <sub>6</sub> H			4.2 -139.				1.3879	230.88	31.40	354.13	0.2654	0.2804
1-Heptene 1-Octene	C7H C8H		7 9 8 11	8.2 –118.9 2.2 –101.7				1.3998 1.4087	264.14 293.50	28.30 25.68	413.15 460.26	0.2617 0.2509	0.3310 0.3764
1-Nonene	C <sub>9</sub> H		9 12						320.10	23.30	528.04	0.2494	0.4171
1-Decene	C10	H <sub>20</sub>	10 14	0.3 –66.	3 170.0	6 0.7450	0.7410		343.25	22.18	584.08	0.2528	0.4800
Acetylene 1,3-Butadiene	C <sub>2</sub> H C <sub>4</sub> H			5.0 -80.3 4.1 -108.9			0.4001 0.6219		35.17 152.02	61.39 42.77	112.97 220.49	0.2706 0.2668	0.1873
1,5-Butadiene	041	L0		•.1 =-100.:	-4,-	4	0.0219		152.02	42.77	220.49	0.2008	
Naphthenes													
Cyclopentane	C5H10	5	70.1	-93.8	49.3	0.7502	0.7456	1.4065	238.61	45.02	257.89	0.2729	0.1959
Methylcyclopentane	C6H12	6	84.2	-142.4	71.8	0.7540	0.7491	1.4097	259.64	37.85	318.92	0.2725	0.2302
Ethylcyclopentane Propylcyclopentane	C <sub>7</sub> H <sub>14</sub>	7 8	98.2 112.2	-138.4 -117.3	103.5 131.0	0.7712 0.7811	0.7667 0.7768	1.4198 1.4263	296.37 322.85	33.98 30.20	375.14 428.03	0.2692 0.2609	0.2716 0.3266
n-Butylcyclopentane	C <sub>8</sub> H <sub>16</sub> C <sub>9</sub> H <sub>18</sub>	9	126.2	-108.0	156.6	0.7893	0.7851	1.4205	347.85	27.20	483.11	0.2545	0.3719
n-Pentylcyclopentane	C10H20	10	140.3	-83.0	180.5	0.7954		1.4352	370.65	24.50	536.79	0.2457	0.4184
n-Hexylcyclopentane	$C_{11}H_{22}$	11	154.3	-73.0	202.9	0.8006		1.4386	390.95	22.20	592.40	0.2382	0.4646
n-Heptylcyclopentane	C12H24	12	168.3	-53.0	223.9	0.8051		1.4416	409.45	20.10	647.30	0.2293	0.5100
n-Octylcyclopentane n-Nonylcyclopentane	C <sub>13</sub> H <sub>26</sub> C <sub>14</sub> H <sub>28</sub>	13 14	182.4 196.4	-44.0 -29.0	243.5 262.0	0.8088 0.8121		1.4446 1.4467	426.35 441.75	18.30 16.70	702.38 757.64	0.2210 0.2129	0.5525 0.5956
n-Decylcyclopentane	C15H30	15	210.4	-22.1	279.4	0.8149		1.4486	455.95	15.30	811.76	0.2049	0.6314
n-Undecylcyclopentane	C16H32	16	224.4	-10.0	295.8	0.8175			469.05	14.00	867.27		0.6741
n-Dodecylcyclopentane	C17H34	17	0 7 0 F			0.0175		1.4503				0.1968	
n-Tridecylcyclopentane n-Tetradecylcyclopentane	$C_{18}H_{36}$		238.5	-5.0	311.2	0.8197		1.4518	481.25	12.80	921.48	0.1968 0.1881	0.7163
n-Pentadecylcyclopentane	CtoHas	18	252.5	5.0	311.2 325.9	0.8197 0.8217		1.4518 1.4531	481.25 492.45	11.80	921.48 977.26	0.1968 0.1881 0.1812	0.7163 0.7582
n-r entauce yie yelopentane	C19H38	19	252.5 266.5	5.0 9.0	311.2 325.9 340.0	0.8197 0.8217 0.8235	••••	1.4518 1.4531 1.4543	481.25 492.45 502.85	11.80 10.90	921.48 977.26 1031.55	0.1968 0.1881 0.1812 0.1743	0.7163 0.7582 0.7949
n-Hexadecylcyclopentane	$C_{20}H_{40}$ $C_{21}H_{42}$		252.5	5.0	311.2 325.9	0.8197 0.8217		1.4518 1.4531	481.25 492.45	11.80	921.48 977.26	0.1968 0.1881 0.1812	0.7163 0.7582
n-Hexadecylcyclopentane n-Heptadecylcyclopentane	$C_{20}H_{40}$ $C_{21}H_{42}$ $C_{22}H_{44}$	19 20 21 22	252.5 266.5 280.5 294.6 308.6	5.0 9.0 17.0 21.0 27.0	311.2 325.9 340.0 353.0 366.0 377.0	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280	···· ···· ····	1.4518 1.4531 1.4543 1.4554 1.4564 1.4564 1.4573	481.25 492.45 502.85 512.55 521.55 538.01	11.80 10.90 10.00 9.20 11.91	921.48 977.26 1031.55 1087.59 1141.97 1198.28	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane	$C_{20}H_{40}$ $C_{21}H_{42}$ $C_{22}H_{44}$ $C_6H_{12}$	19 20 21 22 6	252.5 266.5 280.5 294.6 308.6 84.2	5.0 9.0 17.0 21.0 27.0 6.5	311.2 325.9 340.0 353.0 366.0 377.0 80.7	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823	···· ···· 0.8021	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262	481.25 492.45 502.85 512.55 521.55 538.01 280.43	11.80 10.90 10.00 9.20 11.91 40.73	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14} \end{array}$	19 20 21 22 6 7	252.5 266.5 280.5 294.6 308.6 84.2 98.2	5.0 9.0 17.0 21.0 27.0 6.5 -126.6	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748	  0.8021 0.7702	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262 1.4231	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04	11.80 10.90 9.20 11.91 40.73 34.71	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16} \end{array}$	19 20 21 22 6	252.5 266.5 280.5 294.6 308.6 84.2	5.0 9.0 17.0 21.0 27.0 6.5	311.2 325.9 340.0 353.0 366.0 377.0 80.7	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823	···· ···· 0.8021	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262	481.25 492.45 502.85 512.55 521.55 538.01 280.43	11.80 10.90 10.00 9.20 11.91 40.73	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14} \end{array}$	19 20 21 22 6 7 8	252.5 266.5 294.6 308.6 84.2 98.2 112.2	5.0 9.0 17.0 21.0 27.0 6.5 -126.6 -111.3	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926	 0.8021 0.7702 0.7884	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262 1.4231 1.4330	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00	11.80 10.90 9.20 11.91 40.73 34.71 30.40	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_6H_{12}\\ C_7H_{14}\\ C_8H_{16}\\ C_9H_{18} \end{array}$	19 20 21 22 6 7 8 9	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2	5.0 9.0 17.0 21.0 27.0 6.5 -126.6 -111.3 -94.9	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981	  0.8021 0.7702 0.7884 0.7940	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262 1.4231 1.4231 1.4330 1.4371	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00 366.00	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane	C <sub>20</sub> H <sub>40</sub> C <sub>21</sub> H <sub>42</sub> C <sub>22</sub> H <sub>44</sub> C <sub>6</sub> H <sub>12</sub> C <sub>7</sub> H <sub>14</sub> C <sub>8</sub> H <sub>16</sub> C <sub>9</sub> H <sub>18</sub> C <sub>10</sub> H <sub>20</sub>	19 20 21 22 6 7 8 9 10	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3	5.0 9.0 17.0 21.0 27.0 6.5 -126.6 -111.3 -94.9 -74.7	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033	0.8021 0.7702 0.7884 0.7990 0.7993	1.4518 1.4531 1.4543 1.4554 1.4564 1.4573 1.4262 1.4231 1.4330 1.4371 1.4408	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85	11.80 10.90 10.00 9.20 11.91 40.73 34.71 30.40 28.07 25.70	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Aromatics Benzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3	5.0 9.0 17.0 21.0 27.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033	 0.8021 0.7702 0.7884 0.7940 0.7993	1.4518 1.4531 1.4554 1.4554 1.4564 1.4573 1.4262 1.4231 1.4330 1.4371 1.4408	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01	11.80 10.90 10.00 9.20 11.91 40.73 34.71 30.40 28.07 25.70	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Propylcyclohexane n-Butylcyclohexane Aromatics Benzene Methylbenzene (Toluene) Ethylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 8 7 8	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2	5.0 9.0 17.0 21.0 27.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5 -95.0 -95.0	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.8832 0.8741 0.8737	0.8780 0.8625 0.8784	1.4518 1.4531 1.4531 1.4554 1.4554 1.4564 1.4573 1.4262 1.4231 1.4330 1.4371 1.4408 1.5011 1.4969 1.4959	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05	11.80 10.90 10.00 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2714 0.2635 0.2635	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2350 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Propylcyclohexane n-Butylcyclohexane Aromatics Benzene Methylbenzene (Toluene) Ethylbenzene Propylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2	5.0 9.0 17.0 21.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5 -95.0 -95.0 -99.6	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.8832 0.8741 0.8737 0.8683	0.8780 0.8678 0.8678 0.7993	1.4518 1.4531 1.4543 1.4554 1.4554 1.4554 1.4262 1.4231 1.4330 1.4371 1.4408	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 345.23	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2476 0.2714 0.2635 0.2627	0.7163 0.7582 0.7949 0.8395 0.8755 0.2096 0.2350 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbeyclohexane Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Butylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_6H_{12}\\ C_7H_{14}\\ C_8H_{16}\\ C_9H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9 10	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2 120.2 134.2	5.0 9.0 17.0 21.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5 -95.0 -95.0 -95.0 -99.6 -87.9	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.8033 0.8033 0.8741 0.8737 0.8683 0.8660	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8630 0.8610	1.4518 1.4531 1.4543 1.4554 1.4564 1.4262 1.4231 1.4330 1.4331 1.43408 1.5011 1.4969 1.4959 1.4959 1.4988	481.25 492.45 502.85 512.55 538.01 280.43 299.04 3366.00 366.00 393.85 289.01 318.65 344.05 345.23 387.40	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89	0.1968 0.1881 0.1812 0.1743 0.1665 0.2115 0.2115 0.2684 0.2519 0.2684 0.2519 0.2476 0.2714 0.2635 0.2627 0.2651 0.2651	0.7163 0.7582 0.7949 0.8395 0.8755 0.2096 0.2096 0.2096 0.2350 0.2455 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene Propylbenzene Propylbenzene n-Butylbenzene n-Butylbenzene n-Pentylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9 10 11	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2 134.2 124.8	5.0 9.0 17.0 21.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5 -95.0 -95.0 -95.0 -95.0 -87.9 -75.0	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5	0.8197 0.8215 0.8225 0.8252 0.8252 0.8280 0.7823 0.7748 0.7928 0.7928 0.7928 0.7928 0.7981 0.8033 0.8033 0.8633 0.8737 0.8683 0.8683 0.8663 0.8664	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8630 0.8630 0.8630 0.8583	1.4518 1.4533 1.4543 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4230 1.4371 1.4408 1.5011 1.4969 1.4959 1.4920 1.4898	481.25 492.45 502.85 512.55 531.15 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2476 0.2714 0.2635 0.2627 0.2651 0.2651 0.2632	0.7163 0.7949 0.7949 0.8395 0.8755 0.9060 0.2096 0.2096 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938 0.4378
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbeyclohexane Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Butylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{5}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9 10	252.5 266.5 280.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2 120.2 134.2	5.0 9.0 17.0 21.0 6.5 -126.6 -111.3 -94.9 -74.7 5.5 -95.0 -95.0 -95.0 -99.6 -87.9	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.8033 0.8033 0.8741 0.8737 0.8683 0.8660	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8630 0.8610	1.4518 1.4531 1.4543 1.4554 1.4554 1.4262 1.4262 1.4231 1.4330 1.4331 1.43408 1.5011 1.4969 1.4959 1.4959 1.4988	481.25 492.45 502.85 512.55 538.01 280.43 299.04 3366.00 366.00 393.85 289.01 318.65 344.05 345.23 387.40	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89	0.1968 0.1881 0.1812 0.1743 0.1665 0.2115 0.2115 0.2684 0.2519 0.2476 0.2519 0.2476 0.2714 0.2635 0.2627 0.2651 0.2612	0.7163 0.7582 0.7949 0.8395 0.8755 0.2096 0.2096 0.2096 0.2350 0.2455 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Propylcyclohexane n-Butylcyclohexane n-Butylcyclohexane Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Pentylbenzene n-Hexylbenzene n-Heylbenzene n-Heylbenzene n-Heylbenzene n-Heylbenzene n-Heylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9 10 11 12 13 14	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2 134.2 140.2 120.2 134.2 148.2 162.3 176.3 176.3	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ 5.5\\ -95.0\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1	0.8197 0.8215 0.8225 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.7948 0.7926 0.7981 0.8033 0.8683 0.8683 0.8663 0.8663 0.86624 0.86624 0.86627 0.86617 0.86617	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8678 0.8678 0.8630 0.8613 0.8581 0.8581 0.8552	1.4513 1.4513 1.4513 1.4554 1.4554 1.4554 1.4554 1.4262 1.4231 1.4262 1.4231 1.4371 1.4408 1.5011 1.4969 1.4920 1.4878 1.4878 1.4878 1.4864 1.4845	481.25 492.45 502.85 512.55 531.55 538.01 280.43 299.04 336.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2714 0.2635 0.2627 0.2651 0.2611 0.2612 0.2532 0.2431 0.2384	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2096 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3026 0.3447 0.3378 0.4378 0.4378
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene (Toluene) Ethylbenzene n-Butylbenzene n-Butylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Nonylbenzene n-Nonylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_6H_{12}\\ C_7H_{14}\\ C_8H_{16}\\ C_9H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 6 7 8 9 10 6 7 8 9 10 11 12 13 14 15	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 120.2 12	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ 5.5\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1	0.8197 0.8215 0.8225 0.8252 0.8267 0.8280 0.7823 0.7783 0.7926 0.7981 0.8033 0.8832 0.8741 0.8737 0.8683 0.8683 0.8663 0.86624 0.86624 0.8662 0.8596	 0.8021 0.7902 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8665 0.8663 0.86610 0.8581 0.8576 0.8576	1.4513 1.4533 1.4553 1.4554 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4262 1.4231 1.4371 1.4408 1.5011 1.43969 1.4959 1.4959 1.4920 1.4878 1.4878 1.4878 1.4854 1.4854 1.4854 1.4854	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 336.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 23.80 23.80 21.80 20.20 18.95	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2476 0.2635 0.2627 0.2651 0.2612 0.2532 0.2431 0.2384 0.2315	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2096 0.2096 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938 0.4378 0.4378
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbeyclohexane Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Pentylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Nonylbenzene n-Nonylbenzene n-Nonylbenzene n-Nonylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 8 9 10 6 7 8 9 10 11 12 13 14 15 16	252.5 266.5 280.5 294.6 308.6 84.2 112.2 120.2 140.3 78.1 92.1 106.2 120.2 134.2 148.2 162.3 176.3 190.3 204.4 218.4	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ \\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4 \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 183.3 205.5 226.1 246.1 246.1 246.1 246.4 282.7	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.86832 0.8741 0.8737 0.8683 0.8683 0.8662 0.8624 0.8622 0.8617 0.8602 0.8590	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8685 0.8678 0.8668 0.8668 0.86678 0.86678 0.86678 0.8583 0.8581 0.85562 0.85551	1.4513 1.4513 1.4554 1.4554 1.4554 1.4553 1.4573 1.4262 1.4231 1.4330 1.4371 1.4408 1.5011 1.4969 1.4959 1.4959 1.4959 1.4959 1.4959 1.4878 1.4878 1.4874 1.4854 1.4834 1.4835	481.25 492.45 502.85 512.55 513.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 455.85 467.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 21.80 21.80 21.80 21.80	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55	0.1968 0.1881 0.1812 0.1743 0.1665 0.2715 0.2725 0.2684 0.2519 0.2476 0.2519 0.2476 0.2635 0.2627 0.2651 0.2252 0.2255 0.2651 0.2251 0.2255 0.2651 0.2252 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2255 0.2253 0.2253 0.22531 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2352 0.2351 0.2351 0.2351 0.2351 0.2351 0.2355 0.2251 0.2351 0.2351 0.2351 0.2351 0.2351 0.2351 0.2352 0.2251 0.2352 0.2255 0.2255 0.2555 0.2555 0.25550000000000	0.7163 0.7582 0.7949 0.8395 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3478 0.4378 0.4378 0.4378 0.4378 0.5272 0.5670 0.6331 0.6797
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene Propylbenzene n-Butylbenzene n-Heylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Decylbenzene n-Decylbenzene n-Decylbenzene n-Decylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 6 7 8 9 10 6 7 8 9 10 11 12 13 14 15 16 17	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 140.3 78.1 92.1 106.2 120.2 134.2 140.3 126.2 124.2 124.2 148.4 204.4 218.4 232.4	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ 5.5\\ -95.0\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4\\ -5.2\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 264.4 282.1 264.4 282.1 297.9 313.3	0.8197 0.8215 0.8225 0.8252 0.8267 0.8280 0.7823 0.7782 0.7926 0.7981 0.8033 0.8633 0.8643 0.8643 0.8662 0.8624 0.8624 0.8622 0.8596 0.8590 0.8590	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8685 0.8668 0.8663 0.8583 0.8583 0.8581 0.8552 0.85551 0.8551	1.4513 1.4513 1.4554 1.4554 1.4554 1.4554 1.4564 1.4262 1.4231 1.4371 1.4371 1.4371 1.4408 1.5011 1.4969 1.4920 1.4920 1.4989 1.4920 1.4878 1.4878 1.4878 1.4845 1.4838 1.4838 1.4838 1.4838	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85 467.85 479.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2632 0.2651 0.2612 0.2651 0.2612 0.2631 0.2641 0.2635 0.2627 0.2651 0.2631 0.2631 0.2384 0.2384 0.2315 0.2297	0.7163 0.7949 0.8395 0.8755 0.9060 0.2096 0.2096 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3026 0.3447 0.331 0.4790 0.5670 0.6331 0.6797 0.7333
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Nonylbenzene n-Doctylbenzene n-Dodcylbenzene n-Dodcylbenzene n-Dodcylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 7 8 9 9 10 6 6 7 7 8 9 9 10 10 11 12 13 14 15 16 17 7 18 8 9 9	252.5 266.5 294.6 308.6 84.2 98.2 1126.2 126.2 126.2 126.2 126.2 126.2 126.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 2 120.2	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ \\ 5.5\\ -95.0\\ -95.0\\ -95.0\\ -95.0\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4\\ -52.\\ 2.8\\ 10.0\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 246.1 246.4 282.1 246.1 246.4 297.9 313.3 327.6 341.3	0.8197 0.8215 0.8235 0.8252 0.8267 0.8280 0.7283 0.7748 0.7928 0.7981 0.8033 0.7981 0.8033 0.8633 0.8643 0.8663 0.86622 0.8647 0.86622 0.8647 0.8662 0.8590 0.8585 0.8595	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8663 0.86630 0.8583 0.8561 0.8551 0.85551 0.85545	1.4513 1.4513 1.4513 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4259 1.4958 1.4858	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85 455.85 467.85 479.85 506.85 506.85	11.80 10.90 10.00 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 21.80 21.80 16.72 15.60	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25	0.1968 0.1881 0.1812 0.1743 0.1665 0.2715 0.2725 0.2684 0.2519 0.2476 0.2476 0.2635 0.2651 0.2651 0.2651 0.2651 0.2651 0.2381 0.2381 0.2381 0.2384 0.2384 0.2384 0.2297 0.2284 0.2297	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2595 0.2743 0.2621 0.3026 0.3026 0.3447 0.3038 0.4378 0.44790 0.5272 0.5670 0.5572 0.5733 0.7733 0.7733 0.7733
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Nethylbenzene Propylbenzene n-Butylbenzene n-Heytylbenzene n-Heytylbenzene n-Heytylbenzene n-Netylbenzene n-Decylbenzene n-Dodecylbenzene n-Dodecylbenzene n-Didecylbenzene n-Tridecylbenzene n-Tridecylbenzene n-Tetradecylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 7 7 8 9 9 10 6 7 7 8 9 9 10 10 11 11 12 20 13 13 14 15 16 16 17 7 8 9 9 10 20 10 21 22 22 26 7 8 9 9 10 21 22 22 22 26 7 8 9 9 10 21 22 22 22 22 22 22 22 22 22 22 22 22	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 126.2 120.2 134.2 120.2 134.2 140.3 78.1 92.1 106.2 120.2 134.2 148.4 2162.3 176.3 190.3 204.4 218.4 232.4 246.4 246.4 267.5 274.5	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ 5.5\\ -95.0\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4\\ -14.4\\ -5.2\\ 2.8\\ 10.0\\ 16.0\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1 264.4 282.1 264.4 282.1 264.4 283.1 264.4 284.4 284.1 264.4 284.1 264.4 284.1 264.4 284.1 264.4 284.1 264.4 284.1 264.4 284.1 284.3 284.1 284.4 284.1 284.4 284.1 284.4 284.1 284.4 284.5 284.4 28	0.8197 0.8215 0.8225 0.8252 0.8252 0.8280 0.7823 0.7748 0.7928 0.7928 0.7981 0.8033 0.7981 0.8033 0.8632 0.8737 0.8683 0.8683 0.8662 0.8624 0.8622 0.8612 0.8625 0.85595 0.85587	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8685 0.8678 0.8685 0.8678 0.8583 0.8581 0.8557 0.8557 0.8554 0.8554 0.8554 0.8554	1.4513 1.4513 1.4513 1.4554 1.4554 1.4554 1.4564 1.4262 1.4230 1.4230 1.4371 1.4408 1.4371 1.4408 1.4969 1.4959 1.4959 1.4920 1.4878 1.4878 1.4878 1.4884 1.4828 1.4828 1.4824 1.4824 1.4824 1.4824 1.4824 1.4818	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 318.65 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85 467.85 455.85 467.85 516.85 516.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70 16.72 15.60 14.80	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2632 0.2651 0.2612 0.2651 0.2611 0.2612 0.2532 0.2431 0.2384 0.2315 0.2297 0.2284 0.2215	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3247 0.3026 0.3447 0.3328 0.4378 0.4378 0.4378 0.4378 0.4378 0.4378
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Butylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Ottylbenzene n-Ottylbenzene n-Docylbenzene n-Docylbenzene n-Dodcylbenzene n-Tridecylbenzene n-Tridecylbenzene n-Tetradecylbenzene n-Tetradecylbenzene n-Pentadecylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_6H_{12}\\ C_7H_{14}\\ C_8H_{16}\\ C_9H_{18}\\ C_{10}H_{20}\\ \end{array}\\\\ \begin{array}{c} C_6H_6\\ C_7H_8\\ C_9H_{12}\\ C_{10}H_{14}\\ C_{11}H_{16}\\ C_{12}H_{18}\\ C_{13}H_{20}\\ C_{15}H_{24}\\ C_{15}H_{24}\\ C_{15}H_{24}\\ C_{16}H_{26}\\ C_{17}H_{28}\\ C_{18}H_{30}\\ C_{19}H_{32}\\ C_{20}H_{34}\\ C_{21}H_{36}\\ \end{array}$	19 20 21 22 6 7 7 8 9 9 10 11 11 22 6 6 7 7 8 8 9 10 11 11 22 11 23 14 15 16 16 7 7 21 24 26 21 22 26 21 22 26 26 7 7 8 9 9 10 21 22 22 26 26 7 7 8 9 9 10 20 20 20 20 20 20 20 20 20 20 20 20 20	252.5 266.5 280.5 294.6 308.6 84.2 112.2 126.2 140.3 78.1 106.2 120.2 100.2 10	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \hline \\ 5.5\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4\\ -5.2\\ 2.8\\ 10.0\\ 16.0\\ 22.0\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.7 101.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1 297.9 313.3 327.6 341.3 354.0	0.8197 0.8217 0.8235 0.8252 0.8260 0.8280 0.7248 0.7926 0.7981 0.8033 0.8832 0.8741 0.8633 0.8660 0.8624 0.8662 0.8664 0.8624 0.86590 0.8559 0.8587 0.8584 0.8584 0.8587	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8685 0.86678 0.8685 0.86678 0.8686 0.86810 0.8583 0.8562 0.85551 0.85548 0.85545 0.85545 0.85540	1.4513 1.4533 1.4554 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4330 1.4371 1.408 1.5011 1.4969 1.4959 1.4959 1.4988 1.4878 1.4854 1.4854 1.4854 1.4828 1.4828 1.4821 1.4815	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 440.85 440.85 440.85 479.85 479.85 479.85 506.85 516.85 516.85 516.85 516.85 516.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 21.80 21.80 21.80 21.80 21.80 21.50 16.72 15.60 14.80 13.30	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 492.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2635 0.2627 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2215 0.2651 0.2215 0.2651 0.2234 0.2234 0.2234 0.2224 0.2224 0.2255	0.7163 0.7582 0.7949 0.8395 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2455 0.2595 0.2743 0.2450 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938 0.4370 0.5272 0.5670 0.6331 0.6797 0.7333 0.7333 0.7799 0.8150 0.8567
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Propylcyclohexane n-Butylcyclohexane n-Butylcyclohexane n-Butylcyclohexane Methylbenzene (Topylbenzene n-Butylbenzene n-Butylbenzene n-Hexylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Decylbenzene n-Dodcylbenzene n-Dodcylbenzene n-Dodcylbenzene n-Tridcylbenzene n-Tridcylbenzene n-Tridcylbenzene n-Tridcylbenzene n-Tridcylbenzene n-Tridcylbenzene n-Tetradcylbenzene n-Tetradcylbenzene n-Hexadecylbenzene n-Hexadecylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{4}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 20 21 22 6 6 7 8 8 9 9 10 10 11 12 13 14 15 16 17 7 18 19 20 21 22 22	252.5 266.5 294.6 308.6 84.2 98.2 1126.2 126.2 126.2 126.2 126.2 126.2 126.2 126.2 126.2 126.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 2 120.2 2 120.2 120	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 246.4 282.1 246.4 297.9 313.3 327.6 341.3 354.0 364.0 378.0	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7283 0.7748 0.7981 0.8033 0.7748 0.8033 0.7748 0.8033 0.7748 0.8033 0.8633 0.8643 0.8663 0.8662 0.8644 0.8662 0.8544 0.85590 0.8584 0.8584 0.8587 0.8584	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.86630 0.86630 0.8581 0.8581 0.8551 0.85551 0.85545 0.85553 0.85545 0.85540	1.4513 1.4533 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4259 1.4259 1.4959 1.4959 1.4959 1.4959 1.4959 1.4959 1.4878 1.4878 1.4832 1.4832 1.4818 1.4813	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85 467.85 490.85 506.85 516.85 516.85 526.85 535.85	11.80 10.90 10.00 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70 16.72 15.60 14.80 14.00 13.30 12.70	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71	0.1968 0.1881 0.1812 0.1743 0.1665 0.2715 0.2725 0.2684 0.2519 0.2476 0.2519 0.2476 0.2635 0.2627 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2381 0.2381 0.2384 0.2384 0.2385 0.2297 0.2284 0.2215 0.2216 0.2215 0.2155 0.2130	0.7163 0.7582 0.7949 0.8395 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2595 0.2743 0.2455 0.2743 0.2455 0.2743 0.2421 0.3026 0.3427 0.3026 0.3447 0.3026 0.3447 0.3026 0.4378 0.4478 0.4378 0.4478 0.4378 0.4478 0.4478 0.4478 0.4479 0.4579 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4478 0.4579 0.4478 0.4478 0.4579 0.4478 0.4478 0.4579 0.4478 0.4478 0.4579 0.4478 0.4478 0.4578 0.4578 0.4478 0.45780 0.4578000000000000000000000000000000000000
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene (Toluene) Ethylbenzene Propylbenzene n-Butylbenzene n-Butylbenzene n-Heptylbenzene n-Heptylbenzene n-Heptylbenzene n-Ottylbenzene n-Ottylbenzene n-Docylbenzene n-Docylbenzene n-Dodcylbenzene n-Tridecylbenzene n-Tridecylbenzene n-Tetradecylbenzene n-Tetradecylbenzene n-Pentadecylbenzene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_6H_{12}\\ C_7H_{14}\\ C_8H_{16}\\ C_9H_{18}\\ C_{10}H_{20}\\ \end{array}\\\\ \begin{array}{c} C_6H_6\\ C_7H_8\\ C_9H_{12}\\ C_{10}H_{14}\\ C_{11}H_{16}\\ C_{12}H_{18}\\ C_{13}H_{20}\\ C_{15}H_{24}\\ C_{15}H_{24}\\ C_{15}H_{24}\\ C_{16}H_{26}\\ C_{17}H_{28}\\ C_{18}H_{30}\\ C_{19}H_{32}\\ C_{20}H_{34}\\ C_{21}H_{36}\\ \end{array}$	19 20 21 22 6 7 7 8 9 9 10 11 11 22 6 6 7 7 8 8 9 10 11 11 22 11 23 14 15 16 16 7 7 21 24 26 21 22 26 21 22 26 26 7 7 8 9 9 10 21 22 22 26 26 7 7 8 9 9 10 20 20 20 20 20 20 20 20 20 20 20 20 20	252.5 266.5 280.5 294.6 308.6 84.2 112.2 126.2 140.3 78.1 106.2 120.2 100.2 10	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \hline \\ 5.5\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ -14.4\\ -5.2\\ 2.8\\ 10.0\\ 16.0\\ 22.0\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.7 101.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1 297.9 313.3 327.6 341.3 354.0	0.8197 0.8217 0.8235 0.8252 0.8260 0.8280 0.7248 0.7926 0.7981 0.8033 0.8832 0.8741 0.8633 0.8660 0.8624 0.8662 0.8664 0.8624 0.86590 0.8559 0.8587 0.8584 0.8584 0.8587	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8685 0.86678 0.8685 0.86678 0.8686 0.86810 0.8583 0.8562 0.85551 0.85548 0.85545 0.85545 0.85540	1.4513 1.4533 1.4554 1.4554 1.4554 1.4554 1.4573 1.4262 1.4231 1.4330 1.4371 1.408 1.5011 1.4969 1.4959 1.4959 1.4988 1.4878 1.4854 1.4854 1.4854 1.4828 1.4828 1.4821 1.4815	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 440.85 440.85 440.85 479.85 479.85 479.85 506.85 516.85 516.85 516.85 516.85 516.85	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 21.80 21.80 21.80 21.80 21.80 21.50 16.72 15.60 14.80 13.30	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 492.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2635 0.2627 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2652 0.2651 0.2652 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2651 0.2215 0.2651 0.2215 0.2651 0.2234 0.2234 0.2234 0.2224 0.2224 0.2255	0.7163 0.7582 0.7949 0.8395 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2455 0.2595 0.2743 0.2450 0.2455 0.2595 0.2743 0.2100 0.2621 0.3026 0.3447 0.3938 0.4370 0.5272 0.5670 0.6331 0.6797 0.7333 0.7333 0.7799 0.8150 0.8567
n-Hexadecylcyclopentane n-Heptadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane Propylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene Propylbenzene n-Butylbenzene n-Hexylbenzene n-Hetylbenzene n-Hetylbenzene n-Hetylbenzene n-Nonylbenzene n-Doctylbenzene n-Doctylbenzene n-Dodcylbenzene n-Dodcylbenzene n-Triadecylbenzene n-Tetradecylbenzene n-Pentadecylbenzene n-Pentadecylbenzene n-Petnadecylbenzene n-Petnadecylbenzene n-Petnadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Kylene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 200 21 22 26 6 7 8 9 9 10 11 11 12 13 14 15 16 6 7 7 8 9 9 10 11 11 12 2 20 21 22 23 8 8 8 8	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 126.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 148.4 2162.3 190.3 204.4 218.4 232.4 246.4 264.5 274.5 288.5 302.5 274.5 288.5 302.6 274.5	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \\ 5.5\\ -95.0\\ -95.0\\ -99.6\\ -87.9\\ -75.0\\ -61.2\\ -48.0\\ -36.0\\ -24.2\\ 2.8\\ 810.0\\ 16.0\\ 22.0\\ 16.0\\ 22.0\\ -25.2\\ -47.9\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1 264.4 282.1 264.4 283.3 327.6 313.3 327.6 341.3 354.0 366.0 378.0 378.0 378.0 378.0 377.0 279.0 27	0.8197 0.8215 0.8225 0.8252 0.8267 0.8280 0.7823 0.7748 0.7926 0.7981 0.8033 0.7981 0.8033 0.8632 0.8741 0.8737 0.8683 0.8642 0.8642 0.8642 0.8642 0.8642 0.8595 0.8587 0.85857 0.85857 0.85857 0.85857	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.86630 0.86630 0.8583 0.8581 0.8576 0.8557 0.8555 0.8556 0.85548 0.85548 0.85540 0.8540 0.8799 0.8643	1.4513 1.4533 1.4554 1.4554 1.4554 1.4554 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4230 1.4371 1.4408 1.4579 1.4959 1.4959 1.4959 1.4959 1.4959 1.4845 1.4845 1.4845 1.4845 1.4824 1.4824 1.4824 1.4815 1.4815 1.4813  1.4972	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.85 455.85 467.85 479.85 506.85 516.85 516.85 526.85 535.85 544.85 544.85	11.80 10.90 10.00 9.20 11.91 28.07 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70 16.72 15.60 14.80 14.00 13.30 12.70 37.34 35.36	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71 1140.80 369.17 375.80	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2519 0.2476 0.2519 0.2476 0.2631 0.2632 0.2651 0.2611 0.2612 0.2532 0.2431 0.2384 0.2315 0.2297 0.2284 0.2215 0.2284 0.2284 0.2285 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2285 0.2295 0.2285 0.2295 0.2295 0.2476	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2595 0.2743 0.2595 0.2743 0.2621 0.3026 0.3262 0.3026 0.3262 0.3310 0.5272 0.5670 0.6331 0.6797 0.7333 0.7334 0.7354 0.7354 0.7354 0.7333 0.7333 0.7333 0.7333 0.7333 0.7334 0.7354 0.7354 0.7354 0.7354 0.7355 0.7457 0.7335 0.7357 0.7557 0.7557 0.7557 0.7557 0.7557 0.7557 0.75570 0.75570 0.75570 0.75570 0.75570 0.755700 0.755700 0.7557000 0.75570000000000
n-Hexadecylcyclopentane n-Hexadecylcyclopentane Cyclohexane Methylcyclohexane Ethylcyclohexane n-Butylcyclohexane n-Butylcyclohexane Methylbenzene Methylbenzene (Toluene) Ethylbenzene n-Pentylbenzene n-Pentylbenzene n-Hexylbenzene n-Hexylbenzene n-Heylbenzene n-Heylbenzene n-Dotylbenzene n-Dotylbenzene n-Dodecylbenzene n-Didecylbenzene n-Tridecylbenzene n-Tetadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-Hexadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-tetadecylbenzene n-xylene	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{22}H_{44}\\ C_{6}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 200 21 22 6 6 7 8 9 10 10 11 12 13 14 15 16 6 17 7 8 8 9 20 0 21 22 8 8 8	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 120.2 100.2 10	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 6.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.7 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 264.4 282.1 297.9 313.3 327.6 341.3 354.0 366.0 378.0 144.4 139.1 138.4	0.8197 0.8217 0.8235 0.8252 0.8260 0.7282 0.7748 0.7926 0.7981 0.8033 0.8737 0.86832 0.8741 0.8737 0.86832 0.8741 0.8632 0.8660 0.8654 0.8590 0.85587 0.8586	 0.8020 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7702 0.7844 0.7940 0.8583 0.86678 0.85678 0.85562 0.85562 0.85551 0.85548 0.85551 0.85548 0.85550 0.85543 0.85543 0.85740 0.8799 0.8643	1.4513 1.4533 1.4554 1.4554 1.4554 1.4554 1.4554 1.4262 1.4230 1.4231 1.4371 1.4408 1.4371 1.4408 1.4371 1.4408 1.4371 1.4408 1.4878 1.4878 1.4878 1.4820 1.4828 1.4824 1.4832 1.4824 1.4821 1.4815 1.4813  1.4972 1.4958	481.25 492.45 502.85 512.55 521.55 538.01 280.43 299.04 336.00 336.00 336.00 336.00 336.00 336.00 338.5 289.01 318.65 336.23 387.40 406.75 424.85 440.85 440.85 440.85 455.85 516	11.80 10.90 9.20 11.91 40.73 34.71 30.40 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70 16.72 15.60 14.80 13.30 12.70 13.30 12.53 45.51	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 4923.08 9549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71 1140.80 369.17 375.80	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2582 0.2519 0.2476 0.2476 0.2632 0.2631 0.2631 0.2631 0.2631 0.2384 0.2315 0.2297 0.2284 0.2211 0.2202 0.2168 0.2155 0.2130 0.2590 0.2598	0.7163 0.7582 0.7949 0.8395 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2455 0.2595 0.2743 0.2455 0.2595 0.2743 0.2455 0.2621 0.3026 0.3447 0.3938 0.4370 0.4570 0.5272 0.5670 0.6331 0.6797 0.7333 0.7799 0.8130 0.8567 0.8377 0.83777 0.83777 0.83777 0.837777 0.83777777777777777777777777777777777777
n-Hexadecylcyclopentane   n-Heytadecylcyclopentane   Cyclohexane   Methylcyclohexane   Propylcyclohexane   Propylcyclohexane   n-Butylcyclohexane   Normatics   Benzene   Methylbenzene (Toluene)   Ethylbenzene (Toluene)   Ethylbenzene   n-Butylbenzene   n-Pentylbenzene   n-Pentylbenzene   n-Hexylbenzene   n-Octylbenzene   n-Octylbenzene   n-Dodcylbenzene   n-Dodcylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Hexylenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Tetradecylbenzene   n-Hexylene   c.   isopropylbenzene C.	$\begin{array}{c} C_{20}H_{40}\\ C_{21}H_{42}\\ C_{21}H_{42}\\ C_{2}H_{44}\\ C_{2}H_{44}\\ C_{3}H_{12}\\ C_{7}H_{14}\\ C_{8}H_{16}\\ C_{9}H_{18}\\ C_{10}H_{20}\\ \end{array}$	19 200 21 22 26 6 7 8 9 9 10 11 11 12 13 14 15 16 6 7 7 8 9 9 10 11 11 12 2 20 21 22 23 8 8 8 8	252.5 266.5 294.6 308.6 84.2 98.2 112.2 126.2 126.2 120.2 134.2 120.2 134.2 120.2 134.2 120.2 134.2 148.4 2162.3 190.3 204.4 218.4 232.4 246.4 264.5 274.5 288.5 302.5 274.5 288.5 302.6 274.5	$\begin{array}{c} 5.0\\ 9.0\\ 17.0\\ 21.0\\ 0.5\\ -126.6\\ -111.3\\ -94.9\\ -74.7\\ \end{array}$	311.2 325.9 340.0 353.0 366.0 377.0 80.7 100.9 131.8 156.8 181.0 80.1 110.6 136.2 159.2 183.3 205.5 226.1 246.1 246.1 246.4 282.5 246.1 246.4 297.9 313.3 327.6 341.3 354.0 364.0 378.0 144.4 139.1 138.4 (0) 138.4 (0) 138.4 139.1 138.4 139.11	0.8197 0.8217 0.8235 0.8252 0.8267 0.8280 0.7283 0.7748 0.7926 0.7981 0.8033 0.7748 0.8033 0.7748 0.8033 0.8683 0.8682 0.8662 0.8590 0.8587 0.8587 0.8584 0.	 0.8021 0.7702 0.7884 0.7940 0.7993 0.8780 0.8685 0.8678 0.8663 0.8630 0.8581 0.8551 0.8555 0.8556 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8566 0.8567 0	1.4513 1.4533 1.4554 1.4554 1.4554 1.4554 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4231 1.4262 1.4230 1.4371 1.4408 1.4579 1.4959 1.4959 1.4959 1.4959 1.4959 1.4845 1.4845 1.4845 1.4845 1.4824 1.4824 1.4824 1.4815 1.4815 1.4813  1.4972	481.25 492.45 502.85 512.55 538.01 280.43 299.04 336.00 366.00 393.85 289.01 318.65 344.05 365.23 387.40 406.75 424.85 440.55 85.485 467.85 479.85 506.85 516.85 516.85 526.85 535.85 544.85 544.85	11.80 10.90 10.00 9.20 11.91 28.07 28.07 25.70 48.98 41.06 36.06 32.00 28.87 26.04 23.80 21.80 20.20 18.95 17.70 16.72 15.60 14.80 14.00 13.30 12.70 37.34 35.36	921.48 977.26 1031.55 1087.59 1141.97 1198.28 307.89 367.79 430.13 476.81 534.16 258.94 315.80 373.81 439.71 496.89 549.74 592.64 648.27 703.41 752.70 812.55 867.64 923.08 977.25 1029.88 1089.71 1140.80 369.17 375.80	0.1968 0.1881 0.1812 0.1743 0.1665 0.1590 0.2115 0.2725 0.2684 0.2519 0.2476 0.2519 0.2476 0.2631 0.2632 0.2651 0.2611 0.2632 0.2532 0.2431 0.2384 0.2315 0.2297 0.2284 0.2215 0.2284 0.2284 0.2285 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2284 0.2285 0.2295 0.2285 0.2295 0.2295 0.2476	0.7163 0.7582 0.7949 0.8395 0.8755 0.9060 0.2096 0.2350 0.2455 0.2595 0.2743 0.2595 0.2743 0.2595 0.2743 0.2621 0.3026 0.3262 0.3026 0.3262 0.3310 0.5272 0.5670 0.6331 0.6797 0.7333 0.7334 0.7354 0.7354 0.7354 0.7355 0.7455 0.7455 0.7557 0.75570 0.7333 0.7333 0.7333 0.7333 0.7333 0.7332 0.73570 0.73570 0.7333 0.7333 0.7333 0.7333 0.7330 0.735700 0.735700 0.735700 0.7357000 0.73570000000000000000000000000000000000

Petroleum & Gas Refining Engineering

					P, sat							Flamn	nability	
			API		at 100°F	Viscos	ity, cSt		$T_{\mathbf{F}}$	AI,	AP,	range	, vol.%	RON
Compound	Formula	Nc	gravity	Kw	bar	V38(100)	V99(210)	CH	°C	°C	°C _	Min	Max	clear
Paraffins														
Methane	CH <sub>4</sub>	1	340.3	19.53	344.737			2.98			536.9	5.00	1.00	
Ethane	C <sub>2</sub> H <sub>6</sub>	2	266.6	19.49	55.1579			3.97			471.9	2.90	13.00	1.6
Propane	$C_3H_8$	3	148.0	14.74	12.9621	0.1775		4.47			449.9	2.10	9.50	1.8
n-Butane	C <sub>4</sub> H <sub>10</sub>	4	110.4	13.49	3.5608	0.2533	0.1686	4.77		83.2	287.9	1.80	8.40	93.8
n-Pentane	C5H12	5	92.5	13.02	1.0745	0.3394	0.2643	4.96	-40.0	70.8	242.9	1.40	8.30	61.7
n-Hexane	C6H14	6	81.2	12.79	0.3435	0.4152		5.11	-21.7	68.7	224.9	1.20	7.70	24.8
n-Heptane	C7H16	7	73.5	12.67	0.1112	0.5046	0.3515	5.21	-4.1		203.9	1.00	7.00	0.0
n-Octane	C8H18	8	68.6	12.66	0.0370	0.6364	0.3997	5.30	12.9		205.9	0.96		
n-Nonane	C <sub>9</sub> H <sub>20</sub>	9	64.5	12.66	0.0125	0.8078	0.4694	5.36	30.9		204.9	0.87	2.90	
n-Decane	C10H22	10	61.2	12.67	0.0042	1.0154	0.5537	5.42	45.9		200.9	0.78	2.60	
n-Undecane	C11H24	11	58.7	12.71	0.0014	1.2588	0.6397	5.46	65.0		201.9			
n-Dodecane	C12H26	12	56.6	12.74	0.0005	1.5452	0.7469	5.50	73.9		202.9			
n-Tridecane	C13H28	13	54.4	12.76	0.0002	1.8634	0.8624	5.53	78.9		201.9			
n-Tetradecane	C14H30	14	53.1	12.82	0.0001	2,2294	0.9885	5.56	100.0		199.9			
n-Pentadecane	C15H32	15	51.9	12.87	0.0000	2.6415	1.1328	5.59	113.9		201.9			
n-Hexadecane	C16H34	16	51.6	12.97	0.0000	3.1229	1.2859	5.61	135.1		201.9			
n-Heptadecane	C <sub>17</sub> H <sub>36</sub>	17	51.0	13.05	0.0000	3.6045	1.4413	5.63	147.8		201.9			
n-Octadecane	C18H38	18	49.0	13.01	0.0000	4,1620	1.5815	5.64	165.1		201.9			
n-Nonadecane	C19H40	19	48.1	13.04	0.0000	4.6090	1.7940	5.66	167.9		201.9			
n-Eicosane	C <sub>20</sub> H <sub>42</sub>	20	47.8	13.12	0.0000	5.3165	1.9889	5.67	166.9		201.9	•••		
n-Heneicosane	C21H44	21	46.4	13.11			2.1703	5.69	176.9		201.9			
n-Docosane	C22H46	22	45.8	13.15			2.4099	5.70	184.9		201.9			
isobutane (2-Methylpropane)	C <sub>4</sub> H <sub>10</sub>	4	119.2	13.78	5.0199	0.2773	0.1873	4.77		107.7	460.1	1.80	8.40	0.1
isopentane (2-Methylbutane)	C5H12	5	94.4	13.01	1.4110	0.3066		4.96	-57.2	70.8	420.1	1.40	8.30	92.3
2-Methylpentane	C <sub>6</sub> H <sub>14</sub>	6	83.6	12.82	0.4666	0.3862		5.11	-35.2	73.8		1.20	7.70	73.4
2-Methylhexane	C7H16	7	75.9	12.72	0.1562	0.4730		5.21	-23.2	74.1		1.00	7.00	42.4
2-Methylheptane	C <sub>8</sub> H <sub>18</sub>	8	69.8	12.65	0.0528	0.5908	0.3635	5.30	4.1	73.9		0.98		20.6
2,2,4-Trimethylpentane (isooctane)	C8H18	8	71.0	12.52	0.1181	0.6077	0.3738	5.30	-12.2	79.5		1.00		100.0
2-Methyloctane	C9H20	9	65.7	12.66	0.0177	0.7382	0.4329	5.36	22.9					
2-Methylnonane	C10H22	10	62.1	12.66	0.0058	0.9636	0.5401	5.42	40.9					

			API		P, <sup>sat</sup> at 100°F	Viscosi				AI,	AP.	Flamma range,		RON
Compound	Formula	Nc	gravity	Kw	at 100-r bar	VISCOSI V38(100)	V99(210)	CH	°C	°C	°C	Min	Max	clear
Olefins	Formula	INC -	gravity	<u> </u>	Udi	V38(100)	V99(210)	CH				MIII	Max	cical
Ethene (Ethylene)	$C_2H_4$	2	888.0	48.49				5.96				2.30	32.30	
Propene (Propylene)		3	141.0	14.26	15.7812	0.1801		5.96	-108.2	•••	455.1	2.00	11.00	100.2
1-Butene	C <sub>3</sub> H <sub>6</sub>	4	104.3	14.20	4.2953			5.96			383.9	1.60	9.30	97.4
1-Butene	C <sub>4</sub> H <sub>8</sub>	5	87.7		1.3203				-18.2	19.1	272.9	1.50	8.70	90.9
	C5H10			12.66		0 2415		5.96	-31.2	22.8	253.1	1.00	7.50	76.4
1-Hexene	C <sub>6</sub> H <sub>12</sub>	6	76.9	12.46	0.4143	0.3415	•••	5.96						
1-Heptene	C7H14	7	70.2	12.41	0.1353	0.4317	0.3043	5.96	0.1	27.3	263.1	0.80	6.90	54.5
1-Octene	C8H16	8	65.5	12.42	0.0453	0.5657	0.3590	5.96	20.9	32.6	230.1	0.80	6.80	28.7
1-Nonene	C9H18	9	61.5	12.43	0.0152	0.7004	0.4294	5.96	26.9	38.1	236.9	0.60	6.00	
1-Decene	C <sub>10</sub> H <sub>20</sub>	10	58.4	12.45	0.0051	0.8848	0.5027	5.96	47.1	44.2	235.1	0.55	5.70	
Acetylene	$C_2H_2$	2						11.92	-18.2		305.1	2.50	80.00	
1,3 Butadiene	C <sub>4</sub> H <sub>6</sub>	4			4.0906	0.2030	0.2248	7.94			428.9		• • •	
Naphthenes														
	<u>с и</u>	5	57.1	11.12	0.6839	0.4973		5.96	-39.2	16.8	361.1	1.40	9.40	100.1
Cyclopentane	$C_5H_{10}$			11.12									8.35	91.4
Methylcyclopentane	C6H12	6	56.2	11.31	0.3106	0.5646		5.96	-27.2	33.1	328.9	1.20		
Ethylcyclopentane	C7H14	7	52.0	11.39	0.0970	0.6199		5.96	-4.1	36.8	260.1	1.10	6.70	67.2
Propylcyclopentane	C8H16	8	49.7	11.51	0.0325	0.7257	0.4613	5.96	15.9	44.5	269.1	0.95	6.40	31.2
n-Butylcyclopentane	C9H18	9	47.8	11.63	0.0108	0.9118	0.5148	5.96	31.9	48.8	250.1	0.80	5.90	97.0
n-Pentylcyclopentane	C <sub>10</sub> H <sub>20</sub>	10	46.4	11.75		1.1280	0.6200	5.96				0.74	5.47	
n-Hexylcyclopentane	C11H22	11	45.2	11.86		1.4150	0.7300	5.96				0.68	5.20	
n-Heptylcyclopentane	C <sub>12</sub> H <sub>24</sub>	12	44.3	11.97		1.7480	0.8500	5.96				0.62	5.06	
n-Octylcyclopentane	$C_{12}H_{24}$ $C_{13}H_{26}$	13	43.5	12.07		2.1300	0.9800	5.96				0.57	5.01	
n-Nonylcyclopentane		14	43.5	12.07		2.1300	1.1200	5.96	•••			0.53	5.07	
	C14H28				•••					•••	•••			
n-Decylcyclopentane	C <sub>15</sub> H <sub>30</sub>	15	42.1	12.25		3.0500	1.2700	5.96				0.50	5.24	
n-Undecylcyclopentane	C <sub>16</sub> H <sub>32</sub>	16	41.6	12.33		3.6300	1.4400	5.96				0.47	5.53	
n-Dodecylcyclopentane	C17H34	17	41.1	12.41		4.2500	1.6100	5.96				0.44	5.95	
n-Tridecylcyclopentane	C18H36	18	40.7	12.48		4.9500	1.7800	5.96				0.41	6.53	
n-Tetradecylcyclopentane	C19H38	19	40.3	12.55		5.7100	1.9800	5.96				0.39	7.33	
n-Pentadecylcyclopentane	C <sub>20</sub> H <sub>40</sub>	20	40.0	12.61		6.5600	2.1900	5.96				0.37	8.38	
n-Hexadecylcyclopentane		20	39.7	12.67		7.4900	2.4000	5.96				0.35	9.79	
	C21H42	22								•••	•••		11.67	
n-Heptadecylcyclopentane	C22H44		39.4	12.73	0 2274			5.96			2001	0.34		83.0
Cyclohexane	C6H12	6	49.4	11.00	0.2274	0.9419		5.96	-20.0	31.1	260.1	1.30	8.00	
Methylcyclohexane	C7H14	7	51.1	11.31	0.1106	0.7640	0.4757	5.96	-5.9	41.1	285.1	1.15	7.20	74.8
Ethylcyclohexane	C <sub>8</sub> H <sub>16</sub>	8	47.0	11.35	0.0333	0.8629	0.5122	5.96	22.1	43.8	261.9	0.90	6.60	45.6
Propylcyclohexane	C9H18	9	45.8	11.50	0.0117	1.0010	0.5759	5.96	30.9	49.8	248.1	0.95	5.90	17.8
n-Butylcyclohexane	C10H20	10	44.6	11.64	0.0040	1.2539	0.6100	5.96	47.9	54.4	246.1	0.85	5.50	
	-1020													
Aromatics														
Benzene	C <sub>6</sub> H <sub>6</sub>	6	28.7	9.74	0.2216	0.5927	0.3306	11.92	-11.2	-30.0	560.1	1.40	7.10	
Methylbenzene (Toluene)	C <sub>7</sub> H <sub>8</sub>	7	30.4	10.11	0.0710	0.5604	0.3433	10.43	4.9	-30.0	480.1	1.20	7.10	105.8
Ethylbenzene		8	30.5	10.11	0.0257	0.6540	0.3435	9.53	15.1	-30.0	430.1	1.00	6.70	100.8
	C <sub>8</sub> H <sub>10</sub>	9							30.1	-30.0	456.1	0.88	6.00	100.0
Propylbenzene	C <sub>9</sub> H <sub>12</sub>		31.5	10.59	0.0100	0.7977	0.4534	8.94						
n-Butylbenzene	C <sub>10</sub> H <sub>14</sub>	10	31.9	10.82	0.0033	0.9483	0.5186	8.51	50.1	-30.0	410.1	0.80	5.80	100.4
n-Pentylbenzene	$C_{11}H_{16}$	11	32.6	11.03	0.0011	1.1824	0.6295	8.19	65.1			0.80	5.50	
n-Hexylbenzene	C <sub>12</sub> H <sub>18</sub>	12	32.6	11.19	0.0004	1.4419	0.7334	7.94	80.1			0.70	5.30	
n-Heptylbenzene	C13H20	13	32.7	11.35	0.0001	1.7546	0.8546	7.75	95.1			0.70	5.10	
n-Octvlbenzene	C14H22	14	33.0	11.50	0.0000	2.0974	0.9763	7.58	107.1			0.70	4.90	
n-Nonylbenzene	C15H24	15	33.1	11.63	0.0000	2.5329	1.1089	7.45	98.9			0.60	4.70	
-														
n-Decylbenzene	C16H26	16	33.2	11.75	0.0000	3.0119	1.2490	7.33	106.9	•••		0.60	4.60	••••
n-Undecylbenzene	C <sub>17</sub> H <sub>28</sub>	17	33.3	11.86	0.0000	3.5672	1.3983	7.23	143.9	•••		0.60	4.40	
n-Dodecylbenzene	C <sub>18</sub> H <sub>30</sub>	18	33.1	11.94	0.0000	4.1857	1.5509	7.15	140.9			0.60	4.30	
n-Tridecylbenzene	C19H32	19	33.3	12.05	0.0000	4.9566	1.7258	7.07	164.9			0.50	4.20	
n-Tetradecylbenzene	C <sub>20</sub> H <sub>34</sub>	20	33.3	12.13	0.0000	5.7107	1.8853	7.01	173.9			0.50	4.10	
n-Pentadecylbenzene		21	33.3	12.20	0.0000	6.5716	2.0862	6.95	182.9			0.50	4.00	
	C <sub>21</sub> H <sub>36</sub>													•••
n-Hexadecylbenzene	C22H38	22	33.3	12.28	0.0000	7.4138	2.2939	6.90	192.9	•••		0.50	3.90	• • •
o-xylene (o-dimethylbenzene)	C8H10	8	28.4	10.27	0.0182		0.4238	9.53	16.9		463.1	1.00	6.00	
<i>m</i> -xylene	C <sub>8</sub> H <sub>10</sub>	8	31.3	10.42	0.0226	0.5936	0.3644	9.53	25.1	- 30.0	465.1	1.10	7.00	104.0
p-xylene	$C_{8}H_{10}$	8	32.0	10.46	0.0237	0.6167	0.3704	9.53	25.1	- 30.0	528.1	1.10	7.00	103.4

	Light	Medium	Heavy	
Crude, °API	38.8	30.7	28.2	
Sulfur, % wt	1.1	2.51	2.84	
Light naphtha				
Cut range, °F	68–212	68–212	68–212	
Yield, % vol	10.5	9.4	7.9	
Gravity, °API	77.4	78.4	80.1	
Sulfur, % wt	0.056	0.007	0.0028	
RVP, Psi	6.9	7.9	10.2	
Paraffins, % vol	87.4	89.7	89.6	
Naphthenes, % vol	10.7	8.8	9.5	
Aromatics, % vol	1.9	1.5	0.9	
RON clear	54.7	48.2	58.7	
Heavy naphtha				
Cut range, °F	212-302	212-302	212-302	
Yield, % vol	9.4	7.4	6.8	
Gravity, °API	58.8	59.6	60.6	
Sulfur, % wt	0.057	0.019	0.018	
Paraffins, % vol	66.3	67.8	70.3	
Naphthenes, % vol	20.0	20.8	21.4	
Aromatics, % vol	13.7	11.4	8.3	
Kerosene				
Cut range, °F	302-455	302-455	302-455	
Yield, % vol	18.4	13.5	12.5	
Gravity, °API	48.0	48.9	48.3	
Sulfur, % wt	0.092	0.12	0.19	
Paraffins, % vol	58.9	59.9	58.0	
Naphthenes, % vol	20.5	21.9	23.7	
Aromatics, % vol	20.6	18.2	18.3	
Freeze point, °F	-67	-72	-84	
Smoke point, mm	26	23	26	
Luminometer no.	57	55	60	
Aniline point, °F	133	139	138	
Kin cSt at –30 °F	5.09	4.63	4.74	
Kin cSt at 100 °F	1.13	1.09	1.12	

# Arabian crude and straight run products specifications

# All °F readings must be converted to °C

$$^{\circ}C = \frac{^{\circ}F - 32}{1.8}$$

Light gas oil			
Cut range, °F	455-650	455-650	455-650
Yield, % vol	21.1	17.4	16.4
Gravity, °API	37.3	37.2	35.8
Sulfur, % wt	0.81	1.09	1.38
Pour point, °F	10	0	5
Aniline point, °F	166	156	156
Kin cSt at 100 °F	3.34	3.15	3.65
Kin cSt at 210 °F	1.32	1.22	1.4
	Light	Medium	Heavy
Heavy gas oil			
Cut range, °F	650–1,049	650–1,049	650–1,049
Yield, % vol	30.6	30.5	26.3
Gravity, °API	24.8	22	21.8
Sulfur, % wt	1.79	2.87	2.88
Pour point, °F	100	75	90
Aniline point, °F	195	172	172
Kin cSt at 100 °F	49.0	62.2	62.5
Kin cSt at 210 °F	6.65	7.25	7.05
Atmos. residue			
Cut range, °F	+650	+650	+650
Yield, % vol	38.0	50.0	53.1
Gravity, °API	21.7	14.4	12.3
Sulfur, % wt	2.04	4.12	4.35
Pour point, °F	75	55	55
Con carb, % wt	4.5	10.0	13.2
Kin cSt at 100 °F	146	1,570	5,400
Kin cSt at 210 °F	12.4	54.0	106
Vacuum residue			
Cut range, °F	+1,049	+1,049	+1,049
Yield, % vol	7.4	19.5	26.8
Gravity, °API	11.5	3.8	4.0
Sulfur, % wt	3.0	5.85	5.6
Pour point, °F	80	120	120
Con carb, % wt	19	22.8	24.4
Kin cSt at 210 °F	392	19,335	13,400
Kin cSt at 275 °F	40.1	743	490
Vanadium, ppm	12	249	171
Nickel, ppm	7	55	53
Iron, ppm	36	79	28

All °F readings must be converted to °C